THE No.1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

EVERYDAY PRACTICAL ELECTRONICS

JULY 2003

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EPE MINI METAL DETECTOR
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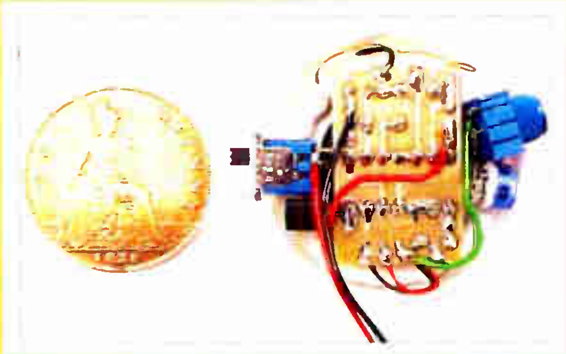

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Measures down to 0.01Ω

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Three more simple projects

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Colour CCTV camera, 8mm lens. 12V d.c. 200mA 582x628 Resolution 380 lines Automatic aperture lens Mirror function PAL Back Light Compensation MLR, 100x40x40mm. Ref EE2 £69

Built-in Audio .15lux CCD camera 12V d.c. 200mA 480 lines s/n ratio >48db 1v P-P output 110x60x50mm. Ref EE1 £99

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 – 100x10x170mm and 2 – 100x70x280mm. Ref EE6 £22 EE7 £26 multi-position brackets. Ref EE8 £8

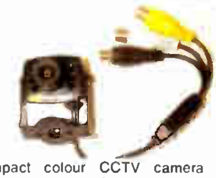
Excellent quality multi-purposeTV/TFT screen, works as just a LCD colour monitor with any of cur CCTV cameras or as a conventional TV. Ideal for use in boats and caravans 49.7MHz-91.75MHz VHF channels 1-5,168.25MHz-222.75MHz VHF channels 6-12, 471.25MHz-869.75MHz, Cable channels 112.325MHz-166.75MHz Z1-Z7, Cable channels 224.25MHz-446.75MHz Z8-Z35 5" colour screen. Audio output 150mW. Connections, external aerial, earphone jack, audio/video input, 12V d.c. or mains. Accessories supplied Power supply, Remote control, Cigar lead power supply, Headphone Stand/bracket. 5" model £139 Ref EE9, 6" model £149. Ref EE10

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. £49. Ref EE11

This device is mains operated and designed to be used with a standard CCTV camera causing it to scan. The black clips can be moved to adjust the span angle, the motor reversing when it detects a clip. With the clips removed the scanner will rotate constantly at approx 2.3rpm. 75x75x80mm £23. Ref EE12

Colour CCTV Camera measures 60x45mm and has a built in light level detector and 12 IR LEDs .2 lux 12 IR LEDs 12V d.c. Bracket Easy connect leads £69. 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" CCD 542x588 pixels 420 lines .05 lux 3.6mm F2 78 deg lens 12V d.c. 400mA Built in light level sensor. £99. Ref EE13



A small compact colour CCTV camera measuring just 35x28x30mm (camera body) Camera is supplied complete with mounting bracket, microphone and easy connect leads. Built in audio. Colour 380 line resolution PAL 0.2 us +18db sensitivity. Effective pixels 628x582 Power source 6-12V d.c. Power consumption 200mW £36. 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 6-12V d.c. manual tuning Available in two versions, pinhole and standard. £79 (pinhole) Ref EE17, £79 (standard). Ref EE18

Small transmitter designed to transmit audio and video signals on 2.4GHz. Unit measures 45x35x10mm.Ideal for assembly into covert CCTV systems Easy connect leads Audio and video input 12V d.c. Complete with aerial Selectable channel switch £30. Ref EE19

2.4GHz wireless receiver Fully cased audio and video 2.4GHz wireless receiver 190x140x30mm, metal case, 4 channel, 12V d.c. Adjustable time delay, 4s, 8s, 12s, 16s. £45. Ref EE20

Colour pinhole cctv camera module with audio Compact colour pinhole camera measuring just 20x20x20mm, built-in audio and easy connect leads PAL CMOS sensor 6-9V d.c. Effective Pixels 628x582 Illumination 2 lux Definition >240 Signal/noise ratio >40db Power consumption 200mW £35. Ref £35

Self-cocking pistol plcr002 crossbow with metal body. Self-cocking 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 rearsight 50lb drawweight 150ft sec velocity Break action 17" string 30m range £21.65 Ref PLCR002 **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 infra-red output only using standard light bulbs Easily cut to shape. 6" square £15. Ref IRF2 or a 12" sq for £29 IRF2A **NEW 12V 12" SQUARE SOLAR PANEL** Kevlar backed, 3watt output. Copper strips for easy solder connections £14.99. Ref 15P42 **PACK OF 4 JUST £39.95. REF 15P42SP**

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 rawl plugs and fixing screws. Camera also has a flashing red LED built in. £9.95. Ref CAMERAB

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Aiptek Pocket DV Up to 2000 still pics before requiring download!! The all new Pocket DV, it's amazing . . . such advanced technology, such a tiny size – you will be the envy of your friends!! This camera will take up to 3.5 minutes of Video and Audio, up to 2000 digital still pictures or 30 minutes of voice recording! Then just connect it to your PC via the USB cable (Supplied) and after transferring the data you can start all over again!! £69. Ref POCKETDV

The smallest PMR446 radios currently available (54x87x37mm).These tiny handheld PMR radios not only look great, but they are 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, 2 x Belt Clips & 2 x Carry Strap £59.95 Ref ALAN1 Or supplied with 2 sets of rechargeable batteries and two mains chargers £84.99. Ref Alan2

Beltronics BEL550 Euroradarand GATSO detector Claimed Detection Range: GATSO up 400m. Radar & Laser guns up to 3 miles. Detects GATSO speed cameras at least 200 metres away, plenty of time to adjust your speed £319. Ref BEL550

Fully Portable – Use anywhere Six automatic programmer for full body pain relief, shoulder pain, back/neck pain, aching joints, rheumatic pain, sports injuries EFFECTIVE DRUG FREE PAIN RELIEF TENS (Transcutaneous Electrical Nerve Stimulation) units are widely used in hospitals, clinics throughout the United Kingdom for effective drug free pain relief. This compact unit is now approved for home use. TENS works by stimulating nerves close to the skin releasing endorphins (natures anesthetics) and helping to block the pain signals sent to the brain. Relief can begin within minutes, and a 30 minute treatment can give up 12 hours relief or more. TheTENS 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. £19.95 Ref TEN327 Spare pack of electrodes £5.99. Ref TEN327X

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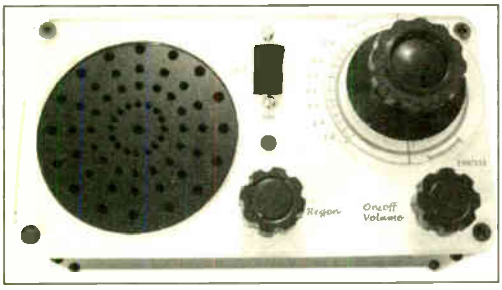

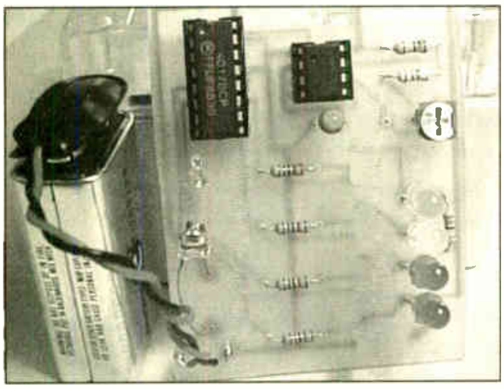

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Our August 2003 issue will be published on Thursday, 10 July 2003. See page 443 for details

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THIS MONTH'S SELECTION FROM OUR VAST EVER CHANGING STOCKS

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A bulk purchase enables us to bring to you these GIANT 7-segment digital displays at a **now affordable** price!! The **10" character size** gives exceptional readability at long distances and enables a host of applications including, score boards, **digital clocks, counters, event timers** etc. As the units are a simple electro-mechanical device and operate from 12V DC, simple switching via switches, relays, PIC or PC may be used to control single or multiple digits. Units feature integral 'Zero Power' memory which greatly simplifies design. For an **excellent DIY practical article**, see the May issue of **'Everyday Practical Electronics' magazine. Ideal School / College construction project**. Supplied in good RFE condition, complete with data sheet.

Less than 30% of makers price **Only £29.95**(B) **or 4 / £99.00**(D)
Order RW44 Order PH26

THE AMAZING TELEBOX

TV SOUND & VIDEO TUNER
CABLE COMPATIBLE

Converts your colour monitor into a QUALITY COLOUR TV!!

The **TELEBOX** is an attractive fully cased mains powered unit, containing all electronics ready to plug into a host of video monitors or AV equipment which are fitted with a composite video or SCART input. The composite video output will also plug directly into most video recorders, allowing reception of **TV channels not normally receivable on most television receivers*** (TELEBOX MB). Push button controls on the front panel allow reception of 8 fully tuneable 'off air' UHF colour television channels. **TELEBOX MB** covers virtually all television frequencies VHF and UHF **including the HYPERBAND as used by most cable TV operators. Ideal for desktop computer video systems** & PIP (picture in picture) setups. For complete compatibility – even for monitors without sound – an integral 4 watt audio amplifier and low level Hi Fi audio output are provided as standard. Brand new – fully guaranteed.

TELEBOX ST for composite video input type monitors	£36.95
TELEBOX STL as ST but fitted with integral speaker	£39.50
TELEBOX MB Multiband VHF/UHF/Cable/Hyperband tuner	£69.95

For overseas PAL versions state 5.5 or 6 mHz sound specification. *For cable / hyperband signal reception Telebox MB should be connected to a cable type service. Shipping on all Telebox's, code (B)

NEW **State of the art PAL (UK spec) UHF TV tuner module** with **composite** 1V pp video & **NICAM** hi fi stereo sound outputs. **Micro electronics** all on one small PCB only 73 x 160 x 52 mm enable full tuning control via a **simple 3 wire link** to an IBM pc type computer. Supplied complete with **simple working program** and documentation. Requires +12V & + 5V DC to operate.
BRAND NEW - Order as MY00. Only £39.95 code (B)
See www.distel.co.uk/data_my00.htm for picture + full details

HARD DISK DRIVES 2½" - 14"

2½"	**TOSHIBA** MK1002MAV 1.1Gb laptop(12.5 mm H) ***New***	£59.95
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2½"	**TOSHIBA**MK6409MAV 6.1Gb laptop (12.7 mm H) ***New***	£98.00
2½"	**TOSHIBA** MK1614GAV 18 Gb laptop (12 mm H) ***New***	£149.95
2½"	to 3½" conversion kit for Pc's, complete with connectors	£15.95
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3½"	**FUJI** FK-309-26 20mb MFM I/F RFE	£59.95
3½"	**CONNER** CP3024 20 mb IDE I/F (or equiv.) RFE	£59.95
3½"	**CONNER** CP3044 40 mb IDE I/F (or equiv.) RFE	£69.00
3½"	**QUANTUM 40S** Prodri ve 42mb SCSI I/F, New RFE	£49.00
5¼"	**MINISCRIBE** 3425 20mb MFM I/F (or equiv.) RFE	£49.95
5¼"	**SEAGATE** ST-238R 30 mb RLL I/F Refurb	£69.95
5¼"	**CDC** 94205-51 40mb HH MFM I/F RFE tested	£69.95
5¼"	**HP** 97548 850 Mb SCSI RFE tested	£99.00
5¼"	**HP** C3010 2 Gbyte SCSI ***differential*** RFE tested	£195.00
8"	**NEC D2246** 85 Mb SMD interface. ***New***	£99.00
8"	**FUJITSU** M2322K 160Mb SMD I/F RFE tested	£195.00
8"	**FUJITSU** M2392K 2 Gb SMD I/F RFE tested	£345.00

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COMPUTER MONITOR SPECIALS

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High spec genuine multysync.
CGA, EGA, VGA, SVGA

Mitsubishi FA3415ETKL 14" SVGA **Multisync** colour monitor with fine 0.28 dot pitch tube and resolution of 1024 x 768. A variety of inputs allows connection to a host of computers including **IBM PC's in CGA, EGA, VGA & SVGA** modes, **BBC, COMMODORE** (including Amiga 1200), **ARCHIMEDES** and **APPLE**. Many features: Etched faceplate, text switching and **LOW RADIATION MPR** specification. Fully guaranteed, in EXCELLENT little used condition. **Tilt & Swivel Base £4.75**

VGA cable for IBM PC included. **Only £129** (E) Order as CG73

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14"	15"	17"
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Supplied in good used condition. Shipping code (D)

VIDEO MONITORS

PHILIPS HCS35 (same style as CM8833) attractively styled 14" colour monitor with **both RGB and standard composite 15.625 Khz video inputs** via **SCART socket** and separate phono jacks. Integral audio **power amp and speaker for all audio visual uses**. Will connect direct to **Amiga and Atari** BBC computers. Ideal for all **video monitoring / security** applications with **direct connection to most colour cameras**. High quality with many features such as front concealed flap controls, VCR correction button etc. Good used condition - fully tested - guaranteed
Dimensions: W14" x H12¾" x 15½" D. **Only £99.00** (E)

PHILIPS HCS31 Ultra compact 9" colour video monitor with **standard composite 15.625 Khz video** input via SCART socket. Ideal for all monitoring / security applications. High quality, ex-equipment fully tested & guaranteed (possible minor screen burns). In attractive square black plastic case measuring W10" x H10" x 13½" D. 240 V AC mains powered. **Only £79.00** (D)

INDUSTRIAL COMPUTERS

Tiny shoebox sized industrial 40 Mhz 386 PC system measuring only (mm) 266 w X 88 h X 272 d. Ideal for dedicated control applications running DOS, Linux or even Windows ! Steel case contains 85 to 265 V AC 50 / 60 hz 70 Watt PSU, a 3 slot ISA passive backplane and a Rocky 318 (PC104) standard, single board computer with 8 MByte NON VOLATILE solid state 'Disk On Chip' RAMDISK. System comprises: Rocky 318 (PC104) SBC ISA card with 40MHz ALi 386SX CPU, 72 pin SIMM slot with 16 Mbyte SIMM, AMI BIOS, battery backed up real time clock. 2 x 9 pin D 16550 serial ports. EPP/ECP printer port, mini DIN keyboard connector, floppy port, IDE port for hard drives up to 528 MByte capacity, watchdog timer and PC/104 bus socket. The 8 MByte solid state 'disk on a chip' has its own BIOS, and can be fdisked, formatted & booted. Supplied BRAND NEW fully tested and guaranteed. For full data see featured item on website. Order as QG36.

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33U	42U	47U
Order as BC44	Order as DT20	Order as RV36
External dimensions mm=1625H x 635D x 603 W. (64" H x 25" D x 23¾" W)	External dimensions mm=2019H x 635D x 603 W. (79.5" H x 25" D x 23¾" W)	External dimensions mm=2019H x 635D x 603 W. (88" H x 25" D x 23¾" W)
Only **£245**	Only **£345**	Only **£410**

Call for shipping quotation

COLOUR CCD CAMERAS

BIG £ SAVER

Undoubtedly a **miracle of modern technology** & our special buying power ! A **quality product** featuring a fully cased **COLOUR** CCD camera at a give away price ! Unit features full autolight sensing for use in low **light & high light applications.**

A 10 mm fixed focus wide angle lens gives **excellent focus and resolution** from close up to long range. The **composite video** output will connect to any composite monitor or TV (via SCART socket) and most video recorders. Unit **runs from 12V DC** so ideal for security & **portable applications** where mains power not available. Overall dimensions 66 mm wide x 117 deep x 43 high. Supplied BRAND NEW & fully guaranteed with user data, 100's of applications including Security, Home Video, Web TV, Web Cams etc, etc.

Order as LK33 ***ONLY £79.00 or 2 for £149.00*** *(B)*

SOFTWARE SPECIALS

NT4 WorkStation, complete with service pack 3 and licence - OEM packaged. ***ONLY £89.00*** *(B)*

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TEST EQUIPMENT & SPECIAL INTEREST ITEMS

Unless marked NEW, items in this section are pre owned.

MITSUBISHI FA3445ETKL 14" Ind. spec SVGA monitors	£245
FARNELL 0-60V DC @ 50 Amps, bench Power Supplies	£995
FARNELL AP3080 0-30V DC @ 80 Amps, bench Suppy	£1850
KINGSHILL CZ403/1 0-50V @ DC 200 Amps - NEW	£3950
1kW to 400 kW - 400 Hz 3 phase power sources - ex stock	£POA
IBM 8230 Type 1, Token ring base unit driver	£760
Wayne Kerr RA200 Audio frequency response analyser	£2500
INFODEC 1U, 24 port, RJ45 network patchpanels. #TH93	£49
3COM 16670 12 Port Ethernet hub - RJ45 connectors #LD97	£69
3COM 16671 24 Port Ethernet hub - RJ45 connectors	£89
3COM 16700 8 Port Ethernet hub - RJ45 connectors NEW	£39
IBM 53F5501 Token Ring ICS 20 port lobe modules	£POA
IBM MAU Token ring distribution panel 8228-23-5050N	£45
AIM 501 Low distortion Oscillator 9Hz to 330Khz, IEEE I/O	£550
ALLGON 8360.11805-1880 MHz hybrid power combiners	£250
Trend DSA 274 Data Analyser with G703(2M) 64 i/o	£POA
Marconi 6310 Programmable 2 to 22 GHz sweep generator	£4500
Marconi 2022C 10KHz-1GHz RF signal generator	£1550
HP1650B Logic Analyser	£3750
HP3781A Pattern generator & **HP3782A** Error Detector	£POA
HP6621A Dual Programmable GPIB PSU 0-7 V 160 watts	£1800
HP6264 Rack mount variable 0-20V @ 20A metered PSU	£475
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Keithley 590 CV capacitor / voltage analyser	£POA
Racal ICR40 dual 40 channel voice recorder system	£3750
Fiskers 45KVA 3 ph On Line UPS – New batteries	£4500
Emerson AP130 2.5KVA industrial spec.UPS	£1499
Mann Tally MT645 High speed line printer	£2200
Intel SBC 486/133SE Multibus 486 system. 8Mb Ram	£945

HP6030A 0-200V DC @ 17 Amps bench power supply	£1950
Intel SBC 486/125C08 Enhanced Multibus (MSA) **New**	£1150
Nikon HFX-11 (Ephiphot) exposure control unit	£1450
PHILIPS PM5518 pro. TV signal generator	£1250
Motorola VME Bus Boards & Components List. SAE / CALL	£POA
Trio 0-18 vdc linear, metered 30 amp bench PSU. **New**	£550
Fujitsu M3041R 600 LPM high speed band printer	£1950
Fujitsu M3041D 600 LPM printer with network interface	£1250
Siemens K4400 64Kb to 140Mb demux analyser	£2950
Perkin Elmer 299B Infrared spectrophotometer	£500
Perkin Elmer 597 Infrared spectrophotometer	£3500
VG Electronics 1035 TELETEXT Decoding Margin Meter	£3250
LightBand 60 output high spec 2u rack mount Video VDA's	£495
Sekonic SD 150H 18 channel digital Hybrid chart recorder	£1995
B&K 2633 Microphone pre amp	£300
Taylor Hobson Tallysurf amplifier / recorder	£750
ADC SS200 Carbon dioxide gas detector / monitor	£1450
BBC AM20/3 PPM Meter (Ernest Turner) + drive electronics	£75
ANRITSU 9654A Optical DC-2.5G/b waveform monitor	£5650
ANRITSU ML93A optical power meter	£990
ANRITSU Fibre optic characteristic test set	£POA
R&S FTDZ Dual sound unit	£650
R&S SBUF-E1 Vision modulator	£775
WILTRON 6630B 12.4 / 20GHz RF sweep generator	£5750
TEK 2445 150 MHz 4 trace oscilloscope	£1250
TEK 2465 300 Mhz 300 MHz oscilloscope rack mount	£1955
TEK TDS380 400Mhz digital realtime + disk drive, FFT etc	£2900
TEK TDS524A 500Mhz digital realtime + colour display etc	£5100
HP3585A Opt 907 20Hz to 40 Mhz spectrum analyser	£3950
PHILIPS PW1730/10 60KV XRAY generator & accessories	£POA
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CLAUDE LYONS 12A 240V single phase auto. volt. regs	£325

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NEXT MONTH

EPE PIC MET OFFICE

Forget the seaweed and proverbs, let technology cater for your insatiable interest in the weather! Using a PIC16F877, the PIC Met Office is a totally solid-state design (no moving parts). It monitors sensors and processes data for the following conditions:

- *Barometric pressure, in millibars*
- *Temperature, in °C and °F, including sub-zero*
- *Atmospheric relative humidity, as an RH percentage*
- *Soil moisture, bone-dry to saturated, as a percentage*
- *Light intensity, as a relative percentage, full sun to total darkness*
- *Rain fall, immediate (is it raining now?)*
- *Rain fall, cumulative (relative depth of water barrel)*
- *Wind speed, in kph, mph and Beaufort, immediate and averaged*
- *Wind direction, immediate and averaged, 0° to 360°*
- *Wind chill factor*
- *Rainbow alert!*
- *Recording of all data to non-volatile serial memory (up to 256 kilobytes)*
- *Selectable data sampling rates, from 1 second to 1 hour intervals*
- *Serial output of realtime and recorded data to PC-compatible computer, running under Windows 95/98/ME*
- *Data formatted by PC for reading as text file compatible with Excel spreadsheet/graphing software*
- *Immediate display of monitored sensor values via alphanumeric liquid crystal display*

Note that you do not need to use a PC if you are content to just observe the l.c.d. readout and ignore the data logging option.

ALARM SYSTEM FAULT FINDER

When false alarms occur on domestic and on cheaper/older commercial intruder alarm systems, it is often difficult to know which sensor has caused the alarm, and even if this is known, many panels do not have a soak test and log facility to test the would-be faulty sensor.
This simple, easy to build project will enable faults to be found on alarm systems without causing the complete system to keep going off.

DCC FOR MODEL TRAINS

DCC (Digital Command Control) is the latest method of controlling model railway layouts. This introductory article looks briefly at its history and then describes how the system works by using "alternating DC" to send signals down the track. The switching protocol is explained as are the advantages and disadvantages of the system.

PLUS **RADIO CIRCUITS PART 3**
TOP TENNERS

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Demand is bound to be high

AUGUST 2003 ISSUE ON SALE THURSDAY, JULY 10

QUASAR ELECTRONICS

Number 1 For Kits

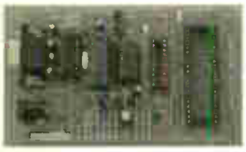
Enhanced 'PICALL' ISP PIC Programmer

Kit will program virtually ALL 8 to 40 pin* serial and parallel programmed PIC micro-controllers. Connects to PC parallel port. Supplied with fully functional pre-registered PICALL DOS and WINDOWS AVR software packages, all components and high quality DSPTH board. Also programs certain ATMEL AVR, SCENIX SX and EEPOM 24C devices. New devices can be added to the software as they are released. Blank chip auto detect feature for super-fast bulk programming. Hardware now supports ISP programming.

*A 40 pin wide ZIF socket is required to program 0·3in. devices (Order Code AZIF40 @ £15.00).

3144KT	Enhanced 'PICALL' ISP PIC Programmer	£59.95
AS3144	Assembled Enhanced 'PICALL' ISP PIC Programmer	£64.95
AS3144ZIF	Assembled Enhanced 'PICALL' ISP PIC Programmer c/w ZIF socket	£79.95

ATMEL AVR Programmer



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

3122KT	ATMEL AVR Programmer	£24.95
AS3122	Assembled 3122	£34.95

Atmel 89Cx051 and 89xxx programmers also available.

PC Data Acquisition & Control Unit

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

FEATURES:

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

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

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

See opposite page for ordering information on these kits

ABC Mini 'Hotchip' Board

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

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

Advanced 32-bit Schematic Capture and Simulation Visual Design Studio

Serial Port Isolated I/O Controller

Kit provides eight relay outputs capable of switching 4 amps at mains voltages and four optically isolated digital inputs. Can be used in a variety of control and sensing applications including load switching, external switch input sensing, contact closure and external voltage sensing. Programmed via a computer serial port, it is compatible with ANY computer & operating system. After programming, PC can be disconnected. Serial cable can be up to 35m long, allowing 'remote' control. User can easily write batch file programs to control the kit using simple text commands. NO special software required – uses any terminal emulator program (built into Windows). All components provided including a plastic case with pre-punched and silk screened front/rear panels to give a professional and attractive finish (see photo).

3108KT	Serial Port Isolated I/O Controller Kit	£54.95
AS3108	Assembled Serial Port Isolated I/O Controller	£64.95

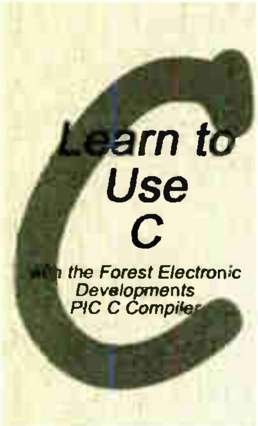
www.QuasarElectronics.com

Credit Card Sales: 0871 717 7168

Full Details on the web – http://www.fored.co.uk

Learn to Program in C with FED !

Free book provides complete introduction to C programming for the PIC



Our free book will take you through the process of learning C from variables through constants to pointers and then structures and unions. Most of the examples are standalone and are as small as possible to enable the purpose and effect to be easily understood. Nearly all can be run on our PIC C Compiler simulator so you can experiment quickly - but code can also be run on practically any C Compiler.

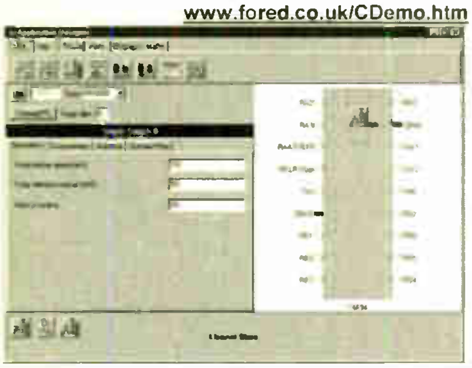
- Start to use C for the PIC – standard portable code with a standard syntax designed to be "close" to the processor for efficiency in size and speed
- Suitable for beginners or BASIC programmers
- Covers Comments and Statements,Variables and Constants,Expressions,Functions,Program Control,Pointers,Structures & Unions, and the Pre-processor.
- The final example is a comprehensive real time programming application showing the simultaneous use of LCD, keypads, timers, clocks and ports
- Examples will run on our development board
- Soft copy of examples provided - ready to run on the PIC C Compiler
- Examples will run on other C Compilers

Download Free of Charge – www.fored.co.uk/ccomp.htm (follow the link "Learn C with FED")

FED – PIC C Compiler products

WIZ – C Visual Development for the FED PIC C Compiler

- An application designer for the FED PIC C Compiler FULLY including the PIC C Compiler
- Drag a software component on to your design & set up the parameters using check boxes, drop down boxes and edit boxes (see shot below
- Connect the component to the PIC pins using the mouse
- Select your own C functions to be triggered when events occur (e.g. Byte received, timer overflow etc.)
- Simulate, Trace at up to 10x the speed of MPLAB
- Generate the base application automatically and then add your own functional code in C or assembler
- Supports over 80 PICS - **16F87x,16F627/8, 16C55x,16C6x, 16F8x, 16C7xx 18Cxx, 18Fxxx, 12F629/675 etc.**
- Demonstration download available : www.fored.co.uk/CDemo.htm



Screen shot (left) shows push button element connected to the PIC, Parameters may be set to control debounce and repeat. C function may be specified to call when the button is pressed

FED PIC C Compiler

- C Compiler designed to ANSI standards
- Supplied with library routines for C standard functions and many interface applications including I2C, LCD, LED's, timers, EEPROM, IRDA,Dallas 1 Wire, Hex Keypad, Maths, asynchronous serial interfacing, clocked data etc.
- With complete development/simulation environment including LCD/Keypad/LED/RS232 terminal
- View your simulation on a logic analyser application showing waveforms, timing or analogue results
- Profiler shows execution count, execution time and average time for functions and code blocks
- Smart linker – efficiently tiles routines throughout memory to minimise long jumps and page setting bits
- Supports the FED In Circuit Debugger for 16F87x and 18Fxx devices

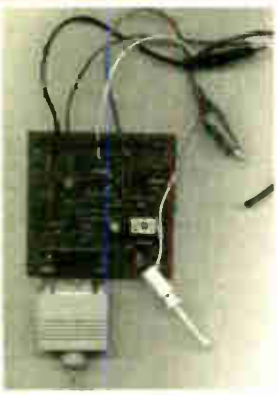
WIZ-C and C Compiler Pricing :

PIC C Compiler	**£60.00**
PIC C Compiler Professional	**£90.00**
WIZ-C	**£70.00**
WIZ-C Professional	**£100.00**

WIZ-C products are provided with introductory tutorial, full extensive manuals provided on CD.
All prices may be reduced by £20.00 if the product is purchased at the same times as WIZ-ASM, or serial programmer, or our Development board.

In Circuit Debugger

Supports 16F87x and 18Fxxx



- Allows real hardware to be examined & programs to be debugged and to be run in real time on your application
- The FED ICD requires only one data I/O pin on the PIC which can be chosen from any of ports B, C or D.
- Can program and re-program applications in circuit
- Up to 13 breakpoints (18F version)
- Run, Animate, single step and step over, run to cursor line, set PC to any value in the program
- Trace execution in the original C or Assembler source files
- View and change values of PIC special function registers, W and the ports.
- Standard serial interface to PC

Programmers and Development Board

(See web pages)

PIC Programmer - Handles serially programmed PIC devices in a 40 pin multi-width ZIF socket. 16C55X, 16C6X, 16C7X, 16C8x, 16F62x, 16F8X, 12C508, 12C509, 16C72XPIC 14000, 16F87X, 18Cxxx, 18Fxxx, 12F6xx etc.
Also In-Circuit programming.
Operates on PC serial port
Price : £45/kit, £50/built & tested

Development Board – For ALL 40 pin PICS from 16cxxx, 16Fxxx and 18C/Fxxx. Includes In-Circuit Programmer – NO separate programmer required. LCD interface, hex keypad, LED's and Driver, 32 I/O pins on header, I2C EEPROM, 2 Serial Interfaces, Will run FED PIC BASIC (supplied free on CD ROM), 1A 5V regulator etc.
The CD-ROM is supplied with FED PIC BASIC and Compiler
Price : £45/kit, £50/built & tested, CD - £5.00. Manual on CD-ROM or download free from our web site

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Email – info@fored.co.uk
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Prices : Please add £3.00 for P&P and handling to each order, and then EU residents add VAT at 17.5%. Cheques/POs payable to Forest Electronic Developments, phone with credit card details, or order from our secure web site

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Programmed PICs for *EPE Projects

12C508/9 – £3.90; 16F627/8 – £4.90
16C84/16F84/16C71 – £5.90
16F876/877 – £10.00
All inc. VAT and Postage
(*Some projects are copyright)

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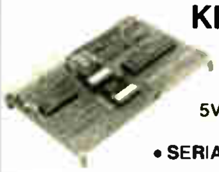
The latest MAGENTA DESIGN – highly stable & sensitive – with I.C. control of all timing functions and advanced pulse separation techniques.

- High stability drift cancelling
- Easy to build & use
- No ground effect, works in seawater
- Detects gold, silver, ferrous & non-ferrous metals
- Efficient quartz controlled microcontroller pulse generation.
- Full kit with headphones & all hardware

KIT 847 ....£63.95

68000 DEVELOPMENT TRAINING KIT

- NEW PCB DESIGN
- 8MHz 68000 16-BIT BUS
- MANUAL AND SOFTWARE
- 2 SERIAL PORTS
- PIT AND I/O PORT OPTIONS
- 12C PORT OPTIONS



KIT 621 £99.95

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MD200...200 step...£12.99
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- SIMPLE TO BUILD
- SWEPT FREQUENCY
- HIGH POWER OUTPUT
- AUDIO & VISUAL MONITORING

An affordable circuit which sweeps the incoming water supply with variable frequency electromagnetic signals. May reduce scale formation, dissolve existing scale and improve lathering ability by altering the way salts in the water behave.
Kit includes case, P.C.B., coupling coil and all components.
High coil current ensures maximum effect. L.E.D. monitor.

KIT 868 .... £22.95 POWER UNIT......£3.99

MICRO PEsT SCARER

Our latest design – The ultimate scarer for the garden. Uses special microchip to give random delay and pulse time. Easy to build reliable circuit. Keeps pets/pests away from newly sown areas, play areas, etc. uses power source from 9 to 24 volts.

- RANDOM PULSES
- HIGH POWER
- DUAL OPTION

Plug-in power supply £4.99

KIT 867..............................£19.99
KIT + SLAVE UNIT...................£32.50

WINDICATOR

A novel wind speed indicator with LED readout. Kit comes complete with sensor cups, and weatherproof sensing head. Mains power unit £5.99 extra.

KIT 856..............................£28.00

★ TENS UNIT ★

DUAL OUTPUT TENS UNIT

As featured in March '97 issue.

Set of 4 spare electrodes £6.50

Magenta have prepared a FULL KIT for this excellent new project. All components, PCB, hardware and electrodes are included.
Designed for simple assembly and testing and providing high level dual output drive.

KIT 866. . Full kit including four electrodes £32.90

1000V & 500V INSULATION TESTER

Superb new design. Regulated output, efficient circuit. Dual-scale meter, compact case. Reads up to 200 Megohms.
Kit includes wound coil, cut-out case, meter scale, PCB & ALL components.

KIT 848. . ...£32.95

EPE TEACH-IN 2000

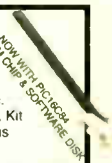
Full set of top quality *NEW* components for this educational series. All parts as specified by *EPE*. Kit includes breadboard, wire, croc clips, pins and all components for experiments, as listed in introduction to Part 1.
**Batteries and tools not included.*

TEACH-IN 2000 -

KIT 879 £44.95
MULTIMETER £14.45

SPACEWRITER

NOW WITH PIC16C84 EEPROM CHIP & SOFTWARE DISK



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

KIT 849 ....£16.99

12V EPROM ERASER

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

KIT 790 ....£29.90

SUPER BAT DETECTOR

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

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

KIT 861 ....£24.99

ALSO AVAILABLE Built & Tested. . . £39.99

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

Kit No. 845 ....£64.95

ULTRASONIC PEsT SCARER

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

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

KIT 812..............................£15.00

SIMPLE PIC PROGRAMMER

KIT 857... £12.99

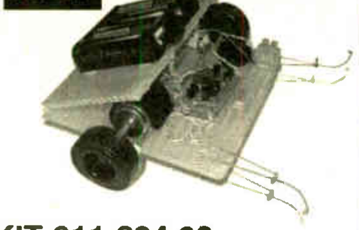
Includes PIC16F84 chip disk, lead, plug, p.c.b., all components and instructions

Extra 16F84 chips £3.84
Power Supply £3.99

MAGENTA BRAINIBOT I & II

NEW

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



KIT 910 £16.99 **KIT 911 £24.99**

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

- ZERO VOLT SWITCHING
- OPTO ISOLATED 5 Amp
- 12 KEYPAD CONTROL
- HARD-FIRED TRIACS
- WITH SOURCE CODE
- SPEED & DIMMING POT.
- EASILY PROGRAMMED

Kit 855 £39.95

PIC 16F84 LCD DISPLAY DRIVER

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

Kit 860 £19.99

Power Supply £3.99

FULL PROGRAM SOURCE CODE SUPPLIED – DEVELOP YOUR OWN APPLICATION!

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

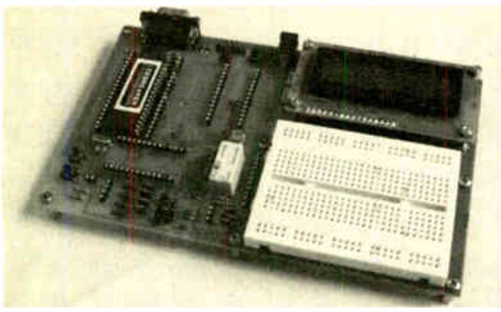
8-CHANNEL DATA LOGGER

NEW!

As featured in Aug./Sept. '99 *EPE*. Full kit with Magenta redesigned PCB – LCD fits directly on board. Use as Data Logger *or* as a test bed for many other 16F877 projects. Kit includes programmed chip, 8 EEPROMs, PCB, case and all components.

KIT 877 £49.95 inc. 8 × 256K EEPROMS

ICEBREAKER



PIC Real Time In-Circuit Emulator

- Icebreaker uses PIC16F877 in circuit debugger
- Links to Standard PC Serial Port (lead supplied)
- Windows™ (95+) Software included
- Works with MPASM and MPLAB Microchip software
- 16 x 2 L.C.D., Breadboard, Relay, I/O devices and patch leads supplied

As featured in March '00 *EPE*. Ideal for beginners AND advanced users.
Programs can be written, assembled, downloaded into the microcontroller and run at full speed (up to 20MHz), or one step at a time.
Full emulation means that all I/O ports respond exactly and immediately, reading and driving external hardware.
Features include: Reset; Halt on external pulse: Set Breakpoint; Examine and Change registers, EEPROM and program memory; Load program, Single Step with display of Status, W register, Program counter, and user selected 'Watch Window' registers.

KIT 900 . . . £34.99

POWER SUPPLY £3.99 STEPPING MOTOR 100 STEP £9.99

EPE PIC TOOLKIT 3

NEW

- THE LATEST TOOLKIT BOARD – 8, 18, 28 AND 40-PIN CHIPS
- MAGENTA DESIGNED P.C.B. WITH COMPONENT LAYOUT AND EXTRAS
- L.C.D., BREADBOARD AND PIC CHIP INCLUDED
- ALL TOP QUALITY COMPONENTS AND SOFTWARE SUPPLIED

KIT 880 . . . £34.99 with 16F84 . . . £39.99 with 16F877

PIC TOOLKIT V2

- SUPER UPGRADE FROM V1
- 18, 28 AND 40-PIN CHIPS
- READ, WRITE, ASSEMBLE & DISASSEMBLE PICS
- SIMPLE POWER SUPPLY OPTIONS 5V-20V
- ALL SWITCHING UNDER SOFTWARE CONTROL
- MAGENTA DESIGNED PCB HAS TERMINAL PINS AND OSCILLATOR CONNECTIONS FOR ALL CHIPS
- INCLUDES SOFTWARE AND PIC CHIP

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At last! A Real, Practical, Hands-On Series

- **Learn Programming from scratch using PIC16F84**
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- **PIC TUTOR Board with Switches, l.e.d.s, and on board programmer**

PIC TUTOR BOARD KIT

Includes: PIC16F84 Chip, TOP Quality PCB printed with Component Layout and all components* (*not ZIF Socket or Displays). Included with the Magenta Kit is a disk with Test and Demonstration routines.

KIT 870 .... £27.95, Built & Tested £42.95

Optional: **Power Supply – £3.99, ZIF Socket – £9.99**

LCD Display .... £7.99 LED Display £6.99

Reprints Mar/Apr/May 98 – **£3.00 set 3**

SUPER PIC PROGRAMMER

- READS, PROGRAMS, AND VERIFIES
- WINDOWS® SOFTWARE
- PIC16C AND 16F – 6X, 7X, AND 8X
- USES ANY PC PARALLEL PORT
- USES STANDARD MICROCHIP
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- OPTIONAL DISASSEMBLER SOFTWARE (EXTRA)
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- SEND FOR DETAILED INFORMATION – A SUPERB PRODUCT AT AN UNBEATABLE LOW PRICE.

Kit 862 £29.99

Power Supply £3.99

DISASSEMBLER SOFTWARE £11.75

PIC STEPPING MOTOR DRIVER

INCLUDES PCB, PIC16F84 WITH DEMO PROGRAM SOFTWARE DISC, INSTRUCTIONS AND MOTOR.

Kit 863 £18.99

FULL SOURCE CODE SUPPLIED ALSO USE FOR DRIVING OTHER POWER DEVICES e.g. SOLENOIDS

Another Magenta PIC project. Drives any 4-phase unipolar motor – up to 24V and 1A. Kit includes all components and 48 step motor. Chip is pre-programmed with demo software, then write your own, and re-program the same chip! Circuit accepts inputs from switches etc and drives motor in response. Also runs standard demo sequence from memory.

MAGENTA

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EVERYDAY PRACTICAL ELECTRONICS

THE No.1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

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BUOYANT

It's good to see our hobby in such a buoyant mood. Sales of our p.c.b.s, back issues – both printed and on CD-ROM – books and CD-ROMs for education, PIC Resources and PIC programming are all doing well. More readers are taking an active role in practical electronics. Warming up the soldering iron, booting up the computer and buying those components, rather than just reading the magazine and thinking about it. Maybe it's because more computer buffs now want something extra to do, instead of just playing games or surfing the net. Maybe it's because it is now so easy to make the electronics do exactly what you want it to – once you have mastered the programming, of course. But that does not explain why such a wide range of projects are now much more popular.

POPULAR PROJECTS

The most popular p.c.b.s we sell cover the whole spectrum from audio and test gear – always popular subjects – through to the more unusual like the *Tesla Transformer, PICronos, L.E.D. Wall Clock, Earth Resistivity Logger* and the *Practical Radio Circuits* designs. So, whilst the PIC programming items have consistently outsold everything else, all the other subject areas are also increasing in popularity. It has to be good for the future of our hobby and I guess good for the future of the electronics industry in general.

AHEAD

We will, of course, continue to bring you a wide range of projects covering all areas of electronics. Our plans for future issues include John Becker's "solid-state" Weather Station, an unusual Radio Controlled Car Wars project, another more advanced Virus Zapper from Andy Flind, a Cardboard Clock and a highly unusual flashing body enhancement for the ultimate party/disco decoration from our innovative contributor Rev. Thomas Scarborough. Plus a new *Top Tenners* series of projects – eight different projects that can each be built for under £10 – which starts in this issue.

In addition to all that, our next Teach-In series, *Teach-In 2004*, will start in the November issue. This one will follow the systems approach and is being written by Max Horsey.

The future looks interesting.

Mike Kenward

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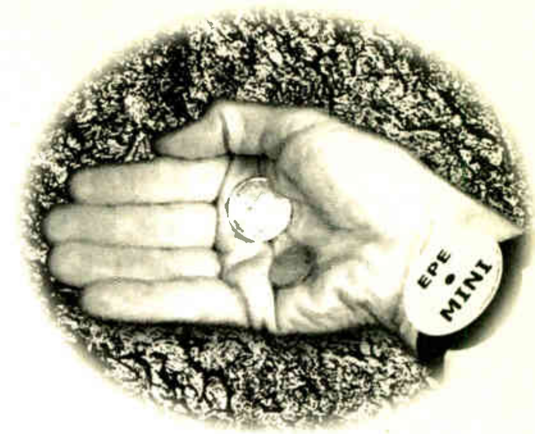
Constructional Project

EPE MINI METAL DETECTOR



THOMAS SCARBOROUGH

Become the proud owner of a low-cost, wrist-band metal detector. Plus a useful companion to your main "search tool"

BEAT frequency operation (b.f.o.) metal detectors were very popular in the 60s and 70s, soon after the advent of the first commercial transistors. Some models sold thousands of times over. But these quickly went out of fashion as superior induction balance (i.b.) and pulse induction (p.i.) designs appeared on the market.

However, b.f.o. metal detectors still have significant advantages in the areas of cost and ease of construction, and may be better suited to certain applications, such as pipe-finding or probing. Also, they are particularly well suited to miniaturisation.

It is this last feature, especially, which is exploited in this present article, which describes how to build a truly miniature b.f.o. metal detector which may be worn on the wrist. For good measure, and just a few additional items, a Pinpointer, which is used to pinpoint items found with a larger detector, is also described.

WRIST DETECTOR

While the performance of the *EPE* Mini Metal Detector is nothing to write home about, it is sufficiently sensitive to be of genuine use. It will clearly detect an old Victorian penny at a depth of 55mm, and a tiny 15mm diameter coin at 35mm. It will vaguely detect these at 70mm and 45mm respectively.

When properly tuned, it will pick up a pin. It will also discriminate between ferrous and non-ferrous metals (e.g. iron and copper), thus giving a good indication as to whether a "noble" metal has been found, or just a rusty piece of iron.

The Mini has many potential uses. It may be used for detecting treasure (we hope!) during idle moments in the school grounds or on the beach. It may be used as a pipe-finder or cable locator. It may also be optimised to detect very small items, such as small nails and screws in furniture – for which purpose a simple modification is described later.

Besides this, the EPE Mini may well be the first metal detector to be worn on the wrist. The author's prototypes, when shown around, proved to be particularly popular for their novelty.

DESIGN PRINCIPLES

A b.f.o. metal detector typically employs two high frequency oscillators, which run side by side at almost the same frequency. One of these is the *reference* oscillator (IC1a in Fig.1), the other the *search* oscillator (IC1f).

The search oscillator incorporates a pick-up coil (L1), the inductance of which will change at the presence of metal – typically just hundredths of one percent. When this happens, the frequency of the search oscillator shifts, and its frequency *in relation* to the reference oscillator increases or decreases.

Now suppose that both the reference and the search oscillator oscillate at around 500kHz, as they do in this present design. If these two frequencies are now *mixed*, so as to produce an audible beat frequency (also called the difference frequency), the presence of metal might shift the beat frequency by a few tens of Hertz, which is easily picked up by the ear.

Notice, therefore, that a minute change in the frequency of the search oscillator (say 0·1%) is greatly magnified in the beat note, so as to cause a far larger shift in the audible beat frequency (perhaps 50%) – which represents an amplification of many hundreds of times.

MINIATURISATION

Generally speaking, existing b.f.o. designs are not well suited to miniaturisation. There are two reasons for this. First, most are simply too complex to fit into a very small space – and second, many would be adversely affected by the close proximity of the human body.

The EPE Mini overcomes these two problems in a number of ways. It employs an unusually compact circuit, based on a single CMOS i.c. This makes miniaturisation possible even without the need to resort to surface mount technology (smt). The small printed circuit board (p.c.b.) itself carries just eight small components.

It overcomes the potential problems associated with close proximity to the human body (that is, wearing it on the wrist) by keeping all connections very short, and by sandwiching the circuit board between the piezo transducer (WD1) and the batteries inside the case, which serves to isolate it from body capacitance. Also, a Faraday shield is

used for the search coil, so as to minimise both capacitive and ground effects.

One further factor aids miniaturisation, which is that b.f.o. circuits tend to be very tolerant to metal items at close proximity. This means that a piezo transducer, a battery and a switch, as well as various other components, may be mounted very close to the search coil without any detrimental effect.

CIRCUIT DETAILS

The full circuit diagram for the *EPE* Mini Metal Detector shown in Fig.1 is virtually self-explanatory, therefore no block diagram was found necessary.

The reference oscillator (IC1a) is a simple *RC* clock generator whose frequency may be finely tuned through preset potentiometers VR1 and VR2. Preset VR2 is a finger-adjust trimmer, which may easily be adjusted at the edge of the small round plastic case.

The search oscillator (IC1f) is a simple *LC* oscillator, which is very similar in appearance to reference oscillator IC1a. However, in the case of IC1f, resistance is replaced with reactance (that is, with search coil L1).

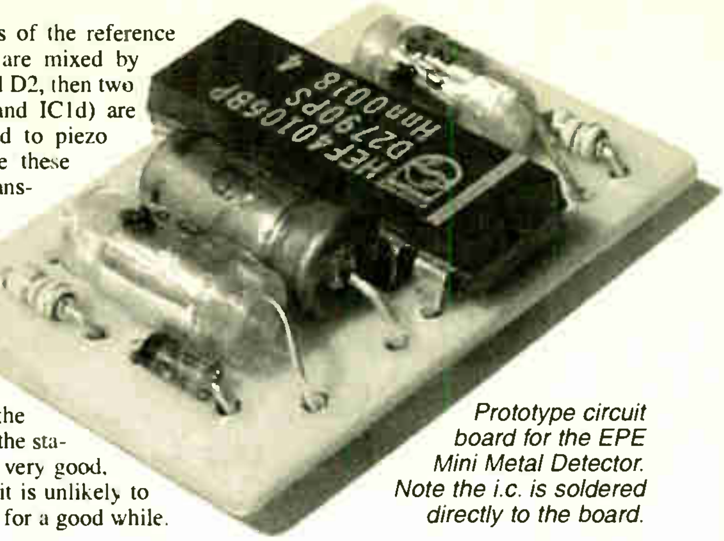
Since L1 is an inductor, it resists a.c., thus causing a delay in the charging and discharging of capacitor C2, and an oscillation is set up. While in some cases a coil in this position could "fry" an i.c. with back-e.m.f., in this case both supply voltage and inductance are relatively low, so that this is excluded.

Each of the two oscillators further employs a buffer (IC1b and IC1e), which largely isolates oscillators IC1a and IC1f from the rest of the circuit, and reduces what is called frequency lock – that is, the tendency of the two oscillators to "lock onto" one another. This makes it possible to set the audible beat note (the difference frequency) of the EPE Mini fairly low.

Since it is easier for the ear to discern, say, a difference between 50Hz and 60Hz than between 1050Hz and 1060Hz, this aids detection. Capacitor C3 additionally helps to reduce frequency lock, and this one component increases the overall sensitivity by some 10%.

The high frequencies of the reference and search oscillators are mixed by means of diodes D1 and D2, then two further buffers (IC1c and IC1d) are used to pass the sound to piezo transducer WD1. Since these buffers operate the transducer in push-pull fashion, this boosts the volume considerably.

A small 5V micropower regulator, IC2, is used mainly to stabilise the frequency of the two oscillators. In fact, the stability of the detector is very good, and after initial tuning it is unlikely to need any further tuning for a good while.



Prototype circuit board for the EPE Mini Metal Detector. Note the i.c. is soldered directly to the board.

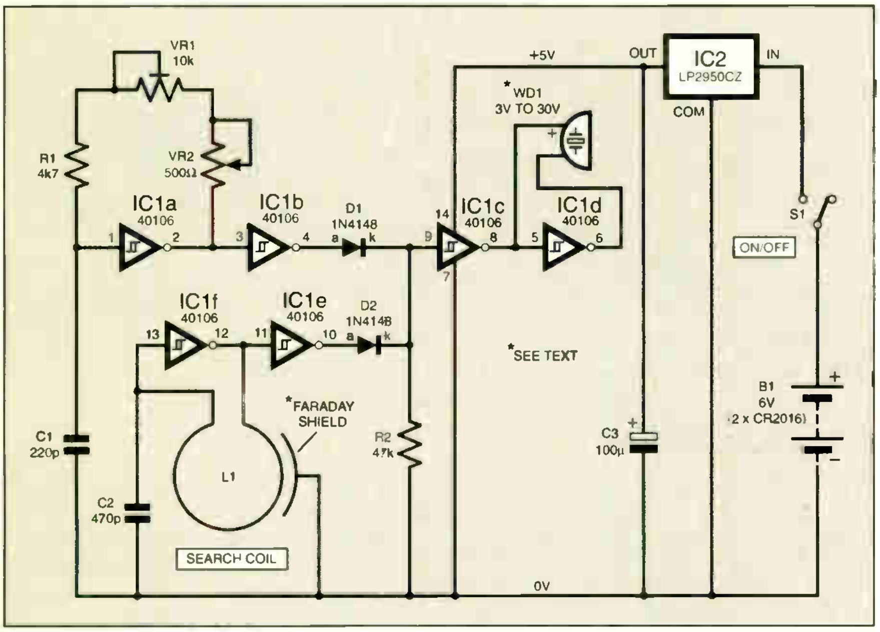


Fig.1. Complete circuit diagram for the EPE Mini Metal Detector.

The addition of a capacitor across the COM and IN terminals of regulator IC1 is not strictly necessary, and is omitted here for reason of space constraints. The circuit consumes just 3mA, so that the specified lithium coin cells (2 × CR2016) should last more than 24 hours continuous.

SEARCH COIL

One of the greatest advantages of b.f.o. designs is the ease with which one may wind and set the search coil. Use 33s.w.g. (about 0·26mm) enamelled copper wire, jumble-winding about 100 turns on a circular former 30mm in diameter (see photographs). A circle of pins may be used for the former. These are stuck into a sheet of cardboard or softwood, with their heads facing slightly outwards.

Once the coil has been wound, snip some narrow strips of insulating tape from a reel, and slip these under the coil, folding them back over the top to hold the coil together. Then carefully remove the pins, and use long strips of insulating tape to tightly bind the coil all round.

COMPONENTS

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

Resistors
R1 4k7
R2 47k
All 0·125W 5% carbon film

See SHOP TALK page

Potentiometers
VR1 10k single-turn cermet preset
VR2 500Ω finger-adjust single-turn cermet preset

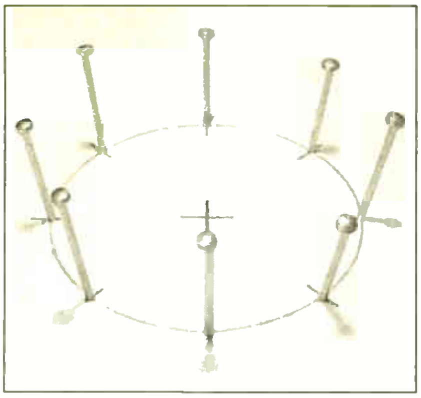
Capacitors
C1 220p min. axial polystyrene
C2 470p min. axial polystyrene
C3 100μ min. axial elect. 10V

Semiconductors
D1, D2 1N4148 signal diode (2 off)
IC1 HEF40106BP hex Schmitt inverter
IC2 LP2950CZ 5V low dropout positive regulator

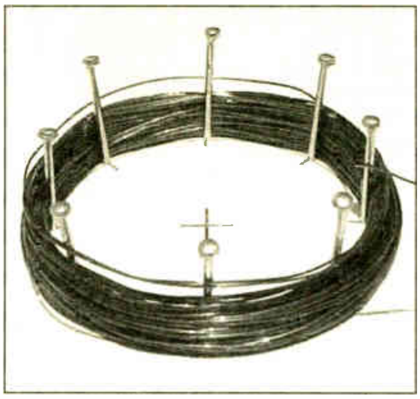
Miscellaneous
WD1 3V-30V piezoelectric transducer, low height, and diameter less than 30mm
S1 s.p.s.t. sub-min. slider switch
L1 10 metres 33s.w.g. (0·26mm) enamelled copper wire (Pinpointer = 6·5 metres)
B1 CR2016 3V lithium cell (2 off)

Printed circuit board (30mm x 20mm) available from the *EPE PCB Service*, code 396; circular case, size 43mm dia. approx.; coin cell battery holder, 3mm thickness x 20mm min. dia.; cardboard/softwood, pins, tin-foil, insulating tape and epoxy glue for search coil (L1) and VR1, VR2; connecting wire; solder, etc.

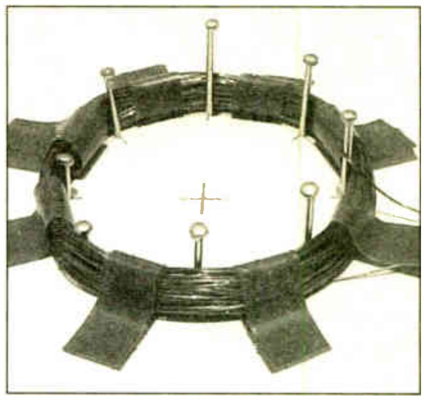
Pinpointer (extras)
One metre 20mm p.v.c. shaft; 1m twin-core screened audio cable; 20mm p.v.c. female adapter; 32mm nylon end plug.



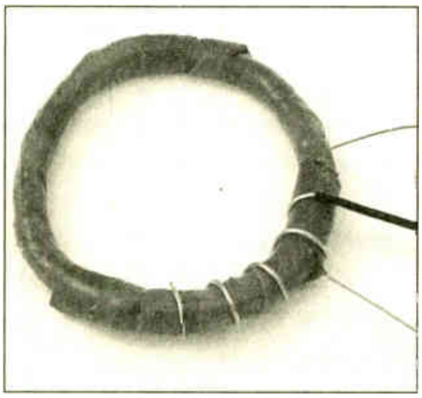
Search coil "pin guide" former, splayed outwards, in a 30mm diameter circle.



Enamelled copper wire (33s.w.g.) "jumble" wound around pin guides.

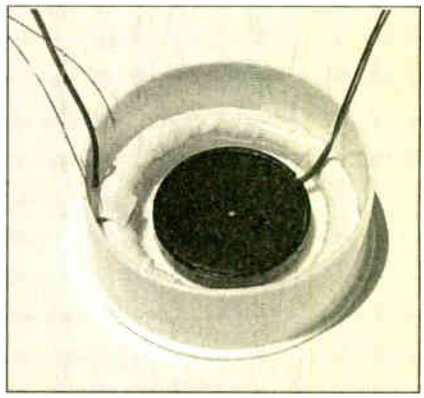


Strips of insulating tape used to hold coil windings together.



Taped-up coil and start of the Faraday shield; bared wire.

Tin-foil Faraday shield, awaiting final covering of insulating tape.



Coil and sound transducer sited in bottom of case.

Next, make the Faraday shield. Bare about 60mm of the end of a 150mm length of thin single-core wire. Twist the bared end around the coil, over the insulating tape. Then wind narrow strips of tin-foil over this wire and around the coil, completely covering all but about 5mm of the coil's circumference (that is, the Faraday shield should not quite complete the full circle).

When this is done, use some long strips of insulating tape to tightly bind the Faraday shield all round. This shield will eventually be connected to the 0V line.

Different sized coils may also be tried, including a full-sized metal detector coil. As a rule of thumb, with every doubling of the coil's diameter, the number of turns should be halved, and vice versa. Alternatively, adjust the component values of oscillators IC1a and IC1f. The author successfully tested coils from 7mm to 4 metres diameter.

If the EPE Mini Metal Detector is to be used to locate small nails and screws, or any particularly small items, wind a second coil just 15mm dia. with about 35 turns. Bind it as described above, and add a Faraday shield.

This coil is wired in *series* with the larger coil, with its turns pointing in the same direction. Its Faraday shield is connected to the Faraday shield of the larger coil. The addition of this smaller coil may necessitate some slight rearrangement of components within the case.

CONSTRUCTION

The EPE Mini Metal Detector printed circuit board (p.c.b.) measures just 20mm × 30mm. This board is available from the *EPE PCB Service*, code 396. Instead of using solder pins, for off-board wiring, it uses small "solder pads" – both to conserve space, and to make construction less finicky, see Fig.2.

Use miniature axial capacitors, and the smallest (0·125W) resistors, to suit the p.c.b. Select a piezo transducer which combines low height with good sound level, with less than 30mm diameter. No dual-in-line (d.i.l.) socket is used for IC1, since this could take up as much as 20% of the vertical space in the case.

Begin construction by soldering the two resistors and two diodes in position on the board, observing the correct orientation of the diodes. Then solder the three capacitors into place, observing the correct orientation of electrolytic capacitor C3.

The soldering of IC1 directly onto the p.c.b. should be done as quickly as possible, so as not to damage it from excessive heat. Also, anti-static precautions are important (touch your body to earth before touching the i.c.). When initial soldering is complete, the p.c.b. is mounted upside-down in the case, with the copper side facing upwards.

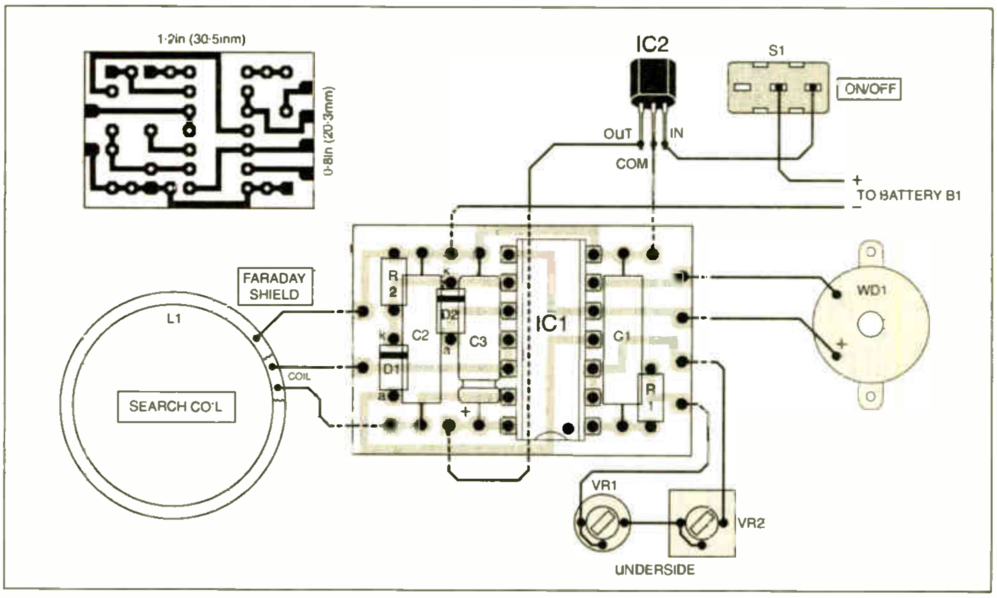


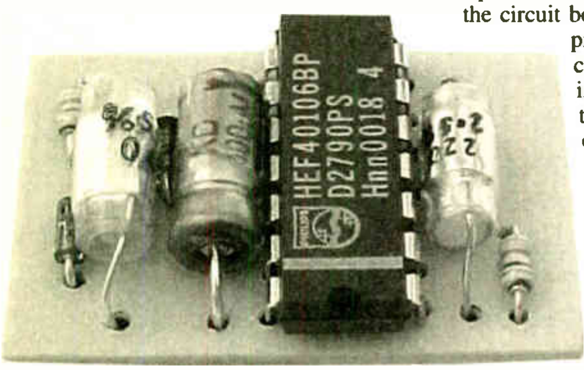
Fig.2. Printed circuit board component layout (enlarged for clarity), interwiring to off-board components and full-size copper foil master for the Mini Metal Detector.

The author's preferred version of IC1 was the HEF40106BP (Philips), with the CD40106BCN being a second choice. The choice of i.c. does make a significant difference to the volume in particular.

CASING-UP

The small circular case came from Aearo Ltd of Stockport (see *Shoptalk*). It is made as a container for a variety of earplugs, and is stocked by many chemists. It is particularly useful for its sliding lid, which offers up to one-third more vertical space if needed.

Drill a small hole in the case for the piezo transducer, and glue the latter in place – see coil photos. If the EPE Mini is worn on the wrist, this hole will face upwards – that is, it will face downwards when searching. Contrary to dampening the sound, the ground acts as a good sounding-board.



Finished Detector circuit board.

It is possible to substitute a crystal earpiece for the piezo transducer WD1, which is wired in the same way to pins 5 and 6 of IC1. This will give very good volume under the worst of listening conditions. Now place the coil inside the case – this will surround the piezo transducer.

Check the overall layout inside the case – the p.c.b., the on/off slider switch, the preset trimmers and the battery holder, and cut or drill holes as appropriate. Only a small hole is required for preset VR1, which will be adjusted with a screwdriver.

The peripheral components, including regulator IC2, are now soldered to the underside copper "solder pads" on the p.c.b. Attach presets VR1 and VR2, using extra stubs of wire as necessary. Finger-adjust preset trimmer VR2 should protrude from the side of the case more or less where a watch's winder would be.

Attach the three leads from the search coil, and the two leads from the piezo transducer (polarity is not important), and solder the switch and the battery holder to the p.c.b., carefully observing the correct polarity of the battery connections. *All leads should be kept as short as possible.*

With the aid of some Blu-Tack (or Pres-Stik) to hold parts in place, use epoxy glue to fix the various parts – if necessary one by one – inside the case. Some insulation (e.g. a piece of card) should be inserted between the circuit board and the battery holder to prevent any possible short circuits. Tape may in some instances be slightly conductive, and may interfere with the operation of the circuit.

Once soldering and gluing is complete, place the lid on the case. This may require a little cutting to close over slide switch S1 and presets VR1 and VR2. It may be held in place with some white insulating tape. A length of braided elastic may be attached to the underside of the case to serve as a wrist-strap – or if you prefer, brackets may be inserted into the sides of the case to hold a strap.

Finally, the EPE Mini could quite easily be further reduced in size. For instance, a custom, slimline battery holder could be made, and surface-mount components used (but with a different p.c.b. design).

SET-UP AND USE

To set the unit up, turn the finger-adjust preset VR2 to its centre position. Keep the search coil away from any metal, and switch on.

Using a screwdriver, turn preset VR1 clockwise and anticlockwise with a slow, sweeping motion to find the "band" of silence between the two most pronounced peaks of sound. There should be one such "band" which is more obvious than all the others (if, due to component tolerances, a clear beat note cannot be found, try increasing the value of capacitor C1).

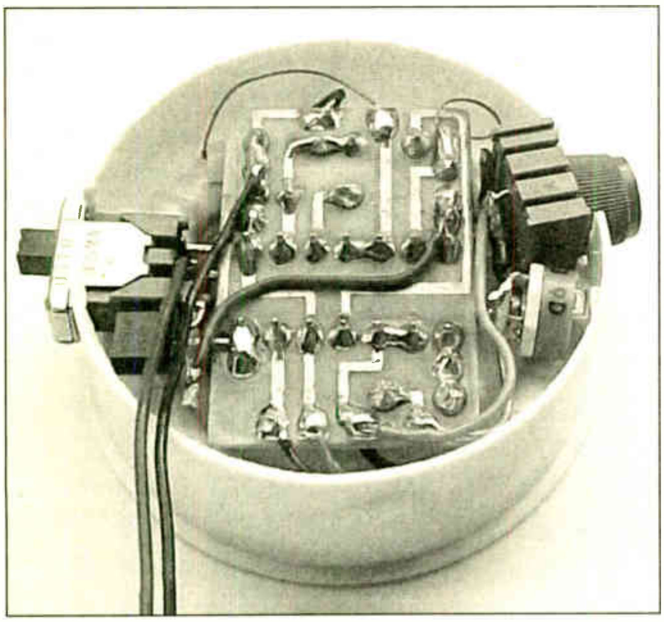
Now, carefully turn finger-adjust preset trimmer VR2 clockwise until the detector makes a low frequency sound. If you wish to detect ferrous metals rather than non-ferrous metals, adjust VR2 carefully anticlockwise until the detector emits a low frequency sound.

Sweep a coin across the coil, and the beat frequency will rise – in some cases markedly. For best results, the search coil should be moved *slowly* to and fro over the ground just skimming its surface.

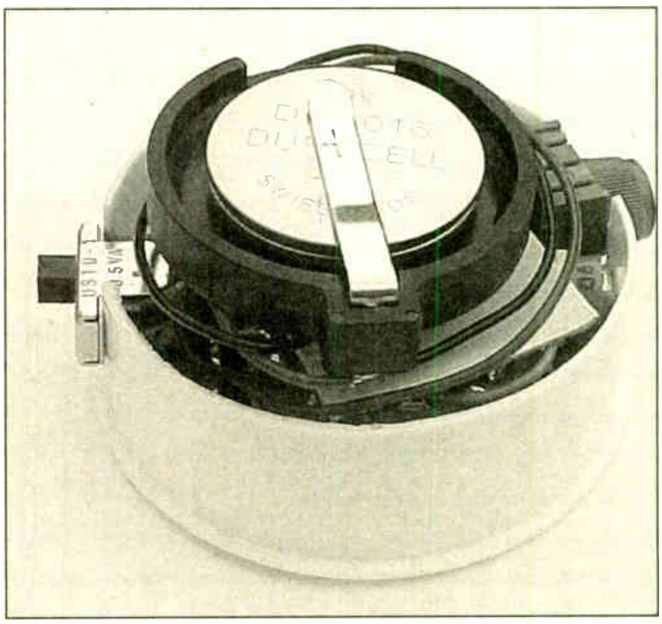
PINPOINTER

A LARGER metal detector may not be very good at locating a smaller find with accuracy. This is where a Pinpointer will "snuffle out" the elusive piece of metal. Usually such a Pinpointer is a luxury, and may cost up to half as much as a full-sized metal detector. In this case, it should cost no more than a few pounds and one or two evenings' work.

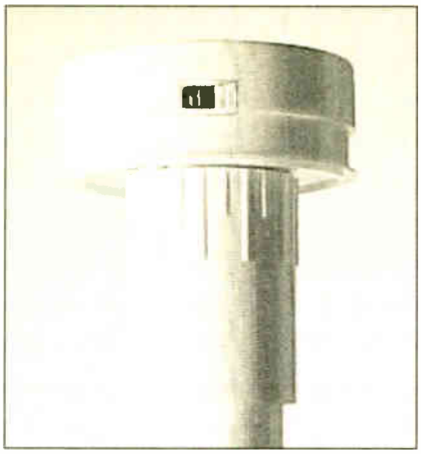
The author and his son have done much metal detecting, and until the Pinpointer came along, their method of finding smaller items was to reach into the excavated earth and hold it under the search-coil handful by handful, until an excavated item was found. With a Pinpointer, things are much easier. Without even needing to stoop down, one can poke about in the earth until the excavated item is located.



Positioning of off-board components inside the case. Note the p.c.b. is placed copper-side up, and the lead-off wires are soldered to copper pads.



Stacking of various components inside the case (bottom-to-top) – coil/transducer, circuit board, piece of card and battery coin cell holder.



Circular case attached to the top end of the shaft, via female adaptor.

Miniaturisation is essential, and the Pinpointer is fitted into the end of a rod, or shaft, with only minor changes to the circuit already described.

CONSTRUCTION

Since only small changes are made to the EPE Mini Metal Detector to make the Pinpointer, only the relevant changes are described here.

The search coil is again wound with 33s.w.g. (about 0·26mm) enamelled copper wire, 100 turns, but its diameter is now reduced to 20mm. The rest of the circuit construction is the same.

The Pinpointer is built into the same small, flat, circular case as previously. However, the search coil is mounted on the far end of a p.v.c. shaft, in a 32mm (or thereabouts) nylon end plug, see photographs and Fig.3. It is attached to the p.c.b. by means of about 1 metre twin-core screened audio cable (assuming that the shaft is also about 1m in length).

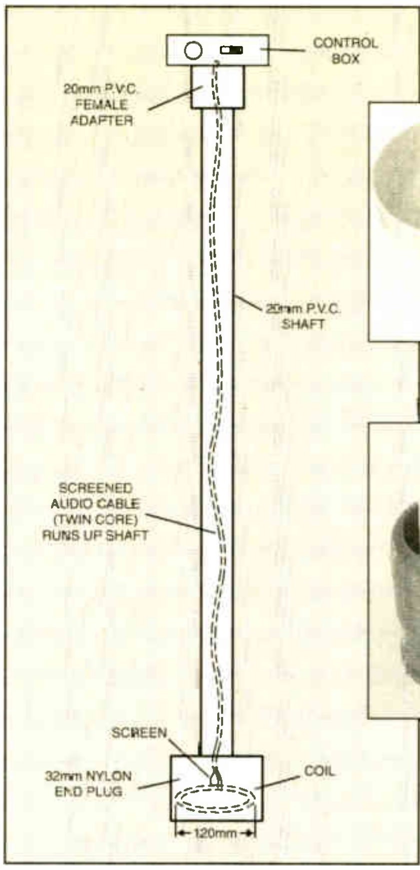


Fig.3. Pinpointer mechanical assembly.

The Faraday shield is taken to the screen, and to 0V on the p.c.b. The cable may be bound to the top of the pinpointer's shaft with a small cable-tie, so that it is not pulled loose from the p.c.b.

Case fixing.

A length of 20mm p.v.c. piping is inserted into the end plug, into which clear polyester resin is now poured. The coil and the end plug are thus bound to the shaft. At the top end of the shaft, the circular case is fitted to the top of the p.v.c. shaft with a 20mm p.v.c. female adapter. The piezo transducer is now mounted on the *lid* of the case – that is, *above* the p.c.b. and the battery holder, not below them as in the "EPE Mini".

Search coil mounting.

SET-UP AND USE

The Pinpointer is set up and operated in the same way as the "EPE Mini". Its coil is slowly moved to and fro over a region of earth (or even poked into it) where an elusive piece of metal is believed to be. When the metal is located, the frequency of the beat note changes.

The author wishes to thank Carl Moreland of the USA for recognising that an earlier version of this circuit had the potential to be miniaturised, thus giving the impetus for this article. Carl maintains an interesting database of metal detector circuits at **http://www.thunting.com/geotech**. □

SHOP TALK
with David Barrington

EPE Mini Metal Detector

Locating components for the *EPE Mini Metal Detector* should not prove to be too difficult a task. If you wish to use a similar miniature case as used by the author, the main problem will be purchasing components that are small enough to fit inside the case together with the p.c.b.

The two miniature preset potentiometers are single-turn cermet types and came from **RS Components**. The "finger-adjust" type is coded 187-292 and the other one is coded 187-539. Once again, you can order RS components through any *bona-fide* stockists, including some of our advertisers. You can also order direct (*credit card only*) from RS on ☎ *01536 444079* or on the web at *rswww.com*. A charge will be made for p&p.

The small circular (43mm dia.) box, which houses all the components, including p.c.b., batteries, sounder and search coil, has a sliding lid and came from **Aearo Ltd, Acumen Centre, First Avenue, Poynton, Stockport, Cheshire, SK12 1FJ** (☎ *01625 878320* or *www.aearo.com*). Unfortunately, they only deal in bulk orders. However, they have informed us that the box is really intended as a container for earplugs and can be purchased, for around £1 (including earplugs), from many leading chemist shops; under the brand name Nivea.

The author's preferred choice of IC1 is the Philips HEF40106BP (RS code 308-461 – see above), but no doubt most 40106 hex Schmitt inverters will operate in this circuit, possibly with some very slight differences in performance.

The small printed circuit board is available from the *EPE PCB Service*, code 396 (see page 507). The plastic plumbing pieces for the Pinpointer version should be stocked by DIY superstores.

Practical Radio Circuits – 2

This month's offering of *Practical Radio Circuits* contains a *Q-Multiplier* add-on for last month's MK484 TRF Receiver, a *MW Reflex Radio*, plus a *Wave Trap* and a simple *Speaker Amplifier*. Most of the components for these projects should be relatively easy to locate.

The same polythene dielectric variable tuning capacitor and ferrite coil (with additional coupling windings) are used for both receivers. The tuning capacitor will normally be found listed as a miniature "transistor radio" type and is currently stocked by **ESR Components** (☎ *0191 251 4363* or *www.esr.co.uk*), code 896-110 and **Sherwood Electronics** (see ad. on page 512), code CT9. The ferrite rod for the aerial/tuning coil is listed by Sherwood (code FR1) and we note **WCN Supplies** (☎ *023 8066 0700*) are offering a 140mm x 10mm rod, with a coil (unwanted), code 48-259.

For the 26s.w.g. enamelled copper wire, the author obtained a 50g (2oz) reel from **JAB Electronic Components** (☎ *0121 682 7045* or *www.jabdog.com*). We also understand **J. Birkett Supplies** (☎ *01522 520767*) stock 50g reels. Most suppliers only sell "large" reels.

We have been given two names for the RWR Toko tuning coil used in the optional Wave Trap module. They are: ***JAB Electronic Components*, Dept EPE, PO Box 5774, Birmingham, B44 8JP** (☎ *0121 682 7045* or *www.jabdog.com* – they appear to only deal with mail orders) and **Sycom, Dept EPE, PO Box 148, Leatherhead, Surrey, KT22 9YW** (☎ *01372 372587* or *www.sycomcomp.co.uk*).

All the printed circuit boards are obtainable from the *EPE PCB Service*, codes as follows: 397 (Q-Multi); 398 (MW Reflex); 399 (Trap) and 400 (Speaker).

Low Range Ohmmeter Adaptor Mk2

Just two items could cause some concern to readers when shopping for parts for the *Low range Ohmmeter Adaptor Mk2* project.

The voltage reference type LM85Z-1.20 was ordered from **RS Components**, code 168-9288. They also supplied the OP97 precision op.amp, code 652-651.

You can order RS components through any *bona-fide* stockists, including some of our advertisers. Alternatively, if a local source proves elusive, you can order direct (*credit card only*) from RS on ☎ *01536 444079* or through the web at *rswww.com*. A post and handling charge will be incurred.

The printed circuit board is available from the *EPE PCB Service*, code 401 (see page 507). The multi-turn, side adjust, cermet preset should be an "off-the-shelf" item and 18-turn to 25-turn seem to be the most popular.

Ultimate Egg Timer

As we are dealing with the kitchen environment when using the completed *Ultimate Egg Timer*, the first of a new selection of *Top Tenners*, it is most important that readers use a metal-cased hermetically sealed ***non-mercury*** tilt switch in this project. If you have problems finding a "mercury-free" switch, one is currently stocked by **Maplin** (☎ *0870 2263 6000* or *www.maplin.co.uk*), code DP50E.

A suitable IP65 spec. sealed case with a translucent lid, similar to the one in the model, is stocked by **Rapid Electronics** (☎ *01206 751166* or *www.rapidelectronics.co.uk*), code 30-1428. If you are into colour schemes, provided it's red or blue, you could try one of their completely translucent boxes, code 30-3862 (red) or 30-3852 (blue). Since the box is a different size, you will, of course, have to rearrange the components inside the box.

The printed circuit board is available from the *EPE PCB Service*, code 403 (see page 507).

PLEASE TAKE NOTE

EPE PIC Tutorial V2 – Part 2 *(May '03 Supplement)*

Page 31, Fig.7. The lefthand circuit notations should read top to bottom as RB0 to RB5.

News . . .

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

TROJAN CYBERWARS

Could any of us unwittingly launch a new era of cyberwars by accepting free download offers? Barry Fox reveals an enemy warplan.

INTEL is warning the computer industry about the threat of Distributed Denial of Service attacks on the Internet. DDoS, says Intel, represents a "significant threat to current society". We are moving towards a new era of cyberwar, with PC users the unwitting foot-soldiers.

Intel warns that the very nature of the Internet, which is open to all and was designed to let the military route messages through roundabout routes after nuclear attack, is its Achilles Heel. The Internet will route the DDoS attack traffic through so many different paths that the established system of relying on human administrators to put in filters that block the attack traffic will be "overwhelmed". Automating the existing response system puts it at risk of being hacked, so that it blocks wanted traffic. So Intel has been planning a secure automated emergency response system that cuts humans right out of the loop.

Malicious Hackers

Hackers prepare for a DDoS attack by sending malicious, virus-like programs to a large number of innocent on-line computers, for instance in Universities. The programs lie dormant and unnoticed until a trigger signal is sent. All the programs then kick in, sending a mass of messages to one targeted computer, such as a military, government, financial or vital services computer. The messages all ask for attention at the same time and completely swamp the target. Because the computers which are unwittingly mounting the attack may be all round the world, the attack messages hit the target from many different routes.

Early attacks, which came from just one or two computers, could be countered by the traditional remedy of a human administrator for the attacked computer asking the administrator of an attacking system to put a filter in the router which carries its traffic out into the Internet. But if hundreds of computers are mounting a "distributed" attack this takes far too long.

The only safe answer, says Intel, is to modify the "routers" which send traffic over the Internet, usually by the shortest route. The routers will then automatically respond to an alarm message from an attacked computer, describing key features of the junk messages which they are directing towards the attacked computer. The alerted routers then all insert a filter that blocks any message that fits the profile.

Before this is done, warns Intel in a recent patent (WO 03/005666), the router and attacked computer must exchange secure handshakes, using encrypted keys. In this way hackers cannot launch attacks that stop key computers sending vital messages, by fooling routers into filtering them out. Intel's plan is to exploit the same "digital certificates" and public and private key encryption systems that are currently used to secure money transactions on the Internet.

Industry Fears

An IT manager working for a major airline told recently what the industry secretly fears the hackers can do – and may already have set in motion. It exploits human inquisitiveness and love of anything free.

Anyone who surfs the Internet frequently will be familiar with the increasing number of pop-up adverts, offering free trial software which claims to clean up their PC, speed performance or hide evidence of visits to adult porn sites.

"The last thing in the world you should do is click ok", he warns. "You have no way of knowing whether the download has a hidden payload. It probably won't be detected by anti-virus software, either".

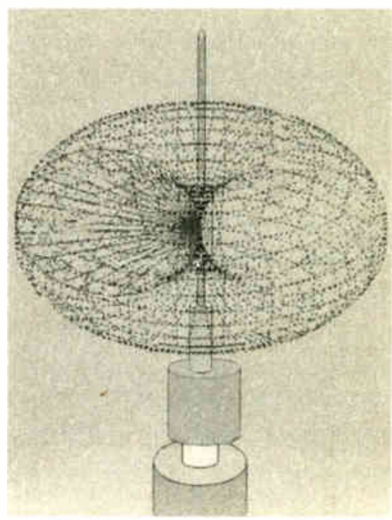
At any time in the future the payload can spring into action, sending requests for information to any Internet server that deals direct with the public. Airline reservation systems, online banks, email systems, medical advice and public service sites and sales organisations could all collapse. An attack on the Domain Name Servers, which translate Internet site names into Internet Protocol number addresses, could bring the whole system to its knees.

Don't Trust the Unknown

Even the most up-to-date antivirus software can only trap known threats. Says Graham Cluley, a security specialist with antivirus company Sophos, "Antivirus software is looking for what it's seen before, or something like it. It's not rocket science for a hacker to write Trojan software from scratch.

"Companies forbid staff from installing software from unknown disks. But they don't tell them that clicking on a download is doing the same thing. It's extraordinary how willing people are to download unknown software. It's like giving your car keys to a stranger who says he will drive it round the block a few times to make it run better".

THE CAT'S WHISKERS?



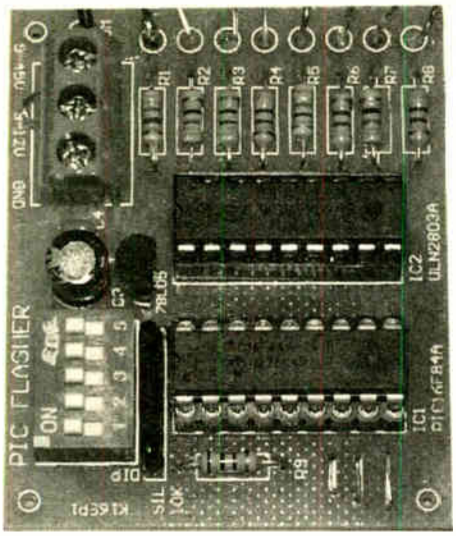
ALPHA Micro have introduced a new range of antennas for home, mobile, fixed, hand portable and GPRS use. The company say they are offering an unrivalled selection of GPS and GSM antennas. Included in the range is an ingenious "covert tax disc antenna" that can be discreetly installed behind a vehicle's tax disc allowing the vehicle to take advantage of both communication and location services.

Other offerings include a magnetic mount GPS antenna – a discreet externally mounted device with 3V or 5V d.c. voltage, SMA plug and 5M RG174. Stylish "shark-fin" GPS and GSM antennas are also available. Alpha also have unobtrusive panel antennas for Bluetooth and IEEE802.11, internal and external rubber antennas, OMNI and Yagi antennas.

Steve Harris, Alpha's Special Products Division General Manager, enthused "We are delighted to launch our new range. Alpha Micro prides itself on providing the widest selection at competitive prices with a service that is second to none".

For more information contact Alpha Micro, Dept *EPE*, Springfield House, Cranes Road, Sherborne St John, Basingstoke, Hants RG24 9LJ. Tel: 01256 851 770. Fax: 01256 851 771. Web: www.alphamicro.net.

QUASAR'S EPE PIC FLASHER



IN December '02 we published Steve Challinor's *Versatile PIC Flasher*, which was very well received by readers, intent on using it as part of their Christmas decorations (a very praiseworthy installation!).

Quasar Electronics, regular advertisers with us, have now introduced a kit version of it, but with a notable simplification. In the circuit for Kit 3169 the BC337 transistors and their associated resistors have been replaced by a single driver i.c., type ULN2803A. This considerably simplifies the construction and provides greater electrical robustness for driving numerous l.e.d.s or external miniature low voltage bulbs.

The design is not only appropriate to Christmas festivities, but to any requirement for interesting and colourful ever-changing lighting situations. For instance, it makes an ideal decoration for a child's bedroom ceiling.

Kit 3169 costs £10.95, including VAT, plus Quasar's standard postage options. Full product details can be found at **www.quasarelectronics.com/3169.htm**.

Quasar Electronics Ltd can be contacted at Dept *EPE*, PO Box 6935, Bishop's Stortford CM23 4WP. Tel: 0870 246 1826. Fax: 0870 460 1045. Email: sales@QuasarElectronics.com. Web: www.QuasarElectronics.com.

CAPS SKULLDUGGERY

PASSIVE Components Industry Magazine has reported that on September 13, 2002 they were informed by contacts in Japan that an unusually high rate of failures of low-ESR aluminum electrolytic capacitors produced in Taiwan had been traced to a problem with an aqueous electrolyte that had been used throughout the Taiwanese electrolytic capacitor industry.

Reportedly, the problem developed after a materials scientist working for Rubycon Corporation in Japan left the company and began working for another in China. The scientist then developed a copy of Rubycon P-50 type water-based electrolyte, used in low-ESR aluminum electrolytic capacitors. Subsequently, the scientist's staff members defected with the formula, and began to sell an electrolyte at a low price to many of the major aluminum electrolytic houses in Taiwan.

It is suggested that the staff members who defected with the formula copied only the partial formula, and the subsequent electrolyte produced was unstable when packaged in a finished aluminum capacitor. The instability leads to the build-up of excess hydrogen inside the aluminum can, which results in either a rupture of the can itself or destruction of the rubber end-seal. Either failure is potentially catastrophic due to the leaking electrolyte.

Total Taiwanese production of aluminum electrolytic capacitors is approximately 22·5 billion pieces, or 30% of the global aluminum electrolytic capacitor unit shipments. Thus, the failure of these Taiwanese aluminum electrolytic capacitors could have a major impact on the prime industries that consume these products, namely computer motherboards and high-speed modems.

However, depending on the number of parts sold and range of buyers, the problem may also affect the power supply, monitor and game console industries. It is important to emphasize, however, that the products that have been affected are only the low-ESR type aluminum capacitors, which account for less than 20% of Taiwan's aluminum electrolytic capacitor production volume.

For the full story as reported by *Passive Components Industry Magazine*, from which this edited extract has been taken, browse **www.nicomp.com/taiwanlowesr.htm**. Our thanks to reader Martyn Thomas who brought this to our attention.

Faster Screen Reading

Barry Fox

DEEP Video Imaging of Hamilton, New Zealand, plans to make pop-up menus on small screens easier to read (patent WO 02/089102). The system also helps people read screen text faster. The screen is made from two transparent l.c.d.s, one over the other, like layers of a sandwich. A backlight illuminates them both. A background image is displayed on the lower screen, and foreground graphics or text on the top screen. So menus stand out more clearly and animation appears in 3D.

By putting one paragraph of text on the top screen, and the next paragraph on the lower screen, the reader's brain "pre-fetches" text as happens when reading a book. The patented system could also let cellphones show 3D images without the expense of complex 3D l.c.d.s.

RF SOLUTIONS CAT

RF SOLUTIONS newly released 2003 catalogue is available in both electronic and hardcopy formats. With detailed specifications of over 500 products that include remote controls, radio modems, FM modules, RF modules and PIC development kits, it provides a host of useful information.

The extensive choice of radio modules available have ranges of just a few metres up to 20km. Products range from simple key fobs to DIN rail mounted industrial rated products and include the ICEPIC range of in-circuit emulators for PIC applications.

For more information contact RF Solutions Ltd, Dept EPE, Unit 21, Cliffe Industrial Estate, South Street, Lewes, E.Sussex BN8 6JL. Tel: 01273 898000. Fax: 01273 480661. Email: sales@rfsolutions.co.uk. Web: www.rfsolutions.co.uk.

AUDIO PARTS WEBSITE

B.K. ELECTRONICS, who have been advertising with us since 1980, have just launched a new sister website, www.AudioParts.co.uk. The aim of this site is to provide an effective and simple way of purchasing audio equipment online, under clearly define categories.

A large investment has been put into the site, which has a simple to use dropdown menu and a Veri Signed secure ordering system. Both leading brands and in-house manufactured items will be readily available. Plans include the introduction of high end hifi and home cinema sub woofers, both complete and in part form. AudioParts will also be supplying Pro Cinema loudspeakers and amplifiers, having already supplied over 700 screens for national cinemas.

For more information browse www.AudioParts.co.uk or email info@audioparts.co.uk (please mention *EPE* when you email!).

ANDY EMMERSON

Wired Wireless: Crazy or What?

If the whole idea of wireless is to replace wires, why do people now advocate sending r.f. down cables? Andy Emmerson investigates.

PEOPLE argued long and loud a decade ago when technology guru Nicholas Negroponte claimed that wires and wireless would change place. Tasks traditionally performed by radio (such as broadcast entertainment distribution) would turn increasingly to cable, he argued, whilst a wirefree future beckoned for communication functions previously handled exclusively by wired means.

Modestly he called this turnabout the *Negroponte Switch* and to a degree his prediction has come true. More recently he has clarified his reasoning and now he argues that both wired and wireless technologies have their place, with wireless being the ideal "transport mechanism" for short-haul communication that's essentially personal or private.

In that case, where does radio go? There's no single answer but for certain applications the answer is optical fibre, using an up-and-coming technique known as Radio over Fibre.

Many cable TV networks use something very similar to distribute television, radio and other entertainment signals over backbone fibres from the headend location to street cabinets. From here a subset of these signals is remodulated onto radio frequency (r.f.) carriers and delivered into homes on coaxial copper cable.

ILLUMINATING IDEA

The novelty, though, is to use Radio over Fibre for delivering cellular radio signals (existing GSM – Global System for Mobile communications – networks and the new third generation or 3G systems) to "illuminate" poor coverage areas such as tunnels, shopping centres and inside office buildings.

Coaxial copper cable has been used for such applications but the microwave frequencies used for cellular radio suffer significant attenuation (signal loss) for distances over a few hundred metres and need booster amplifiers and complex combiners and filters.

All this is resolved using Radio over Fibre. The system uses the radio signal to modulate a laser that launches the lightwave signal down the optical fibre. At the far end the signal is converted back to r.f. with minimal degradation. It is easy to combine multiple signals on separate optical wavelengths, making distributed networks easy to deploy.

The cellular signals can be transmitted many kilometres without significant attenuation, making a viable proposition of serving remote locations (tube station platforms for instance) that were previously uneconomic to serve. All in all, this technique is likely to bring major benefits to cellphone companies – and users.

THE PENNY DROPS

A fundamental feature of Radio over Fibre is that only the modulated optical signal (the useful part of the transmission) is transmitted along the fibre, not the actual r.f. carrier frequency. That must sound obvious but it took time for "the penny to drop" when the wired wireless technique was first exploited in the 1920s.

One of the first commercial users of "wired wireless" was the Great Western Railway, which made some experiments with telephone calls on a trunk line from Reading to Swindon in March 1928. The system worked on a duplex basis (two separate wavelengths sent down the wires) without any switching for transmission and reception. After a few problems were sorted out (such as interference from high-power Morse transmissions), the system was brought into daily use in November of that year.

At that time the railway was transmitting both the carrier frequency and all the products of modulation to the line. In 1929, a comparison was made between the existing "wired wireless" systems working on radio frequencies that ran into hundreds of kilohertz and the alternative "carrier frequency" system, which operated at just tens of kHz. The principle of suppressed carrier transmission was also discovered.

The original "wired wireless" system was not the way to go and was withdrawn in 1931, to be replaced by standard carrier systems, which incidentally did not interfere with the baseband audio frequencies and allowed the telephone wires to carry normal calls as well as the carrier signals. Over the decades carrier telephony was much improved, with up to 960 simultaneous telephone conversations being carried over a single copper cable.

WIRE BROADCASTING

During the 1930s another kind of "wired wireless" became popular in what was also known as "wire broadcasting" or "radio relay". In parts of Britain and many other countries the cost of radio sets was more than some people could afford. A cheaper solution was to deliver a small number of programmes to houses by cable and provide just a switch and a loudspeaker in each home.

Although long forgotten now, companies such as Rediffusion, British Relay and Radio Rentals built up large businesses hiring the equipment to subscribers and in some towns you can still see the old cables and junction boxes on the side of houses, also the odd-shaped porcelain insulators on chimneys where the signal was distributed on open wires. During the 1950s many of these networks were upgraded to provide television signals as well, lasting into the mid-1980s.

The key advantage of the systems just described was low cost; customers avoided the then quite considerable cost of buying a wireless set, and providing the loudspeaker and switch unit was a far lower overhead for network operators than a full-blown radio receiver. But it was also user-proof, with just a volume control and programme selector switch, customers could not mistune the device. There were no valves or other electronic components to go wrong either; the signal came down the line as audio with an amplitude of around 85 volts (plenty of power to blast through dodgy cable joints and dirty switch contacts!).

Even better, as a Rediffusion advertisement of the 1940s proclaims, the system eliminated all outside interference and distortion. "Programmes from foreign stations are received on specially designed aerials situated in the best possible reception areas, then re-transmitted by private wire to Rediffusion subscribers."

This was doubtless a reference to Radio Luxembourg, which was extremely popular in those days as its sponsored programmes broadcast far more pop music than the BBC. Unfortunately, its signal suffered badly from fading, making reception on normal radios a nerve-wracking battle of constant knob twiddling!

PAST PERFECT

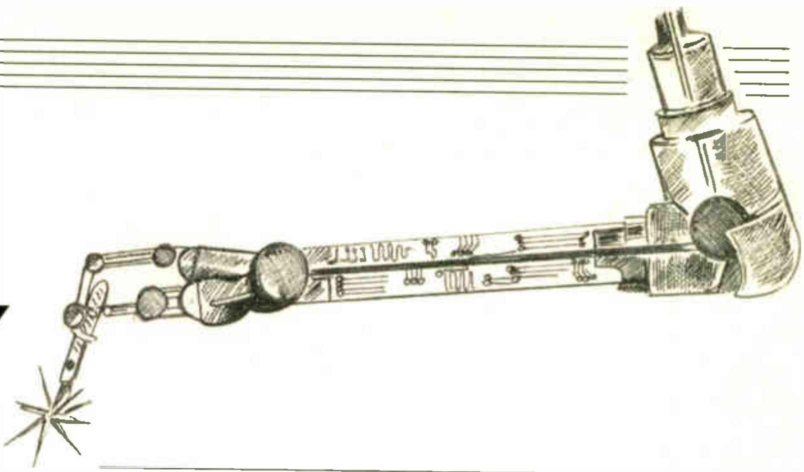
Several countries took this notion a step further and delivered broadcast radio and other entertainment services over telephone wires. A simple filter next to the telephone separated the telephone and radio frequency signals with great technical elegance.

Although a national radio relay system using this technology announced by the British Post Office in 1939 came to nought, the idea took off in a number of European countries and the USSR. In 1950 some 15 per cent of Swiss listeners opted for wired wireless, whilst in the Netherlands the percentage was 28 and 35 in Sweden.

In New York a service offering commercial-free music even allowed subscribers to pick their own selected records to be played at a particular time and thanks to the number of records available, they could expect to hear tunes repeated no more than once a fortnight.

Many cities in Germany were equipped for radio distribution over telephone lines, which proved a major advantage during the Second World War. When normal radio broadcasting had to be taken off the air to prevent the Allies using radio transmitters as homing beacons, entertainment and air raid bulletins could continue to be delivered via the "wired wireless".

Regular Clinic



CIRCUIT SURGERY

ALAN WINSTANLEY and IAN BELL

Why is a 50 ohm connector so called? The answer to this and more, is given in this month's round-up of readers' electronics-related queries.

Not So Simple

THIS month we hear from a reader confused about the impedance ratings of BNC connectors. Regular reader ***Gerard Gavin*** writes:

"I am very interested in Andy Flind's function generator in the March '03 issue. He refers to 50 ohm BNC chassis sockets. But what is meant by 50 ohm? Is this a built-in series resistance with the centre conductor? A 50 ohm shunt across the centre conductor and the screened outer?

I had a look on the Internet and saw that probably the most common BNC connectors are labelled 50 or 75 ohm. I couldn't find the answer to my query though, and I am none the wiser after trying to measure one with an ohmmeter!"

When we connect together components, circuit boards or electronic equipment we tend to assume that the wiring provides a perfect connection (Fig.1a). If we think a little more we may accept that the wiring has some resistance – either in series (usually quite small) due to the resistance of the conductor, or in parallel due to imperfect insulation (usually quite large resistance) (Fig.1b). At higher frequencies we probably have to include some wiring capacitance and inductance as well (Fig.1c).

If the wire is very long then the signal will take a significant time to travel along it. However, "lumping" all the components together may not provide an accurate picture of how the signal behaves. In order to model this situation we could use an *RLC* network comprising a long chain of resistors, inductors and capacitors (Fig.1d).

The chain of *R*s, *L*s and *C*s shown becomes more accurately defined the larger the number of sections we use. Ultimately, we can think of the wire as an infinite extension of this circuit, at which point it becomes better to describe the characteristics in terms of resistance, capacitance and inductance per unit length. But remember that, from the point of view of the high-frequency signal, these characteristics are distributed *all along the wire.* You cannot simply multiply the capacitance per unit length (e.g. so many picoFarads per metre) by the length to get a capacitance value, as the signal is not the same at all points on the wire.

Just characterising the wire's distributed *R*s, *L*s and *C*s isn't the complete story. We also have to think about how the signal actually travels down the wire. For d.c. or low frequencies we typically think of signals being conducted along wires in terms of the flow of electrons. For high frequencies and long wires, we also need to consider the *electromagnetic fields* created by the signal and think of them propagating down the wire as a *wave*.

This is more like the way in which we think of radio transmission, except the signal is guided down the wire rather than travelling through free space. When we think of wiring in this way we are dealing with what are known as **transmission lines** (Fig.1e).

At the Speed of Light

We know that radio waves travel through a vacuum at the speed of light. In other materials, the speed is reduced. Similarly a

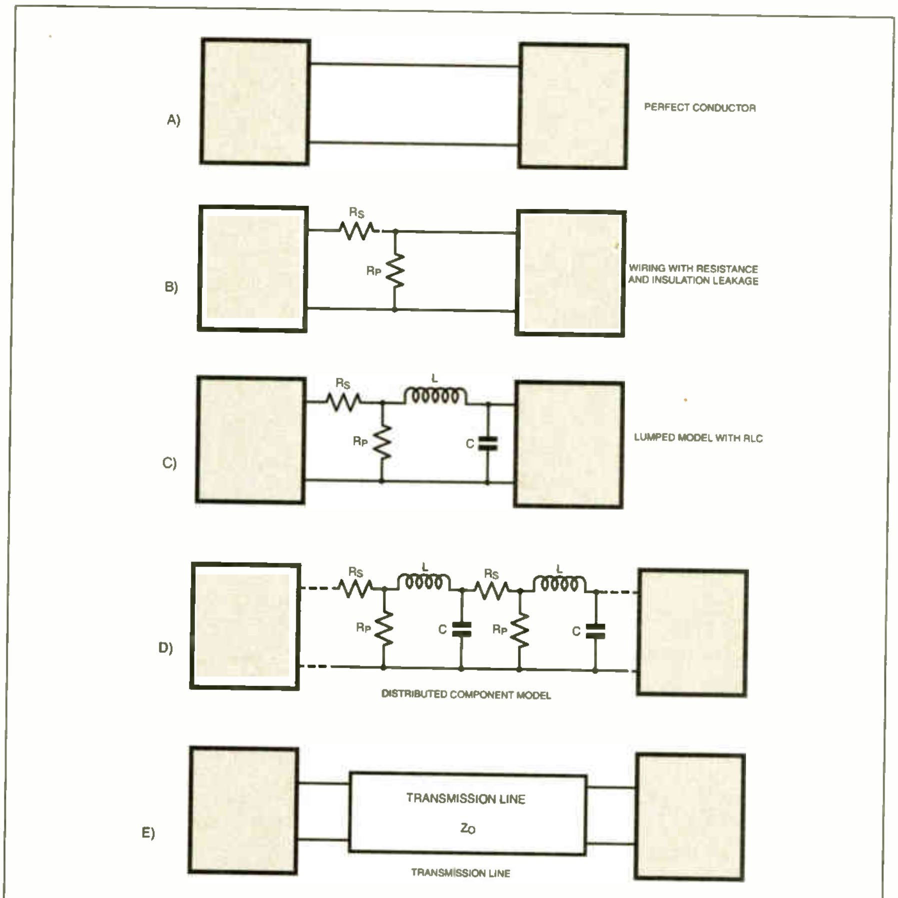


Fig.1. How complex can a wire get? At high frequencies and for very long wires we cannot assume a perfect connection between two subcircuits. Once the length of a connection exceeds 10% of the signal wavelength, transmission line theory should be considered. At 1MHz, this point is 15 metres.

signal on a pair of conductors (a transmission line) separated by a vacuum would also travel at the speed of light. However, if we place some material between them – e.g. the central insulation in coaxial cable – then the speed of the wave will be reduced. For example, using p.v.c. insulation, the speed of the wave will be about half of the speed of light in a vacuum.

The speed of light is about 3×10^8 m/s so a signal will travel down a 1m cable in approximately 3·5ns to 7ns, depending on the insulator characteristics. A signal with a period of about 7ns has a frequency of around 150MHz, so for any signals anywhere near or above this frequency we would have to regard our 1m cable as a transmission line.

The higher the frequencies that are present, the shorter the distance at which we have to use transmission lines to take full account of the behaviour of circuits. The signals on the circuit boards of PCs and, amazingly, even the interconnections in high speed i.c.s have to be modelled as transmission line by circuit designers.

As a rule of thumb, we have to use transmission lines rather than basic circuit theory when the length of a connection is more than about 1/10th the wavelength of the signal. The wavelength is given by *c/f*, where *c* is the speed and *f* is the frequency.

For connections with a speed of half light speed, this works out as 1·5km at 10kHz, 15m at 1MHz and 15mm at 1GHz. Remember, digital signals with sharp "square wave" edges have important frequency components at much higher frequencies than the basic repetition rate.

At a Loss

Imagine a signal wave travelling down an infinitely long, perfectly conducting and perfectly insulated (lossless) wire-pair or coax cable. If we measured the voltage and current at any *point* on the wave we will get the same *V/I* ratio. This is known as the **characteristic impedance** (Z_0) of the transmission line, and is determined by the electromagnetic properties of the materials separating the conductors.

The characteristic impedance is related to the electromagnetic wave propagation on the line and is not the d.c. resistance as, for instance, measured by a multimeter (in the ideal case the d.c. resistance is zero). The characteristic impedance of free space is 377 ohms, and of course, the characteristic impedance of a 50 ohm coaxial cable is 50 ohms!

If we have a lossless transmission line it turns out (if you do the maths) that the characteristic impedance, Z_0, is given by

$$Z_0 = \sqrt{L/C}$$

where *L* and *C* are the inductance and capacitance per unit length. The characteristic impedance of this perfect transmission line is purely resistive, despite the fact the line has inductance and capacitance. Coax cables are not perfect transmission lines, but for most purposes they are close enough – the 50 ohms (or 75 ohms) characteristic impedance is a pure resistance.

Making Waves

Next, imagine a narrow channel with water in it (like a canal). Create ripples at one end of it and they will travel down the channel. Imaging the far end is blocked with a solid wall. What happens? The ripples reflect off the wall and travel back up the channel, creating "interference" patterns as they interact with the incoming ripples. The same thing happens with electrical signals in transmission lines.

Now imagine a wider water channel connecting to a narrower one. This also creates reflections and interference, although some of the original waves will continue down the second channel. In electrical terms this is like a *mismatch* – connecting two cables with different characteristic impedances will actually cause signal reflections and not all of the signal will go straight to the load.

One interesting point related to this concerns what happens when you try to measure a 50 ohm coax with a meter, which understandably our reader did attempt to do. If you and your multimeter were fast enough you would see a 50 ohm reading between the conductors of a open circuit cable until the reflected wave got back from the end of the cable to the meter (probably a few nanoseconds). Of course, a multimeter cannot do this, but equipment that makes measurements on reflected signals in cables is available. The technique is called **time domain reflectometry** and can be used to detect faults in long cables.

Good matching ensures that as much of the signal as possible goes to the load rather than being reflected back. For this to happen, all cables and connectors must have the same characteristic impedance and source and load impedances must match this as well. That is why you need a 50 ohm BNC connector as well, with a 50 ohm coax cable. *IMB.*

Normally Open and Closed

I'm hoping you can give me a clear definition of "normally open" and "normally closed". My understanding is that a normally open switch is normally open until activated by force in which case it becomes closed. The reason I ask is because I have come across an Allen Bradley overload relay, which has a normally open contact built in, but the normally open switch was "closed" until the relay tripped, when it opened!
Scott Rennie (*EPE Chat Zone* message board at **www.epemag.wimborne.co.uk**).

Your definition is quite correct, Scott, a normally open (n.o.) contact is indeed open or "broken" when its actuator (e.g. a relay coil) is in the "de-energised" state. My Telemecanique Electrical Controls data book states: "*normally closed poles operate in the reverse manner to normally open poles: with the coil de-energised the normally-closed poles conduct and when it is energised they do not conduct.*"

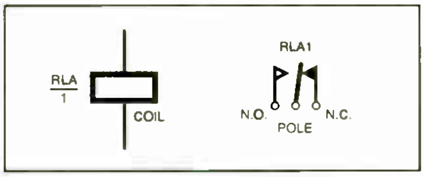


Fig.2. How the normally open and closed poles of a relay are designated. The contacts are shown in the "de-energised" state. The relay coil, when powered, causes the pole to move away from the n.c. contact to the n.o. contact instead.

Usually relays have changeover (c/o) contacts with a moving terminal called the pole, which is the contact that is common to both the n.o. and n.c. circuits. Fig.2 shows the circuit schematic symbol for a relay with changeover contacts.

I didn't find anything in electrical data books to show that the naming conventions for overload relays are the opposite from those that we use. I suspect that the "closed" normally open switch in your overload relay simply indicates that the relay is somehow energised in the control's running state, so the n.o. contact conducts. Presumably when the overload trips, the contact opens again. Reader input on this is welcome. *ARW.*

Constructional Project

LOW RANGE OHMMETER ADAPTOR MK2

LYN JONES

Improved accuracy when measuring low resistance.

TAKING measurements of low resistance components and printed circuit board tracks below 10Ω is a common requirement in electronics. However, most digital multimeters are not able to measure low resistances accurately as their resolution is inadequate. Whilst specialist digital meters are available they are normally reserved for professional use due to their high cost.

DRAWBACKS

If an analogue meter is used it is unlikely that meter resolution would allow accurate measurements of small resistances. Analogue meters require the user to guess the value as the needle normally falls between scale markings. This is fraught with danger, as estimation by eye may not be accurate enough, especially as the scale is usually not linear.

Digital meters also have other major drawbacks. Most 3½ digit meters can only display with a resolution of 0·1Ω. The measurement is rounded up or down inside the meter to allow it to be displayed, so the actual reading could have a considerable measurement error at low resistances. There is also an error caused by the test leads, which requires a special technique to gain accurate low resistance measurements.

BASIC ADAPTOR

This article presents an adaptor that can be connected to most multimeters to enable low resistance readings to be taken. The operation of the adaptor is based on the circuit previously published in *EPE* September 1995, designed by Steve Knight.

The circuit diagram in Fig.1 is a redrawn version of Steve's original. The adaptor passes a known current through the resistance under test, which allows a voltage reading to be taken across the component. The voltage corresponds to the resistance due to Ohm's Law:

resistance = voltage across component/ known current from adaptor

At the heart of the circuit is a single transistor current source, TR1. The current through the resistance under test depends on a number of factors, including the base voltage and the emitter resistance. The formula that gives the current through the resistor is:

Current through resistor ≈ (Base voltage – 0·6) / Emitter resistor (assuming a large transistor h^{FE})

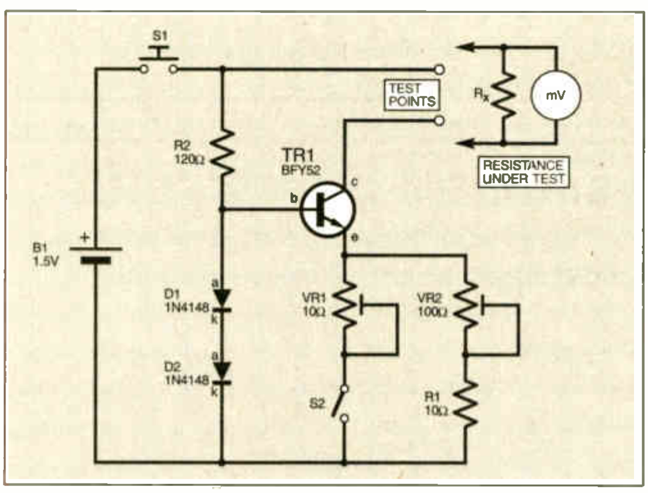


Fig.1. Functional equivalent circuit diagram for the original Low Range Ohmmeter Adaptor of September '95.

The original circuit has one major drawback in that the calibration shifts with temperature. While this is acceptable for occasional use, it is desirable that any measurement instrument is consistent over both time and temperature. This is especially true when constructors need quick measurements when faultfinding circuits and do not have time for re-calibrating equipment.

The temperature dependent changes are caused by the use of the two diodes to set the base voltage of the transistor. Any semiconductor device will change its electrical characteristics with temperature, which is a factor that is often used in diode-based temperature sensors. It is therefore of primary importance that the base voltage is kept constant, which was the main design consideration for the updated circuit.

ADAPTED ADAPTOR

The circuit diagram for the Low Range Ohmmeter Adaptor Mk2, is shown in Fig.2. This has a voltage reference device, IC1, to provide a consistent reference voltage of typically 1·26V. This voltage is passed into the non-inverting input (pin 3) of op.amp IC2.

The inverting input (pin 2) is fed from the emitter of transistor TR1 to form a negative feedback loop. This is because the characteristics of the transistor also change with temperature, including the heating effects on its *npn* junction as the circuit is used.

Note that a precision op.amp has been specified due to the temperature stability that render many other op.amps (including the 741) unsuitable for this application.

The output (pin 6) of the op.amp is connected directly to the base of transistor TR1. The inclusion of capacitor C2 helps to improve circuit stability and remove unwanted noise that may otherwise interfere with the accuracy of the adaptor.

The transistor is configured as an emitter follower, so the voltage presented at the base dictates the emitter voltage. It is therefore possible to set the emitter current by varying the emitter resistance, which consists of preset VR1 and resistor R2. This in turn sets the collector current, which is the test current.

TEST POINTS

The test points (sockets SK1 and SK2) are where the resistance under test is connected, along with a millivoltmeter or multimeter that has been set to a suitable range. Capacitor C1 and Zener diode D1 provide a minimal protection against brief misconnection and external interference, but not to the same extent that a more sophisticated or a commercial design would require.

Unlike the original circuit, only one range is provided. However, testing resistances of 10Ω or more is possible using this adaptor due to the increased power supply voltage.

This circuit is quite current hungry, and special care needs to be taken to select a good quality alkaline or NiCd/NiMH battery or battery pack. For many circumstances a 9V PP3 battery will be adequate but a pack of six AA cells would be more appropriate where regular use is anticipated.

CONSTRUCTION

Printed circuit board component positioning and track layout details are shown in Fig.3. This board is available from the *EPE PCB Service*, code 401.

Start by inserting the smallest components first. Make sure that all semiconductors are inserted correctly, using a socket for IC2. A heatsink may be fitted to the transistor to improve stability and reliability but is not absolutely necessary

After thoroughly checking the assembly, connect the battery, switch and 4mm binding posts (SK1, SK2) to the pads provided on the p.c.b. It is suggested that the circuit is mounted in a plastic case with an internal battery compartment. The exact detail is left to the preference of individual constructors.

Apply power to the circuit with preset VR1 being turned to its highest resistance. Check that the current across the test points is less than 100mA using an ammeter. If not, first check that VR1 is set correctly, then inspect the board for faults.

IN USE

After the initial testing, the unit must be calibrated (see later) but before calibration can take place, it is necessary to know how the unit would normally be used.

COMPONENTS

Resistors
- R1 1k
- R2 10Ω
- R3 1Ω 1% 1W (for calibration)

Resistors R1, R2 0·25W 5% carbon film or better.

See SHOP TALK page

Potentiometer
- VR1 10Ω multiturn preset, 18 turns or better, p.c.b. mounting

Capacitors
- C1, C2 100n ceramic disc, 5mm pitch (2 off)

Semiconductors
- D1 5V1 1·3W Zener diode
- TR1 BFY52 *npn* 1A transistor
- IC1 LM385Z-1.20 voltage reference
- IC2 OP97 precision op.amp

Miscellaneous
- S1 push-to-make switch
- SK1, SK2 4mm binding post (2 off)

Printed circuit board, available from the *EPE PCB Service*, code 401; 8-pin d.i.l. socket; plastic case to suit; 9V battery and clip (see text); heatsink for TR1 (see text); connecting wire; solder, etc.

Approx. Cost Guidance Only **£11** *excl. case & batt.*

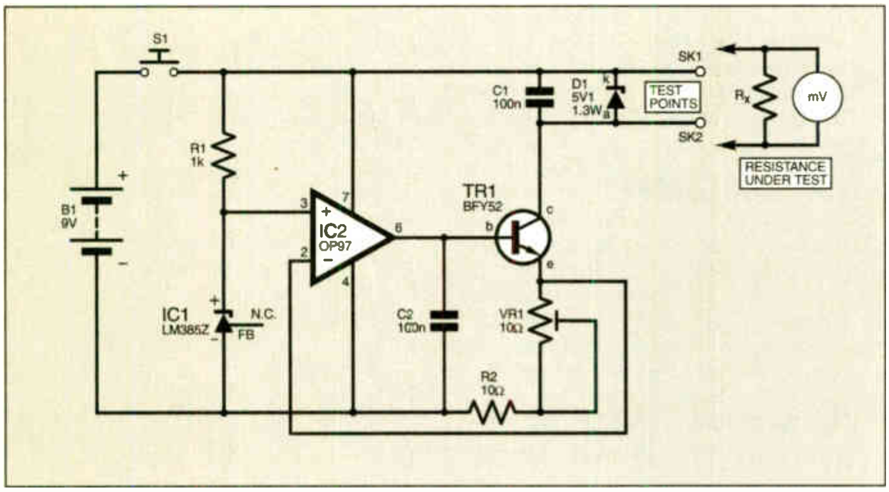


Fig.2. Full circuit diagram for the Low Range Ohmmeter Adaptor Mk2.

In essence, the adaptor is very simple to use. Simply clamp the resistance under test to the binding posts. Plug in a millivoltmeter or multimeter to the 4mm sockets in the binding posts, press the test switch (S1) momentarily and take the voltage reading from the meter.

The Low Range Ohmmeter Adaptor Mk2 linked to a Digital Multimeter.

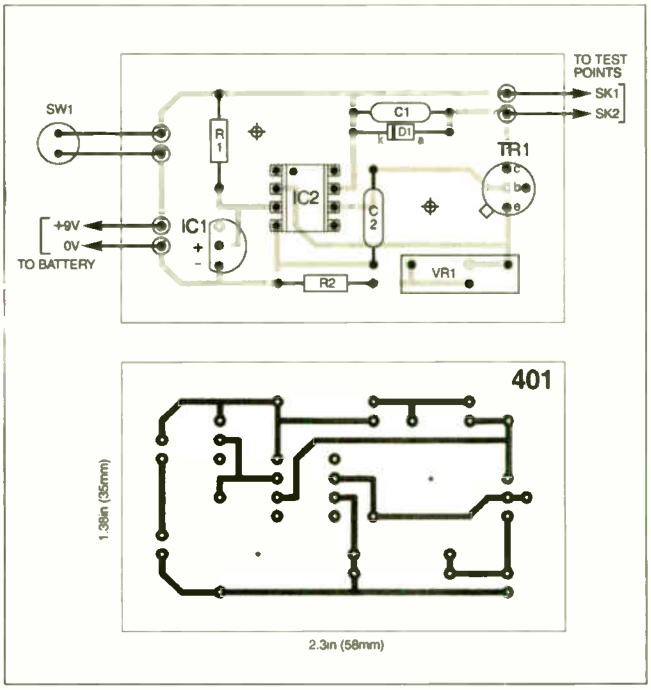
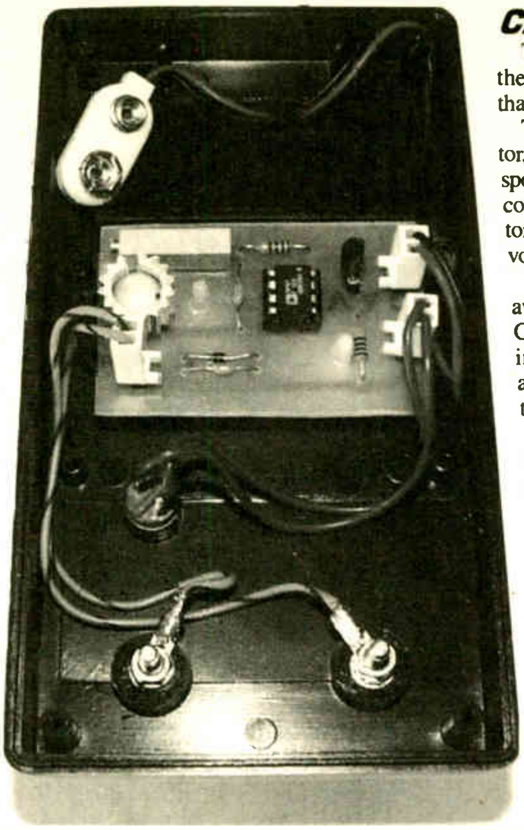


Fig.3. Printed circuit board component layout for Mk2 Adaptor. A heatsink is required for TR1, see internal photograph.



Internal layout of the completed Ohmmeter Adaptor. Note TR1 heatsink.

Each millivolt is equal to 0·1Ω. A reading of 56·3mV would indicate that the resistance under test is 0·56Ω. Ignore any decimal place, as the accuracy of this adaptor and the meter cannot be guaranteed to that extent.

Do not hold down the test button for more than a few seconds due to battery loading and the effects of the high current through the transistor, which will affect the stability of the reading.

CALIBRATION

There are two methods of calibration, the choice depending on the equipment that is available.

The first method is to use a 1Ω fixed resistor, which must have a very tight tolerance specification, preferably 1% or better. Simply connect the resistor to the adaptor and monitor the voltage across it. Adjust VR1 until the voltage reading shows 100mV.

The second method depends on the availability of an accurate milliammeter. Connect the meter across the test points in place of the resistor and millivoltmeter and adjust VR1 until the current through the meter is 100mA.

Leave the adaptor for about ten minutes and check that the calibration has not shifted (caused by the current through TR1 heating its *npn* junction). Recalibrate if needed for consistent results.

Owing to the stability of the voltage reference and op.amp, this circuit should prove to be quite stable and give repeatable results independent of temperature. The calibration should be checked from time to time, like any other piece of test equipment, as calibration can drift.

Naturally, the accuracy depends on the meter used and the accuracy of circuit calibration.

REMOTE MEASUREMENT

It is often necessary to measure resistances that are remote from the meter. This could be because the resistance will not fit into the binding posts or when measuring p.c.b. tracks. This adaptor is equally at home making remote measurements as well as with the resistance under test clamped to the binding posts.

Many people take a reading using normal test lead sets then remove the error by subtracting the lead resistance (obtained by taking a reading with the leads shorted together). This is prone to errors and limits the reading accuracy. A better approach (as used on commercial equipment) is the four-wire method, sometimes called Kelvin Contacts, which is shown in Fig.4.

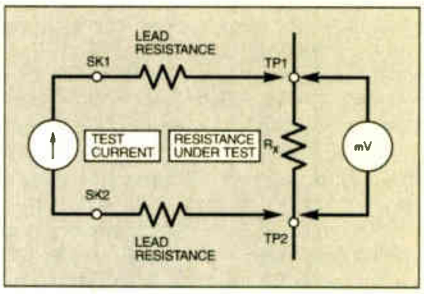


Fig.4. The four-wire method of measuring low resistance.

With this method, the test current is passed from the adaptor through the main set of test leads. The two resistors shown in Fig.4 represent the lead resistance which normally causes errors (note that no additional components are placed in the test leads).

If we now add a second pair of test points (TP1 and TP2), we may accurately take a voltage reading across the resistance under test. The voltmeter has a high resistance, and so we ignore the lead resistance on these test contacts.

The exact accuracy of the design (i.e. lower limit) depends simply on the meter used. A normal digital meter will be ok down to 0·01Ω (the display will show 1·xmV, ignoring the decimal place). A more sensitive meter could be used, although the author has not tried this.

This adaptor should be a welcome addition to any test kit, providing stable and repeatable results, whether or not the 4-wire test method is used. □

New Technology Update

The introduction of 3D l.c.d. technology should give renewed impetus to the display market, predicts Ian Poole.

THREE dimensional display technology has been a laboratory curiosity and never quite taken off – that is until now. Sharp has recently announced that its new 2D-3D display has been adopted for phone use by DoCoMo, the Japanese phone company and this could change the display market significantly for the future.

With 3G cell phone technology already widely used within Japan, this development is likely to mean that the new display technology will also be widely used. It may also herald the adoption of similar displays in many other applications from laptops and PCs to televisions and many other applications.

On Display

The new display technology has taken Sharp over a decade to develop at their European laboratories located near Oxford in England. It is now being launched and was demonstrated at the *CEATEC* exhibition in the autumn of 2002 when ten displays ranging in size from 3·5 to 15 inches were exhibited.

The commercial product is now available with small production quantities of a few tens of thousands a month being manufactured. This is expected to rise to in excess of 500,000 items a month within a year from now. With these quantities it has been possible to hold the price premium of the displays to just 20% above that of a normal TFT (twisted fibre technology) l.c.d. It is expected that with these prices the take-up of the displays should be reasonably significant.

In addition to the hardware itself, Sharp has been able to provide a complete support package including the driver and other software needed for the devices. The company reasons that in order to enable equipment manufacturers to use the product, a complete package is required.

In addition to this Sharp is building relationships with thirteen equipment manufacturers. These include Microsoft, a division of Eastman Kodak, Sony, Toshiba, Sanyo, Fuji, and Olympus. In this way a development consortium can be created to enable standards to be set up and support provided as required. The number of companies that are involved indicates the significant level of interest that it has generated.

Viewpoint

There are two types of stereo display. They are known in the industry as stereoscopic and auto-stereoscopic displays.

The stereoscopic variety requires the use of a viewing aid such as coloured, polarising switching spectacles. These types have been reported quite extensively, and some experiments have even been carried out on television using them.

However, they have never been likely to catch on because of the fact that spectacles are always required and they are not convenient to use. A far better option is to have a system that is known as auto-stereoscopic. Here all the stereo capability is included within the display itself.

Both systems have been known about for a considerable time. Even the auto-stereoscopic variety has been known about for over 100 years. However the means to implement the technology has not been viable for many applications until recently.

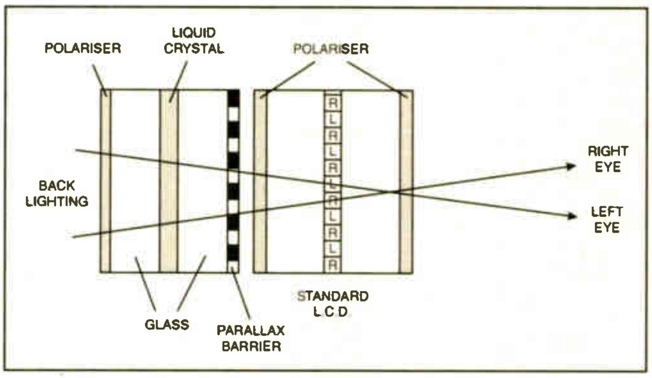


Fig.1. Construction of the Sharp 2D-3D display.

Double Vision

In order to create a stereo image it is necessary to generate and display two separate images, one for the left eye and the other for the right eye. Both images are viewed and the brain combines them in such a way that it creates a sense of depth and greater reality than using a simple 2D image.

To achieve this the Sharp system generates the two images from a single display using highly modified back light and an active matrix within the display. This could be considered as a parallax generator.

To realise this the company developed a specialised parallax barrier as well as a switching device and a polarising film. These are placed between the backlight and a standard l.c.d.

The parallax barrier is the secret to the operation of the display. It consists of a switching liquid crystal, a polarising film, and a polymer liquid crystal display. These are all held together and in turn this assembly is held in close contact with a standard l.c.d. panel.

How It Works

Light from the specialised backlight passes through the first polariser and then as it passes through the switching l.c.d. it is rotated by 45 degrees. It then passes through the retardation film or parallex barrier. This has a striped coating and causes the polarisation of the light to change by 90 degrees between where the coating is present and where it is not, see Fig.1.

This results in the light being in stripes with different polarisations as it enters the normal section of the liquid crystal display. The slits then alternate between opaque and translucent.

The image is then displayed on the l.c.d. such that there are two images, one for the left eye and one for the right eye. To enable the two images to be seen by the different path, the light direction is controlled by the parallax generator, and accordingly the images are perceived as a 3D representation.

The display has the advantage that it can be used in both 3D and 2D modes. In 2D mode, the slits in the parallax generator of which every other one is opaque are switched so that they are all translucent. This means that the display has its full resolution, whilst in the 3D mode it has a lower horizontal resolution.

Although displays using a very similar principle have been demonstrated before, the real innovation of this idea is that the slits in the display have been integrated with the rest of the assembly so that they are extremely close to the pixels of the image display. This greatly enhances the resolution of the image and allows users to view it at distances closer than 30cm whilst still visualising a good 3D image. A further advantage is that the thinner displays are also brighter.

Summary

Until recently 3D displays had been considered to occupy a very niche market. Now with their adoption for use with cell phones, this may herald their widespread use in this and many other applications.

The phone itself allows users to take and receive 2D photos, and then convert them into pseudo 3D images with the onboard software for the 3D display.

This application could be yet another element that could help to add value to the struggling 3G cell phone services and also give the impetus required to get 3D imaging off to a flying start.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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 A DIGITAL MULTIMETER

A $3^{1}/_{2}$ digit pocket-sized l.c.d. multimeter which measures a.c. and d.c. voltage, d.c. current and resistance. It can also test diodes and bipolar transistors.

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

★ LETTER OF THE MONTH ★

WATER RIPPLES

Dear EPE.

I have read of Noel Harvey's problems with ripple in ponds when attempting to measure the water level (*Circuit Surgery* April '03). What Noel needs is not a filter, which will need a bit of design, but rather the water equivalent of the smoothing capacitor. Such a device is simple, easy and cheap to construct. For reasons that will become apparent, it is called a Stilling Well.

Construction is simple. Take a length of suitable piping such as the domestic waste water pipe (2ins/50mm o.d.) and seal one end. Next drill a small hole in the end far enough away from the seal so that this hole is clear of any silt. Mount the pipe in a vertical position such that it reaches the bottom of the pond with the open end uppermost. Water will enter the pipe at a rate governed by the size of the drilled hole. Long term level changes will be measured as normal, however short term changes, i.e. ripples, will have little or no effect on the level of water in this Stilling Well.

This method of calming open water is widely used in the water industry.

Peter Mitchell, via email

You are absolutely right, Peter. Sometimes a seemingly difficult electronic problem can have a simple solution taken from another discipline.

HATS OFF TO PICRONOS!

Dear EPE,

I have read with interest in June '03 issue how John Becker has come up with a new clock, *PICronos*, that combines analogue with digital while even incorporating a PIC! Wow! I seem to remember saying exactly that in my *Digilogue Clock* project published in *EPE* way back in 1997. Seems nothing is new eh! But no sour grapes to you John, in fact if I had a hat, I'd take it off to you simply for tackling the horrendous multiplexing required in such a project. I know, I've been there!

Finally, on an aesthetic note. I would have opted for large 7-segment displays in the middle, as I find discrete ones very hard to decipher and difficult to line up during construction.

Anyway John, keep the designs coming, just wish I had the time, it's been years since I programmed a PIC.

John Scott Paterson (AKA Jasper), via email

How nice to hear from you Jasper! Yes I recall your Digilogue Clock *and indeed had a look to remind me of how you'd done similar. I decided though that I wanted mine to be totally l.e.d.s for the sheer novelty of it, and indeed to be close to the design that reader Fernando had suggested.*

Yes, multiplexing that lot of l.e.d.s was a challenge! Readers have the benefit of better l.e.d. spacing than on my prototype – I forgot about the rim round l.e.d.s and had fun(?) getting them to fit straight in the 7-segs area. The published board allows a bit more space between them. All the best to you (and do find time to enjoy PICing!).

COLOURFUL PICRONOS

Dear EPE,

I am writing to you with a possible thought regarding the *PICronos* project in the June '03 edition, which I have been eagerly waiting to read about and build.

What I am thinking about is the possibility of using bicolour l.e.d.s for the 60 inner seconds/minutes. Then, by setting appropriate logic control signals on the row/column matrix (i.e. two 1s or two 0s to turn the l.e.d. off, with 1/0 for red and 0/1 for green etc.) a green (or red) l.e.d. would then rotate round for the seconds, with the hours l.e.d. lit with the opposite colour. Please forgive me if what I'm suggesting does not make sense or is technically not possible without major hardware/software re-design, but I think this is an excellent and very interesting project.

Lee Hewitt, via email

Thanks for your comments, Lee. Sadly, it would not be possible to use bicolour l.e.d.s with this design because of the nature of the multiplexing, which would become prohibitively complicated to cope with your suggestion (and too much for my aching brain!).

Glad you like the design, and lots of other readers do too, as sales of the p.c.b. prove – all very satisfying to me!

P.C.B. PINOUTS FOR L.C.D.S

Dear EPE,

Why does John Becker always use the same, but unusual, pinout arrangement for l.c.d.s on his p.c.b.s? I think it would be good to arrange the pins in-line with the l.c.d. connections. That way you can just plug it in with a 10-pin connector.

Neil Pagel, via email

Well Neil, the p.c.b. pinouts for l.c.d.s on my boards are historical, used first in my PIC Tutorial V1 *of '98 when the l.c.d. I was connecting had its pins in two rows at the left, not in line at the bottom. The same arrangement was used on the commercial interpretation of my board when the* Tutorial *was enhanced to become* PICtutor *(the forerunner of the current Assembly for* PICmicro V2 *and its* Version 2 PICmicro MCU Development Board *(see advert elsewhere in this issue).*

Magenta Electronics arranged manufacture of the commercial PICtutor *board and supplied l.c.d.s with connectors to match the pin order. I continue to use those same l.c.d. modules (of which I have many) and so consistently use the same pin order. I agree it's a pity that I did not do* Tut V1 *board with a different order. But I'm stuck with it now, and shall be for ever!*

NAMING PICS

Dear EPE,

As a regular reader of *EPE* (from early 1970s *PE* days), I have been a keen follower of the PIC projects that have been appearing and gaining in popularity since around 1995. With respect to the latest *EPE PIC Tutorial V2*, you hypothetically ask "What is a PIC?". The answer given is that it is just a trade name adopted by Microchip to cover a family of microcontrollers.

I remember looking at some early Arizona Microchip reference books in which they stated that the acronym PIC stands for "Programmable Interface Controller". I am surprised that no one from Microchip can remember using this acronym. Unfortunately I no longer have the data book in which I read this ID data. The book described typical applications for the PIC, such as replacement circuitry for washing machine program control, microwave oven and satellite TV box controllers etc.

Anyway, regardless of what a PIC is, keep up the good work producing these interesting articles and projects!

Bill Ellingford, via email

Thanks for the comments, Bill. In fact the question came up in Readout *many years back, and various suggestions were made, but when writing* Tut V2 *I did not have the time go through the many issues, so I rang Tech at Microchip, who gave me the reply I quoted. Certainly your answer is one that I find satisfying. I assume MC no longer know what it means, and just regard the letters as their trademark (I believe their full trademark is actually PICmicro). I also understand that G.E.C. were the manufacturers of the first PICs and it was they who coined the acronym.*

PASCALITE

Dear EPE,

I have no connection, beyond being a happy customer, with Control Plus, but I think their Pascalite microcontroller might be something many of my fellow *EPE* readers would enjoy. It makes using a PIC really easy, and is in the hobbyist's price bracket, too.

All the software for program development is available as a free download, and the download includes a simulator. If you go ahead and buy the hardware, you don't have to change the software you've already set up. The hardware plugs into your PC with a serial cable. Besides the ordinary facilities of a PIC, the Pascalite offers a temperature sensor, real time clock, and l.c.d. modules (you can buy all or none) already integrated with the device's software. So, for instance, you can put: **write (LCD,"Hello World")** in your program to get that on the l.c.d.

Pascalite also has an I^2C interface as standard, i.e., it comes ready to be a master on an I^2C net.

As I say, I'm only a happy customer. As such I've set up a few web pages on my own site. For an overview go **www.arunet.co.uk/tkboyd/ele1ps.htm**.

For a "Now that you have one" Getting Started guide (which you might want to glance at, just to see how easy everything would be), go **http://sheepdogsoftware.co.uk/plh1.htm**.

Tom Boyd, via email

Thanks Tom. Readers, Tom's site is worth a visit in its own right, ***www.arunet.co.uk/tkboyd.***

SUPER MOTION SENSOR

Dear EPE,

In the *Super Motion Sensor* (May '03), the author refers to flicker at 50Hz from lighting in the UK and 60Hz in the USA; a common fallacy. Fluorescent lights and incandescent lights are not polarity sensitive like l.e.d.s. The flicker is therefore double the supply frequency, 100Hz and 120Hz respectively.

Guy Selby-Lowndes, Billinghurst

Thank you Guy. You are, of course, quite right about the error. We should have spotted it.

PIC BOARDING

Dear EPE,

So glad to see you have covered some info on the PIC16F877 in the new *PIC Tutorial V2*.

I am confused about the *PICmicro MCU Development Board*. It appears to have various sockets, one looks like it is for the PIC16F877. Is this correct, and does your updated *PICmicro V2* CD-ROM have much information on this chip?

I have just bought two of the bare *PIC Toolkit Mk3* boards. Can I buy one assembled? If not, can I buy a kit that has all the parts so I don't have to chase them down? What is the difference in the *Mk3* board and the *MCU Development Board?* Can I use the latter board for your *PIC Tutorial V2* course? I am pleased you also cover PICs and serial communications via the PIC16F877.

You have opened up a whole new area for me with microcontrollers. I have bought and downloaded a lot of information but yours is where I really learn. You know so many programming tricks. It takes me a while to figure out some of them but I have never had assembly until your course and development boards. Thanks and keep up the good work. You're the best!

Anthony Allen, via email

Thank you Anthony. The big socket is indeed for the PIC16F877. No, PIC datasheets are not on the CD-ROMs, but they can be download free from ***www.microchip.com****. I tried to get Microchip's permission to include them on the* PIC Resources CD-ROM, *but they wanted to perform "The Spanish Inquisition" on us in such a fashion that we dropped the idea.*

We only sell unpopulated p.c.b.s and do not supply components. We have many excellent component advertisers who will gladly help you.

Mk3 *is my general purpose board for* Toolkit TK3 *as published in* EPE *(Oct/Nov '01). The* MCU Dev *board is a commercial product with additional facilities, ready-made, but otherwise is similar in concept – it can be used with* PIC Tutorial V2 *but I do not refer to it in my discussions. Where I make reference to particular pins you will need to use just a bit of intelligence to match my intentions to the* MCU *board!*

We have an article on serial interfacing between PICs and PCs coming later in the year. Joe Farr (of IC Tester *fame – Oct '02) has written the software, and developed a versatile interface p.c.b. to go with it. I've recently been testing it all for him and it's excellent.*

Your kind comments are much appreciated, Anthony. Keep up being a nice reader!

PIC BANKS

Dear EPE,

I would like to say how much I appreciated John Waller's article *Using the PIC's PCLATH Command* (July '02), and Malcolm Wiles' *PIC Macros and Computed GOTOs* (Jan '03).

However, I am having problems with Malcolm's code in that he assigns his working file registers all in Page zero. I am sure his code works and the problem is my lack of understanding. I would like to display the various results in his table access but I am having problems accessing the ANS file register in other than Page 0. Perhaps Malcolm can clear up my confusion.

Please keep up the excellent articles on PICs.

Royce Simmons, via email

Malc kindly replied as follows:

Thank you for your kind comments about my recent article.

First a point about terminology. On the PIC16F87x, both program memory and data memory are segmented. Microchip documentation refers to the program memory segments as "Pages", and the data memory segments as "Banks". For clarity it's helpful to use this terminology consistently, as I try to do in the Jan '03 article. So when you refer to "data registers in Page zero", it would be less confusing to refer instead to "data registers in Bank zero".

My Jan '03 article was mainly about using macros to simplify manipulation of the page segment register PCLATH when using data tables held in program memory. I chose to put all the data locations into Bank 0 because that avoided complicating the example program with additional bank selection code, which would have tended to obscure the main points I wanted to make. If you want to access data locations in other banks, you will need to add the necessary bank selection code.

The example program defines two macros, BANK0 and BANK1, to manipulate (part of) the bank segment register (physically bits 5 and 6 of the STATUS register), but doesn't actually use them. Placed before a data file access, they will allow you to address Banks 0 and 1. If you also want to address Banks 2 and 3, then these definitions of BANK0 and BANK1 are not sufficient – you would need instead to do something along the lines of:

```
BANK0   macro
        bcf     0x03,5
        bcf     0x03,6
        endm
BANK1   macro
        bsf     0x03,5
        bcf     0x03,6
        endm
BANK2   macro
        bcf     0x03,5
        bsf     0x03,6
        endm
BANK3   macro
        bsf     0x03,5
        bsf     0x03,6
        endm
```

and use these macros to address the correct data bank. Thus in your case, if ANS is in Bank 3, you would need to do:

```
        CALLTAB Tab1,ZERO
        BANK3
        movwf   ANS
```

and so on. Don't forget that the bank register will stay pointing at Bank 3, so if your offset, disp etc data registers are in Bank 0 as mine are, then you will need to do BANK0 before the next CALLTAB (or else modify the definition of CALLTAB to do this).

Malc Wiles, via email

GET GOOGLING!

Dear EPE,

I am battling to source a MOSFET BF981. I have tried a number of UK suppliers, but to no avail. Have you any idea where it could be purchased?

Barry J. Clarke, South Africa

So sorry, Barry, but we cannot help you directly on sourcing components unless they are used in our published project designs, in which case colleague Dave Barrington goes to great lengths to ensure that sources of supply are available, giving details of anything unusual through his Shoptalk *column.*

However, looking at the web via the excellent search engine ***www.google.com****, over 500 entries showed there for the BF981 so I suggest you have a browse. It could also be useful to ask readers via our* Chat Zone *(accessed via our Home page at* ***www.epemag.wimborne.co.uk****) to see if anyone knows a source.*

Readers – both lines of enquiry are worth taking for all sorts of information. It's amazing what knowledge many of our CZ-ers have. It is always a courtesy though, to at least do a bit of your own research, via Google for instance, before asking others for help. It is an even more important courtesy to thank anyone who has been able to help you. Sadly, I notice that this is not always done.

HAPPY CAMPING

Dear EPE,

I'm trying to learn PICs. I'm just thinking that with all the programmers offered and options presented, I'll make a mistake and the wife will not be a happy camper. I just have to be comfortable I'm not selecting a piece that I won't be able to use to program another PIC in the future. PIC projects needing one programmer module per project would be costly if I want to make several of them.

What do you suggest I purchase in the way of programmer setup so I can keep doing projects and all I need to do is get new code and a new PIC each time? Sounds sorta dumb, given the amount of PIC articles, but I see the ads and then I get unsure. I want a simple but expandable and reusable system in which all I need to do is change PICs.

Dave Mynatt, Manchaca, Texas

Dave, all PIC programmers by their nature are reusable, plug in PIC, program PIC, take out PIC, use PIC, plug in another PIC for another project later, etc.

You'll find my Toolkit TK3 *programmer very versatile – and I have been using it for all my programs since I wrote it. Build it and enjoy happy camping – well happy PICing anyway!*

VERSE AND WORSE!

Dear EPE,

I found these "gems" in the November '75 issue of *Radio & Electronics Constructor* magazine in a second-hand bookshop and hope you and other *EPE* readers find them amusing.

- When capacitors have a holiday do they go to the C-side Faraday?
- In 1875 Alexander Graham Bell invented the telephone; this was a failure until 1876 when he invented the other telephone.
- Guide to metrication:
  10 Hertz = 5 bicycles per second
  10 millipedes = 1 centipede
  10 decimals = 1 mal
  10^{12} pins = 1 terrapin
  Millicent = Hector
  Centigram = unit for weighing rose petals
- Transistors? They're as easy as E-B-C.
- Dud f.e.t.s – money down the drain.
- A meter takes a sample
  And shows if the current is ample
  It also shows up faults
  By measuring the volts
- Soot all over the bench! It came out of the sweep generator.
- Cat's whiskers – are they made of mu-metal?
- Guide to technical terms:
  Portable – it has a handle on it
  Hi-Fi/Stereo – it has two loudspeakers
- I don't like the explanation about how transistors work. It's full of holes.
- Cheap alternative to the videocassette recorder – wait three months then turn the set on again.

P.S. I'm currently in my final year at Sussex University, reading Electrical & Electronic Engineering (BEng).

Jonathan Grainger, via email

Splendid, Jonathan! Astonishing what reading up for BEng reveals – may you pass with Honours!

Constructional Project

PRACTICAL RADIO CIRCUITS

RAYMOND HAIGH

Part 2: Regeneration, Q-Multiplier, Reflex Radio and a Speaker Amp.

Dispelling the mysteries of Radio. Features a variety of practical circuits for the set builder and experimenter.

IN Part One, last month, we looked at the fundamental principles and early history of radio, and detailed the construction of a TRF (tuned radio frequency) receiver. Its selectivity and sensitivity are barely adequate and, this month, a simple add-on unit that will transform its performance is described.

Also included is an alternative circuit for a simple medium wave portable radio. But first, some historical background.

AUDION

The invention of the triode valve, by Lee de Forest, in 1906, made available, for the first time, a means of amplifying radio frequency signals.

These early valves were only partially evacuated (soft), hand made, and extremely expensive. Their operation was not completely understood, and they were used, initially, as detectors and audio frequency amplifiers.

Lee de Forest called his invention the Audion. It was only later that Eccles, of flip-flop fame, described the device as a *triode*.

SERENDIPITY

In 1913, whilst experimenting with a triode detector, Edwin Howard Armstrong realized that radio frequencies were present at the anode (plate in the USA) or output port of the valve. He connected a second tuning coil in the output circuit and noticed a dramatic rise in receiver sensitivity when he brought it closer to the grid tuning coil. When the coils were very close, the circuit began to oscillate.

He had, almost by accident, discovered the regenerative detector and valve oscillator. He patented the circuit in October 1913, two months before his twenty-third birthday.

Lee de Forest, Alexander Meissner, Irving Langmuir, C. S. Franklin and others made similar discoveries, and there was much patent litigation. In 1921, the Columbia Court of Appeals gave judgement to Lee de Forest on the basis of a legal technicality. It is widely accepted, however, that the credit, at least for the regenerative receiver, is Armstrong's.

BREAKTHROUGH

Armstrong's discoveries made reliable, long distance radio communication a possibility. The valve oscillator eventually formed the basis of powerful transmitters capable of operating at higher frequencies than those attained hitherto.

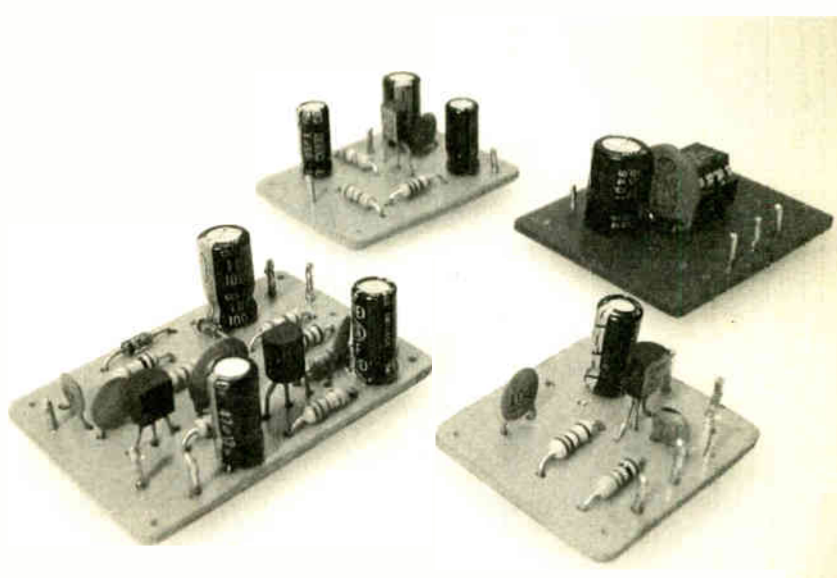
His regenerative circuit provided a simple and inexpensive means of greatly increasing receiver sensitivity and selectivity. It remained the most popular receiving system until the superhet (another invention of Armstrong's) achieved dominance during the 1930s.

MAGNIFICATION

In Part One we touched on the signal magnifying effect of a resonant tuned circuit formed by combining an inductor (coil) and a capacitor. It will be recalled that magnification is limited mainly by resistive and other losses in the coil.

If losses are kept low, the coil is said to have a high Q factor. With careful design and construction, Q factors in excess of 100 are not difficult to achieve. However, when the coil is connected into circuit, the loading or damping effect of valves, transistors and other components reduces its Q significantly.

If a signal at the resonant frequency is applied to the coil and capacitor combination, its voltage will be increased in proportion to the Q factor. Thus, with a Q of 100, a 1mV signal will be magnified to 100mV or 0·1V. Off-resonance signals are not magnified in this way, and the greater the Q the more selective the tuned circuit.



Completed circuit boards for the following (left to right, clockwise): MK484 TRF Receiver (Pt 1 – June '03), Headphone Amplifier (Pt 1 – June '03), Speaker Amplifier (this issue) and Q-Multiplier (this issue).

REGENERATION

By progressively feeding back energy to the tuned circuit in phase with the incoming signal, i.e. *positive feedback*, the resistive and other losses in the coil are gradually overcome and very high Q factors can be achieved. As the positive feedback is increased beyond the point where the losses are eliminated, the circuit begins to oscillate.

Armstrong found that feedback, or ***regeneration*** as it came to be known, increases the strength of weak signals by a factor of 1000 or more and, because the increase is due wholly to the dramatic rise in tuned circuit Q, there is also a big improvement in selectivity.

Regeneration enhances weak signals more than strong ones, and the system exhibits an a.g.c. (automatic gain control) action. In practice, however, the effect is not pronounced, and there is a much greater range of output levels than is the case with a superhet receiver with conventional a.g.c. circuitry.

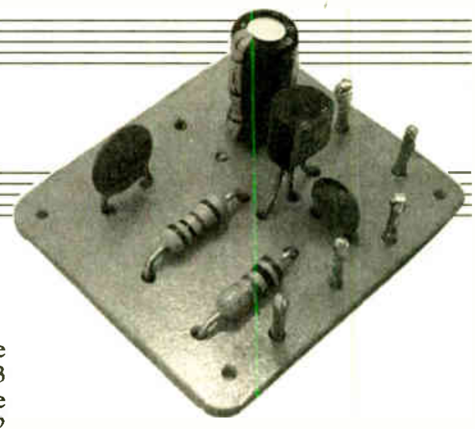
DRAWBACKS

Regenerative receivers are easily swamped by powerful signals (the tuning tends to lock onto strong carriers), and their sharply peaked selectivity curve attenuates the higher audio frequencies. Overloading by strong signals can, however, be avoided by fitting a simple input attenuator, and some top cutting is not too high a price to pay for a big improvement in selectivity.

Skill is required of the operator if high performance is to be achieved. The regeneration control has to be carefully set to bring up weak signals, and the input level adjusted to prevent overload. This, more than anything else, brought about the gradual demise of the system after Armstrong invented the superhet, with its more user-friendly controls, in 1918.

Like the author, readers will no doubt be keen to get high performance at the lowest possible cost, and a regenerative receiver is as close as it comes in the field of radio and electronics to getting something for nothing. A number of modern examples of the technique will, therefore, be included in the series.

SIMPLE Q-MULTIPLIER



Improve the performance of last month's MK484 TRF Receiver

Q-MULTIPLIER

By applying regeneration, or Q multiplication, to its ferrite loop aerial, the performance of the MK484 TRF Receiver described last month can be dramatically improved. Levels of sensitivity and selectivity approaching those of a domestic superhet can be achieved. Because of the small voltages developed across the loop aerial, swamping by strong signals is not normally a problem, especially if the ferrite rod is rotated for minimum pick-up, as described last month.

The circuit diagram of the simple add-on Q-Multiplier unit is given in Fig.2.1 where L1 is the receiver's ferrite loop aerial, and field effect transistor, TR1, provides the radio frequency amplification needed for the multiplying process.

Amplification, and hence the level of feedback, is controlled by potentiometer VR1, which varies the voltage on the drain (d) of transistor TR1. Bypass capacitor C1 eliminates potentiometer noise.

The received signal is taken from the tuned circuit via d.c. blocking capacitor C3 (biasing puts a positive voltage on the input pin of the MK484 radio i.c.), and R2 is TR1's gate (g) bias resistor. Source (s) bias is developed across resistor R1, which is bypassed, at radio frequencies, by capacitor C2.

The circuit is configured as a Hartley oscillator with feedback from the source of TR1 being coupled to the tuned circuit by coil L2. This is two turns of plastic insulated hook-up wire wound over the "earthy" end of tuning coil L1. If the feedback coil L2 is wound in the same direction as the tuning coil, the correct connections for Q-enhancing positive feedback are as shown in Fig.2.2.

CONSTRUCTION

With the exception of the Regeneration control, VR1, all of the components are mounted on the small printed circuit board as illustrated in Fig.2.2. A full-size copper track master is also included. This board is available from the *EPE PCB Service*, code 397.

Commence construction by mounting the resistors and capacitors on the board first and the transistor TR1 last. It is good practice to clip a miniature crocodile clip onto the leads of field effect devices to act as a heat shunt whilst they are being soldered into position.

Terminal pins, inserted at the board lead-out points, will simplify the task of off-board wiring, details of which are also given in Fig.2.2. Locate the multiplier p.c.b. close to the receiver's ferrite loop aerial in order to keep the leads to coil L2 reasonably short; no more than two or three inches (50mm to 75mm).

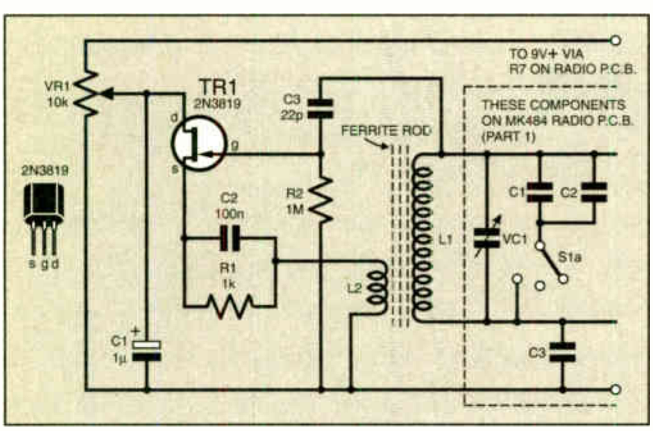


Fig.2.1 (above). Circuit diagram for the simple add-on Q-Multiplier for the MK484 TRF Receiver. (Tuning coil L1 was covered last month.)

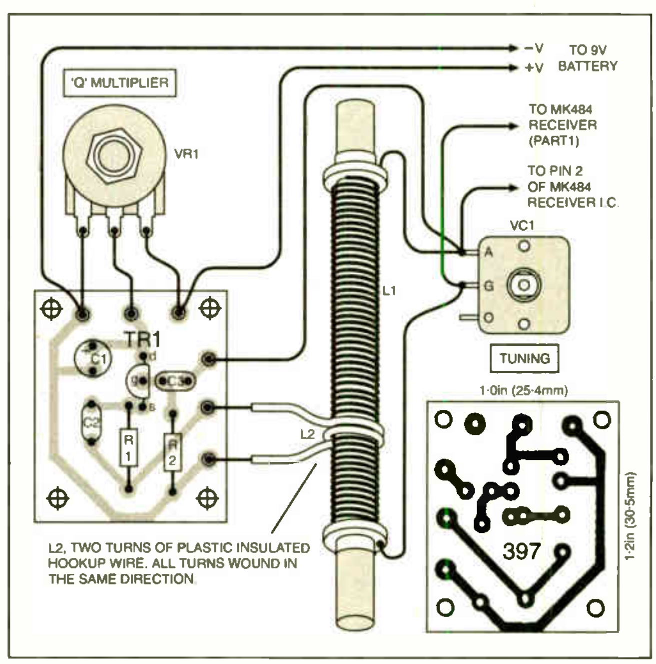


Fig.2.2 (right). Printed circuit board component layout, wiring and full-size copper foil master for the Q-Multiplier.

COMPONENTS

Approx. Cost Guidance Only £6 excl. case & 'phones

Q-MULTIPLIER

Resistors

R1	1k
R2	1M

All 0·25 5% carbon film

Potentiometers

VR1	10k rotary carbon, lin.

Capacitors

C1	1μ radial elec. 16V
C2	100n disc ceramic
C3	22p disc ceramic

Semiconductors

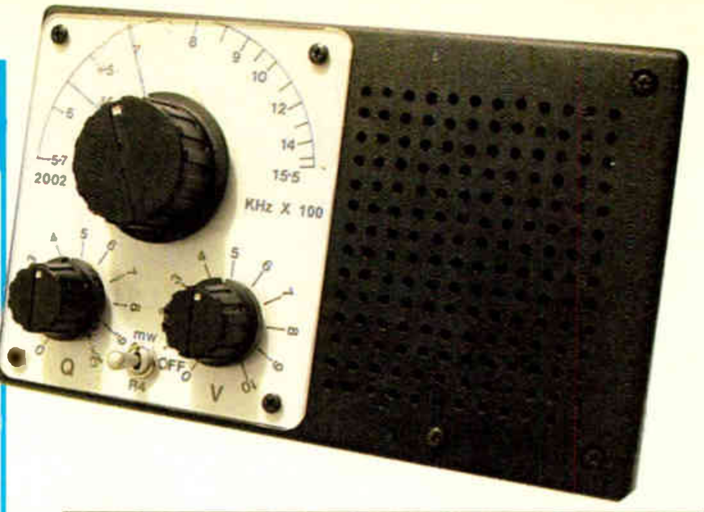
TR1	2N3819 field effect transistor

Miscellaneous

L1/L2	ferrite loop aerial (last month), with the addition of two turns of plastic-covered wire – see text

Printed circuit board available from the *EPE PCB Service*, code 397; plastic case, size and type to choice; control knob; connecting wire; solder pins; solder etc.

See SHOP TALK page



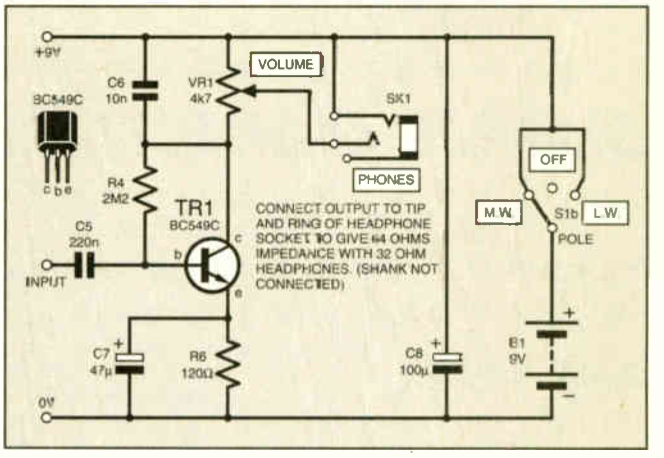


Fig.2.3. Circuit modifications for connecting headphones to last month's TRF Receiver. The front-end Q-Multiplier must be included to ensure sufficient output – see text.

SETTING UP

Check the p.c.b. for poor soldered joints and bridged copper tracks, and check the orientation of TR1 and electrolytic capacitor C1. If all is in order, connect the "hot" end of VR1 to the receiver's power supply.

Tune in a weak station on the receiver and advance VR1. Perceived signal strength will greatly increase, and receiver tuning may have to be adjusted slightly because of the improved selectivity.

Weak signals, formerly below the sensitivity threshold of the MK484 i.c., can now be made clearly audible. Maximum sensitivity and selectivity are obtained with VR1 set close to the onset of oscillation, when current consumption of the Q-Multiplier will be approximately 1mA.

The unit should go into oscillation when VR1 is approaching its maximum setting. If difficulty is encountered with receivers that have a lower supply voltage, increase the number of turns on L2 and/or reduce the value of resistor R1. Conversely, if the action is too vigorous, connect a fixed resistor of, say, 10 kilohms in series with VR1 and/or increase the value of R1.

Other than the need to connect L2 in the correct sense for positive feedback, the circuit is not critical and very easy to set up.

OTHER RECEIVERS

Problems of alignment will be encountered if this Q-Multiplier is used with superhet receivers. The ganged tuning stages (aerial and oscillator) of a superhet cannot be maintained in perfect alignment over the full swing of the tuning capacitor. (When correctly adjusted, alignment is perfect at three points on the dial).

This inherent defect is unnoticeable with broadly tuned ferrite loop aerials of normal *Q*. However, loop tuning becomes extremely sharp when *Q* is increased, and the misalignment is then very apparent.

Experienced constructors who have a domestic portable they are not afraid of modifying can overcome this by disconnecting the set's aerial trimmer capacitor (or turning an integral trimmer to minimum capacitance) and substituting a 25pF variable capacitor as a front panel control. By this means the alignment or tracking of the receiver can be continuously adjusted. Some repositioning of the coil on the receiver's ferrite rod may also be necessary.

HEADPHONE LISTENING

The boost in performance given by the add-on Q-Multiplier eliminates the need for the single transistor headphone amplifier described last month. A circuit for connecting Walkman type 'phones directly to the radio p.c.b. is given in Fig.2.3, where TR1 is the audio amplifier following the MK484 radio i.c. used in last month's TRF Receiver, and VR1 is a potentiometer connected in place of the original collector load resistor R5.

Details of the wiring between the receiver p.c.b., the potentiometer and the jack socket are shown in Fig.2.4.

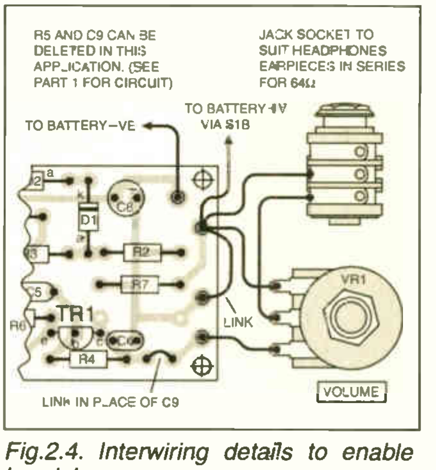
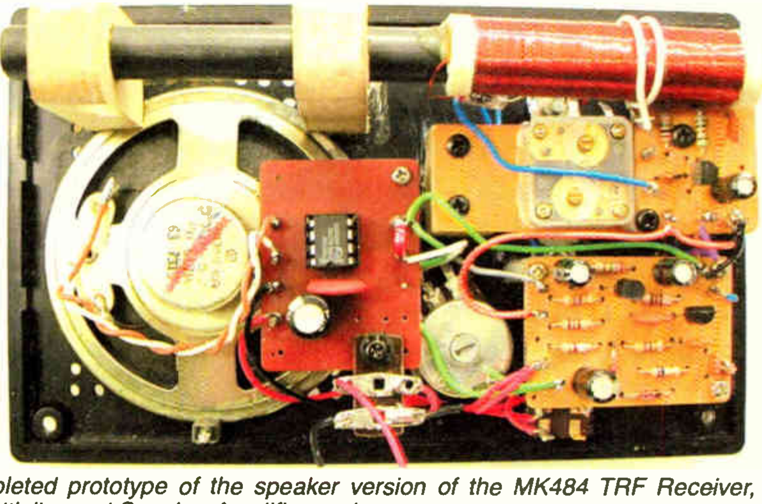


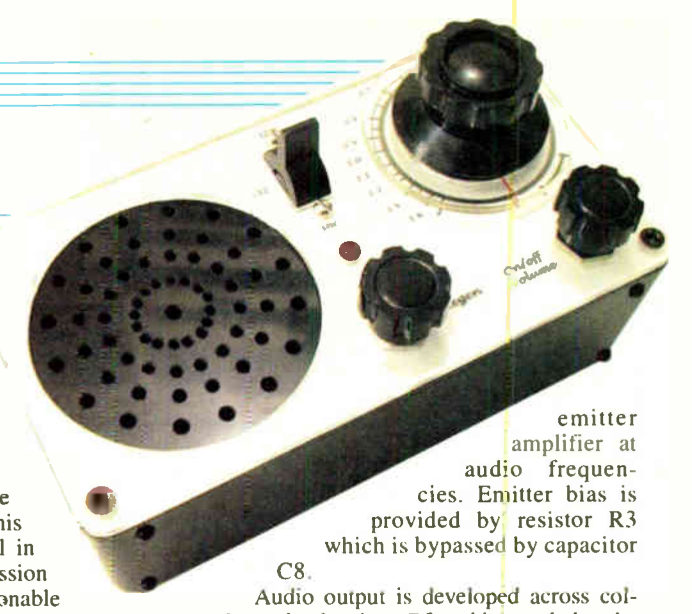
Fig.2.4. Interwiring details to enable headphone use.



Completed prototype of the speaker version of the MK484 TRF Receiver, with Q-Multiplier and Speaker Amplifier p.c.b.s.

MW REFLEX RADIO

A 60's style, low-cost, easy-build medium wave portable



REFLEXING

The high cost of valves in the early days of radio led designers to contrive ways of using them twice, first as radio frequency amplifiers and then, after the signal had been demodulated, as amplifiers of the recovered audio frequency signal.

This technique, known as ***reflexing***, was adopted again when transistors were first introduced in the 1950s. At that time, devices with a modest specification cost the present day equivalent of £10 ($15) or more, and there was the same incentive to use them twice.

Although the cost of transistors has plummeted, some of the reflex designs developed during the 1960s combined simplicity with good performance, and they are well worth a second look.

In 1964, Sir Douglas Hall published the first transistor reflex circuit in which impedances along the signal path were roughly matched. It was subsequently reworked by G. W. Short and others, including the author, and the version given here uses current production transistors and components. It also incorporates a smooth and effective regeneration control and an optional circuit for preventing strong-signal overload.

REFLEX RECEIVER

The circuit diagram for the MW Reflex Radio is given in Fig.2.5. Coil L1 is a ferrite loop aerial tuned by variable capacitor VC1. If desired, an additional capacitor, made up of C1 and C2, can be switched across the coil by S1a to tune it to *Radio 4* on the Long Wave band. This arrangement works well in areas where the transmission can be received at reasonable strength.

Coupling winding L2 matches the low impedance presented by the base (b) of transistor TR1 to the tuned circuit. Potentiometer VR1 controls the gain of the circuit at radio frequencies and acts as the Q-Multiplier or regeneration control.

Transistor TR1 functions as a grounded emitter stage at both radio and audio frequencies, with the amplified signals being developed across collector (c) load resistor R1.

Transistor TR2 is configured as an emitter follower buffer at radio frequencies, the output being developed across radio frequency (r.f.) choke L5. The relatively high impedance at the base of TR2, in this mode, optimizes signal transfer from the collector of TR1, whilst the low emitter impedance is a reasonable match for detector diode D1.

The demodulated signal is fed back to the base of TR1, via coupling coil L2, for further amplification at audio frequency. Residual radio frequencies are removed by capacitor C4.

Output from the collector (c) of TR1 is directly coupled to the base (b) of TR2, which functions as a common emitter amplifier at audio frequencies. Emitter bias is provided by resistor R3 which is bypassed by capacitor C8.

Audio output is developed across collector load resistor R2 and is coupled to the Volume control by d.c. blocking capacitor C10. Radio frequencies are removed from the audio signal path by the shunting action of capacitor C9.

Power is connected to the circuit via switch S1b, and a low current l.e.d., D2, with its dropping resistor R5, act as an optional On indicator. Readers may wish to connect the tuner and a power amplifier to the same battery, and the necessary supply line decoupling is provided by resistor R4 and capacitor C11.

FEEDBACK

Connecting the collector of TR1 to the "hot" end of the tuning coil L1, via capacitors C5 and C6, provides the positive feedback needed for the Q multiplying process. In order to keep the feedback at the correct level, the capacitors must have a very low value, and C5 comprises about 6mm ($^1/_4$in.) lengths of plastic covered hook-up wire twisted together.

Low value ceramic capacitor C6 is placed in series with C5 so that the twisted wires can have a reasonable length. Shunt capacitor C7 improves the action of VR1, the Regeneration or Q-Multiplier control.

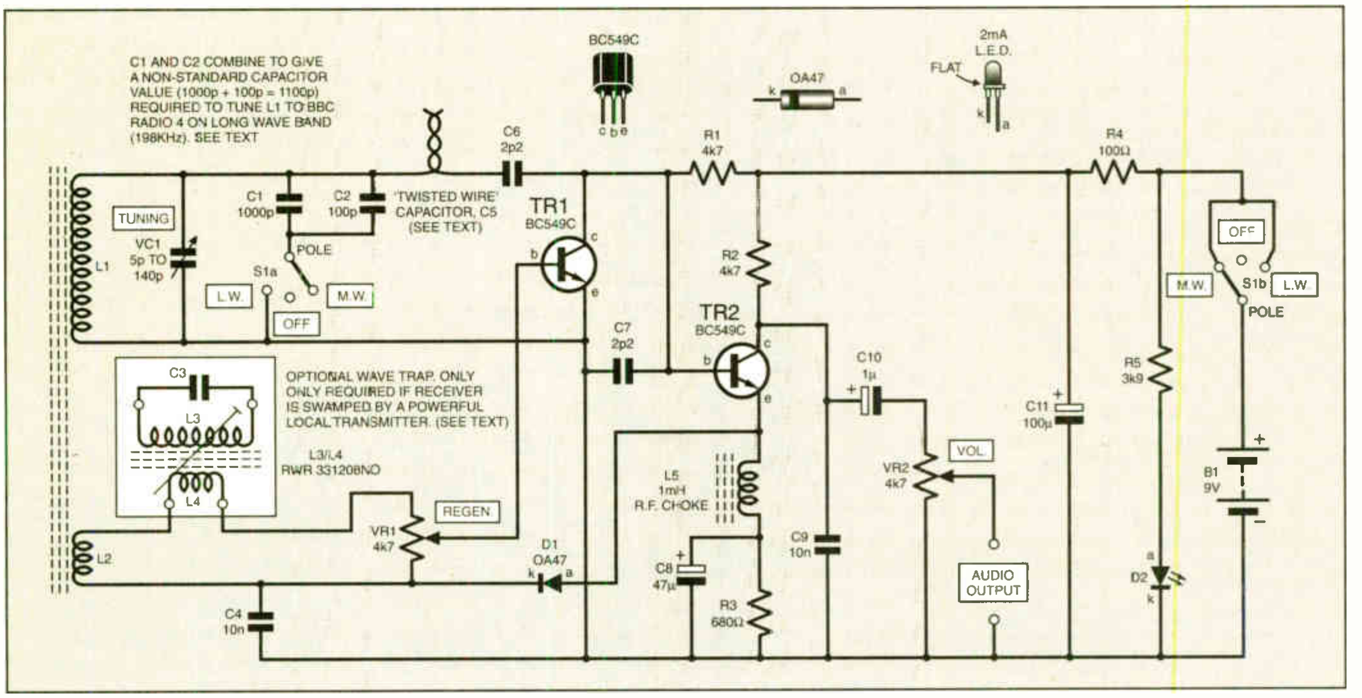
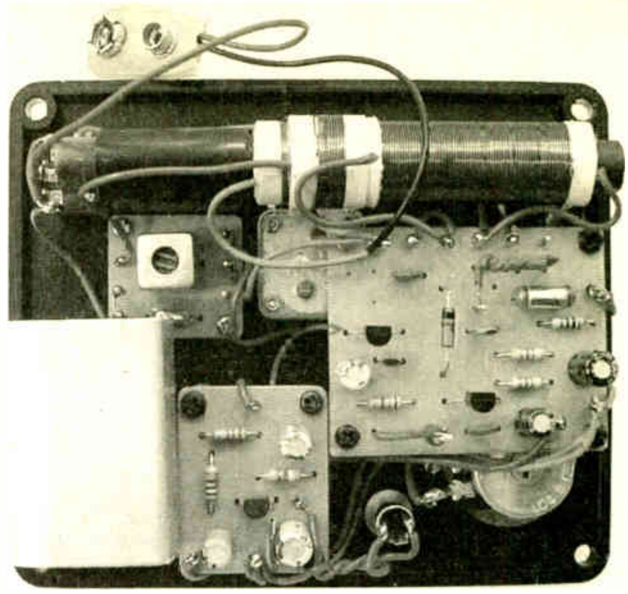


Fig.2.5. Circuit diagram for the MW Reflex Radio. Provision is provided for one preset longwave station – BBC Radio 4.

Table 2.1: Wave Wrap Tuning Ranges with Standard Value Capacitors

Capacitor Value pF	*Frequency (kHz) (core fully In)*	*Frequency (kHz) (core fully Out)*
33	1300	1700
47	1100	1400
68	900	1200
82	820	1100
100	740	1000
120	680	900
150	600	800
180	550	700
220	500	650

Notes:
(1) The above tuning ranges are obtained with a Toko type RWR331208 tuning coil
(2) Use polystyrene or "low k" ceramic capacitors



Interior of the headphone version of the MW Reflex Radio showing the wave trap, receiver and headhone amp p.c.b.s.

SWAMPING

Since the 1960s, often powerful local stations have proliferated on the medium wave band and they tend to swamp these simple receivers. (The author lives almost in the shadow of a transmitter mast, and the radiated energy is strong enough to badly overload domestic superhets.)

Other readers may be affected in this way, and the simple tuned circuit formed by L3 and C3 is included to attenuate the offending signal. The device is known as a *Wave Trap*.

The tuned circuit takes more than one form and the principles are discussed later. The value of trap tuning capacitor C3 must be selected so that the adjustable core of the coil can be set to the frequency of the offending station. Table 2.1 gives a range of values for the medium wave band.

Coupling winding L4 matches the high impedance trap to the low impedance circuit formed by L2, VR1 and the base/emitter junction of TR1.

CONSTRUCTION

Most of the components for the MW Reflex Radio are mounted on a small printed circuit board. The component side of the board and the off-board wiring together with a full-size copper track master are illustrated in Fig.2.6. The board is available from the *EPE PCB Service*, code 398.

Solder the resistors and r.f. choke L5 in place first, then the capacitors and, finally, the semiconductors. Germanium diodes can be damaged by excessive heat during soldering, and the leads of diode D1 should, therefore, be long enough to permit the attachment of a miniature crocodile clip to act as a heat shunt. The dropping resistor for the optional on/off indicator l.e.d., D2, is *not* mounted on the p.c.b.

With very compact receivers, it is possible for radio frequency choke L5 to interact with the ferrite loop, L1, and produce unwanted feedback (some designs use this as a means of providing preset regeneration). Assuming that the p.c.b. will be mounted in the same plane as the loop aerial (it invariably is), the choke should be mounted vertically on the board to avoid this problem. Miniature radio frequency chokes look like, and are colour coded in the same way as, resistors, the code giving the value in microhenries (1000μH = 1mH).

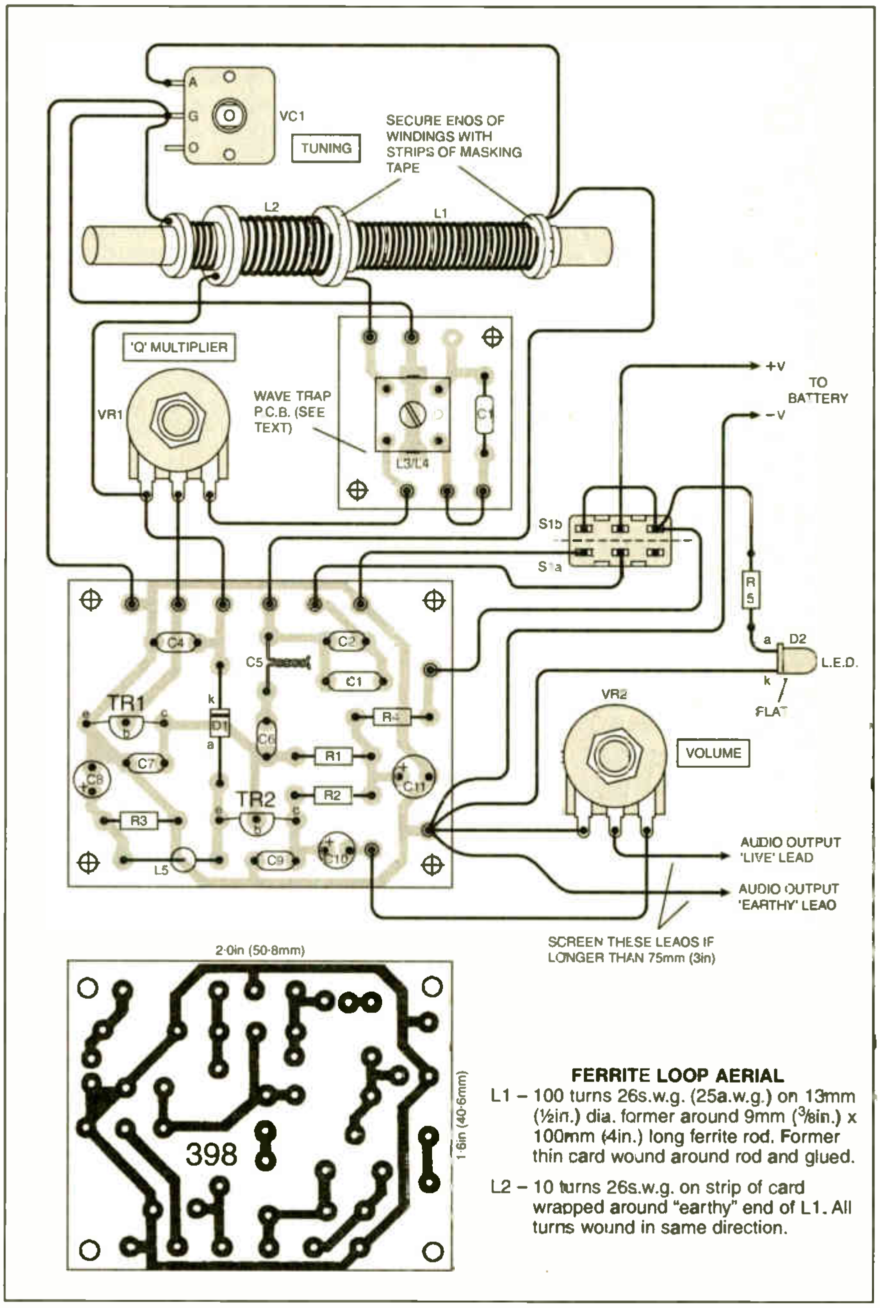
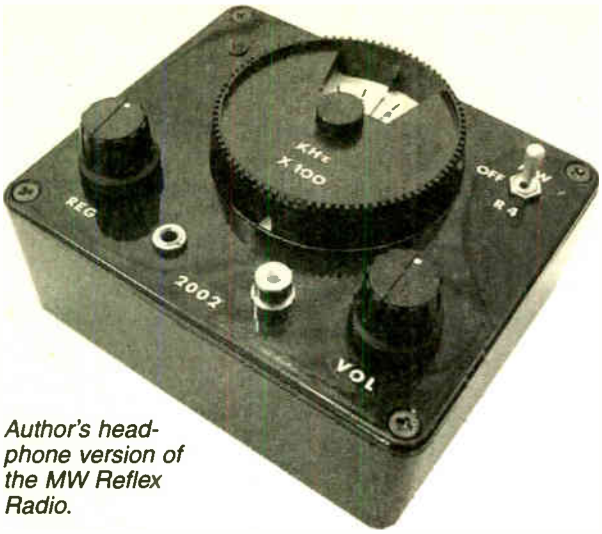
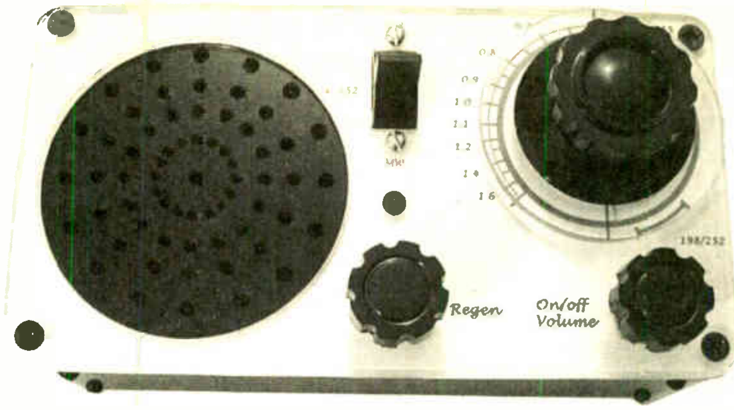


Fig.2.6. Printed circuit board component layout, interwiring and full-size copper foil master for the MW Reflex Radio. Ferrite loop aerial construction was covered in Part 1. The Wave Trap is only needed where a local transmitter swamps the receiver. Connect VR1 directly across L2 when the trap is not wanted.



Author's headphone version of the MW Reflex Radio.



Completed speaker version of the MW Reflex Radio.

COMPONENTS

REFLEX RADIO

Resistors

R1, R2,	4k7 (2 off)	See SHOP TALK page
R3	680Ω	
R4	100Ω	
R5	3k9Ω	

All 0·25W 5% carbon film

Potentiometers

VR1	4k7 rotary carbon, lin.
VR2	4k7 rotary carbon, log.

Capacitors

C1	1000p polystyrene (see text)
C2	100p polystyrene (see text)
C3	see Table 2.1, only required if using Wave Trap
C4, C9	10n disc ceramic(2 off)
C5	twisted wires (see text)
C6, C7	2p2 disc ceramic (2 off)
C8	47µ radial elect. 16V
C10	1µ radial elect. 16V
C11	100µ radial elect 16V
VC1	5p to 140p (minimum), polythene dielectric variable capacitor

Semiconductors

D1	OA47 germanium diode
D2	low current (2mA) l.e.d.
TR1, TR2	BC549C *npn* small signal transistors (2 off)

Miscellaneous

L1/L2	ferrite loop aerial: 100mm (4in.) x 9mm/10mm (3/8in.) dia. ferrite rod with coil (see text)
L3/L4	tuning coil, Toko RWR 331208 (only required if Wave Trap fitted)
S1	d.p.d.t. centre-off toggle switch (see text)

Printed circuit board available from the *EPE PCB Service*, code 398; plastic case, size and type to choice plastic control knob (3 off); 50g (2oz) reel of 26s.w.g. (25a.w.g.) enamelled copper wire, for tuning coil; card and glue for coil former; l.e.d. holder; connecting wire; 9V battery and clip; stand-off pillars; solder pins; solder etc.

Approx. Cost Guidance Only £12 excl. case, wire & batt.

Again, solder pins inserted at the lead-out points will simplify off-board wiring. Readers who do not require the Wave Trap should, of course, connect coupling coil L2 directly to the "hot" end of VR1.

LOOP AERIAL

The loop aerial is the same as the one used in the MK484 TRF Receiver described last month, but with the addition of a ten turn base coupling winding, L2.

A strip of card or masking tape, wound over the "earthy" or start end of L1, will make it easier to add the coupling coil. The base winding of L2 must be connected in the correct sense to ensure positive feedback, and full details are given in Fig.2.6.

SETTING UP

Check the completed p.c.b. for poor soldered joints and bridged tracks, check the orientation of the semiconductors and electrolytic capacitors, and make sure the off-board wiring has been correctly routed.

If all is in order, connect the board to a 9V battery. Current consumption, without l.e.d. D2, should be around 3mA.

Connect the Reflex Radio p.c.b. to the Headphone Amplifier described last month or the Speaker Amplifier described later. Switch on and tune in a weak signal at the low frequency end of the medium wave band and advance Regen. control VR1.

Signal strength should increase dramatically. If it does not, reverse the connections to L2. The circuit should begin to oscillate (a hiss in the speaker) when VR1 is close to its maximum setting. If the Q-Multiplier action is too fierce, untwist capacitor C5 a little.

If the Wave Trap (L3/L4 and C3) option has been fitted, tune the receiver to the offending station, then, with a plastic trimming tool, adjust the core of L3/L4 until its perceived strength has been reduced as much as possible.

If provision has been made for reception of *BBC Radio 4* on long waves, switch in capacitors C1 and C2 and peak the signal with tuning capacitor VC1.

WAVE TRAPS

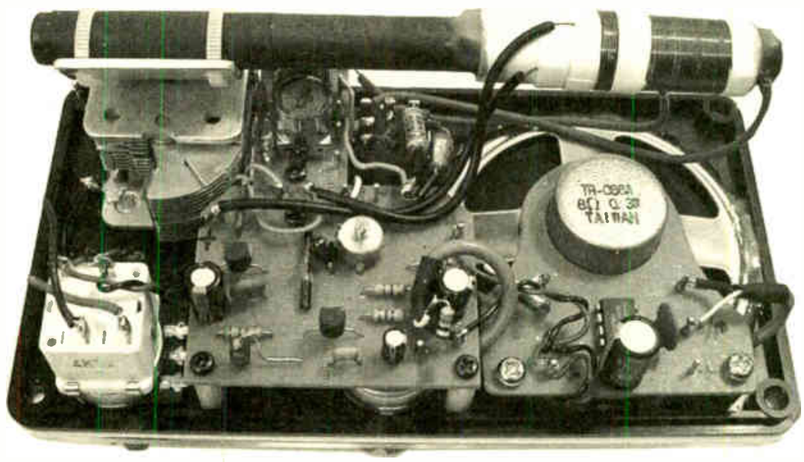
Simple receivers are swamped by powerful signals, which can also degrade the performance of complex communications equipment. An old, but effective, solution is to attenuate the offending signal before it gets into the receiver. If this is not practicable (e.g., sets with loop aerials), then it should be attenuated *before* it reaches the amplifier stages.

This single-frequency attenuator is called a Wave Trap. It is no more than a tuned circuit resonant at the frequency of the signal to be blocked out or shunted to ground.

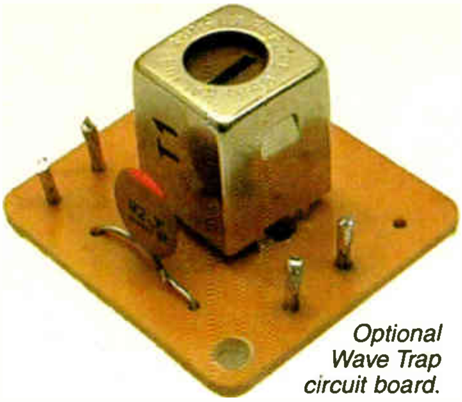
Rejection

The most common arrangement is shown in Fig.2.7a. Here the parallel tuned circuit, connected in the aerial lead, presents a high impedance to the unwanted signal and heavily attenuates it. This arrangement is very effective when the input impedance of the receiver is less than 1000 ohms (most are either 50 ohms or around 600 ohms).

A parallel tuned trap can be inserted in a loop aerial coupling circuit if an impedance matching winding is provided. This



Interior layout of the Reflex Radio built by a friend (Dr. P. O'Horan) of the author. Note the air-spaced tuning capacitor, trimmer capacitor in place of twisted wires, and mods. to amplifier p.c.b. This set worked "first time" and is claimed to be as good as many small superhet sets.



Optional Wave Trap circuit board.

has already been described in connection with the MW Reflex Receiver project, and the basic circuit is repeated in Fig.2.7b. Without the matching winding, L2, the low impedance presented by the loop coupling circuitry would appear directly across L1 and reduce its *Q* to a useless level.

Acceptance

It will be recalled (see Part 1 – June '03) that a capacitor and inductor in series present a low impedance at resonance and a much higher impedance at other frequencies. The circuit is shown in Fig.2.7c.

In the past, this type of trap was often connected between the aerial and earth terminals of receivers with a high input impedance where it exhibited a shunting effect at the unwanted frequency. (Some valve era receivers had aerial coupling windings that were self-resonant within the medium wave band, and this resulted in the high input impedance). It is occasionally encountered in superhet receivers designed around integrated circuits, where it is used to shunt the intermediate frequency.

TRAP COMPONENTS

The trap tuning inductor should, preferably, be screened to prevent re-radiation of the unwanted signal within the receiver. A modern Toko coil is suitable, and details of suppliers are given in the *Shoptalk* column.

Capacitors should, preferably, have a polystyrene dielectric but "low k" ceramic plate components can be used. Different frequency ranges, within the medium wave band, for various standard capacitor values, are given in Table 2.1.

TRAP CONSTRUCTION

A universal printed circuit board, which can accommodate any of the trap configurations described here, is illustrated alongside Figs.2.7a to 2.7c. The copper track side master of the board is also included This board is available from the *EPE PCB Service*, code 399.

Mount the board as close as possible to the "trapping point" to keep connecting leads as short as possible. Aerial traps should be located inside any metal chassis, alongside the aerial terminal.

ADJUSTMENT

Tune in the offending station and, using a plastic trimming tool, adjust the "trap" tuning coil core until maximum attenuation is achieved.

Traps of this kind work well on the long and medium wave bands where swamping problems are usually encountered. As frequency increases, trap bandwidth widens, and the circuit is no longer capable of single-signal attenuation.

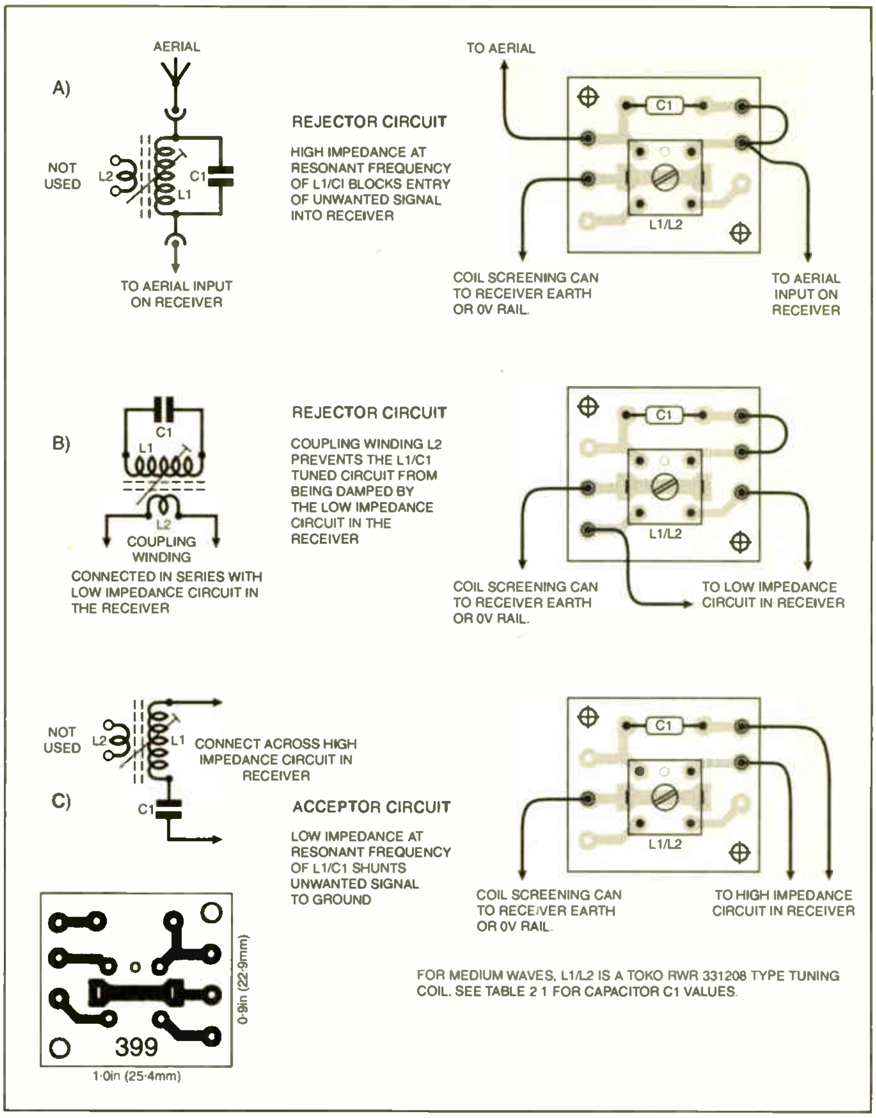
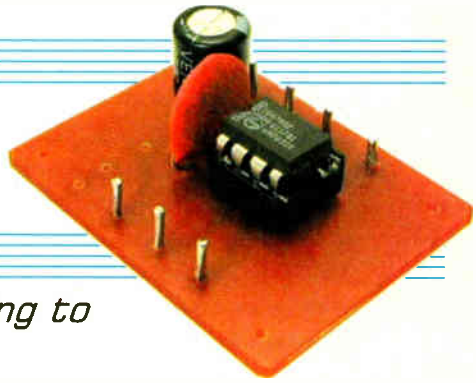


Fig.2.7. Various Wave Trap circuit arrangements to prevent "swamping" of receivers by powerful, usually local, signals. Wiring details and a full-size printed circuit board are also illustrated.

SPEAKER AMPLIFIER



Add loudspeaker listening to your receivers

Many readers will require a loudspeaker output from the various receivers described in the series. A suitable power amplifier can be built using the Philips TDA7052 integrated circuit.

The designers of the i.c. adopted an internal bridge configuration for the output stage, and the device will deliver reasonable power at low supply voltages (450mW with a 4·5V, and 1W with a 9V, supply into an 8 ohm speaker). It also eliminates the need for a speaker coupling capacitor. The external component count is minimal; just two capacitors.

The circuit diagram for a simple TDA7052 Speaker Amplifier is shown in Fig.2.8, where bypass capacitors C1 and C2 ensure stability at radio and audio frequencies. The input pin (IC1 pin 2) is connected to the signal source via a potentiometer (Volume control) and a d.c. blocking capacitor. These components are included with the radio receiver circuits, but are shown again here in the interests of clarity. This input arrangement must also be adopted if the amplifier circuit is to be used with other equipment.

CONSTRUCTION

The printed circuit board component layout, wiring and full-size copper track master for the Speaker Amplifier is illustrated in Fig.2.9. This board is also available from the *EPE PCB Service*, code 400.

COMPONENTS

Approx. Cost Guidance Only £7 excl. speaker

SPEAKER AMPLIFIER

Capacitors

C1	100n disc ceramic
C2	220μ radial elect. 16V

Semiconductors

IC1	TDA7052 (Philips) power amp

Miscellaneous

LS1	8 ohm miniature loudspeaker (see text)

See SHOP TALK page

Printed circuit board available from the *EPE PCB Service*, code 400; 8-pin d.i.l. socket; multistrand connecting wire; twin-core screened audio cable, if leads to Volume control will be longer than 75mm (3in.); solder pins; solder etc.

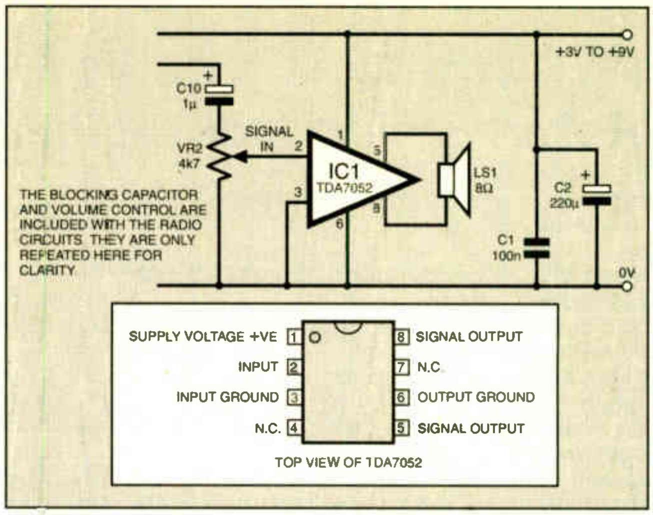


Fig.2.8. Circuit diagram for the Speaker Amplifier.

An 8-pin d.i.l. socket is recommended for IC1 as this makes substitution checking easy. Again, solder pins at the lead out points are a help when carrying out the off-board wiring.

On completion, check the board for bridged tracks and poor soldered joints, and check the orientation of the i.c. and the electrolytic capacitor.

If all is in order, connect an 8 ohm speaker, the volume control potentiometer, and a 9V battery. With the volume control turned to minimum, current consumption should be approximately 5mA. With a good output from the speaker, current drain will increase to approximately 100mA.

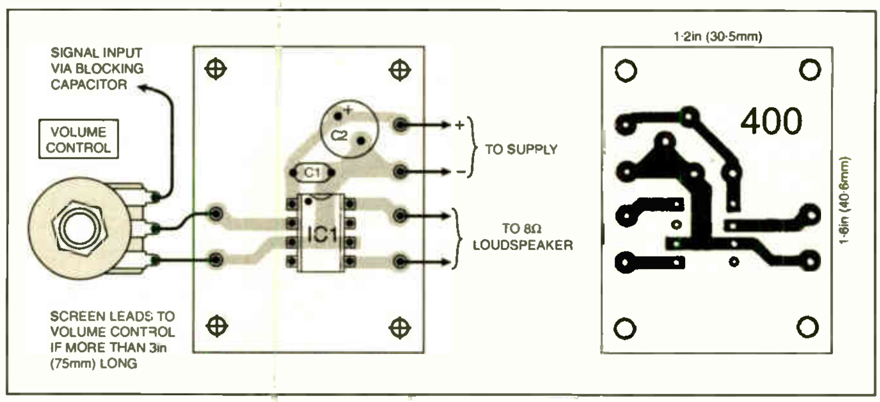


Fig.2.9. Speaker Amplifier printed circuit board component layout, wiring and full-size copper foil master. Note the Volume control pot. is included in the radio circuits.

PERFORMANCE

The noise level of the amplifier is extremely low and its output is free from audible distortion up to the power levels quoted earlier. With a sensitivity of 40mV r.m.s., it can easily be driven to full output by any of the receivers in this series (other than last month's Crystal Set).

Output short circuit protection is built into the chip, which shuts down when dissipation becomes excessive. It will not, however, withstand prolonged abuse, especially with higher supply voltages.

Current consumption for a given power output, although acceptable, is almost twice that of other i.c.s which have more complex external circuitry; e.g., the LM386N-1 and the TBA820M. (The May 2002 edition of *EPE* contained full circuit details of these and other amplifiers).

COMPONENTS

Most of the components for the circuits in Part Two are widely available and no difficulty should be encountered in obtaining them. The semiconductors are not particularly critical. Most *n*-channel junction f.e.t.s should work in the add-on Q-Multiplier.

Similarly, most high gain (h_{fe} at least 400) small signal *npn* transistors should be suitable for the Reflex Radio. The BC239C, BC547, 2N2926 and 2N3711 have been tried and found acceptable. A germanium point contact signal diode must be used (small signal silicon diodes are not suitable), but the actual type is not critical and an OA90 or OA91 could be substituted.

Semiconductor base connections vary and must be checked.

Next month's article will describe high performance regenerative receivers for both general coverage (150kHz to 30MHz) and the amateur bands. We also hope, space permitting, to take a close look at coils, variable capacitors and tuning systems.

PRACTICALLY SPEAKING

Robert Penfold looks at the Techniques of Actually Doing It!

THE USUAL starting point with project construction is the building of the circuit board. With that task out of the way it is tempting to consider the project virtually finished.

With some projects this might actually be the case, but with most there is still a fair way to go before you are ready to start testing the new masterpiece. In fact the mechanical aspects of construction, the hard wiring, and adding panel lettering could easily take longer than building the circuit board.

Turning a circuit board into a fully finished project is not as high-tech as constructing the board, and probably requires fewer new skills to be learned. Most of the tasks involve familiar do-it-yourself tools such as screwdrivers and drills. There is still a certain amount of learning involved though, and a few pitfalls to be avoided.

A lack of care taken on this aspect of construction will not necessarily prevent the project from working, although it is quite likely to do so. A fairly rough finished product is more or less guaranteed, but there is also a slight risk of damaging the circuit board that was so carefully put together.

Guided Tour

Normally, the first task after building the circuit board is to undertake any drilling required on the case so that the controls, sockets, etc. can be fitted in place. Any mounting holes required for the circuit board are also drilled at this stage.

In most instances a few mounting holes for the circuit board will be required, but some cases have built-in guide rails that could render mounting holes unnecessary. The circuit board simply slides into the guide rails, and it is usually locked in place when the removable lid or rear panel is fitted on the case. A board partially fitted into position is shown in Fig.1.

Guide rails are quite common in plastic and die-cast aluminium boxes, but are not often included in most other types of case. Many of the boxes that sport guide rails have a slightly tapered shape. In order to obtain a reliable and rattle-free fit it is sometimes necessary to file the board slightly to produce a matching taper. The guide rail method is perfectly straightforward in other respects.

Unfortunately, for the home constructor there is a major drawback to this system. It is often impractical to use the guide rails unless the circuit board has been specifically designed to suit that particular case.

One potential solution is to produce an over-length version of the circuit board so that it will fit the guide rails. This is often a practical proposition when using stripboard or if you are making your own p.c.b.s, but it is otherwise a non-starter.

There are some variations on the guide rail system, and the most common of these has four plastic clips fitted onto the board. The board is then slotted into the guide rails via these clips. The point of this method is that it enables the circuit board to be mounted at right angles to the rails, which usually permits the case to accommodate a larger circuit board.

It is a good system, but is does have a couple of minor drawbacks. One is simply that it can be awkward to use, and it can be difficult to get everything in place. The second is that with this round-about method the board is not held as securely as with most other mounting systems.

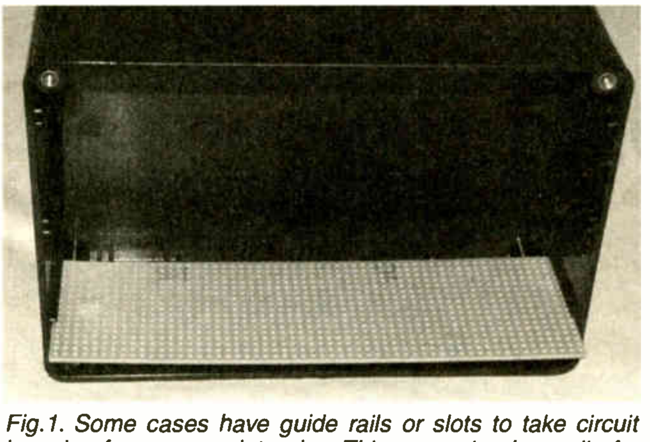


Fig.1. Some cases have guide rails or slots to take circuit boards of an appropriate size. This case also has rails for mounting the board vertically.

Shattering Experience

Due to their limitations for the home constructor, most projects have the circuit board held in place using small nuts, bolts, and spacers, or some sort of plastic stand-off. A common mistake is for beginners to simply bolt the board straight onto the case without using any form of stand-off.

With a metal case this results in many of the soldered connections on the underside of the board being short-circuited through the case. The components on the circuit board are usually quite safe because it is likely the battery will be short-circuited. The battery is likely to be short lived though.

Even if a project is housed in a plastic case, the board must still be held slightly clear of the case. The underside of the circuit board might start out flat, but the completed board has soldered joints standing a few millimetres proud of the board's surface. Tightening the mounting nuts results in the areas of the board in their vicinity being pressed flat against the case, but the areas around the soldered joints are kept a few millimetres clear of the case.

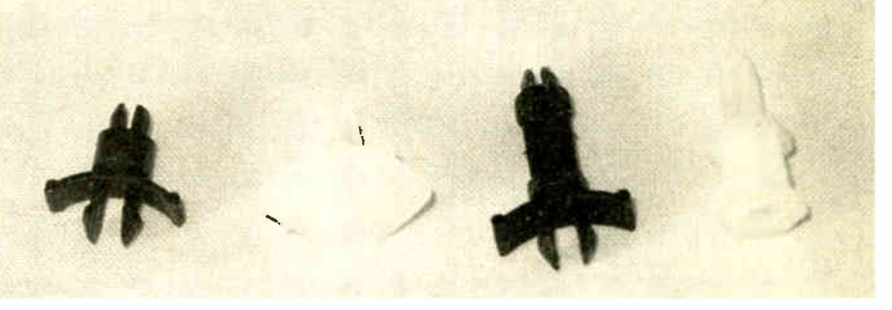


Fig.2. A selection of four plastic or nylon stand-offs for mounting circuit boards.

If the circuit board is made from s.r.b.p. or the like it will at best become badly distorted, and at worst it will shatter into a number of pieces. The brittleness of stripboard makes it particularly vulnerable to this type of failure. Boards made from fibreglass are much tougher and much stiffer.

A fibreglass board might be distorted, but with something like a simple folded aluminium case it is more likely that the case will buckle and be ruined. One of the more brittle plastic cases could come to serious grief. Not bothering to include the spacers virtually guarantees problems will occur.

Stand-off Situation

Various types of plastic stand-off are available, so it is essential to look carefully at the descriptions and illustrations in component catalogues to make sure an appropriate type is obtained. A selection of four different types of stand-offs is shown in Fig.2.

The early types were mainly designed to clip into holes in the case, with the circuit board clipping in place on top of the stand-offs. On the face of it this is a very quick and easy way of doing things, but in practice it often fails to hold the board as securely as other methods. All the mounting holes must be just the right size or the board will not clip into place properly at all.

Many of these clip-on stand-offs require rectangular cut-outs in the case. Probably the easiest way of making a small rectangular cut-out is to first drill a small circular hole. Then file this to the right size and shape using a miniature square or triangular file.

These days there are several alternative types of stand-off available, and some of these are probably better options for the home constructor. One of these alternatives clips into the case in the normal way, but at the other end has long guide into which the circuit board is slotted (see Fig.3).

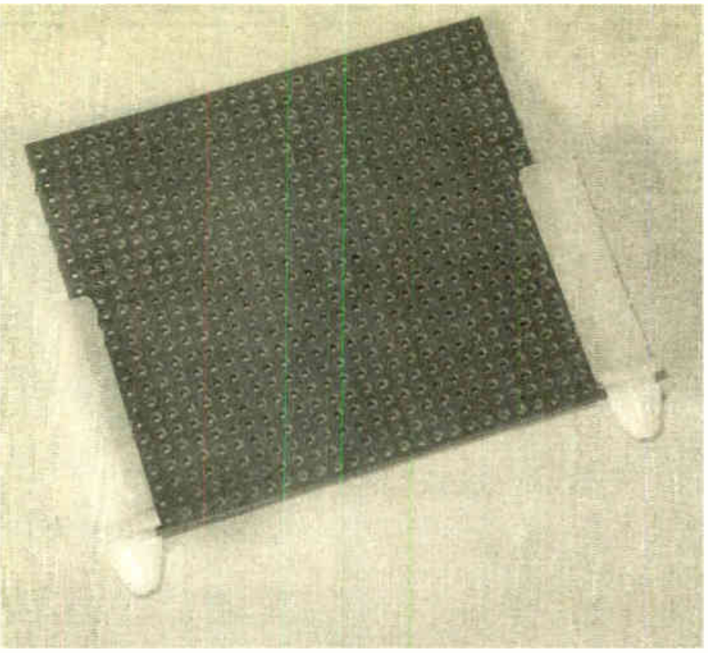


Fig.3. This type of stand-off effectively provides add-on guide rails.

This is unlike any other form of stand-off, and it has the board mounted at 180 degrees to the stand-offs instead of perpendicular to them. In other words, with the board fitted on the base panel via this type of stand-off it will be in a vertical rather than horizontal position. It is a bit like an add-on version of built-in guide rails.

With this system, and with ordinary guide rails, a few millimetres at each end of the circuit board must be kept free from components. Otherwise the board will not fit into the guides properly.

In The Bushes

Another type of stand-off is fixed to the case by way of a self-tapping screw, which avoids some of the wobble associated with the clip-on type. However, with many of these stand-offs the board still clips in place in the normal way.

A further variation has threaded bushes at both ends, and yet another accepts self-tapping screws at both ends. It is also possible to obtain metal spacers that have a screw thread down the middle, and these can be used in the same fashion as the non-threaded stand-offs. Of course, metal spacers will not insulate the board from a metal case, which could sometimes be an issue.

Excellent rigidity and reliability is provided by the stand-offs and spacers that are bolted to the case and then have the board bolted in place. The stand-offs that use self-tapping screws are also very good. All these methods are well suited to home constructed projects.

When using stripboard it is definitely advisable to use a method of mounting that has the board firmly bolted in place. The holes already in stripboard tend to combine with the mounting holes to produce mounting holes that are far from circular. This usually results in the boards being very loose fits when they clipped into place on stand-offs.

There is a further variation in the form of stand-offs which are fixed to the case via self-adhesive pads. The circuit board then clips into place. This type of stand-off undoubtedly offers the ultimate in speed and ease of use. They are ideal for small circuit boards, but are probably not well suited to larger and heavier boards.

Spaced Out

It is perhaps worth mentioning that there is an alternative method of using threaded metal spacers. They can be used with bolts that are a few millimetres longer than the spacers, so that the bolts protrude above the tops of the spacers when they are mounted on the case.

The circuit board fits onto the ends of the bolts, and nuts are used to fix the board in place in the normal way. This method is very simple and holds the board securely in place, but always make sure that the spacer is firmly in position before trying to fit the board.

What is perhaps the most popular method is a variation on this approach, and it uses non-threaded spacers (see Fig.4). It can be a bit fiddly getting everything in place, especially with boards that have three or four mounting bolts. Bostik Blu-Tack or Plasticine can be used to hold the bolts in place while everything is loosely assembled. After removing the Blu-Tack or Plasticine the mounting nuts can be fully tightened.

In the past 6BA bolts were the most popular for mounting boards, but the imperial sizes have now been largely phased out and replaced with the metric M series. The number after the letter "M" indicates the bolt's diameter in millimetres. M3 is fractionally larger than 6BA, and M2·5 is slightly smaller.

Bolts of M3 size are a good choice for custom printed circuit boards, but the relatively large mounting hole can be a slight problem when using stripboard. They can merge with the existing holes to become rather too large. M2·5 is the safer option when using stripboard. M2·5 bolts together with mounting holes of about 2·8mm to 3mm dia. work well with stripboard.

Stress Free

Good accuracy is essential when using bolts and spacers with stripboard. Be careful to position the mounting holes in the case with good accuracy. Even quite small errors can result in the board being placed under a fair amount of stress when the mounting nuts are tightened.

This is not good when using fibreglass printed circuit boards, but it is unlikely that any damage would occur. However, the situation is different with stripboard, which tends to be quite brittle. There is a real risk of the board breaking.

The circuit board can be used as a template when marking the positions of the mounting holes on the case. This makes it easy to achieve good accuracy. Also, if the mounting holes in the board have "wandered" slightly, the ones in the case will still match them perfectly.

Once the mounting holes have been drilled in the case, hold the board over them to check that there is a proper match. If necessary, use a miniature round file to adjust the mounting holes in the case in order to obtain a better match between the two sets of holes.

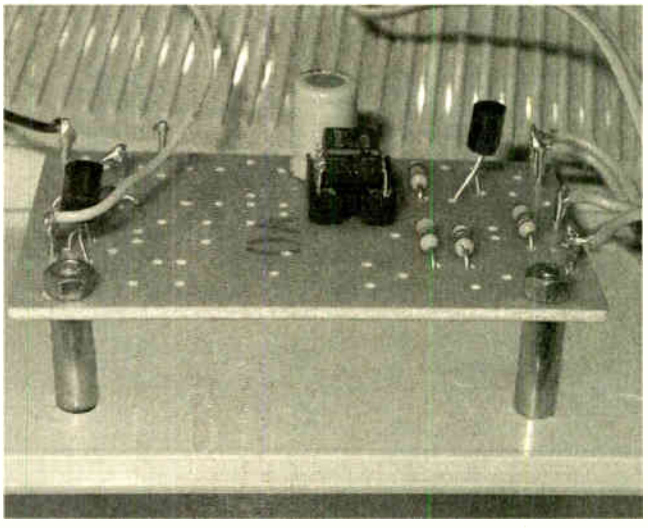
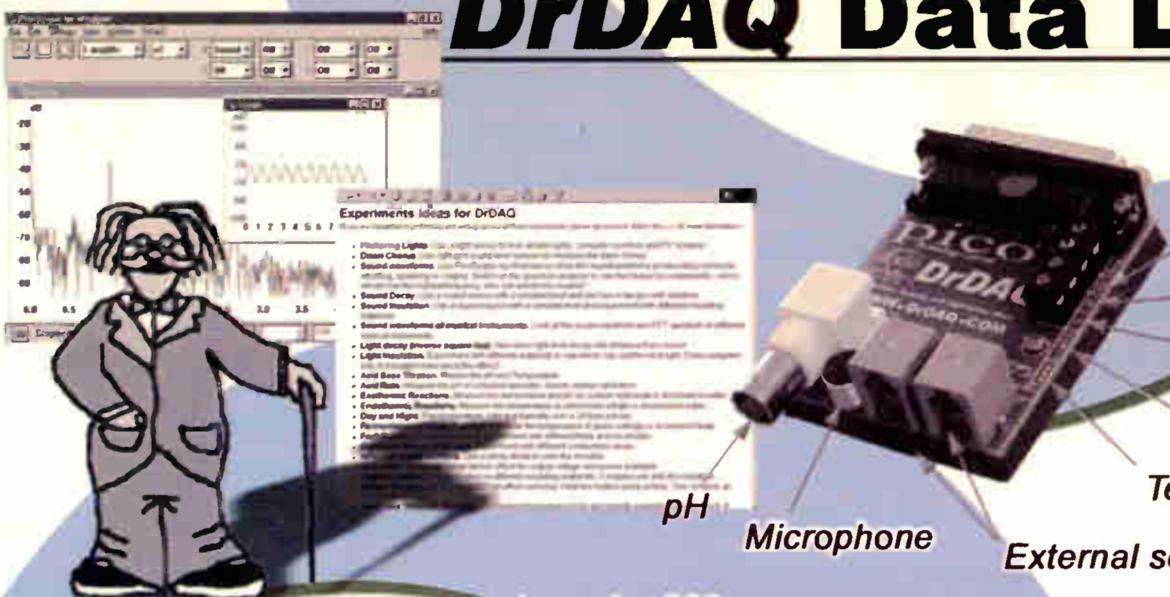


Fig.4. Metal spacers are probably the most popular method for mounting circuit boards. Putting "lock-nuts" between the bottom and top of spacers will save a lot of additional "fiddling" when removing and replacing boards.

DrDAQ Data Logger



- Low cost - under £60
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- Use DrDAQ to capture fast signals
- Outputs for control experiments
- Supplied with both PicoScope (oscilloscope) and PicoLog (data logging) software

For more information on DrDAQ, please visit:

www.picotech.com/drdaq61

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pico Technology Limited

ULTIMATE EGG TIMER

OWEN BISHOP

This short collection of projects, some useful, some instructive and some amusing, can be made for around the ten pounds mark. The estimated cost does not include an enclosure. All of the projects are battery powered, so are safe to build. In a few cases where the project is to be run for long periods, power may be provided by an inexpensive mains adaptor.

OUR first project in this series is a handy device for timing eggs, telephone calls, player's moves in games like chess, and for how long you brush your teeth!

The popularity of a boiled egg as a breakfast dish has ensured that an egg timer is a useful yet simple project for a beginner to build. Almost everyone needs such a timer. However, it is generally cheaper to buy one than to make one, so why bother? Perhaps one of the main reasons is that the home-constructed device can be readily customised to your preferences, as can the circuit presented here.

Also, there is the novelty factor, of which this timer is a good instance.

The author has been designing timers for almost as long as the advent of the 555 timer i.c. made this an easy thing to do. Each has had its own particular gimmick. Now we have the very latest word in timers – one that has no switches or buttons.

It is as simple to operate as the old-fashioned sandglass timer. Just turn it over and watch for all the sand to run through, only in this case watch for the l.e.d. to light. In addition, since this is the last word in timers (at least until the next one is hatched!), we call it the Ultimate Egg Timer.

HOW IT WORKS

This project is intended to take up the minimum of space in the kitchen workspace or on the bathroom shelf. For use in a splashy, possibly humid, environment, a sealed enclosure is an essential. This means that the lid of the enclosure must be wholly transparent, or at least translucent enough for the l.e.d.s to show through. Power comes from a small 9V PP3 battery. A tilt switch controls it, so power is switched on and off according to whether the device is upright or upside down.

As is typical for such designs, the basic timing circuit uses a 555 timer, although the low-power 7555 version is used in order to extend battery life. Referring to Fig.1, the timer, IC1, is wired as an astable. That is, it produces a succession of pulses. With the values of resistors R1, R2 and tantalum capacitor C1 as shown, the pulse rate is approximately one every 30 seconds. Preset control VR1 allows the rate to be adjusted to compensate for the 20% tolerance value of the capacitor.

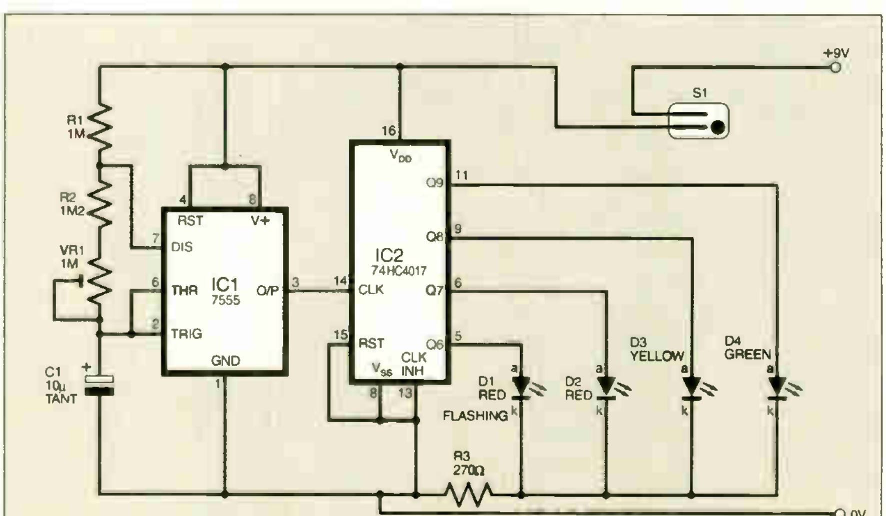


Fig.1. Complete circuit diagram of the Ultimate Egg Timer.

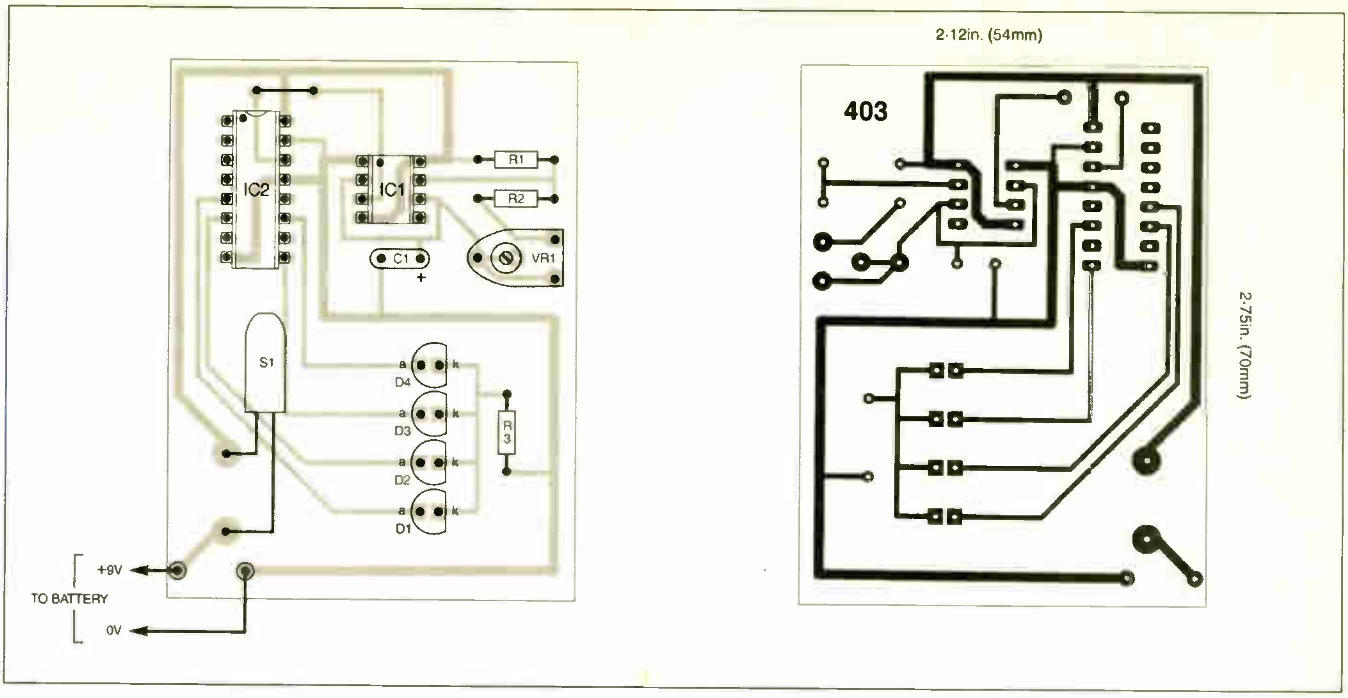


Fig.2. Printed circuit board component layout and full-size underside board copper track layout.

The pulsed output from IC1 pin 3 goes to the clock input of IC2. This device is a type 4017 decade counter, which has its Reset and Inhibit inputs held at 0V, to allow the counter to operate normally.

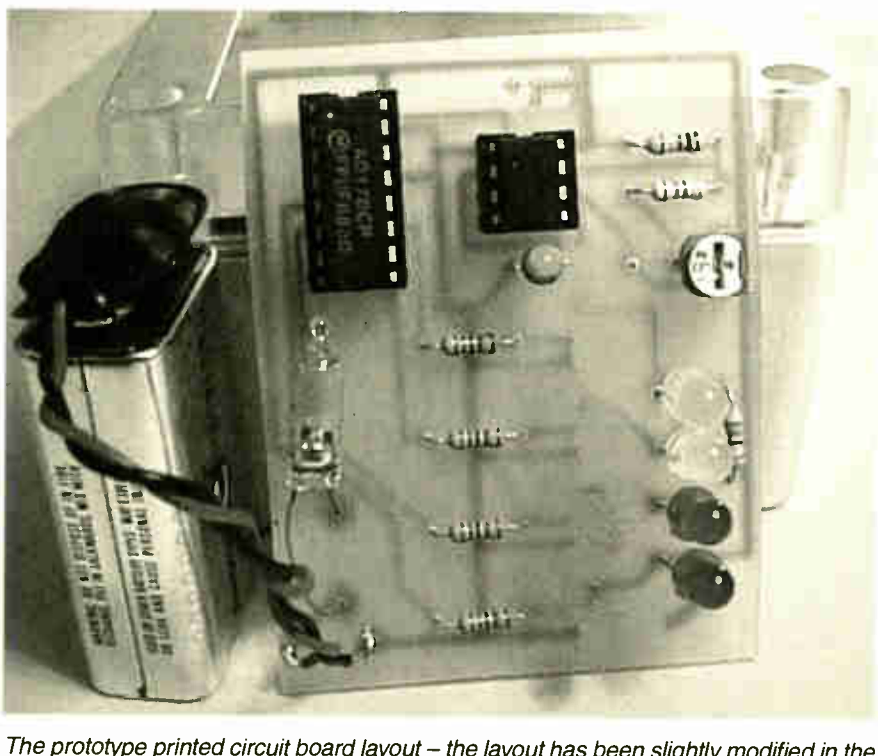
The counter has "1-of-10" outputs, meaning that only one of its ten outputs is at logic high (9V for a 9V supply) at any given instant. The rest are low (0V). When the circuit is first switched on, the clock output of IC1 goes high and so does output Q0 of IC2.

The clock output goes low after about 18 seconds but this has no effect on the counter. The count is advanced only when the timer output goes from low to high. The first positive edge, as it is called, occurs after 30 seconds. At this point, the count becomes "1". The Q0 output goes low and the Q1 output goes high. The count advances every 30 seconds and the consecutive outputs of IC2 go high in turn.

FLASHING

After three minutes the Q6 output goes high, and current flows through l.e.d. D1, which is a flashing type. This acts as a warning that the timed period is approaching its end. At 3½ minutes, the flashing l.e.d. is turned off and the red l.e.d., D2, comes on for 30 seconds and goes off at four minutes.

If you like a four-minute egg, take position beside the cooker, spoon in hand, as soon as the red l.e.d. comes on.



*The prototype printed circuit board layout – the layout has been slightly modified in the final version. Note a mercury switch of the type shown should **not** be used – see text.*

COMPONENTS

See SHOP TALK page

Resistors

R1	1M	
R2	1M2	
R3	270Ω	

All 0·25W, 5% carbon film

Potentiometer

VR1	1M min. preset, horizontal open skeleton or round (see text)

Capacitor

C1	10μ tantalum bead, 16V

Semiconductors

D1	red l.e.d., flashing, 5mm
D2	red l.e.d., 5mm
D3	yellow l.e.d., 5mm
D4	green l.e.d., 5mm
IC1	7555 CMOS timer
IC2	74HC4017, decade counter with 1-of-10 outputs

Miscellaneous

S1	tilt switch (non-mercury type)

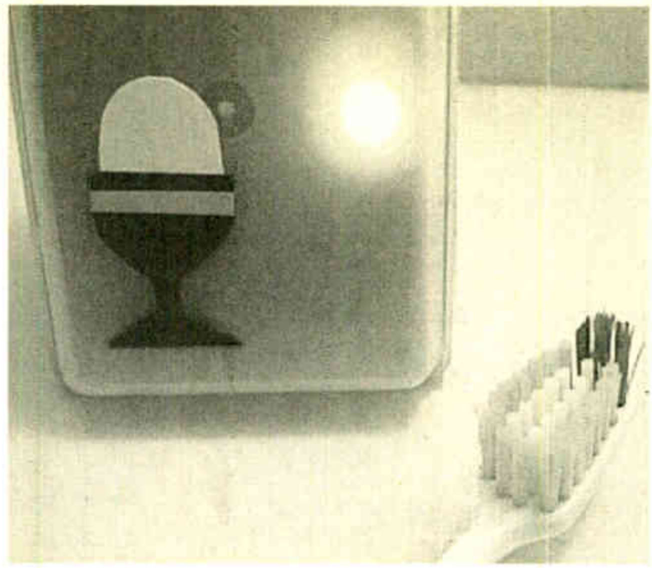
Printed circuit board, available from the *EPE PCB Service*, code 403; case to suit (see text); 8-pin d.i.l. socket; 16-pin d.i.l. socket; PP3 battery and clip; connecting wire; solder etc.

Approx. Cost Guidance Only **£9** ***excl. case & batt.***

Immediately it goes out, remove the perfectly timed egg from the saucepan. The yellow and green l.e.d.s come on in turn and go out at the end of 4½ and five minutes respectively.

Note that the sequence repeats every five minutes, so be sure not to miss the first sequence! Ideally, the timer would switch off completely at the end of the sequence, but this cannot be accomplished in a circuit that is limited in cost to £10.

The timer can be used for toothbrush timing without any modification. Turn the timer over and brush steadily until you see the flashing l.e.d. come on. This is a period of exactly three minutes.



Not only good for eggs but also good to time teeth cleaning

CONSTRUCTION

The component positioning and track layout details for the Ultimate Egg Timer printed circuit board (p.c.b.) are shown in Fig.2. This board is available from the *EPE PCB Service*, code 403.

Assemble the board in order of ascending component size, and use sockets for IC1 and IC2. The board allows for preset potentiometer VR1 to be a round or an open skeleton type. Take care to align the l.e.d.s neatly in an evenly spaced row and at the same height above the board. Ensure that they are correctly orientated.

The board is designed for a miniature tilt switch with leads spaced 10·2mm apart. Use a "mercury-free" type. It is imperative that a mercury type should not be used in a food environment – mercury is a hazardous substance.

The switch must be mounted so that it is off when the board is vertical and the switch is on the right. It may be held rigidly in place using a dab of holt-melt glue.

Using a hand magnifier, check the soldered side of the board to see that there are no dry solder joints and no threads of solder bridging between tracks.

After checking thoroughly, connect power to the board, place it in the "on" position and use a voltmeter to monitor the output from IC1 pin 3. This should go high as soon as the power comes on, and then settle into a slowly changing down/up cycle. Adjust VR1 to bring the cycle period close to 30 seconds.

CORRECTLY BOILED

Egg connoisseurs, of course, will know that the optimum timing for a correctly boiled egg depends on the egg's size and its freshness. Preset VR1 can be adjusted for a timing cycle that provides a "correctly-boiled" period set to one or other side of the true 4-minute period, as preferred.

The circuit can be enclosed in a small plastic box of which at least the lid should be transparent or translucent. The prototype is housed in an IP65 enclosure with a neoprene sealing gasket. The "6" in the code means that it is totally protected against dust. The "5" means that it is protected against low-pressure jets of water from all directions.

The dust proofing is not so important but the waterproofing could be a useful feature in a kitchen or bathroom. However, if you cannot find a local supplier for IP65 enclosures, or want to save costs, use the kind of box in which processed photo-slides are returned.

The way the circuit and batteries are arranged depends on the dimensions of the box. In the prototype the battery was fixed inside the bottom of the box using a double-sided sticky pad. A second pad was then used to fix the printed circuit board to the battery. You could use Blu-Tack instead.

Having closed the box, the Ultimate Egg Timer is ready for the first boiling! □

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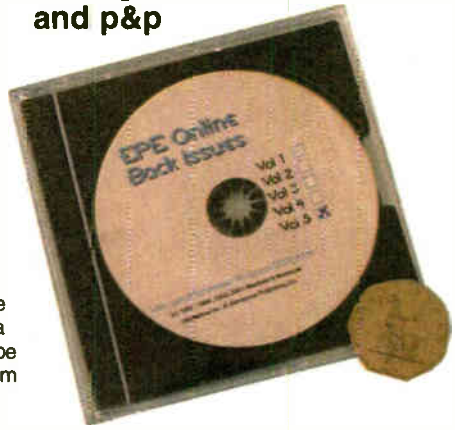

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PEDOMETER – FOOTPAD

A FEW months back, I was given a free (cheap rubbish) calculator. Having two already, I took it apart just out of curiosity (as you do!). Then with a flash of inspiration I came up with an idea to change this calculator into a Pedometer.

The circuit in Fig.1 consists of a 4066 quad bilateral switch that is triggered by tilt switch S1. Pulses from switch S1 are applied to IC1a's control input, simultaneously charging capacitor C1. When each pulse ends, C1 discharges through resistor R1. The result is a very short pulse at IC1a's Y output. This is applied to the control input of IC1b, with resistor R2 preventing this input from floating. IC1b acts as a switch, connecting points J1 and J2 when its control input is high. This action is used to trigger the calculator each time a step is taken.

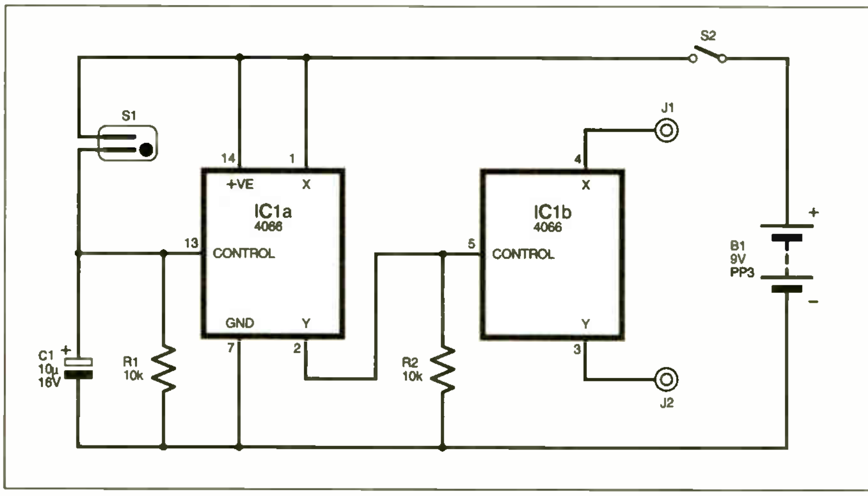

Fig.1. Circuit diagram for the calculator-based Pedometer.

A typical calculator's keypad is shown in Fig.2. It will vary between models but you should be able to work out the key connections required. On my calculator points J1 and J2 were connected across the "=" key.

It is important that the calculator is mounted in a case so that keypads cannot be accidentally pressed, maybe one with a clear lid.

The first step is to set the switch S1 so that it triggers every time a step is taken (a small sounder connected between IC1a pin Y and battery negative may aid this). With the tilt switch set up and the calculator connected, get someone to help you measure an average step. Try a few steps at different speeds. Now key this distance into the calculator (in metric or imperial – the choice is yours). Now press "+" or "++" (depending on model).

Close the lid, put the unit in your pocket and go for a walk. At the end of the walk press "M+" (add to memory) then "Clear". Before setting off on the return walk via the same route, measure your step distance again. Once back at your starting point you can use the memorised distance and the last one to tweak your step's value.

The unit can be used for other applications by changing S1 for a different switch type. For instance, you could use a reed switch and magnet on a bicycle or other wheeled object to measure distance – lots of room for using ingenuity! But note that the count rate can only be a few hertz at the most.

M. James, Billingham, Cleveland

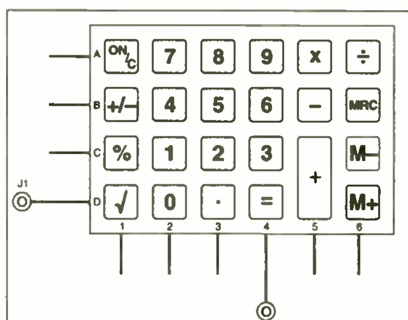

Fig.2. Typical keypad layout.

ASTRONOMY TORCH – STAR LIGHT

THE circuit shown in Fig.3 provides an adjustable red light for use in astronomy, to preserve the "dark adaptation" of the eyes. For economy, it works from two AA size batteries.

The 3V supply is fed via resistor R1 to diode D1 and resistor R2 to produce a turn-on voltage at base of transistor TR1, which forms one half of a complementary feedback amplifier. Transistor TR2 produces a current through the light emitting diode, D2, sufficient to balance this bias voltage. If the voltage across R3 is too low, TR1 and TR2 will conduct more strongly to balance, and vice-versa, maintaining a constant light output. With 0·2V across R3 the current will be 20mA.

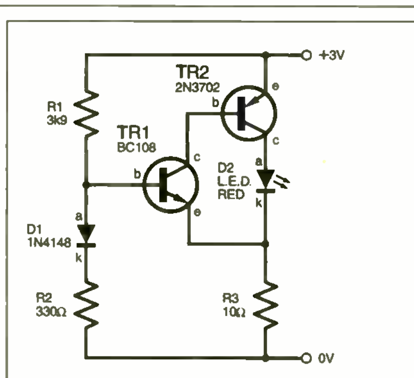

Fig.3. Astronomy Torch circuit diagram.

Due to transistor variations, resistor R1 may have to be selected to avoid too much or too little l.e.d. current. A useful possibility is to add a 20kΩ variable resistor in series with R2 to produce a variable brightness control, as found in astronomer's commercial torches.

If a fixed brightness is required, R2 could perhaps be replaced by a forward biased germanium diode, but then R3 may need a slightly higher value.

A suitable light emitting diode is a hyperbright red type with a 30 degree beam. This has a low voltage and a suitable size spot of light by which to read star charts.

Colin Menear, Birmingham

Electronic Stethoscope – Heart Throbbery

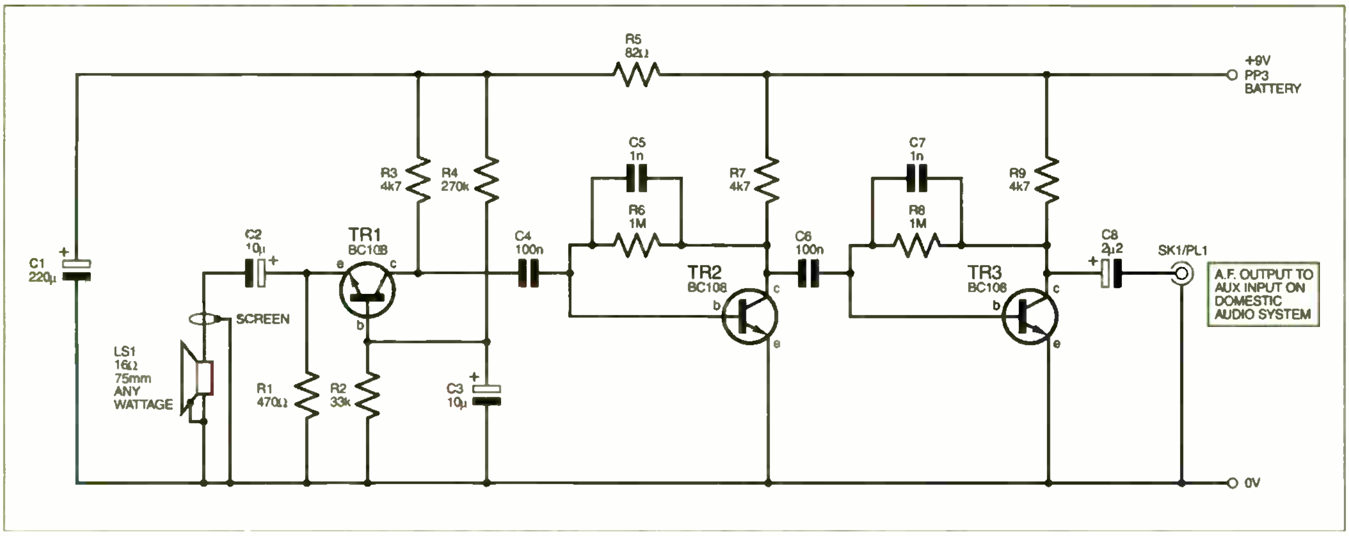

Fig.4. Circuit diagram for an Electronic Stethoscope.

EVERYONE must have seen an ordinary acoustic stethoscope being used by a GP to assist diagnosis or just to check aspects of one's physical health.

With care, it is quite feasible to arrive at an electronic version which has the advantage of being capable of far higher sensitivity than an acoustic version. It can also be provided with a fair amount of frequency range adjustment.

On the Surface

To implement an electronic stethoscope, it is the vibration of *surfaces* rather than actual sound generation caused by vibration of *air* that is required. Consequently, the input transducer needs to be in direct physical contact with the surface being investigated. This makes modern microphones with their inaccessible or very thin mylar diaphragms unsuitable, but a small moving coil loudspeaker is suitable, as is used in the design shown in Fig.4.

Loudspeaker LS1 is connected to the first amplifier stage, formed around transistor TR1, using a length of screened cable. The loudspeaker must be a metal framed one not plastic. A short piece of wire should be connected between the cable braid and the loudspeaker frame to increase electrostatic screening of the input wiring.

As the source impedance of the loudspeaker is very low, a mere 16Ω in this case, transistor TR1 is operated in common base mode. Its supply is obtained via resistor R5, and is decoupled by capacitor C1, to prevent unwanted positive feedback through the supply rail.

The next two stages, formed around TR2 and TR3, are simple common emitter voltage gain stages, but with added frequency selective negative feedback, provided by C5 in the case of TR2, and C7 in the case of TR3. This reduces the bandwidth of these two stages – keeping it to a minimum in this way greatly reduces risk of breakthrough from radio transmitters and also greatly reduces the hiss level at the circuit's output.

The design allows heartbeats to be heard very easily by pressing the loudspeaker gently against the chest. Headphones are essential for live listening and need to be the big padded type, but they do not have to be hi-fi ones.

The impedance of the output is low enough to drive the AUX input on a domestic audio system with plenty of level. The output can also be tape recorded for later reference.

Michael Robertson,
Chasetown

Optical Illusion – Magic Colour

IT is well known that by pulsing monochromatic or white light various colours may be observed. This effect was first noted in 1826 by Benedict Provost, a monk who saw a "heavenly light" on his fingers as he waved his hands about in the cloisters.

The classic means of demonstrating the effect is Benham's Top – a spinning disc with black and white sector rings which give intermittent stimulation to retinal regions as it is rotated. The experiment may, however, be replicated electronically with pulsed l.e.d.s. These satisfy the conditions of the experiment, namely monochromatic light, high contrast, and precise frequency.

The circuit of Fig.5 pulses an l.e.d. with an equal mark-space ratio, using almost any monochromatic l.e.d. of moderate intensity. A flicker rate just below the optical fusion frequency is required (that is, where the flicker just becomes noticeable). You then fix your gaze on l.e.d. D1. A red l.e.d. will clearly turn yellow, and a yellow l.e.d. turn green. Various other effects will be observed as the flicker rate is altered.

These "subjective colours" were once the basis of experimental colour television, using a black and white tube. The experiments were successful to some degree, but colour saturation was not high enough, nor was the subjective experience from individual to individual close enough to make the idea commercially viable.

Thomas Scarborough,
Cape Town,
South Africa

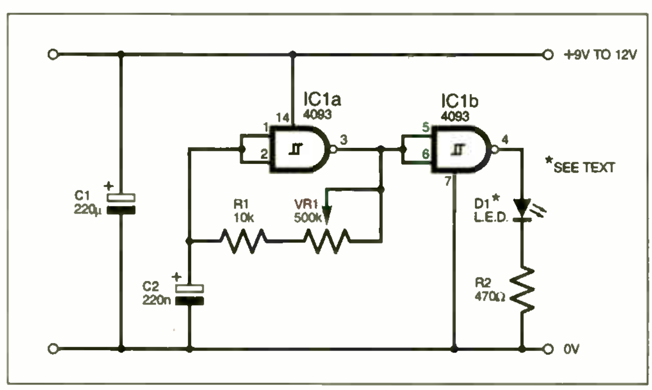

Fig.5. Circuit diagram for creating an optical illusion of colour.

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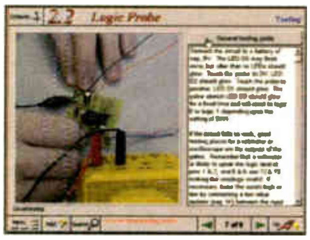

Logic Probe testing

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

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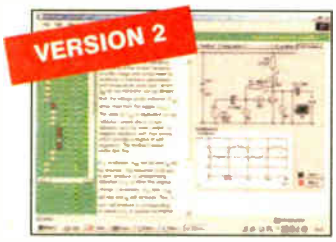
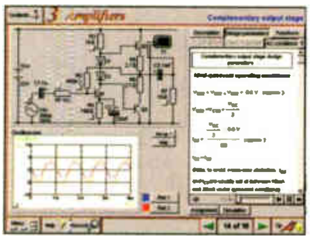


Circuit simulation screen

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.

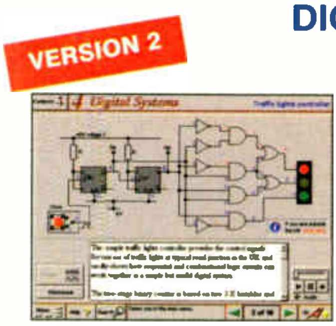
ANALOGUE ELECTRONICS



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.

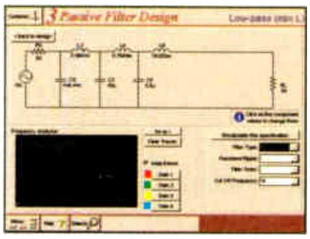
DIGITAL ELECTRONICS V2.0



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.

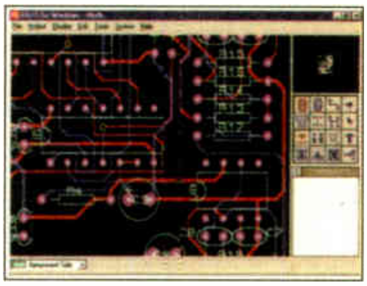
FILTERS



Filter synthesis

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

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)..........£199 *plus* VAT
Site Licence....................£499 *plus* VAT

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

PICmicro TUTORIALS AND PROGRAMMING

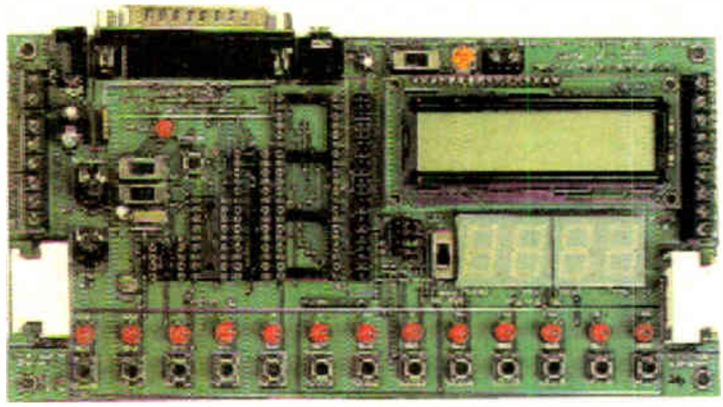
HARDWARE

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.

ASSEMBLY FOR PICmicro V2
(Formerly PICtutor)

Assembly for PICmicro microcontrollers V2.0 (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 39 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.

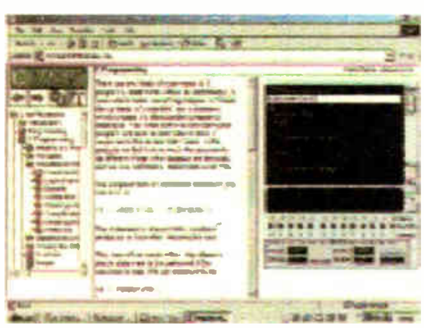
Virtual PICmicro

'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.

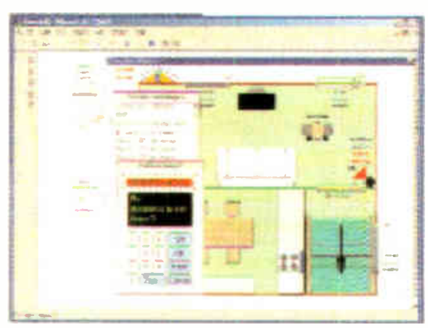
FLOWCODE FOR PICmicro

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 8, 18, 28 and 40-pin devices ● Institutional versions include virtual systems (burglar alarms, car parks etc.).



Burglar Alarm Simulation

PRICES

Prices for each of the CD-ROMs above are:

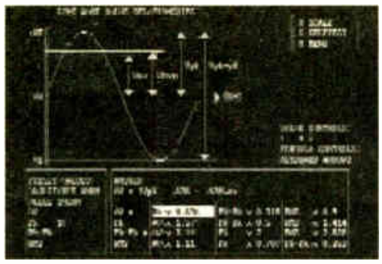
(Order form on next page)

Hobbyist/Student	£45 inc VAT
Institutional (Schools/HE/FE/Industry)	£99 *plus* VAT
Flowcode Institutional	£70 *plus* VAT
Institutional 10 user (Network Licence)	£249 *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

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 covering all aspects of the series. We have also added Alan Winstanley's highly acclaimed *Basic Soldering Guide* which is fully illustrated and which also includes *Desoldering*. The *Teach-In* series covers: Colour Codes and Resistors, Capacitors, Potentiometers, Sensor Resistors, Ohm's Law, Diodes and L.E.D.s, Waveforms, Frequency and Time, Logic Gates, Binary and Hex Logic, Op.amps, Comparators, Mixers, Audio and Sensor Amplifiers, Transistors, Transformers and Rectifiers, Voltage Regulation, Integration, Differentiation, 7-segment Displays, L.C.D.s, Digital-to-Analogue.



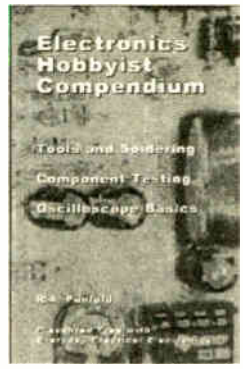
Sine wave relationship values

Each part has an associated practical section and the series includes a simple PC interface 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.

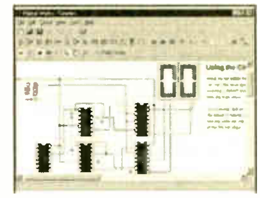
£12.45 Including VAT and postage. Requires Adobe Acrobat (available free from the Internet – **www.adobe.com/acrobat**).

FREE BOOK WITH TEACH-IN 2000 CD-ROM



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 £199 *plus* VAT.
Site Licence £499 *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
(UK and EU customers add VAT at 17.5% to "plus VAT" prices)

ELECTRONIC COMPONENTS PHOTOS

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

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

Price £19.95 inc. VAT

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

CD-ROM ORDER FORM

Please send me:

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

Version required:

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

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

- ☐ **Teach-In 2000 + FREE BOOK**
- ☐ **Electronic Components Photos**
- ☐ **Electronics In Control – Single User**
- ☐ **Electronics In Control – Multiple User**
- ☐ **Modular Circuit Design – Single User**
- ☐ **Modular Circuit Design – Multiple User**

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

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ORDERING

ALL PRICES INCLUDE UK POSTAGE

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

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

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

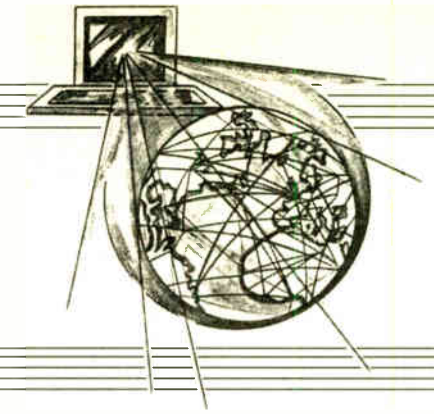
To order by phone ring
01202 873872. Fax: 01202 874562

Goods are normally sent within seven days

E-mail: orders@wimborne.co.uk

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

SURFING THE INTERNET



NET WORK

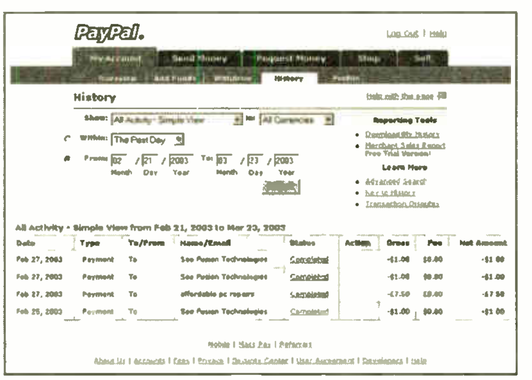
ALAN WINSTANLEY

Pay the PayPal way

MY THANKS to *David Preston* who emails:

"I've enjoyed your last two features on the delights of eBay. PayPal is a good method of payment but does have a few limitations. If, for instance, you have an online subscription it is easy to forget it is active, unless looking at the 'My account' tab in PayPal. I've only had a few cases where money is exchanged but the goods haven't arrived. On the plus side, it's a great way of selling goods to foreign buyers, especially to the US."

In last month's *Net Work*, the online credit card processing company PayPal (**https://www.paypal.com**) was outlined. PayPal is an online card processor with a difference, because it operates an *account-based* system. Acting as a virtual credit card "swipe" machine and cash register all in one, PayPal enables you to buy online for free, or sell online for a small commission (up to 3·4% + 20 pence for Sterling transactions). They can charge your customer's credit or debit card and receive monies on your behalf, the cash being held in the seller's PayPal account.



PayPal's accounting system in "simple view" makes the details of transactions easier to follow.

Sounds easy – and in most cases the system works perfectly, and I have purchased a number of items through PayPal with no problem at all. In some countries, you can empty the cash register by transferring from your PayPal account into your own registered bank account.

However, from the seller's point of view, the system is not foolproof and there is scope for things to go awry. It seems that if any query arises over the conduct of an account or transaction, there is a likelihood that a PayPal account will be suspended pending further enquiries. This denies the seller access to his sales revenue, which can prove frustrating or damaging to a small business.

Peter Crowcroft emailed from Hong Kong with his own experiences of PayPal:

"I joined PayPal in January 2002. It was easy to use and I liked it. Then in August 2002 my account was suspended and I was asked for passport, identification, etc. No problems, I faxed copies. On August 27 I received two emails saying I was back on line. Then on August 31 I was again suspended for no reason.

Now, one cannot email PayPal. And I am not going to try to phone. At the time of writing they owe me US$44.99. After several frustrating months and after quickly realized by Googling "PayPal" that many other people have been similarly treated, I am now part of a class action lawsuit against PayPal at ***www.girardgibbs.com/paypal.html****.*

I have an unblemished record but never have I been so poorly treated by an American company, and I am certainly not the only 'victim'".

Also on the web is the well-known web site **www.paypalsucks.com** that publishes real-life examples of bad experiences or poor treatment received at the hands of PayPal. The web site **www.nopaypal.com** has more feedback as well.

Highlighted is the fact that if you are outside the US and selling through PayPal, in effect you are using an offshore account to manage your online sales income, and for what may be a quite trivial reason, the account could be suspended without warning. Individuals have no Ombudsman to complain to, either.

Trying to take a balanced view of all this however, it should be recognised that online payments have grown exponentially over recent years, and if a system is developed that is generally workable and easy to use, then a large uptake can wrong-foot the supplier, causing all sorts of problems. Service invariably suffers and vendor companies have to play catch-up afterwards. Security is also generally far tighter due to the risks of stolen credit cards and money laundering, so the PayPal account holder will probably not receive the benefit of the doubt when questions are asked.

Tread Carefully

Of some concern is the risk that a legitimate PayPal account could be suspended at a stroke. For this reason alone, I never advise sellers to rely solely on such an account for handling mainstream sales revenue, because when things go wrong it may be difficult or frustrating to get the account restored.

What also concerned the writer was the way in which it was supposedly free to sign up, but in fact a $1.95 test transaction is involved. PayPal is not up-front about this, so what else is lurking in the small print that isn't made clear initially? You do ultimately get your money back (my thanks to reader ***Nigel Warburton*** for reminding me, as I failed to mention this last month). On the plus side, a $5 New Account bonus has been now paid into the writer's account as promised. A pint of beer, on PayPal – cheers!

The class action lawsuit mentioned earlier complains of the lack of a customer service contact number and the unlawful freezing of consumer accounts. As evidence that PayPal is slowly getting its act together, in April this year PayPal launched in the UK a 24 hour telephone support line (which is **0870 730 7191**) and we're told to watch for further improvements in the future.

I would also add that when I queried PayPal myself by email concerning changing the name on a Premier account, I received a personal reply within the hour and had no problems whatsoever. Overall, there is no doubt that the system is indispensable and works perfectly for most users, but there have been some bad-luck stories and businesses who are considering using PayPal for sales should tread carefully, take their time and have their eyes wide open.

Shopping System

If you are thinking of using PayPal to process credit card sales, then having set up an account, the easiest way is to cut and paste some HTML buttons into a web page. An example is at **www.dartmoor-cellars.co.uk** which at the time of writing uses PayPal to sell cufflinks and small jewellery. A range of very simple shopping cart options is provided by PayPal: follow the Merchant Tools link on the home page.

Buy Now buttons can be pasted into your own web pages, or a full shopping cart system is also available, again set up using simple cut and paste. PayPal also offers a simple, ready-made solution for the collection of donations. All you then need to do is copy the pages onto a web server using FTP, and you're trading online.

Coming up – we'll be looking again at broadband and other offerings, checking out domain names and covering other Internet-related topics in the next few months. You can email me at **alan@epemag.demon.co.uk**.

Special Review

FLOWLOG LITE REVIEW

ROBERT PENFOLD

Putting the data logging, control and measurement PC add-on through its paces.

FLOWLOG is a PC add-on for data logging, control, and measurement, and it is primarily aimed at the education market. However, it should be of interest to individuals wishing to learn about and experiment with PC interfacing. Flowlog is available in two versions, and it is the more basic "Lite" version that is reviewed here. This is a bare board with three sockets and a three connector blocks to accommodate the inputs and outputs.

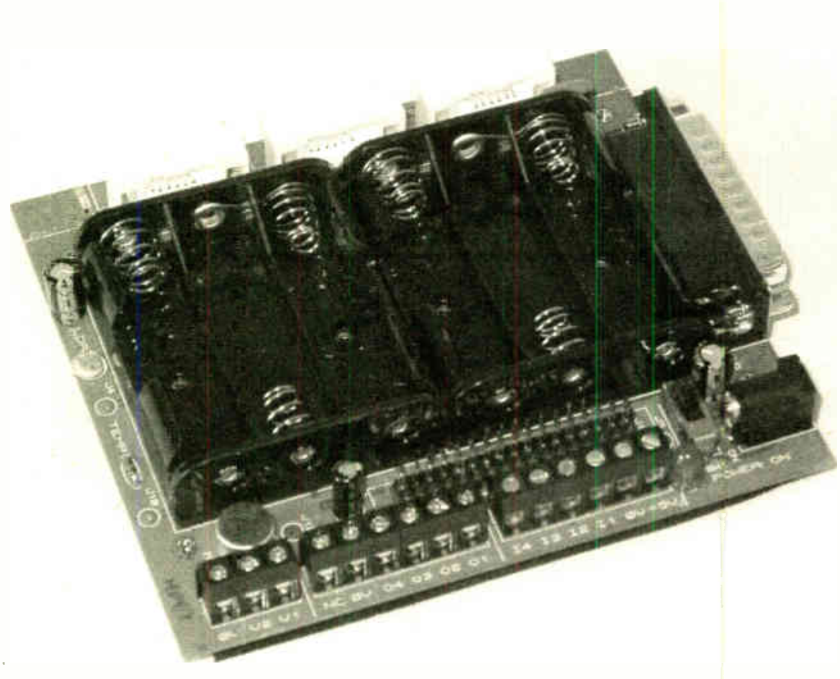
The Standard version is essentially the same, but fitted in a plastic box with 4 millimetre sockets instead of the connector blocks. The Lite version has a foam rubber pad on the underside to protect work surfaces. Presumably the PIC processor at the heart of the unit is hidden away under this pad, because it is not visible on the top side of the good quality fibreglass circuit.

INS AND OUTS

In fact there are only a few components on the top side of the board, which is dominated by the battery holder for six AA size batteries. There is also an on/off switch, a power indicator l.e.d., and a socket for a battery eliminator. The latter is not supplied as standard with the Lite version of Flowlog.

Connection to the PC is via a printer port and a standard PC parallel cable. Note that this must be the type of cable that has a 25-way "D" connector at each end, as used with some scanners and other parallel peripherals. A PC printer cable having a Centronics connector at the peripheral end is not suitable. A parallel cable is available as an optional extra if you do not have something suitable.

The connector blocks provide four digital inputs, four power outputs. and two analogue inputs. The power outputs provide about 8 volts when switched on and can be used to drive relays, indicator lights, etc. An optional solderless breadboard can be connected to this block, but it should be easy to use it with any prototyping system.



The Flowlog Lite hardware.

There are a few components fitted on the top side of the board, and three of these are built-in sensors. A diode acts as a temperature sensor, a cadmium sulphide cell provides light sensing, and an electret microphone insert enables the unit to detect sounds. Three telephone style sockets enable the unit to be used with a range of external sensors that are available as optional extras. Two of these sockets provide analogue inputs and the third is a digital type.

SOFTWARE

With something like this the hardware is only half the story. It is important to have good software to support the hardware, which is of no practical value without proper software. The supplied software is in the form of a single program, but it has three sections that deal with data logging, control, and electrical measurement.

The dialogue box of Fig.1 appears when the program is launched, and this gives the option of selecting one of the three main categories and then a function within that category. Alternatively, there is the option of simply going straight into the main program. The main program has the usual menu bar at the top and a small toolbar just beneath this. The status of the interface is indicated to the right of the toolbar, and this says "OK" if the interface is detected properly. A "Not connected" message indicates that there is a problem.

The New Scope option of the Scope menu is a good place to start. This produces a window like the one of Fig.2, a form of virtual dual trace oscilloscope. Radio buttons give a choice of digital or analogue operation. The two modes have different controls, and it is the analogue version that is shown in Fig.2. In the analogue mode the sampling rate is given as 25kHz and there are two channels available. A somewhat faster rate would be desirable, but 25kHz gives reasonable results with most audio signals.

The converter has 10-bit resolution, which is high enough for good accuracy but low enough to avoid noise problems. Fig.2 shows the display of two a.c. waveforms. In the digital mode there are four inputs and the maximum sampling rate is given as 100kHz.

The timebase runs from 0·1 to 100 milliseconds per division using the standard 1, 2, 5, 10 progression. Each channel has an input voltage range of 0 to 5 volts, and six

Fig.1. There are various options available when the program is launched.

levels of scaling are available from 0·05 to 2 volts per division. Each channel can monitor one of the built-in sensors, one of the two external analogue inputs, or a digital input. The trigger options are none, rising edge, and falling edge, and channel A or channel B can be used as the trigger source. The trigger level is adjustable from 0 to 100 percent. The virtual rotary controls are adjusted by simply left-clicking at the required new setting or by dragging a control knob to a new setting.

GRAPH

Signals that change very slowly are handled by a separate graphing routine. New Graph is selected from the Graph menu, and then one or two signal sources are selected via submenus. Fig.3 shows a graph being produced, it is monitoring the light level using the internal light sensor. One of the buttons on the toolbar produces a dialogue box that enables the scaling to be adjusted, but the automatic scaling does quite a good job. It is possible to zoom in and move along the graph, making it easy to carry out detailed checks when large amounts of data have been stored.

With the virtual oscilloscope there are facilities to print and save screen images, but there are many more options available with the Graph function. Data can be exported in the standard CSV spreadsheet format for example, or data can be opened in Microsoft's Excel on a suitably equipped PC. Screen images can be saved to disk or copied to the clipboard. Data can be saved to disk and loaded again at a later time. Text can be added to graphs, to show what instigated various changes in the graph for example, in addition to a facility for adding a title.

There is a Meter facility that enables the values from sensors to be displayed in real-time on a digital display. This can be used on its own so that the unit operates as (say) a digital thermometer, or the readout can be used in addition to one of the other facilities, such as the graphing type.

Fig.3. This graph shows the light level received by the built-in light level sensor.

IN CONTROL

The Control section of the program produces a small window where programs can be entered. The code is entered in the main part of the window on the left, which is subdivided into two sections. A narrow column down the left-hand side is included for labels that can be used with program instructions such as GOTOs. The main area to the right of this is for the program instructions themselves. Down the extreme right-hand side there are several buttons marked with the names of program commands such as Repeat, Until and Delay.

An instruction is added by dragging from one of the buttons to the appropriate point in the program listing. This usually produces a dialogue box so that the appropriate parameters can be entered. In Fig.4 for example, a Repeat...Until instruction has been selected. The menu on the left is used to select a signal source such as the built-in temperature sensor or an external source. The menu to the right of this is used to choose between less than or greater than, and then the slider control is used to select the required value. In the example of Fig.4 the loop will repeat until the temperature is less than 24.89°C.

DATA LOGGING

Selecting the New Task option from the Datalog menu launches a wizard that enables the required parameters to be programmed into the Flowlog unit. For instance, the required event to trigger logging can be selected, or logging can be started immediately. The signal source or sources are specified, and so is the sampling rate. Eventually a full set of parameters is produced and displayed by the wizard (Fig.5). The program can then be run and the results displayed on a graph.

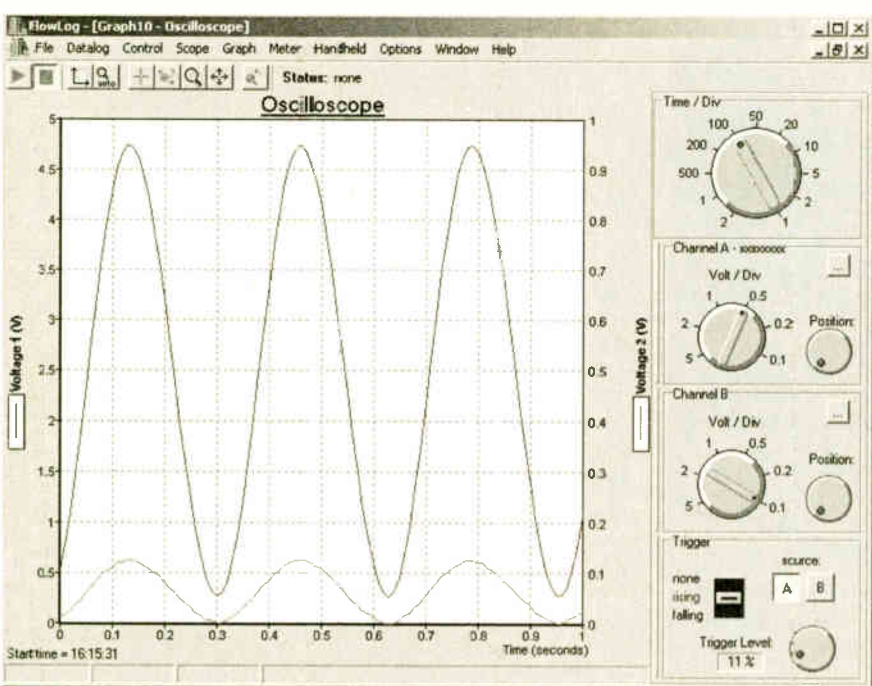


Fig.2. The Flowlog oscilloscope display.

CONCLUSION

The Flowlog hardware is well made and has a useful range of features. There are various add-ons available to extend its

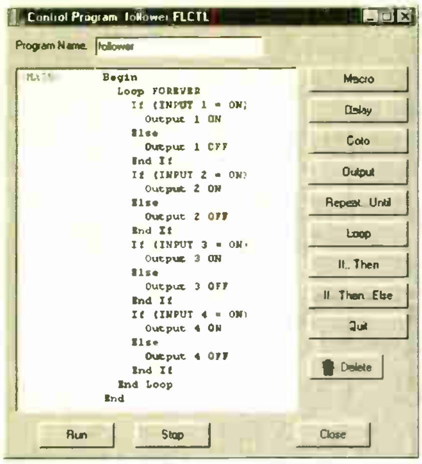


Fig.4. Program lines are added using a drag and drop system.

capabilities, and it should be possible to use it with any breadboard or prototyping system to "do your own thing". The software supplied with the review unit is a pre-production version, and a bit of clipping

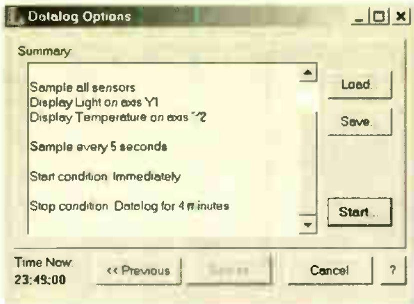


Fig.5. A wizard is used to produce the required set of data logging parameters.

occurred on the oscilloscope control panel when the program was used with a high resolution screen. All the major features are present and working though, and the pre-production software is perfectly usable. No problems with instability were experience when using the system under Windows ME or XP. There is no printed manual, but there is the usual Help system and some useful tutorial videos are included on the installation CD-ROM.

Flowlog Lite is a useful device in its own right that could be used for scientific experiments or to learn about computer interfacing. Its versatility is greatly enhanced by the wide range of add-ons that are available, such as sensors and an instrumentation amplifier. The optional sensors cover things as diverse as magnetism, flow rate, pH, and relative humidity.

At £99 plus £5 for a parallel cable the Flowlog Lite is very reasonably priced. The software is not an expensive extra and is included as standard. If mains rather than battery operation is preferred, a 1 amp mains power supply unit is an additional £10. These prices exclude £7.50 for delivery and VAT. It is certainly a system that can be recommended for educational use or for the hobbyist.

For more details contact: Matrix Multimedia Ltd, The Factory, Emscote Street South, Halifax, HX1 3AN. Tel 0870 700 1831. Fax 0870 700 1832.

Email **sales@matrixmultimedia.co.uk**. Web **www.matrixmultimedia.co.uk**.

Constructional Project

PICRONOS L.E.D. WALL CLOCK

JOHN BECKER

Part Two

Ancient and modern techniques display timely brilliance on a grand scale!

LAST month we described the circuit and construction of the *PICronos L.E.D. Wall Clock*. This month we conclude by describing its software and setting-up.

FIRST CHECKS

Having thoroughly checked the board, apply power and immediately check that the output of regulator IC2 is at 5V, within a few per cent, and that the output of regulator IC3 can be varied by VR1 from about 1·5V to 10·6V (assuming a 12V power supply input voltage).

If all is well switch off the power and insert the pre-programmed PIC. Whilst the board has connections (TB1) which allow the PIC to be programmed in situ, brand new PIC16F877s should be programmed for the first time in a PIC programmer, with **no external components connected to other PIC pins**.

This restriction is due to the configuration set for the PIC16F87x family of devices during manufacture. (The same also applies to PICs in the 'F62x family.)

Once the PIC has been programmed, further programming can then be performed in situ on the PICronos board. For instance, you might want to modify some of the author's code to suit your own preferences. Re-programming on-board can then offer considerable advantages.

RING TIME

With the programmed PIC in place and the power on, the two rings of l.e.d.s should be "active". The outer ring should have one l.e.d. turned on, indicating the hours time that the programming currently thinks exists. The timing and correction values used at this time are those last used by the author as data statements in the source code (applies only to PICs that have been programmed with the embedded data statements in the HEX file), and could have any value.

The inner ring should show two active l.e.d.s., indicating the seconds and minutes counts respectively. Apart from the central "colon" no other l.e.d.s should be on.

Check that all l.e.d.s in the inner ring come on at some point during a one minute cycle. If any do not, check that they are inserted the correct way round, and that both their leads are soldered! The same check should be made with the other l.e.d.s as appropriate once the clock is fully running.

Ignore the switches for the moment.

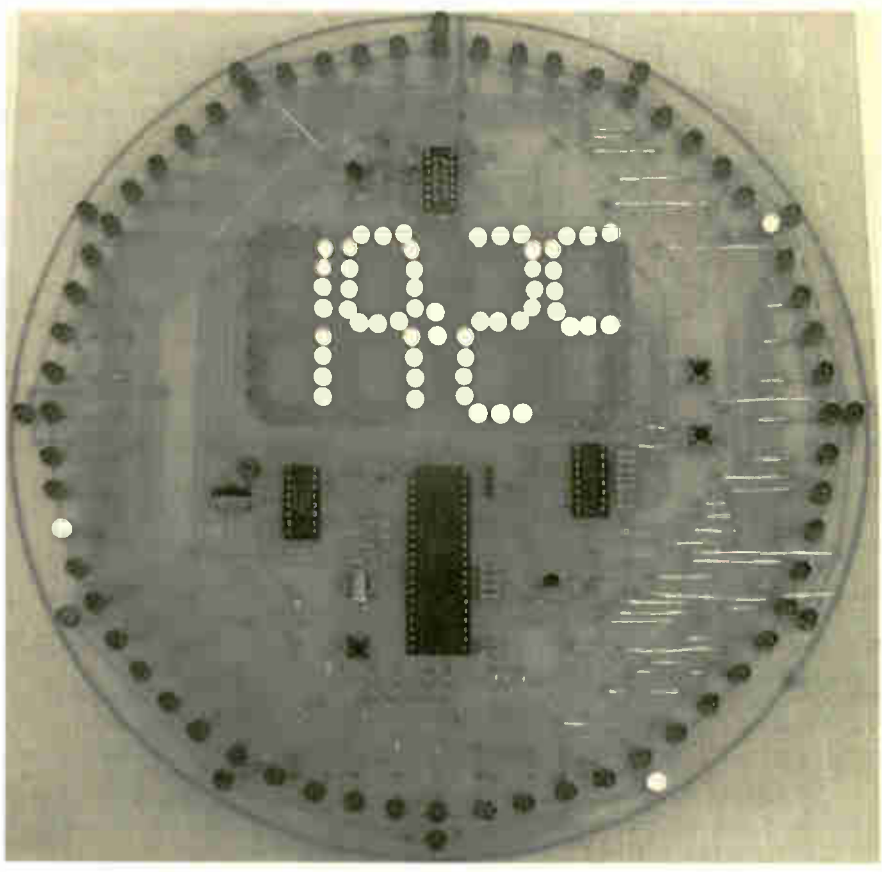
TEMPERATURE

Before checking the digits display, insert temperature sensor IC6 and op.amp IC7. Carefully measure the voltage between the sensor's output and negative (–) pins on a digital multimeter, set to a range suited to monitoring up to +5V d.c.

Note the voltage shown. The sensor has an output that changes by 0·1V per degree Celsius in relation to the voltage at its negative pin. Zero volts between the output and negative pins indicates a temperature of 0°C. Consequently, the ambient temperature experienced by the sensor will be displayed by the reading on your meter in millivolts. Thus, if your meter shows 205mV, the ambient temperature is 20·5°C.

Warm the sensor between your fingers and observe how the meter reading changes, probably upwards.

Now check the voltage at the output of the op.amp at pin 14. It should change in sympathy with the voltage across the two points just measured, but at an amplified value of ×10 per °C. There will, however, be a bias voltage at the op.amp output, typically in the region of about 2·5V. This is due to the sensor's negative lead being raised above 0V by the two diodes, D176 and D177, at about 0·6V per diode.



A mild day, 19·2°C, at 5.10 p.m., 42 seconds and counting!

This displacement is taken care of later through the software, as will be discussed. For the moment, note the output voltage at IC7 pin 14.

DIGITS CHECK

You are now in a position to check the four display digits. With the power still on, first adjust preset VR1 for a the maximum possible output voltage at regulator IC3, and note the value.

Then switch off and insert IC4 and IC5, the interface devices that power the "digit" l.e.d.s.

Applying power again, check that the outputs of both regulators are still at 5V for IC2 and the noted value for IC3.

Observe the digits, checking in particular that all l.e.d.s in each segment come on at some stage. Correct the cause if any do not (with the power off, of course). Check that their brilliance can be changed using potentiometer VR1.

Next observe the specific behaviour of the digits in terms of what they display. A cycle of three values should be seen repeating, changing every five seconds.

The cycle should show hours and minutes in the form hh:mm, date in the form dd:mm, and temperature in the form 20:6^c (the 'c' – for Celsius – occupying segments *a, f, g*, and the colon representing a decimal point).

All four digits will be always be active whenever time is displayed. With the calendar data, any leading zeros of the "tens" will appear blank. The "tens" digit of the temperature display will also be blanked for values less than 10.

While watching the digits, also note that the ring displays indicate the time values, appropriate to the numerical values of the digits when hours and minutes are shown.

The temperature display is likely to show an inaccurate value at this time, although it should still change if the sensor's temperature is changed.

ALIGNMENT

Two paths are provided for aligning the clock values to those that actually exist. The main path is concerned with values that you occasionally have to change with any calendar clock – current time, month and day of month.

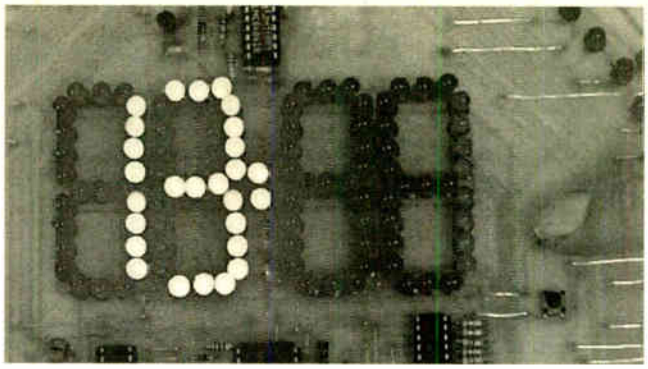
The second path allows correction of less likely factors to be made, the accuracy of the clock's time keeping (is it gaining or losing?), the range of the temperature display (is it showing too hot or too cold?), and of the year (although this is never displayed except in correction mode).

The main path is more appropriate to use first. There are several modes within this path and they are selected in order by switch S2. The values displayed within each mode are changed by switch S1. The value only increments (counts upwards), rolling over to an appropriate start value once an upper value has been reached.

The modes will now be discussed in turn, and in the order that occur for each press of switch S2.

1. MONTH VALUE

When S2 is pressed while the clock is still in the normal time-keeping display, the first correction mode entered is that for changing the month value. This is in numerical form, from 1 to 12. It is not possible to display the months in an alphabetical form with 7-segment displays.



Setting the day of the month.

It is only the month value displayed (in the two right-hand digits). The days digits are blanked. The l.e.d. rings are also blanked.

Momentarily pressing switch S1 increments the displayed value by one unit. Holding it pressed causes it to repeatedly increment at a rate of about twice per second. After passing 12 it will roll over to 1. A pause of up to half a second may be experienced between the switch being pressed and a response seen.

2. DAY OF THE MONTH

When in the previous mode, pressing switch S2 causes the next mode to be selected – days of the month. Again only those digits required for correction are displayed, on the first two digits this time, with the months digits blanked. The l.e.d. rings remain blanked.

The maximum days count for any month is that appropriate to the month in question, including February in relation to leap years (see later).

Pressing switch S1 increments the days count, rolling over to 1 following the maximum for the selected month.

3. HOURS CHANGING

Pressing switch S2 now calls up the hours correction mode. The hours are displayed in the first two digits, while the other two digits (the minutes) are blanked. In this mode the hours l.e.d. ring is made active.

Pressing switch S1 increments the hours digits in a 24-hour cycle, recommencing from 0 when 23 has been passed. The l.e.d. hours ring will also been seen to increment, although it functions on a 12-hour basis, as with a standard analogue clock.

4. MINUTES CHANGING

The next press of switch S2 enters the minutes changing mode. Minutes are displayed in the right-hand digits, with the left-hand digits blanked. The hours l.e.d. ring is blanked, but the minutes ring is activated.

Switch S1 causes the minutes to increment between 0 and 59, rolling over to zero following 59. The count is displayed on the digits and on the l.e.d. ring.

The next press of switch S2 ends the main correction cycle. At this point, the set date and time values are stored to the PIC's data EEPROM, where they remain even if the power supply should cease. They are automatically recalled when power is restored.

Immediately following the data storage, the inner ring of l.e.d.s cycles rapidly through all 60 positions, and continues to do so until switch S2 is released. At that moment the seconds count is set to zero and real-time clock display is resumed, using the newly set values.

Note that in any of the above correction modes, if a value does not need changing, just press switch S2 again to bypass it.

SECONDARY ALIGNMENT

The second alignment path is concerned with three values – the accuracy of the clock's time keeping, the correctness of the temperature display, and the setting of the year value.

This path is activated by pressing switch S3. Within the path's modes, switch S1 continues to increment values when pressed, but switch S2 now causes them to decrement, in other words, a plus and minus count facility now applies.

TIMING ACCURACY

Even though the clock is crystal controlled, its timing accuracy can still drift with time. This is due to low-cost crystals such as used with microcontrollers being subject to a manufacturing tolerance. This factor is not always quoted in manufacturing data sheets, nor is it of relevance in many microcontrolled designs.

It becomes important, though, in a real-time clock situation and so such a clock requires some form of timing adjustment to be included. In some applications a small-value trimmer capacitor may be included with the crystal circuit. It is, though, comparatively easy to implement correction through software in conjunction with plus and minus switches.

The technique used in this design is similar to that used in the author's *Canute Tide Predictor* of June '00. Three counting registers are allocated in relation to the pre-seconds count, and three registers which hold a changeable timing factor. Effectively, it is a fractional value having many decimal places.

The default value for the correction registers is in the binary form of:

10000000 00000000 00000000

that is, three bytes of which the most significant byte (MSB – left-hand byte) holds binary 10000000 (128 decimal).

The PIC's internal Timer 0 (TMR0) is set in software for its pre-count register to divide the clock cycle rate by 1:4 (ADCON0 is set with a binary value of 00000010 during the PIC's initialisation routine).

The PIC automatically divides its controlling crystal rate by four. Each of these subdivisions is regarded as one PIC clock cycle. The pre-count divider is decremented by each clock cycle. Each time the divider rolls over to zero, an interrupt flag is set. The divider is then reloaded with its preset division value (four in this case). The effective rate is 1/400 of a second (400Hz).

In this application, the PIC's interrupt procedure is not activated and the status of the flag is simply read by the software, Each time the flag becomes set, the software resets the flag to zero and decrements a counter which has initially been set to 200. The pre-count cycle then starts again and the process is repeated.

When the "200" counter has reached zero, the three bytes of the above timing value are added to the three bytes of the registers associated with the fractions of a second count.

It will be seen that if these three fractional counters start at zero, then adding the timing value twice will cause bit 7 of the MSB to rollover to 0, i.e. 128 + 128 = 256, which equals 0 for an 8-bit byte (you need to understand binary to follow this argument!). Because MSB rollover has occurred during an adding procedure, the PIC's Carry flag becomes set. If MSB rollover has not occurred, the Carry flag remains unset.

Each time the Carry flag is found to be set, a true seconds counter is incremented. When it rolls over beyond 59, it is reset to zero and a minutes counter is incremented. When it rolls over beyond 59 it too is reset and the hours are incremented. Similarly, the clock and calendar values are incremented and reset as a ripple effect when appropriate through the chain of values.

It will be seen that if the MSB of the timing value is actually set to binary 10000001 (129 decimal), then the additive cycles will cause the Carry flag to become set more quickly than in the previous case, resulting in the clock's timing running faster. Equally, it will be seen that an MSB binary value of 01111111 (127 decimal) will cause the clock to run more slowly.

At the far end of the correction scale, it should be obvious that by changing the value in the least significant byte (LSB – right-hand byte) even smaller fractional corrections can be made. Have a think about what a difference of just one unit between LSB values can achieve in terms of the clock's accuracy – not quite infinitesimally small, but close!

ADJUSTMENT CONSIDERATIONS

Timing accuracy adjustment is the first option offered when switch S3 is pressed. In this mode both digits and seconds l.e.d.s are activated. Although the discussion in the previous section implied that a single bit of the LSB could be affected to change the timing, in practice there is a physical constraint.

The constraint is due to the best rate of response of the plus/minus switches being about half a second. Any faster response could adversely test the response time of the user – resulting in overshoot beyond the value required.

However, a response time of half a second becomes a problem when the value of the *second* byte needs changing by just one unit. The user could well have to sit with a finger on the button for possibly 256/2 = 128 seconds while byte one, the LSB, increments from zero and rolls over to cause the increment in byte two. Tedious to say the least!

This is especially true in the early days of the clock being put into service, when changes to any of the bytes may be required to bring the timing accuracy into range. Ideally, another switch is required for this aspect, but it would have been extremely complicated to implement a fourth switch since all PIC pins are otherwise in use.

Consequently, the value changes in the LSB have been set at eight units change per switch press, resulting in a maximum of 32 changes being required to affect byte two. It is a compromise, but the end result is still a remarkable degree of timing accuracy that can be achieved.

ADJUSTING FRACTIONS

The value of the LSB is displayed via the seconds l.e.d. ring. Prior to activating the required l.e.d. the LSB value is divided by eight and the result is displayed on the appropriate l.e.d., between positions (seconds) 0 and 31.

Any rollover of the LSB, upwards or downwards, accordingly changes byte two by one unit.

Putting the effect of this into context, the author's clock when first tested using the MSB set to binary 10000000 (decimal 128) and with the other bytes at zero (i.e. no correction), gained 10 seconds in about 20 hours.

Lowering the MSB value by one unit (to binary 01111111, decimal 127) to slow down the clock caused it to lose about 23 seconds in a similar period.

Progressively adjusting the values in the correction bytes between the upper and lower extremes just stated, the correct setting for the three bytes was established at decimal 127, 127, 250. During this procedure, the clock was typically left to run for about 12 to 20 hours between settings, with much extended periods the nearer the required final value became. Simple maths were also used to estimate the next setting that should be tried in relation to the previous two.

A similar procedure needs to be performed by everyone building this clock, although you may be fortunate enough to be supplied with a crystal whose exact value is nearer to the ideal of 3276800·00Hz.

TIMING ADJUSTMENT

Once the timing accuracy adjustment mode has been entered, the current value of the LSB (divided by eight) will be displayed on the seconds l.e.d. ring as described. In a sense this display can be regarded as the "fraction" of the change in units of the other bytes, whose value is displayed on the digits l.e.d.s.

These values are displayed in relation to a plus and minus value, not the actual byte values just discussed. Zero correction (when the MSB is set at decimal 128, and the other bytes at 0) is just displayed as 0. Each change of the value in the second byte is then represented as a change of units from the so-called zero value represented by bytes one and two, preceded by a minus sign on the left-hand digit for negative values.

The three other digits are used for the numerical value, allowing a correction range of –999 to 0 to 999 to be displayed. The fractional values in byte three are shown on the l.e.d. ring, lying between 0 and 31 as discussed. The author's above correction byte values are thus displayed as "– : 6" on the digits (leading zeros blanked). Ignore the colon's presence in this mode – it does not represent a decimal point.

Switches S2 and S1 increment or decrement the count as required.

TEMPERATURE ADJUSTMENT

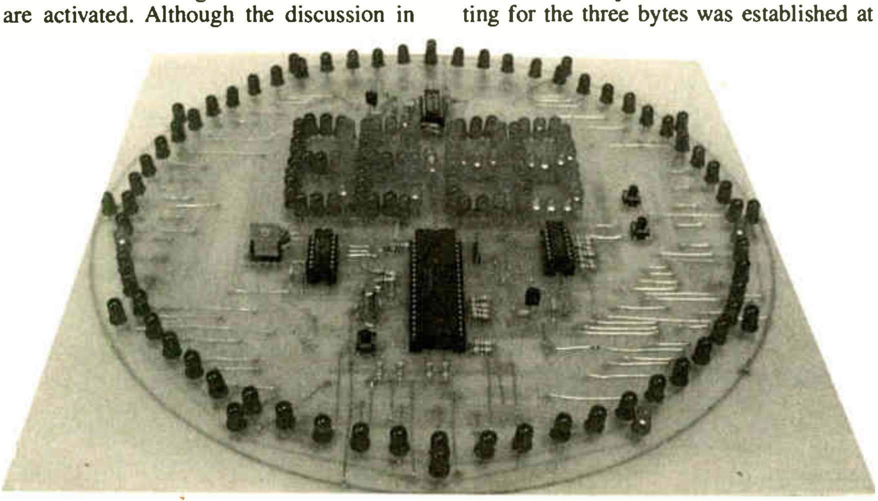
Pressing switch S3 while in the timing adjustment mode causes the temperature adjustment mode to be entered. As in the main display, the four digits show the temperature in the form of 20·6^{C}.

Because the amplifier around IC7 provides a gain of ×10 within the tolerance of the resistors (one per cent), it is only the range of the display value that needs adjusting, either upwards or downwards (but note reference to VR2 and R30A in Part One).

Again switches S1 and S2 provide plus/minus adjustment. Calibration of the display can be made in one of two ways. With both of them the unit should have been left switched on for several minutes for its operating temperature to stabilise before making changes.

The first method is to place an accurate (mercury filled) thermometer alongside the sensor. Wait for its temperature reading to stabilise in that position. Using the switches, then adjust the display value until it corresponds with the thermometer reading.

The second method is to monitor the voltage across the sensor's output and minus pins (as done earlier), and then to adjust the display value accordingly.



YEAR ADJUSTMENT

The clock software has been made "millennium compliant", up to the year 9999! To set it for the correct year, press switch S3. On releasing the switch the display will show 2003. It can be incremented (or even decremented) by using S1 and S2 as before.

The years value is never shown when the clock is running "in real time", but the value is used to assess whether February has 28 or 29 days. If you happen to be setting up the clock for the first time on 29th February of a leap year, year setting should be done prior to setting the month and its days. Otherwise it can wait until later.

When satisfied with the years display, press switch S3 again, causing the new correction values to be stored into the EEPROM memory, as before. Again the l.e.d. ring is fully activated and when the switch is released, the seconds count is set to zero and the clock resumes its normal role.

In either of these three correction modes, if a value does not need changing, just press switch S3 again to bypass it.

MODE FREEZING

A final facility has been included with the clock – to "freeze" the cyclic display mode changing on any function, clock, date or temperature. Press switch S1 when the required display is shown, wait about a second, release it and the cyclic change stops. It resumes again next time S1 is pressed.

TIMELY DEPARTURE

It just remains for the author to thank Fernando for inspiring him to design this clock. It has been a challenge in several ways, but principally because of the necessity to maintain high speed multiplexing at all stages without visual flicker.

Readers familiar with PIC programs might care to see how many repeated subroutine calls associated with multiplex maintenance are included, especially in the adjustment and calibration routines. If any of you think you can simplify it all – well, maybe you can, if you "have time on your hands", and good luck if you do try it.

Despite the complexities of achieving this design, it has been time well spent and the end result was worth the effort!

Now, where can this design be hung on the overcrowded walls of the workroom? ...

PLEASE TAKE NOTE

Part 1, June '03, Fig.5, IC5 pins 1 and 9 should be connected to the +5V line, not 0V. The p.c.b. is correct.

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The contents include an Overview of State-of-the-Art Robots; Robotic Locomotion; Motors and Power Controllers; All Types of Sensors; Tilt; Bump; Road and Wall Detection; Light; Speech and Sound Recognition; Robotic Intelligence (Expert Type) Using a Single-Board Computer Programmed in BASIC; Robotic Intelligence (Neutral Type) Using Simple Neural Networks (Insect Intelligence); Making a Lifelike Android Hand; A Computer-Controlled Robotic Insect Programmed in BASIC; Telepresence Robots With Actual Arcade and Virtual Reality Applications; A Computer-Controlled Robotic Arm; Animated Robots and Androids; Real-World Robotic Applications.

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Radio

BASIC RADIO PRINCIPLES AND TECHNOLOGY
Ian Poole

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

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

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

263 pages **Order code NE30** **£17.99**

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

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

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

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

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

AN INTRODUCTION TO AMATEUR RADIO
I. D. Poole

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

150 pages **Order code BP257** **£5.49**

VALVE RADIO AND AUDIO REPAIR HANDBOOK
Chas Miller

This book is not only an essential read for every professional working with antique radio and gramophone equipment, but also dealers, collectors and valve technology enthusiasts the world over. The emphasis is firmly on the practicalities of repairing and restoring, so technical content is kept to a minimum, and always explained in a way that can be followed by readers with no background in electronics. Those who have a good grounding in electronics, but wish to learn more about the practical aspects, will benefit from the emphasis given to hands-on repair work, covering mechanical as well as electrical aspects of servicing. Repair techniques are also illustrated throughout.

A large reference section provides a range of information compiled from many contemporary sources, and includes specialist dealers for valves, components and complete receivers.

288 pages **Temporarily out of print**

Computers and Computing

MULTIMEDIA ON THE PC
Ian R. Sinclair

In this book, you'll find out what a CD ROM is, how it works, and why it is such a perfect add-on for a PC, allowing you to buy programmes, text, graphics and sound on a CD. It also describes the installation of a CD ROM drive and a sound card, pointing out the common problems that arise, and then shows how to use them to create a complete multimedia presentation that contains text, photos, a soundtrack with your own voice recorded as a commentary, even animation and edited video footage.

184 pages **Temporarily out of print**

HOW TO BUILD YOUR OWN PC – Third Edition
Morris Rosenthal

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

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

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PIC YOUR PERSONAL INTRODUCTORY COURSE SECOND EDITION John Morton

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

A uniquely concise and practical guide to getting up and running with the PIC Microcontroller. The PIC is one of the most popular of the microcontrollers that are transforming electronic project work and product design.

Assuming no prior knowledge of microcontrollers and introducing the PIC's capabilities through simple projects, this book is ideal for use in schools and colleges. It is the ideal introduction for students, teachers, technicians and electronics enthusiasts. The step-by-step explanations make it ideal for self-study too: this is not a reference book – you start work with the PIC straight away.

The revised second edition covers the popular reprogrammable EEPROM PICs: P16C84/16F84 as well as the P54 and P71 families.

270 pages **Order code NE36** **£13.99**

UNDERSTANDING PC SPECIFICATIONS
R. A. Penfold (Revised Edition)

If you require a microcomputer for business applications, or a high quality home computer, an IBM PC or compatible is often the obvious choice. They are competitively priced, and are backed up by an enormous range of applications programs, hardware add-ons, etc. The main difficulty for the uninitiated is deciding on the specification that will best suit his or her needs. PCs range from simple systems of limited capabilities up to complex systems that can happily run applications that would have been considered beyond the abilities of a microcomputer not so long ago. It would be very easy to choose a PC system that is inadequate to run your applications efficiently, or one which goes beyond your needs and consequently represents poor value for money.

This book explains PC specifications in detail, and the subjects covered include the following: Differences between types of PC (XT, AT, 80386, etc); Maths co-processors; Input devices (keyboards, mice, and digitisers); Memory, including both expanded (EMS) and extended RAM; RAM disks and disk caches; Floppy disk drive formats and compatibility; Hard disk drives (including interleave factors and access times); Display adaptors, including all standard PC types (CGA, Hercules, Super VGA, etc); Contains everything you need to know if you can't tell your EMS from your EGA!

128 pages **Order code BP282** **£5.45**

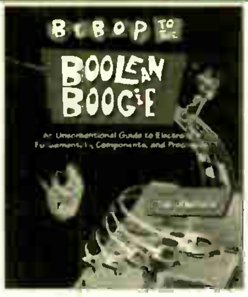
Theory and Reference

Bebop To The Boolean Boogie

By Clive (call me Max) Maxfield

Specially imported by *EPE – Excellent value*

An Unconventional Guide to Electronics Fundamentals, Components and Processes



This book gives the "big picture" of digital electronics. This indepth, highly readable, up-to-the-minute guide shows you how electronic devices work and how they're made. You'll discover how transistors operate, how printed circuit boards are fabricated, and what the innards of memory ICs look like. You'll also gain a working knowledge of Boolean Algebra and Karnaugh Maps, and understand what Reed-Muller logic is and how it's used. And there's much, MUCH more (including a recipe for a truly great seafood gumbo!). Hundreds of carefully drawn illustrations clearly show the important points of each topic. The author's tongue-in-cheek British humor makes it a delight to read, but this is a REAL technical book, extremely detailed and accurate. A great reference for your own shelf, and also an ideal gift for a friend or family member who wants to understand what it is you do all day. . . .

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CD-ROM

Clive (Max) Maxfield and Alvin Brown

This follow-on to *Bebop to the Boolean Boogie* is a multimedia extravaganza of information about how computers work. It picks up where "Bebop I" left off, guiding you through the fascinating world of computer design . . . and you'll have a few chuckles, if not belly laughs, along the way. In addition to over 200 megabytes of mega-cool multimedia, the CD-ROM contains a virtual microcomputer, simulating the motherboard and standard computer peripherals in an extremely realistic manner. In addition to a wealth of technical information, myriad nuggets of trivia, and hundreds of carefully drawn illustrations, the CD-ROM contains a set of lab experiments for the virtual microcomputer that let you recreate the experiences of early computer pioneers. If you're the slightest bit interested in the inner workings of computers, then don't dare to miss this!

Over 800 pages in Adobe Acrobat format

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ELECTRONICS MADE SIMPLE
Ian Sinclair

Assuming no prior knowledge, *Electronics Made Simple* presents an outline of modern electronics with an emphasis on understanding how systems work rather than on details of circuit diagrams and calculations. It is ideal for students on a range of courses in electronics, including GCSE, C&G and GNVQ, and for students of other subjects who will be using electronic instruments and methods.

Contents: waves and pulses, passive components, active components and ICs, linear circuits, block and circuit diagrams, how radio works, disc and tape recording, elements of TV and radar, digital signals, gating and logic circuits, counting and correcting, microprocessors, calculators and computers, miscellaneous systems.

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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 — Order code NE27 — £21.99

GETTING THE MOST FROM YOUR MULTIMETER
R. A. Penfold

This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.

In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.

96 pages — Order code BP239 — £4.49

DIGITAL GATES AND FLIP-FLOPS
Ian R. Sinclair

This book, intended for enthusiasts, students and technicians, seeks to establish a firm foundation in digital electronics by treating the topics of gates and flip-flops thoroughly and from the beginning.

Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.

No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.

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Music, Audio and Video

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.

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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.

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ELECTRONIC MUSIC AND MIDI PROJECTS
R. A. Penfold

NEW LOW PRICE

Whether you wish to save money, boldly go where no musician has gone before, rekindle the pioneering spirit, or simply have fun building some electronic music gadgets, the designs featured in this book should suit your needs. The projects are all easy to build, and some are so simple that even complete beginners at electronic project construction can tackle them with ease. Stripboard layouts are provided for every project, together with a wiring diagram. The mechanical side of construction has largely been left to individual constructors to sort out, simply because the vast majority of project builders prefer to do their own thing in this respect.

None of the designs requires the use of any test equipment in order to get them set up properly. Where any setting up is required, the procedures are very straightforward, and they are described in detail.

Projects covered: Simple MIDI tester, Message grabber, Byte grabber, THRU box, MIDI auto switcher, Auto/manual switcher, Manual switcher, MIDI patchbay, MIDI controlled switcher, MIDI lead tester, Program change pedal, Improved program change pedal, Basic mixer, Stereo mixer, Electronic swell pedal, Metronome, Analogue echo unit.

124 pages — Order code PC116 — ~~£10.95~~ £4.95

THE INVENTOR OF STEREO – THE LIFE AND WORKS OF ALAN DOWER BLUMLEIN
Robert Charles Alexander

This book is the definitive study of the life and works of one of Britain's most important inventors who, due to a cruel set of circumstances, has all but been overlooked by history.

Alan Dower Blumlein led an extraordinary life in which his inventive output rate easily surpassed that of Edison, but whose early death during the darkest days of World War Two led to a shroud of secrecy which has covered his life and achievements ever since.

His 1931 Patent for a Binaural Recording System was so revolutionary that most of his contemporaries regarded it as more than 20 years ahead of its time. Even years after his death, the full magnitude of its detail had not been fully utilized. Among his 128 patents are the principal electronic circuits critical to the development of the world's first electronic television system. During his short working life, Blumlein produced patent after patent breaking entirely new ground in electronic and audio engineering.

During the Second World War, Alan Blumlein was deeply engaged in the very secret work of radar development and contributed enormously to the system eventually to become 'H2S' – blind-bombing radar. Tragically, during an experimental H2S flight in June 1942, the Halifax bomber in which Blumlein and several colleagues were flying, crashed and all aboard were killed. He was just days short of his thirty-ninth birthday.

420 pages — Order code NE32 — £16.99

VIDEO PROJECTS FOR THE ELECTRONICS CONSTRUCTOR
R. A. Penfold

NEW LOW PRICE

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~~ £4.95

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 setups, FAQs, a glossary, advice on hardware and software, and a list of industry contacts.

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HIGH POWER AUDIO AMPLIFIER CONSTRUCTION
R. A. Penfold

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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

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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.

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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

DOMESTIC SECURITY SYSTEMS
A. L. Brown
This book shows you how, with common sense and basic do-it-yourself skills, you can protect your home. It also gives tips and ideas which will help you to maintain and improve your home security, even if you already have an alarm. Every circuit in this book is clearly described and illustrated, and contains components that are easy to source. Advice and guidance are based on the real experience of the author who is an alarm installer, and the designs themselves have been rigorously put to use on some of the most crime-ridden streets in the world.
The designs include all elements, including sensors, detectors, alarms, controls, lights, video and door entry systems. Chapters cover installation, testing, maintenance and upgrading.

192 pages Temporarily out of print

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** £21.99

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

Project Building & Testing

ELECTRONIC PROJECTS FOR EXPERIMENTERS
R. A. Penfold
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The subjects covered include:- Magnetic field detector, Basic Hall effect compass, Hall effect audio isolator, Voice scrambler/descrambler, Bat detector, Bat style echo location, Noise cancelling, LED stroboscope, Infra-red "torch", Electronic breeze detector, Class D power amplifier, Strain gauge amplifier, Super hearing aid.

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The construction and use of a Tristate Continuity Tester, a Signal Tracer, a Logic Probe and a CMOS Tester are also included.

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PRACTICAL FIBRE-OPTIC PROJECTS
R. A. Penfold
While fibre-optic cables may have potential advantages over ordinary electric cables, for the electronics enthusiast it is probably their novelty value that makes them worthy of exploration. Fibre-optic cables provide an innovative interesting alternative to electric cables, but in most cases they also represent a practical approach to the problem. This book provides a number of tried and tested circuits for projects that utilize fibre-optic cables.
The projects include:- Simple audio links, F.M. audio link, P.W.M. audio links, Simple d.c. links, P.W.M. d.c. link, P.W.M. motor speed control, RS232C data links, MIDI link, Loop alarms, R.P.M. meter.
All the components used in these designs are readily available, none of them require the constructor to take out a second mortgage.

132 pages **Order code BP374** £5.45

RADIO BYGONES

We also carry a selection of books aimed at readers of *EPE*'s sister magazine on vintage radio *Radio Bygones*. These books include the *Comprehensive Radio Valve Guides* (five books with a Free copy of the Master Index) for just £15. Also Jonathan Hill's excellent *Radio Radio,* a comprehensive book with hundreds of photos depicting the development of the British wireless set up to the late 1960s.
The three volumes of our own *Wireless For the Warrior* by Louis Meulstee are also available. These are a technical history of radio communication equipment in the British Army from pre-war through to the 1960s.
For details see the shop on our UK web site at **www.epemag.wimborne.co.uk** or contact us for a list of *Radio Bygones* books.

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NOTE: While 95% of our boards are held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail.

Back numbers or photostats of articles are available if required – see the *Back Issues* page for details. We do not supply kits or components for our projects.

Please check price and availability in the latest issue.
A number of older boards are listed on our website.
Boards can only be supplied on a payment with order basis.

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★Digitimer – Main Board		311	£6.50
– R.F. Board		312	£4.36
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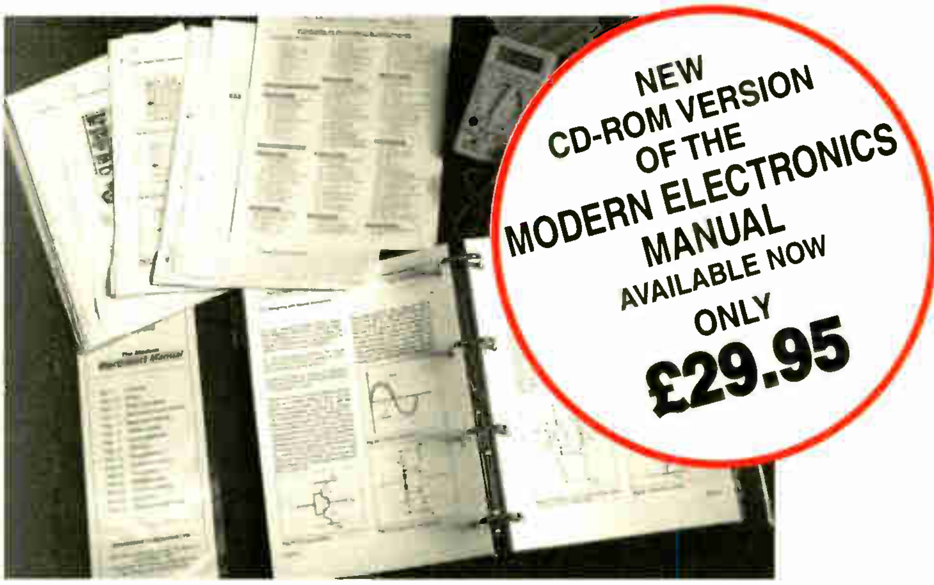

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POWER AMPLIFIER MODULES-LOUDSPEAKERS-MIXERS 19 INCH STEREO AMPLIFIERS-ACTIVE CROSS/OVERS.

BK ELECTRONICS

* PRICES INCLUDE V.A.T.
* PROMPT DELIVERY

OMP MOS-FET POWER AMPLIFIERS
HIGH POWER, TWO CHANNEL 19 INCH RACK

10,000's SOLD TO PRO USERS

THE RENOWNED MXF SERIES OF POWER AMPLIFIERS

FOUR MODELS:- MXF200 (100W + 100W) MXF400 (200W + 200W)
MXF600 (300W + 300W) MXF900 (450W + 450W)

ALL POWER RATINGS ARE R.M.S. INTO 4 OHMS, WITH BOTH CHANNELS DRIVEN

FEATURES:- * Independent power supplies with two toroidal transformers * Twin L.E.D. Vu Meters * Level controls * Illuminated on/off switch * Jack / XLR inputs * Speakon Outputs *Standard 775mv inputs *Open and Short circuit proof * Latest Mos-Fets for stress free delivery into virtually any load * High slew rate * Very low distortion * Aluminium cases * MXF600 & MXF900 fan cooled with D.C. Loudspeaker and thermal protection.

USED THE WORLD OVER IN CLUBS, PUBS, CINEMAS, DISCOS ETC

SIZES:-
MXF200 W19" D11" H3½" (2U)
MXF400 W19" D12" H5¼" (3U)
MXF600 W19" D13" H5¼" (3U)
MXF900 W19" D14" H5¼" (3U)

PRICES:- MXF200 £175.00 MXF400 £233.85
MXF600 £329.00 MXF900 £449.15
SPECIALIST CARRIER DEL £12.50 Each

ibl FLIGHTCASED LOUDSPEAKERS

A new range of quality loudspeakers, designed to take advantage of latest loudspeaker technology and enclosure designs. All models utilise high quality studio cast aluminium loudspeakers with factory fitted grilles, wide dispersion constant directivity horns, extruded aluminium corner protection and steel ball corners, complimented with heavy duty black covering. The enclosures are fitted as standard with top hats for optional loudspeaker stands. The FC15-300 incorporates a large 16 X 6 inch horn. All cabinets are fitted with the latest Speakon connectors for your convenience and safety. Five models to choose from.

PLEASE NOTE:- POWER RATINGS QUOTED ARE IN WATTS R.M.S. FOR EACH INDIVIDUAL CABINET ALL ENCLOSURES ARE 8 OHMS

15 15 Inch speaker
12 12 Inch speaker

ibl FC15-300 WATTS Freq Range 35Hz-20kHz, Sens 101dB, Size H695 W502 D415mm
Price:- £299.00 per pair

ibl FC12-300 WATTS Freq Range 45Hz-20kHz, Sens 96dB, Size H600 W405 D300mm
Price:- £249.00 per pair

ibl FC12-200 WATTS Freq Range 40Hz-20kHz, Sens 97dB, Size H600 W405 D300mm
Price:- £199.00 per pair

ibl FC12-100 WATTS Freq Range 45Hz-20kHz, Sens 100dB, Size H546 W380 D300mm
Price:- £179.00 per pair

ibl WM12-200 WATTS Freq Range 40Hz-20kHz, Sens 97dB, Size H418 W600 D385mm
Price:- £125.00 Each

SPECIALIST CARRIER DEL:- £12.50 per pair, wedge monitor £7.00 each
Optional Metal Stands PRICE:- £49.00 per pair Delivery:- £6.00

CATALOGUE 2001-2002

OMP XO3-S STEREO 3 WAY ACTIVE CROSSOVER
SWITCHABLE 2-WAY

BASS / MID / TOP — CONFIGURED 3 WAY
BASS/MID / TOP — 2 WAY BASS/MID COMBINED
BASS / MID/TOP — 2 WAY MID/TOP COMBINED

FEATURES:-

Advanced 3-Way Stereo Active Cross-Over (Switchable two way), housed in a 19" x 1U case. Each channel has three level controls: Bass, Mid & Top. The removable front facia allows access to the programmable DIL switches to adjust the cross-over frequency: There are two versions available:-
XO3-S Bass-Mid 125/250/500Hz, Mid-Top 1.8/3/5kHz, all at 24 dB per octave.
XO3 Bass-Mid 250/500/800Hz, Mid-Top 1.8/3/5kHz, all at 24 dB per Octave.
Please make sure you ask for the correct model when ordering. The 2/3 way selector switches are also accessed by removing the front facia. Each stereo channel can be configured separately. Bass Invert Switches are incorporated on each channel. Nominal 775mV input/output. Fully compatible with the OMP Rack Amplifier and Modules.

BOTH MODELS PRICED AT :- £117.44 + £5.00 P&P

OMP MOS-FET POWER AMPLIFIER MODULES
SUPPLIED READY BUILT AND TESTED

These modules now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models are available to suit the needs of the professional and hobby market ie. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE that all models include toroidal power supply, integral heatsink, glass fibre P.C.B. and drive circuits to power a compatible Vu meter. All models are open and short circuit proof.

THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS

OMP/MF 100 Mos-Fet Output Power 110 watts R.M.S. into 4 ohms, frequency response 1Hz - 100kHz -3dB, Damping Factor >300, Slew Rate 45V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. 110dB. Size 300 x 123 x 60mm.
Price:- £42.85 + £4.00 P&P

OMP/MF 200 Mos-Fet Output Power 200 watts R.M.S. into 4 ohms, frequency response 1Hz - 100kHz -3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. 110dB. Size 300 x 155 x 100mm.
Price:- £66.35 + £4.00 P&P

OMP/MF 300 Mos-Fet Output Power 300 watts R.M.S. into 4 ohms, frequency response 1Hz - 100kHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. 110dB. Size 330 x 175 x 100mm.
Price:- £83.75 + £5.00 P&P

OMP/MF 450 Mos-Fet Output Power 450 watts R.M.S. into 4 ohms, frequency response 1Hz - 100kHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. 110dB. Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti Thump Delay. Size 385 x 210 x 105mm.
Price:- £135.85 + £6.00 P&P

OMP/MF 1000 Mos-Fet Output Power 1000 watts R.M.S. into 2 ohms, frequency response 1Hz - 100kHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. 110dB. Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti Thump Delay. Size 422 x 300 x 125mm.
Price:- £261.00 + £12.00 P&P

NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 500mV, BANDWIDTH 100kHz. OR PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BANDWIDTH 50kHz. ORDER STANDARD OR PEC

100 WATT ACTIVE SUB BASS AMPLIFIER PANEL

AN ACTIVE SUB BASS AMPLIFIER WITH A TRUE 100W RMS OUTPUT. SUPERB CONSTRUCTION WITH THE FACILITIES TO INTEGRATE SEEMLESSLY INTO MOST HI-FI OR HOME CINEMA SETUPS. USE THIS PANEL PLUS ONE OF OUR LOUDSPEAKERS TO MAKE YOUR OWN SUB WOOFER THAT WILL MATCH OR BEAT MOST COMMERCIALLY AVAILABLE SUB WOOFERS.

FEATURES:- * 100W RMS INTO 8 OHMS * HIGH AND LOW LEVEL INPUTS * TOROIDAL TRANSFORMER * SHORT CIRCUIT PROTECTION * D.C. SPEAKER PROTECTION * FREQUENCY ROLL OFF, LOWER 10Hz, UPPER 60Hz TO 240Hz (FULLY ADJUSTABLE) * AC3 COMPATIBLE FILTER CAN BE BYPASSED FOR 5-1 FORMATS. * AIRTIGHT CONSTRUCTION * TENS OF THOUSANDS OF OUR PANELS ALREADY IN USE. * COMPLETE WITH LEADS

SPECIFICATIONS:-* POWER 100W RMS @ 8 OHMS *FREQ RESP. 10Hz 15KHz -3dB * DAMPING FACTOR >200 * DISTORTION 0.05% * S/N A WEIGHTED >100dB * SUPPLY 230V A.C. *WEIGHT 2.7Kg * SIZE H254 X W254 X D94mm

THERE ARE 2 VERSIONS OF THE ABOVE PANEL AVAILABLE :-BSB100/8 8 OHM VERSION BSB100/4 4 OHM VERSION BOTH PANELS ARE PRICED AT £117.44 + £5.00 P&P INCL. V.A.T. CHECK WEBSITE FOR PANELS UP TO 500W

VISA

DELIVERY CHARGES:- PLEASE INCLUDE AS ABOVE, TO A MAXIMUM AMOUNT £30.00. OFFICIAL ORDERS FROM SCHOOL, COLLEGES, GOVT., PLCs ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER. CREDIT CARD ORDERS ACCEPTED BY POST PHONE OR FAX.

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REF D5

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