EVERYDAY
FEBRUARY 1999

PRACTICAL ELECTRONICS

http://www.epemag.wimborne.co.uk
£2.65

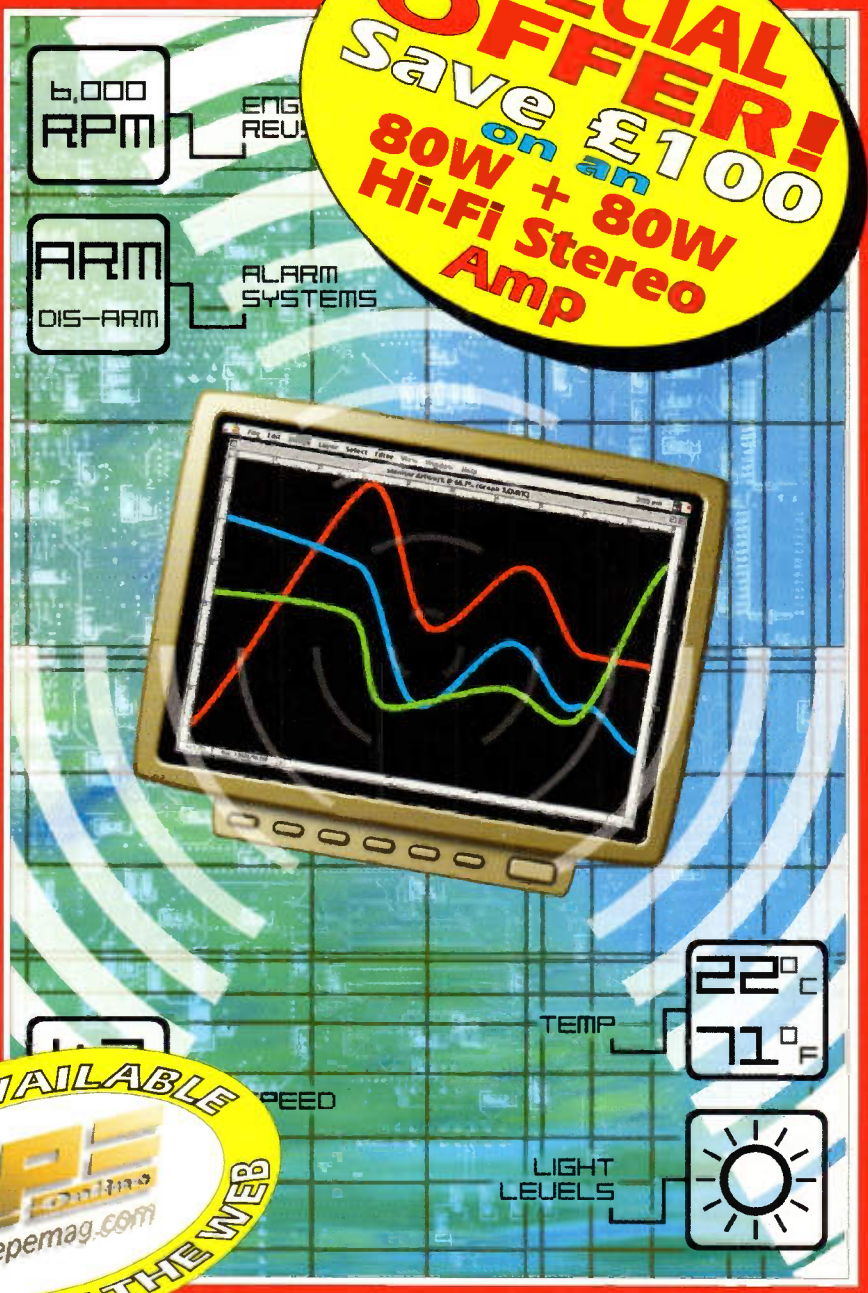
WIRELESS MONITORING SYSTEM
Radio linked PC data logging

PIC MIDI SUSTAIN PEDAL
Easy to build sustain or glissando

LIGHT ALARM
Multiple use light triggered design

SCOLAR POWER
School computers powered by the sun

SPECIAL OFFER! Save £100 on an 80W + 80W Hi-Fi Stereo Amp



NOW AVAILABLE TO BUY ON THE WEB
www.epemag.com

THE No.1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

9 770262 361089 02

PLUS PhizzyB Computers • Ingenuity Unlimited
Circuit Surgery • New Technology Update • Innovations

WIND GENERATORS 380 WATT 1.14 metre dia blades, carbon matrix blades, 3 year warranty, 12vdc output, 24v version available, control electronics included, brushless neodymium cubic curve alternator, only two moving parts, maintenance free, simple roof top installation, start up speed 7mph, max output (30mph) 380w. £499 ref AIR1

HYDROPONICS DO YOU GROW YOUR OWN? We have a full colour hydroponics catalogue available containing nutrients, pumps, fittings, enviromental control, light fittings, plants, test

TELEKINETIC ENHANCER PLANS Mystify and amaze your friends by creating motion with no known apparent means or cause. Uses no electrical or mechanical connections, no special gimmicks yet produces positive motion and effect. Excellent for science projects, magic shows, party demonstrations or serious research & development of this strange and amazing phychic phenomenon. £4/set Ref F/TKE1

ELECTRONIC HYPNOSIS PLANS & DATA This data shows several ways to put subjects under your control. Included is a full volume reference text and several construction plans that when assembled can produce highly effective stimuli. This material must be used cautiously. It is for use as entertainment at parties etc only, by those experienced in its use. £15/set. Ref F/EH2

GRAVITY GENERATOR PLANS This unique plan demonstrates a simple electrical phenomena that produces an anti-gravity effect. You can actually build a small mock spaceship out of simple materials and without any visible means - cause it to levitate. £10/set Ref F/GRA1

WORLDS SMALLEST TESLA COIL/LIGHTENING DISPLAY GLOBE PLANS Produces up to 750,000 volts of discharge, experiment with extraordinary HV effects, 'Plasma in a jar', St Elmo's fire, Corona, excellent science project or conversation piece £5/set Ref F/BTC1/LG5

VOICE SCRAMBLER PLANS Minature solid state system turns speech sound into indecipherable noise that cannot be understood without a second matching unit. Use on telephone to prevent third party listening and bugging. £6/set Ref F/VS9.

PULSED TV JOKER PLANS Little hand held device utilises pulse techniques that will completely disrupt TV picture and sound! works on F/M too! DISCRETION ADVISED. £8/set Ref F/TJ5

BURNING, CUTTING CO2 LASER PLANS Projects an invisible beam of heat capable of burning and melting materials over a considerable distance. This laser is one of the most efficient, converting 10% input power into useful output. Not only is this device a workhorse in welding, cutting and heat processing materials but it is also a likely candidate as an effective directed energy beam weapon against missiles, aircraft, ground-to-ground, etc. Particle beams may very well utilize a laser of this type to blast a channel in the atmosphere for a high energy stream of neutrons or other particles. The device is easily applicable to burning and etching wood, cutting, plastics, textiles etc £12/set Ref F/LC7

ULTRASONIC BLASTER PLANS Laboratory source of sonic shock waves. Blow holes in metal, produce 'cold' steam, atomize liquides. Many cleaning uses for PC boards, jewllery, coins, small parts etc. £6/set Ref F/ULB1

ANTI DOG FORCE FIELD PLANS Highly effective circuit produces time variable pulses of accoustical energy that dogs cannot tolerate £6/set Ref F/DOG2

LASER BOUNCE LISTENER SYSTEM PLANS Allows you to hear sounds from a premises without gaining access. £12/set Ref F/LLIST1

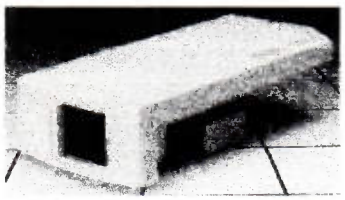
PHASOR BLAST WAVE PISTOL SERIES PLANS Handheld, has large transducer and battery capacity with external controls. £6/set Ref F/PSP4

INFINITY TRANSMITTER PLANS Telephone line grabber/ room monitor. The ultimate in home/office security and safety! simple to use! Call your home or office phone, push a secret tone on your telephone to access either: A) On premises sound and voices or B) Existing conversation with break-in capability for emergency messages. £7 Ref F/TELEGRAB.

ELECTROMAGNETIC GUN PLANS Projects a metal object a considerable distance-requires adult supervision £5 ref F/EML2.

ELECTRIC MAN PLANS, SHOCK PEOPLE WITH THE TOUCH OF YOUR HAND! £5/set Ref F/EMA1.

2 FOR 1 MULTIFUNCTIONAL HIGH FREQUENCY AND HIGH DC VOLTAGE, SOLID STATE TESLA COIL AND VARIABLE 100,000 VDC OUTPUT GENERATOR PLANS Operates on 9-12vdc, many possible experiments. £10 Ref F/HVM7/ TCL4.



COLOUR CCTV VIDEO CAMERAS From £99

Works with most modern video's, TV's, Composite monitors, video grabber cards. Pal, 1v P-P, composite, 75ohm, 1/3" CCD, 4mm F2.8, 500x582, 12vdc, mounting bracket, auto shutter, 100x50x180mm, 3 months warranty, 1 off price £119 ref XEF150, 10 or more £99 ea 100+ £89

CIRCUIT PACKS Packs of 35 circuit diagrams covering lasers, SW radios, geigers,bugs,char etc. Pack1, Pack2, Pack3 £4.99 each.

SMOKE ALARMS Mains powered, made by the famous Gent company, easy fit next to light fittings ,power point. £4.99 ref SMKX

CONVERT YOUR TV INTO A VGA MONITOR FOR £25! Converts a colour TV into a basic VGA screen. Complete with built in psu, lead and s/ware. Ideal for laptops or a cheap upgrade. Supplied in kit form for home assembly. **SALE PRICE £25** REF SA34

***15 WATT FM TRANSMITTER** Already assembled but some RF knowledge will be useful for setting up. Preamp req'd, 4 stage 80-108mhz, 12-18vdc, can use ground plane, yagi or dipole £69 ref 1021

***4 WATT FM TRANSMITTER KIT** Small but powerful FM transmitter kit. 3 RF stages, mic & audio preamp inc. £24 ref 1028

PIR CAMERA Built in CCTV camera (composite output) IR strobe light,PIR detector and battery backup. Designed to 'squirt' pictures down the 'phone line but works well as a standalone unit. Bargain price £49.95 ref SS81, 3 or more £44.95 ref SS80.

4AH D SIZE NICADS pack of 4 £10 ref 4AHPK

ELECTRIC FENCE KIT Everything you need to build a 12vdc electric fence, complete with 200m of electric fence wire. £49 ref AR2

SENDER KIT Contains all components to build a A/V transmitter complete with case £35 ref VSXX2

UV LIGHTS 4' flourescent 340nm £38.99 ref UV23

33 KILO LIFT MAGNET Neodynium,32mm £15 ref MAG33

10 WATT SOLAR PANEL Amorphous silicon panel fitted in a anodized aluminium frame. Panel measures 3' by 1' with screw terminals for easy connection. **3' x 1' solar panel £55 ref MAG45**

Unframed 4 pack (3'x1') £58.99 ref SOLX

12V SOLAR POWERED WATER PUMP Perfect for many 12v DC uses, ranging from solar fountains to hydroponics! Small and compact yet powerful. Will work direct from our 10 watt solar panel in bright sunlight. Max head:17 ft Max flow = 8 Lpm,1. 5A Ref AC8 £18.99

SOLAR ENERGY BANK KIT 50x 6"x12" 6v solar panels(amorphous)+50 diodes £99 ref EF112

PINHOLE CAMERA MODULE WITH AUDIO! Superb board camera with on board sound! extra small just 28mm square (including microphone) ideal for covert surveillance. Can be hidden inside anything, even a matchbox! Complete with 15 metre cable, psu and tv/vcr connnectors. £73.95 ref CC6

SOLAR MOTORS Tiny motors which run quite happily on voltages from3-12vdc. Works on our 6v amorphous 6" panels and you can run them from the sun! 32mm dia 20mm thick. £1.50 each

WALKIE TALKIES 1 MILE RANGE £37/PAIR REF MAG30

DRILL OPERATED PUMP Fits to any drill in seconds, uses standard garden hose,pumps up to 40 gph! £8.99 ref DRL3

GIANT SCREEN VIEWER Turn your TV picture into a supersize screen! This high precision Fresnel lens converts even the smallest screen up to a massive 26", at a fraction of the cost of a big TV. Easily fitted in minutes.Also ideal for PC monitors etc £26.95 ref SVGA2

TELEPHONES Just in this week is a huge delivery of telephones, all brand new and boxed. Two piece construction with the following features- Illuminated keypad, tone or pulse (switchable), reacall, redial and pause, high/low and off ringer switch and quality construction, finished in a smart off white colour and is supplied with a standard International lead (same as US or modems) if you wish to have a BT lead supplied to convert the phones these are also available at £1.55 each ref BTLX **Phones £4.99 each ref PH2**

LIQUID CRYSTAL DISPLAYS Bargain prices,

20 character 2 line, 83x19mm £3.99 ref SMC2024A

16 character 4 line, 62x25mm £5.99 ref SMC1640A

40 character 1 line 154x16mm £6.00 ref SMC4011A

LM255X HITACHI LAPTOP SCREENS 240x100mm, 640x200 dots. New with data £15 ref LM2

SEALED LEAD ACID BATTERIES

12V 6.5AH, NEW £12 REF BATT12

12V 6.5AH, S/HAND PACK OF 5 £20 REF EF99

12V 15AH AS NEW, £18 REF LOT8

THE ULTIMATE ENCLOSURE for your projects must be one of these!Well made ABS screw together beige case measuring 120 x 150 x 50mm.Fitted with rubber feet and front mounted LED. Inside is a pcb fitted with other bits and pieces you may find useful. Sold as a pack of five for £10 ref MD1,pack of 20 for £19.95 ref MD2

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

LOW COST CORDLESS MIC 500' range, 90 - 105mhz, 115g, 193 x 26 x 39mm, 9v PP3 battery required. £17 ref MAG15P1

AUTO SUNCHARGER 155x300mm solar panel with diode and 3 metre lead fitted with a cigar plug. 12v 2watt **£12.99** REF AUG10P3

SOLAR POWER LAB SPECIAL 2x 6"x6" 6v 130mA cells, 4 LED's, wire, buzzer, switch + 1 relay or motor. **£7.99** REF SA27

SOLAR NICAD CHARGERS 4 x AA size £9.99 ref 6P476, 2 x C size £9.99 ref 6P477

AIR RIFLES .22 As used by the Chinese army for training, so there is a lot about! £39.95 Ref EF78. 500 pellets £4.50 ref EF80.

Interactive websites designed and hosted.

bullnet.co.uk

REGISTER FOR OUR ELECTRONIC NEWSLETTERS

BULL-ELECTRICAL.COM

BULL ELECTRICAL

250 PORTLAND ROAD, HOVE, SUSSEX. BN3 5QT. (ESTABLISHED 50 YEARS).

MAIL ORDER TERMS: CASH, PO OR CHEQUE WITH ORDER PLUS £4.00 P&P PLUS VAT.

24 HOUR SERVICE £6.50 PLUS VAT.

OVERSEAS ORDERS AT COST PLUS £3.50

(ACCESS,VISA, SWITCH, AMERICAN EXPRESS)

'phone orders : 01273 203500

FAX 01273 323077

Sales@bull-electrical.com

200 WATT INVERTERS plugs straight into your car cigarette lighter socket and is fitted with a 13A socket so you can run your mains operated devices from your car battery. £49.95 ref SS66

THE TRUTH MACHINE Tells if someone is lying by micro tremors in their voice, battery operated, works in general conversation and on the 'phone and TV as well! £42.49 ref TD3

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

HYDROGEN FUEL CELL PLANS Loads of information on hydrogen storage and production. Practical plans to build a Hydrogen fuel cell (good workshop facilities required) £8 set ref FCP1

STIRLING ENGINE PLANS Interesting information pack covering all aspects of Stirling engines, pictures of home made engines made from an aerosol can running on a candle! £12 ref STIR2

ENERGY SAVER PLUGS Saves up to 15% electricity when used with fridges,motors up to 2A,light bulbs,soldering irons etc. £9 ea ref LOT71, 10 pack £69 ref LOT72

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

HI POWER ZENON VARIABLE STROBES Useful 12v PCB fitted with hi power strobe tube and control electronics and speed control potenthometer. Perfect for interesting projects etc 70x55mm 12vdc operation. £6 ea ref FLS1, pack of 10 £49 ref FLS2

DRILL OPERATED PUMP Fits to any drill in seconds, uses standard garden hose,pumps up to 40 gph! £8.99 ref DRL3

NEW LASER POINTERS 4.5mw, 75 metre range, hand held unit runs on two AA batteries (supplied) 670nm. £29 ref DEC49

HOW TO PRODUCE 35 BOTTLES OF WHISKY FROM A SACK OF POTATOES Comprehensive 270 page book covers all aspects of spirit production from everyday materials. Includes construction details of simple stills etc. £12 ref MS3

NEW HIGH POWER MINI BUG With a range of up to 800 metres and a 3 days use from a PP3 this is our top selling bug! less than 1" square and a 10m voice pickup range. £28 Ref LOT102.

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

CCTV CAMERA MODULES 46X70X29mm, 30 grams, 12v 100mA, auto electronic shutter, 3.6mm F2 lens, CCIR, 512x492 pixels, video output is 1v p-p (75 ohm). Works directly into a scart or video input on a tv or video. IR sensitive. £49 ref EF137.

IR LAMP KIT Suitable for the above camera, enables the camera to be used in total darkness! £6 ref EF138

UK SCANNING DIRECTORY As supplied to Police, MOD,M15 and GCHQ! coverers everything from secret government frequencies, eye in the sky, prisons, military aviation etc £18.50 ref SCANB

INFRA RED POWERBEAM Handheld battery powered lamp, 4 inch reflector, gives out powerful pure infrared light! perfect for CCTV use, nightsights etc. £29 ref PB1

SUPER WIDEBAND RADAR DETECTOR Detects both radar and laser, X K and KA bands, speed cameras, and all known speed detection systems. 360 degree coverage, front&r earwaveguides. 1.1"x2.7"x4.6" fits on visor or dash £149

CHIEFTAN TANK DOUBLE LASERS 9 WATT+3 WATT+LASER OPTICS Could be adapted for laser listener, long range communications etc Double beam units designed to fit in the gun barrel of a tank, each unit has two semi conductor lasers and motor drive units for alignement. 7 mile range, no circuit diagrams due to MOD, new price £50,000? us? £199. Each unit has two gallium Arsenide injection lasers. 1 x 9 watt, 1 x 3 watt, 900nm wavelength, 28vdc, 600hz pulse frequency. The units also contain an electronic receiver to detect reflected signals from targets. £199 Ref LOT4

MAGNETIC CREDIT CARD READERS AND ENCODING MANUAL £9.95 Cased with flyleads, designed to read standard credit cards! complete with control elctronics PCB and manual covering everything you could want to know about whats hidden in that magnetic strip on your card! just £9.95 ref BAR31

EXTERNAL CAMERA Introducing the Bulldog model 4 vandal resistant camera in heavy steel case for interior or exterior use. Top quality case housing a 420 line camera module. Each camera is supplied with a 15m cable terminating in Scart and phono plugs. Multi angle bracket for easy installation in any situation. A 12vdc psu is also included. Easily installed in a few minutes, plugs straight into VCR or TV (phono or scart). **Bargain price £89.95 ref CC1**

3HP MAINS MOTORS Single phase 240v brand new, 2 pole, 340x180mm, 2850 rpm, builtin automatice reset overload protector, keyed shaft (40x16mm)Made by Leeson. £99 each ref LEE1

LOPTX Made by Samsung for colour TV £3 each ref SS52

LAPTOP LCD SCREENS 240x175mm, £12 ref SS51

PIR WITH BUILT IN CCTV CAMERA Module also includes an infra red strobe light, battery backup etc. 320x240 pixels, 90x65 field of view. £49.95 ea ref SS81, 3 or more £44.95 ref SS82

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

HIGH POWER DC MOTORS, PERMANENT MAGNET 12 - 24v operation, probably about 1/4 horse power, body measures 100m x 75mm with a 60mm x 5mm output shaft with a machined flat on it. Fixing is simple using the two threaded bolts protruding from the front. £22 ref MOT4

ELECTRONIC SPEED CONTROLLER KIT For the above motor is £19 ref MAG17. Save £5 if you buy them both together, 1 motor plus speed controller rrp is £41, offer price £36 ref MOT5A

Online web catalogue

bull-electrical.com

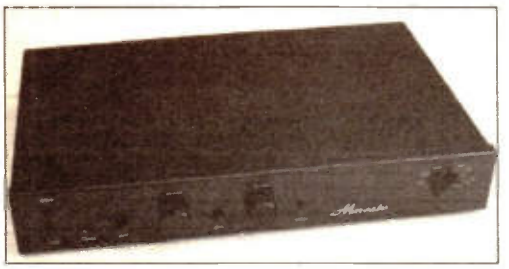
ISSN 0262 3617
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .

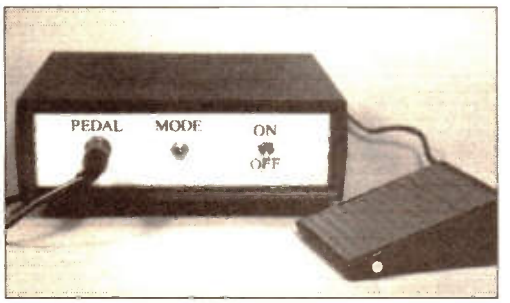
VOL. 28 No. 2 FEBRUARY 1999

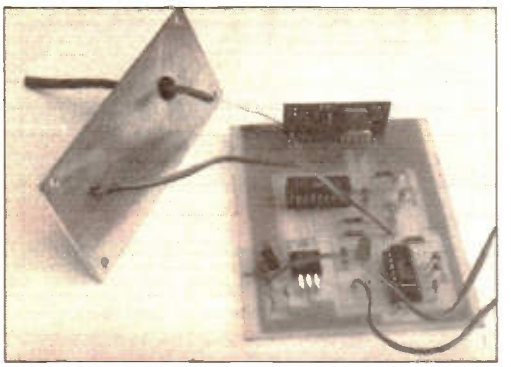
EVERYDAY PRACTICAL ELECTRONICS

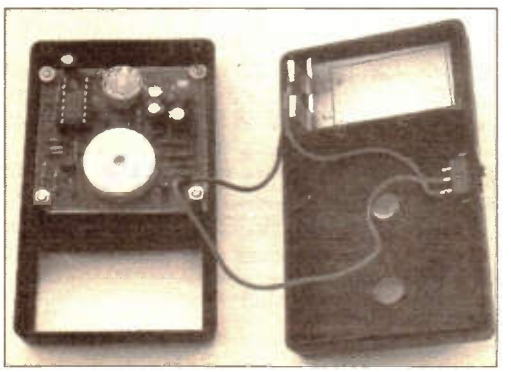
http://www.epemag.wimborne.co.uk

The No. 1 Magazine for Electronics Technology and Computer Projects









Next Month
ETI readers join us
– see page 83

© Wimborne Publishing Ltd 1999. Copyright in all drawings, photographs and articles published in EVERYDAY PRACTICAL ELECTRONICS is fully protected, and reproduction or imitations in whole or in part are expressly forbidden.

Projects and Circuits

PIC MIDI SUSTAIN PEDAL by Robert Penfold 84
Add sustain and glissando to your MIDI line-up with this inexpensive PIC-controlled effects unit

LIGHT ALARM by Gavin Cheeseman 94
Looking for undercover protection? Try this simple light-activated alarm!

WIRELESS MONITORING SYSTEM – 1 by James Humpris 102
Low cost radio-linked short-range data logging is now readily and simply available

INGENUITY UNLIMITED hosted by Alan Winstanley 111
Zener Diode Tester; Microcontroller Interface for A.C. Monitoring; Reverse Polarity Indicator; A.F. Sweep Signal Generator

PhizzyB COMPUTERS – 4 by Clive 'Max" Maxfield, Alvin Brown and Alan Winstanley 126
Constructing and testing the 8-switch Polling and Latching modules

Series and Features

TECHNIQUES - ACTUALLY DOING IT by Robert Penfold 98
Getting it working when it doesn't!

SCOLAR POWER by Terry de Vaux-Balbirnie B.Sc. 114
Schools are switching on to a new Government solar power initiative

PhizzyB COMPUTERS – 4 by Clive 'Max" Maxfield and Alvin Brown 120
Examining the merits of Polling and Latching techniques

NEW TECHNOLOGY UPDATE by Ian Poole 130
MESFETS, PHEMTs and HBTs, examining the latest r.f. semiconductor techniques for cellular phones

CIRCUIT SURGERY by Alan Winstanley 134
Electret "Mics"; Textbook Voltage; Relays – More Contacts; P.C.B. Facilities in Singapore

NET WORK - THE INTERNET PAGE surfed by Alan Winstanley 141
Freeserve Rising Fast; Give it a Whirl; More to Come

Regulars and Services

EDITORIAL 83

BACK ISSUES Did you miss these? 88

INNOVATIONS – Barry Fox highlights technology's leading edge 91
Plus everyday news from the world of electronics

ELECTRONICS VIDEOS Our range of educational videos 101

SPECIAL OFFER Save £100 on an 80W + 80W Hi-fi Stereo Amp 109

CD-ROMS FOR ELECTRONICS 118
Parts Gallery + Electronic Circuits and Components; Digital Electronics; *plus* PICtutor, *plus* Modular Circuit Design

SHOPTALK with David Barrington 131
The *essential* guide to component buying for *EPE* projects

READOUT John Becker addresses general points arising 132

DIRECT BOOK SERVICE 137
A wide range of technical books available by mail order

PRINTED CIRCUIT BOARD SERVICE 140
PCBs for *EPE* projects – some at "knockdown" prices! Plus *EPE* software

ADVERTISERS INDEX 144

Our March '99 issue will be published on Friday, 5 February 1999. See page 75 for details.

Readers Services • Editorial and Advertisement Departments 83

Surplus always wanted for cash!

THE *ORIGINAL* SURPLUS WONDERLAND!

THIS MONTH'S SELECTION FROM OUR VAST EVER CHANGING STOCKS

Surplus always wanted for cash!

THE AMAZING TELEBOX

Converts your colour monitor into a QUALITY COLOUR TV!!

TV SOUND & VIDEO TUNER
CABLE COMPATIBLE

The **TELEBOX** is an attractive fully cased mains powered unit, containing all electronics ready to plug into a host of video monitors made by makers such as **MICROVITEC, ATARI, SANYO, SONY, COMMODORE, PHILIPS, TATUNG, AMSTRAD** etc. 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.** A composite video output is located on the rear panel for direct connection to most makes of monitor or **desktop computer video systems.** 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.

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 Teleboxe'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 software control via a simple 2 wire link to any IBM type computer. Supplied complete with simple working program and documentation. Requires +12V & + 5V DC to operate.**
BRAND NEW - Order as MY00. ***Only £49.95*** ***code (B)***

FLOPPY DISK DRIVES 2½" - 14"

Massive purchases of standard 5¼" and 3½" drives enables us to present prime product at industry beating low prices! All units (unless stated) are ***BRAND NEW*** or removed from often brand new equipment and are fully tested, aligned and shipped to you with a full 90 day guarantee. ***Call*** for over 2000 unlisted drives for spares or repair.

3½" Panasonic JU363/4 720K or equivalent RFE **£24.95(B)**
3½" Mitsubishi MF355C-L. 1.4 Meg. Laptops only **£25.95(B)**
3½" Mitsubishi MF355C-D. 1.4 Meg. Non laptop **£18.95(B)**
5¼" Teac FD-55GFR 1.2 Meg (for IBM pc's) RFE **£18.95(B)**
5¼" Teac FD-55F-03-U 720K 40/80 (for BBC's etc) RFE **£29.95(B)**
5¼" BRAND NEW Mitsubishi MF501B 360K **£22.95(B)**
Table top case with integral PSU for HH 5¼" Flopp or HD **£29.95(B)**
8" Shugart 800/801 8" SS refurbished & tested **£210.00(E)**
8" Shugart 810 8" SS HH *Brand New* **£195.00(E)**
8" Shugart 851 8" double sided refurbished & tested **£260.00(E)**
8" Mitsubishi M2894-63 double sided *NEW* **£295.00(E)**
8" Mitsubishi M2896-63-02U DS slimline *NEW* **£295.00(E)**
Dual 8" cased drives with integral power supply 2 Mb **£499.00(E)**

HARD DISK DRIVES

2½" TOSHIBA.(19 mm H) MK2101MAN 2.16 Gb. ***New*** **£199.00**
2½" TOSH.(12.5 mm H) MK1002MAV 1.1 Gb laptop. ***New*** **£115.00**
2½" to 3½" conversion kit for Pc's, complete with connectors **£12.95**
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 40mb IDE I/F (or equiv.) RFE **£69.00**
3½" RODIME RO3057S 45mb SCSI I/F (Mac & Acorn) **£69.00**
3½" QUANTUM 40S Prodrive 42mb SCSI I/F, New RFE **£49.00**
3½" WESTERN DIGITAL 850mb IDE I/F ***New*** **£185.00**
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*** **£199.00**
8" FUJITSU M2322K 160Mb SMD I/F RFE tested **£195.00**
8" FUJITSU M2392K 2 Gb SMD I/F RFE tested **£345.00**
Many other drives in stock - Shipping on all drives is code (D)

IC's -TRANSISTORS - DIODES

OBSOLETE - SHORT SUPPLY - BULK

6,000,000 items EX STOCK

For *MAJOR SAVINGS* - CALL OR SEE OUR WEBSITE

VIDEO MONITOR SPECIALS

One of the highest specification monitors you will *ever* see - At this price - Don't miss it!!

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, supplied in EXCELLENT little used condition.
Tilt & Swivel Base £4.75 **Only £119** (E) Order as MITS-SVGA
VGA cable for IBM PC included.
External cables for other types of computers CALL

As New - Ex Demo
17" 0.28 SVGA Mitsubishi Diamond Pro monitors
Full multisync etc. Full 90 day guarantee. £325.00 (E)

Just In - Microvitec 20" VGA (800 x 600 res.) colour monitors.
Good SH condition - from £299 - CALL for info

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 **Only £99** (E)
Dimensions: W14" x H12¾" x 15½" D.

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 bums). In attractive square black plastic case measuring W10" x H10" x 13½" D. 240 V AC mains powered. **Only £79.00** (D)

KME 10" 15M10009 high definition colour monitors with 0.28" dot pitch. Superb clarity and modern styling. Operates from any 15.625 khz sync RGB video source, with RGB analog and composite sync such as Atari, Commodore Amiga, Acorn Archimedes & BBC. Measures only 13½" x 12" x 11". Good used condition. **Only £125** (E)

20" 22" and 26" AV SPECIALS

Superbly made UK manufacture. PIL all solid state colour monitors, complete with composite video & *optional* sound input. Attractive teak style case. Perfect for Schools, Shops, Disco, Clubs, etc.In EXCELLENT little used condition with full 90 day guarantee.

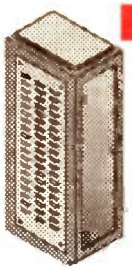
20"....£135 **22"....£155** **26"....£185** (F)

DC POWER SUPPLIES

Virtually every type of power supply you can imagine.Over 10,000 Power Supplies Ex Stock Call or see our web site.

LOW COST PC's

Always over 1000 PC's from stock. 1000's of spares and accessories. Call or see our web site for info.



19" RACK CABINETS

Superb quality 6 foot 40U
Virtually New, Ultra Smart
Less than Half Price!

Top quality 19" rack cabinets made in UK by **Optima Enclosures Ltd.** Units feature designer, smoked acrylic lockable front door, full height lockable half louvered back door and louvered removable side panels. Fully adjustable internal fixing struts, ready punched for any configuration of equipment mounting plus ready mounted integral 12 way 13 amp socket switched mains distribution strip make these racks some of the ***most versatile we have ever sold.*** Racks may be stacked side by side and therefore require only two side panels to stand singly or in multiple bays.
Overall dimensions are: 77½" H x 32½" D x 22" W. **Order as:**
OPT Rack 1 Complete with removable side panels. **£345.00 (G)**
OPT Rack 2 Rack, Less side panels **£245.00 (G)**

Over 1000 racks, **shelves, accessories 19" 22" & 24" wide 3 to 46 U high. Available from stock !!.**

32U - High Quality - All steel RakCab

Made by **Eurocraft Enclosures Ltd** to the **highest possible spec,** rack features **all steel construction** with removable side, front and back doors. Front and back doors are **hinged for easy access** and all are lockable with five **secure 5 lever barrel locks.** The front door is constructed of double walled steel with a **'designer style'** smoked acrylic front panel to enable status indicators to be seen through the panel, yet remain unobtrusive. Internally the rack features fully slotted reinforced vertical fixing members to **take the heaviest of 19" rack equipment.** The two movable vertical fixing struts (extras available) are pre punched for standard 'cage nuts'. A **mains distribution panel** internally mounted to the bottom rear, provides 8 x IEC 3 pin Euro sockets and 1 x 13 amp 3 pin **switched utility socket.** Overall ventilation is provided by fully louvered back door and double skinned top section with top and side louvres. The top panel may be removed for fitting of **integral fans** to the sub plate etc. Other features include: fitted castors and floor levelers, prepunched utility panel at lower rear for cable / connector access etc. Supplied in **excellent,** slightly used condition with keys. Colour Royal blue. External dimensions mm=1625H x 635D x 603 W. (64" H x 25" D x 23¾" W)
Sold at LESS than a third of makers price !!

A superb buy at only £245.00 (G)
42U version of the above only £345 - CALL

BATTERY SCOOP - 50% off !!

A special bulk purchase from a **cancelled export order** brings you the most **amazing savings** on these ultra high spec **12v DC 14 Ah** rechargeable batteries. Made by **Hawker Energy Ltd, type SBS15** featuring **pure lead** plates which offer a far superior shelf & guaranteed 15 year service life. **Fully BT & BS6290 approved.** Supplied **BRAND NEW** and boxed. Dimensions 200 wide, 137 high, 77 deep. M6 bolt terminals. Fully guaranteed. Current makers price over £70 each ! ***Our Price £35 each*** (c) ***or 4 for £99*** (D)

RELAYS - 200,000 FROM STOCK

Save £££££'s by choosing your next relay from our Massive stocks covering types such as - Military, Octal, Cradle, Hermetically Sealed, Contactors, Time Delay, Reed, Mercury Wetted, Solid State, Printed Circuit Mounting, CALL US WITH YOUR NEEDS. Many obsolete types from stock. Save £££££'s

LOW COST RAM & CPU'S

INTEL 'ABOVE' Memory Expansion Board. Full length PC-XT and PC-AT compatible card with **2 Mbytes** of memory on board. Card is fully selectable for Expanded or Extended (286 processor and above) memory. **Full data and driver disks supplied.** RFE. Fully tested and guaranteed. Windows compatible. **£59.95**
Half length 8 bit memory upgrade cards for PC AT XT expands memory either 256k or 512k in 64k steps. May also be used to fill in RAM above 640k DOS limit. Complete with data.
Order as: XT RAM UG. 256k. £34.95 ***or*** **512k £39.95**

SIMM SPECIALS

1 MB x 9 SIMM 9 chip 120ns **Only £8.50**
1 MB x 9 SIMM 3 chip 80 ns **£10.50** or 70ns **£11.95**
1 MB x 9 SIMM 9 chip 80 ns **£10.50** or 70ns **£11.75**
4 MB 70 ns 72 pin SIMM ***-with parity-*** **Only £35.00**
INTEL 486-DX33 CPU £19.95 **INTEL 486-DX66 CPU £59.00**
FULL RANGE OF CO-PROCESSOR'S EX STOCK - CALL FOR £££
MOTOROLA 25 Mhz 68040 (XC68040RC25M) CPU'S £59.00
shipping charges for RAM / CPU upgrades is code B

SOFTWARE SPECIALS

NT4 WorkStation, complete with service pack 3 and licence - OEM packaged.
Special Price ONLY £99.00
Microsoft - Windows for Workgroups 3.11 & DOS 6.22. *Supplied on* 3½" disks with licence & concise documentation. ***£39.95***
DOS 5.0 on 3½" disks with concise books c/w QBasic . ***£14.95***
Wordperfect 6 for DOS supplied on 3½" disks with manual **£24.95**
shipping charges for software is code B

TEST EQUIPMENT & SPECIAL INTEREST ITEMS

MITS. FA3445ETKL 14" Industrial spec SVGA monitors **£245**
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**
IBM 53F5501 Token Ring ICS 20 port lobe modules **£750**
IBM MAU Token ring distribution panel 8228-23-5050N **£95**
AIM 501 Low distortion Oscillator 9Hz to 330Khz, IEEE **£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 **£6500**
Marconi 2022C 10KHz-1GHz RF signal generator **£1550**
Marconi 2030 opt 03 10KHz-1.3 GHz signal generator,New **£5150**
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 **£675**
HP54121A DC to 22 GHz four channel test set **£POA**
HP8130A opt 020 300 MHz pulse generator, GPIB etc **£8500**
HP A1, A0 8 pen HPGL high speed drum plotters - from **£950**
EG+G Brookdeal 9503SC Precision lock in amp **£650**
View Eng. Mod 1200 computerised inspection system **£POA**
Sony DXC-3000A High quality CCD colour TV camera **£1100**
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 **£9500**
ICI R5030UV34 Cleanline ultrasonic cleaning system **£POA**
Mann Tally MT645 High speed line printer **£2200**
Intel SBC 486/133SE Multibus 486 system. 8Mb Ram **£945**
Siemans K4400 64Kb to 140Mb demux analyser **£2950**
Intel SBC 486/125C08 Enhanced Multibus (MSA) NEW **£1450**
Zeta 3220-05 A0 4 pen HPGL *fast* drum plotters **£1150**
Nikon HFX-11 (Ephiphot) exposure control unit **£1450**
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 band printer **£1950**
Fujitsu M3041D 600 LPM printer with network interface **£1250**
Perkin Elmer 299B Infrared spectrophotometer A **£500**
Perkin Elmer 597 Infrared spectrophotometer **£3500**
VG Electronics 1035 TELETEXT Decoding Margin Meter **£3750**
LightBand 60 output high spec 2u rack mount Video VDA's **£495**
Sekonic SD 150H 18 channel digital Hybrid chart recorder **£1995**
Taylor Hobson Tallysurf amplifier / recorder **£750**
ADC SB200 Carbon dioxide gas detector / monitor **£1450**
System Video 1152 PAL waveform monitor **£485**
ANRITSU 9654A Optical DC-2.5G/b waveform monitor **£5,650**
ANRITSU MS9001B1 0.6-1.7 uM optical spectrum analyser **£POA**
ANRITSU ML93A optical power meter **£990**
ANRITSU Fibre optic chracateristic test set **£POA**
VISION ENGINEERING TS3 Dynascopic microscope **£1850**
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 1502 Portable TDR (time domain reflectometer) **£600**
PHILIPS PW1730/10 XRAY generator with accessories **£POA**
CLAUDE LYONS 12A 240V single phase auto. volt. regs **£325**
CLAUDE LYONS 100A 240/415V 3 phase auto. volt. regs **£2900**

DISTEL on the web !! - Over 16,000,000 items from stock - www.distel.co.uk

DISPLAY ELECTRONICS

ALL MAIL & OFFICES
Open Mon - Fri 9.00 - 5:30
Dept PE , 32 Biggin Way
Upper Norwood
LONDON SE19 3XF

LONDON SHOP
Open Mon - Sat 9:00 - 5:30
215 Whitehorse Lane
South Norwood
On 68A Bus Route
Nr.Thornton Heath & Selhurst Park SR Rail Stations

NEW **DISTEL©**
Visit our web site
www.distel.co.uk
email admin@distel.co.uk

ALL ☎ ENQUIRIES
0181 679 4414
FAX 0181 679 1927

SWITCH MasterCard VISA EST. 25 YEARS

All prices for UK Mainland. UK customers add 17.5% VAT to TOTAL order amount. Minimum order £10. Bona Fide account orders accepted from Government, Schools, Universities and Local Authorities - minimum account order £50. Cheques over £100 are subject to 10 working days clearance. Carriage charges (A)=£3.00, (A1)=£4.00, (B)=£5.50, (C)=£8.50, (D)=£12.00, (E)=£15.00, (F)=£18.00, (G)=CALL. Allow approx 6 days for shipping - faster CALL. All goods supplied to our Standard Conditions of Sale and unless stated guaranteed for 90 days. All guarantees on a return to base basis. All rights reserved to change prices / specifications without prior notice. Orders subject to stock. Discounts for volume. Top CASH prices paid for surplus goods. All trademarks, tradenames etc acknowledged. © Display Electronics 1998. E & O E. 06/98

STOP PRESS ANNOUNCEMENT

NEXT MONTH

Next month we will be joined by the readers of* ETI.** ***We have just purchased* ETI (Electronics Today International)** ***from Nexus Special Interests Ltd, and will merge the magazine into* EPE** ***from the March 99 issue. This will mean you will be getting an even better magazine and, with the strength of an increased readership, we will be able to continue to bring you the widest range of projects, features, news and products to buy.

Watch out for the familiar* Everyday Practical Electronics** ***logo on the news-stands – from next month you will also see the* ETI** ***logo on the cover, as shown below. See the Editorial page for more details.

TIME AND DATE GENERATOR

With the availability of cheap video cameras, more and more people are adding surveillance cameras to the exterior and interior of their homes. Cameras connected to a video recorder will record all sorts of amusing and sometimes nefarious activities, and usually it is useful to know the precise time that these events occurred. The generator inserts a steady and easily readable time and/or date caption onto any composite video signal. The time and date information is displayed at the bottom of the screen.

Although originally intended for adding time and date information to security cameras, it is equally useful for adding time and date to home videos for those who have not got this capability built into their video camera. This design is based on a PIC16C84 which performs the real time clock function and display character generation. The main features of the unit are: • Adds time or date or both to a composite video signal (NTSC, PAL and SECAM video signals) • Selectable character height of 5, 10, 15 or 20 lines • Inverse or normal video display • Day and month display are swappable for those who prefer the American standard • Leap year correction • Year 2000 compliant.

AUTO CUPBOARD LIGHT

Commercial battery-operated cupboard lights are widely available in DIY stores and by mail order from electronic component suppliers. These lamps are useful as a simple means of lighting up a cupboard or other dark area. They are also handy for garden sheds and other places where no mains supply exists.

The one drawback is that if they are left on, the batteries are exhausted with monotonous (and expensive) regularity. This simple project provides automatic timed control of the light.

SMT SMOKE ABSORBER

When working with tiny surface mount devices (SMDs) the constructor is drawn closer to the circuit in order to get a clear view of the soldering operation. Close working with SMDs therefore involves a much higher risk of solder fumes being inhaled and potential bronchial problems. The smoke absorber is very compact and can be placed close to any circuit during population. It will remove the solder fumes from the immediate area.

The smoke absorber is automatically triggered by the heat from the soldering iron and it switches off after about half a minute unless re-triggered. Very useful for all hobbyist soldering operations.

PLUS • PHIZZYB–5, WIRELESS MONITORING–2 AND ALL THE REGULARS

NO ONE DOES IT BETTER

EVERYDAY PRACTICAL ELECTRONICS

ETI ELECTRONICS TODAY INTERNATIONAL

DON'T MISS AN ISSUE – PLACE YOUR ORDER NOW!

Demand is bound to be high

MARCH ISSUE ON SALE FRIDAY, FEBRUARY 5

SHERWOOD ELECTRONICS

FREE COMPONENTS

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

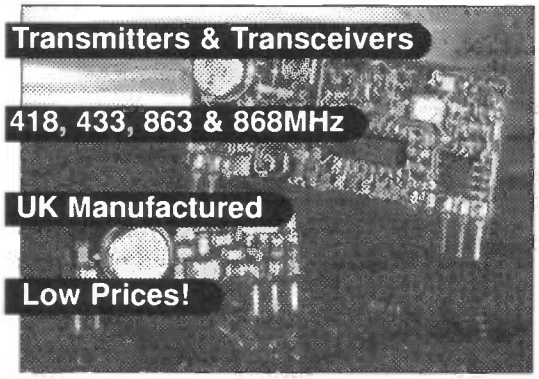
SP1	15 x 5mm Red Leds	SP132	2 x TL082 Op.amps
SP2	12 x 5mm Green Leds	SP133	20 x 1N4004 diodes
SP3	12 x 5mm Yellow Leds	SP134	15 x 1N4007 diodes
SP6	15 x Red Leds	SP136	3 x BFY50 transistors
SP7	12 x Green Leds	SP137	4 x W005 1·5A bridge rectifiers
SP10	100 x 1N4148 diodes	SP138	20 x 2·2/63V radial elect. caps.
SP11	30 x 1N4001 diodes	SP140	3 x W04 1·5A bridge rectifiers
SP12	30 x 1N4002 diodes	SP142	2 x Cmos 4017
SP18	20 x BC182 transistors	SP143	5 Pairs min. crocodile clips (Red & Black)
SP20	20 x BC184 transistors		
SP21	20 x BC212 transistors	SP144	3 x TIP31A transistors
SP23	20 x BC549 transistors	SP145	6 x ZTX300 transistors
SP24	4 x Cmos 4001	SP146	10 x 2N3704 transistors
SP25	4 x 555 timers	SP147	5 x Stripboard 9 strips x 25 holes
SP26	4 x 741 Op.amps	SP151	4 x 8mm Red Leds
SP28	4 x Cmos 4011	SP152	4 x 8mm Green Leds
SP29	4 x Cmos 4013	SP153	4 x 8mm Yellow Leds
SP31	4 x Cmos 4071	SP154	15 x BC548 transistors
SP36	25 x 10/25V radial elect. caps.	SP156	3 x Stripboard, 14 strips x 27 holes
SP37	15 x 100/35V radial elect. caps.		
SP39	10 x 470/16V radial elect. caps.	SP160	10 x 2N3904 transistors
SP40	15 x BC237 transistors	SP161	10 x 2N3906 transistors
SP41	20 x Mixed transistors	SP165	2 x LF351 Op.amps
SP42	200 x Mixed 0·25W C.F. resistors	SP167	6 x BC107 transistors
SP47	5 x Min. PB switches	SP168	6 x BC108 transistors
SP102	20 x 8-pin DIL sockets	SP175	20 x 1/63V radial elect. caps.
SP103	15 x 14-pin DIL sockets	SP177	10 x 1A 20mm quick blow fuses
SP104	15 x 16-pin DIL sockets		
SP105	5 x 74LS00	SP182	20 x 4·7/63V radial elect. caps.
SP109	15 x BC557 transistors	SP183	20 x BC547 transistors
SP111	15 x Assorted polyester caps	SP187	15 x BC239 transistors
SP112	4 x Cmos 4093	SP191	3 x Cmos 4023
SP115	3 x 10mm Red Leds	SP192	3 x Cmos 4066
SP116	3 x 10mm Green Leds	SP193	20 x BC213 transistors
SP118	2 x Cmos 4047	SP194	10 x OA90 diodes
SP120	3 x 74LS93	SP195	3 x 10mm Yellow Leds
SP124	20 x Assorted ceramic disc caps	SP197	6 x 20 pin DIL sockets
SP130	100 x Mixed 0·5W C.F. resistors	SP198	5 x 24 pin DIL sockets
SP131	2 x TL071 Op.amps		

RESISTOR PACKS – C.Film

RP3	5 each value – total 365 0·25W	£2.80
RP7	10 each value – total 730 0·25W	£4.00
RP10	1000 popular values 0·25W	£5.80
RP4	5 each value-total 365 0·5W	£3.75
RP8	10 each value-total 730 0·5W	£6.35
RP11	1000 popular values 0·5W	£8.10

1999 Catalogue £1 inc. P&P or **FREE** with first order.
P&P £1.25 per order. **NO VAT.**
Orders to:
Sherwood Electronics,
7 Williamson St., Mansfield,
Notts. NG19 6TD.

Free Additional Transmitter with every order !



Order the FM TXM-418-A/F and SILRX-418-A/F pair (as shown above) for only £25.00 + VAT and get an additional transmitter free! P & P £ 1.50

Please call for a free catalogue, wall chart or a competitive volume quotation on an any Radiometrix Ltd module. Simply just e-mail sales@radtec.demon.co.uk. alternatively Fax or Telephone quoting ref: EPE-RM1

Telephone +44(0)1992 576107
Fax +44(0)1992 561994
http://www.radio-tech.co.uk

Radio - Tech **Radio-Tech Limited**

Your official Radiometrix Distributor

SQUIRES

MODEL AND CRAFT TOOLS

A comprehensive range of Miniature Hand and Power Tools and now an extensive range of Electronic Components featured in a fully illustrated

336-page Mail Order Catalogue

1999 Issue

SAME DAY DESPATCH
FREE POST & PACKING

For your free copy of our catalogue write, telephone or fax to:

Squires, 100 London Road,
Bognor Regis, West Sussex
PO21 1DD
Tel: 01243 842424
Fax: 01243 842525

EUROCARD MasterCard VISA

NATIONAL COLLEGE OF TECHNOLOGY

DISTANCE LEARNING COURSES in:

Analogue and Digital Electronics
Circuits, Fibres & Opto-Electronics
Electronic Testing & Fault Diagnosis
Programmable Logic Controllers
Mechanics and Mechanisms
GCSE and BTEC Mathematics

- Courses to suit ***beginners*** and those wishing to ***update*** their knowledge and practical skills
- Courses are delivered as self-contained kits
- No travelling or college attendance
- Learning is at your own pace
- Courses may have BTEC Certification and Tutoring

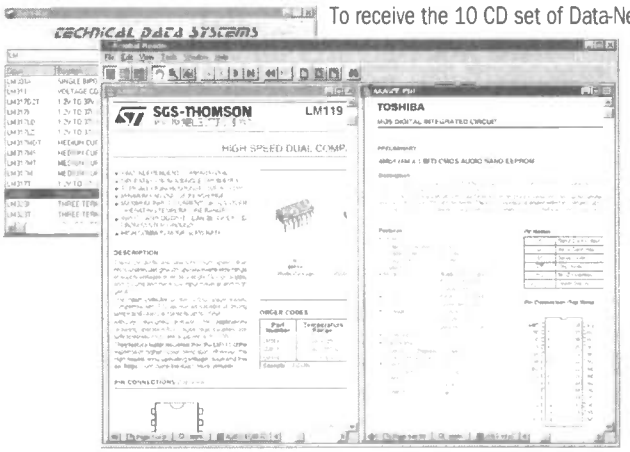
For information contact:
NCT Ltd., P.O. Box 11
Wendover, Bucks HP22 6XA
Telephone 01296 624270; Fax 01296 625299
Web: http://www.nct.ltd.uk

DATA-NET The Encyclopaedia of Electronic Circuits

Whether you are an Amateur or an Engineer, this encyclopaedia is an incredible mine of information and will help you to save hundreds of hours of search.

The 10 CD-ROM set contains complete datasheets on over ***180.000 circuits*** from ***61 manufacturers*** which represents more than ***300.000 pages*** of technical information in PDF format.

The search engine helps you to find the datasheet of a specific circuit in seconds, compare several circuits at the same time and print or export the data.



To receive the 10 CD set of Data-Net for only £39 (inc. VAT and UK Postage), please send your order to :

Dannell Electronics Ltd
Unit 15, Enterprise Court
Lakes Road • Braintree • Essex CM7 3QS
Phone : 01376 550262 • Fax : 01376 550019
email : datanet@dannell.co.uk

Data-Net runs with Windows® 3.1/95/NT3.51 and NT 4.0

10 CDs, 180.000 circuits, 300.000 pages of info. for £39 only (inc. VAT and UK postage)

Cheques & Postal Orders should be made payable to Dannell Electronics Ltd. Visa, Master/Eurocard orders are accepted. Please give card number and expiry date. For orders from within EU, please add £5.50 for airmail postage. For foreign orders, we use the VAT portion of the price for airmail postage and packing.

FREE!

OUR LATEST BARGAIN LIST - 32 PAGES FULL OF QUALITY SURPLUS STOCK AND ALL AT THE LOWEST PRICES!

GREENWELD
ELECTRONIC COMPONENTS
27D Park Road · Southampton · SO15 3UQ
TELEPHONE: 01703 236363 FAX: 01703 236307
E-Mail: greenweld@aol.com INTERNET: http://www.greenweld.co.uk

PHONE, FAX OR WRITE TODAY FOR YOUR FREE COPY!

£1 BARGAIN PACKS – List 1

1,000 items appear in our Bargain Packs List – request one of these when you next order.

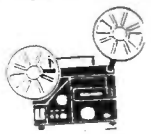
2 LITHIUM COIN CELLS, 3V p.c.b. mounting, Order Ref: 1078.
2×5A BRIDGE RECTIFIERS with heatsink couplers for 12V charger. Order Ref: 1070.
1×12V STEPPER MOTOR, 7·5 degrees. Order Ref: 910.
1×10 PACK SCREWDRIVERS. Order Ref: 909.
2×AMP PULL CORD CEILING SWITCHES, brown. Order Ref: 921.
5×REELS INSULATION TAPE. Order Ref. 911.
2×CORD GRIP SWITCH LAMP HOLDERS. Order Ref: 913.
1×DC VOLTAGE REDUCER, 12V-6V. Order Ref: 916.
LIGHTWEIGHT STEREO HEADPHONES, moving coil so superior sound. Order Ref. 896.
2×25W CROSSOVERS for 4ohm loudspeakers. Order Ref: 22.
2×Nicad CONSTANT CURRENT CHARGERS, easily adaptable to charge almost any NiCad Battery. Order Ref: 30.
18V-0-18V 10VA mains transformer. Order Ref: 813.
2×WHITE PLASTIC BOXES with lids, approx. 3in. cube. Lid has square hole through the centre so these are ideal for light-operated switch. Order Ref: 132.
2×REED RELAY KITS, you get 8 reed switches and 2 coil sets. Order Ref: 148.
12V-0-12V 6VA mains transformer, p.c.b. mounting. Order Ref: 938.
1×BIG-PULL SOLENOID, mains operated, has ½in. pull. Order Ref: 871.
1×BIG-PUSH SOLENOID, mains operated, has ½in. push. Order Ref: 872.
1×MINI MONO AMP. 3W into 4 ohm speaker or 1W into 8 ohm. Order Ref: 495.
1×MINI STEREO 1W AMP. Order Ref: 870.
15V DC 150mA P.S.U., nicely cased. Order Ref: 942.
1×IN-FLIGHT STEREO UNIT is a stereo amp. Has two most useful mini moving coil speakers. Made for BOAC pasengers. Order Ref: 29.
1×0-1mA PANEL METER. Full vision face 70mm square. Scaled 0-100. Order Ref: 756.
2×LITHIUM BATTERIES. 2·5V penlight size. Order Ref: 874.
2x3m TELEPHONE LEADS. With BT flat plug. Ideal for 'phone extensions, fax, etc. Order Ref: 552.
1×12V SOLENOID. Has good ½in. pull or could push if modified. Order Ref: 232.
3×IN-FLEX SWITCHES. With neon on/off lights, saves leaving things switched on. Order Ref: 7.
2×6V 1A MAINS TRANSFORMERS. Upright mounting with fixing clamps. Order Ref: 9.
1×HUMIDITY SWITCHES. As the air becomes damper, the membrane stretches and operates a microswitch. Order Ref: 32.
4×13A ROCKER SWITCH. Three tags so on/off, or changeover with centre off. Order Ref: 42.
1×SUCK OR BLOW-OPERATED PRESSURE SWITCH. Or it can be operated by any low pressure variation, such as water level in tanks. Order Ref: 67.
1×6V 750mA POWER SUPPLY. Nicely cased with mains input and 6V output lead. Order Ref: 103A.
2×STRIPPER BOARDS. Each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of capacitors, etc. Order Ref: 120.
12 VERY FINE DRILLS. For p.c.b. boards etc. Normal cost about 80p each. Order Ref: 128.
5×MOTORS FOR MODEL AEROPLANES. Spin to start so needs no switch. Order Ref: 134.
6×MICROPHONE INSERTS. Magnetic 400 ohm, also act as speakers. Order Ref: 139.
6×NEON INDICATORS. In panel mounting holders with lens. Order Ref: 180.
1×IN-FLEX SIMMERSTAT. Keeps your soldering iron etc. always at the ready. Order Ref: 196.
1×ELECTRIC CLOCK. Mains operated. Put this in a box and you need never be late. Order Ref: 211.
4×12V ALARMS. Makes a noise about as loud as a car horn. All brand new. Order Ref: 221.
2×(6in.×4in.) SPEAKERS. 16 ohm 5 watts, so can be joined in parallel to make a high wattage column. Order Ref: 243.
1×PANOSTAT. Controls output of boiling ring from simmer up to boil. Order Ref: 252.
2×OBLONG PUSHSWITCHES. For bell or chimes, these can switch mains up to 5A so could be footswitch if fitted in pattress. Order Ref: 263.
50×MIXED SILICON DIODES. Order Ref: 293.
1×6 DIGIT MAINS OPERATED COUNTER. Standard size but counts in even numbers. Order Ref: 28.
2×6V OPERATED REED RELAYS. One normally on, other normally closed. Order Ref: 48.
1× CABINET LOCK. With two keys. Order Ref: 55.
6½ 8Ω 5 WATT SPEAKER. Order Ref: 824.
1× SHADED POLE MAINS MOTOR. ¾in. stack, so quite powerful. Order Ref: 85.
1×CASE, 3½×2¼×1¾ with 13A socket pins. Order Ref: 845.
2×CASES. 2½×2¼×1¾ with 13A pins. Order Ref: 565.
4×LUMINOUS ROCKER SWITCHES. 10A mains. Order Ref: 793.

BATTERY MOTOR WITH GEARBOX. Will operate on any DC voltage between 6V and 24V, price £3. Order Ref: 3P108. A speed controller is available for this, £12 in kit form or £20 made up, but if you intend to operate it from the mains, then our power supply 2P3 will give you 3 speeds and will also reverse. Price of power supply is £2.
A MUCH LARGER PROJECT BOX. Size 216mm×130mm×85mm with lid and 4 screws. This is an ABS box which normally retails at around £6. All brand new, price £2.50. Order Ref: 2.5P28.
BT TELEPHONE EXTENSION WIRE. This is proper heavy duty cable for running around the skirting board when you want to make a permanent extension. Four cores properly colour coded, 25m length only £1. Order Ref: 1067.
LARGE TYPE MICROSWITCH. With 2in. lever, changeover contacts rated at 15A at 250V, 2 for £1. Order Ref: 1/21R7.
MINI MICROSWITCH. Only approximately 15mm long with a 20mm lever which could quite easily be removed, changeover contacts rated at 5A AC, 50p each. Order Ref: 1/21R8.
FLEX PROTECTORS. Rubber, 30mm long, 8mm diameter with a 12mm shoulder. Ideal for protecting flex passing through a metal panel, 5 for £1. Order Ref: 1/21R10.
10K POT. With double-pole mains on/off switch, good length of ¼in. spindle and hex fixing nut, 50p each. Order Ref: 1/22R6.
DITTO but 5K. Order Ref: 1/11R24.
BALANCE ASSEMBLY KITS. Japanese made, when assembled ideal for chemical experiments, complete with tweezers and 6 weights 0·5 to 5 grams. Price £2. Order Ref: 2P444.
SUPER CROMPTON PARKINSON MAINS MOTOR. Really well made, totally enclosed by ventilated framework. Size approximately 4in. diameter, 4in. high and with 2in. of a ⅜in. spindle. Speed is 750rpm, hp is not quoted but we estimate this to be around 1/6hp. Price £10. Order Ref: 10P149.
EQUIPMENT COOLING BLOWER. Near enough 5in. square and 1½in. thick but a really good air mover. Mains operated, price £4. Order Ref: 715L.
OVEN THERMOSTAT with knob calibrated so you can set it to cut out at any temperature up to 600°F, £3. Order Ref: 3P229.
DOORBELL PSU. This has A.C. voltage output so is ideal for operating most doorbells. The unit is totally enclosed so perfectly safe and it plugs into a 13A socket. Price only £1. Order Ref: 1/30R1.

THIS MONTH'S TWO FOR ONE OFFER IS THE POWER SUPPLY
Made by Astec, outputs are 12V at 4A and 5V at 15A. This PSU can be modified with a few extra components and would then give 12V at 10A d.c. We give the details. The price is still £9.50 but you get two instead of one.
Offer ends 31st December. Order Ref: 9.5P4.

GEAR WHEELS. Set of 5, quite small, should enable you to get a variety of speeds, mounted in a metal case but easy to remove and use separately. Price £1 the set. Order Ref: D409.
ULTRASONIC MOVEMENT DETECTOR. Nicely cased, free standing, has internal alarm which can be silenced. Also has connections for external speaker or light. Price £10. Order Ref: 10P154.
CYCLE LAMP BARGAIN. You can have 100 6V 0·5A MES bulbs for just £2.50 or 1,000 for £20. They are beautifully made, slightly larger than the standard 6·3V pilot bulb so they would be ideal for making displays for night lights and similar applications. 50 joined in series can be connected to the mains and would make a very attractive window display. 100 for £2.50. Order Ref: 2.5P29.
12Vx12V RELAY. Miniature, clear platic enclosed, has one set changeover contacts, one set that breaks contact and 3 sets that make contact. Price £1 each. Order Ref: GR30.
COMPONENT MOUNTING PANEL. Heavy Paxolin, size approximately 10in.×2in. with 32 pairs of brass pillars for soldering or binding on components, £1. Order Ref: 1/7RC26.
AIR-SPACED TUNING CAPACITOR. Twin 100pF with trimmers, extra small. Fixed from the front by 3 screws, £2 each. Order Ref: 1/7RC29.
PEA LAMPS. Very tiny, only 4mm, but 14V at 0·04A, wire-ended, 25p each. Order Ref: 1/7RC28.
HIGH AMP THYRISTOR. Normal two contacts from the top and heavy threaded fixing underneath. We don't know the amperage of this but think it to be at least 25A. Price 50p each. Order Ref: 1/7RC43.
THREE LEVEL PRESSURE SWITCH. All 3 are low pressures and the switch could be blow-operated. With a suitable tubing these switches could control the level of liquid, etc., price £1. Order Ref: 67.
FLASHING BEACON. Ideal for putting on a van, a tractor or any vehicle that should always be seen. Uses a Xenon tube and has an amber coloured dome. Separate fixing base is included so unit can be put away if desirable. Price £5. Order Ref: 5P267.

MEDICINE CUPBOARD ALARM. Or it could be used to warn when any cupboard door is opened. The light shining on the unit makes the bell ring. Completely built and neatly cased, requires only a battery, £3. Order Ref: 3P155.
WATER LEVEL ALARM. Be it bath, sink, cellar, sump or any other thing that could flood. This device will tell you when the water has risen to the preset level. Adjustable over quite a useful range. Neatly cased for wall mounting, ready to work when battery fitted, £3. Order Ref: 3P156.
BIKE RADIO. In fact, it's more than a radio, it's an alarm and a spotlight. The radio is battery operated, of course, and needs 3 AA cells. Only one band but this is the FM band so will receive Radio 1 and 2. Comes complete with handlebar fixing clips. Price £4. Order Ref: 4P72.
EMERGENCY LIGHTING UNIT with perspex cover. Contains internal rechargeable batteries and its own charger to operate an internal fluorescent tube. Stays on for 3 hours should mains fail. Price £15. Order Ref: 15P32.
PHILIPS 9in. MONITOR. Not cased, but it is in a frame for rack mounting. It is high resolution and was made to work with the IBM 'One per disk' computer. Price £15. Order Ref: 15P1.
METAL CASE FOR 9in. MONITOR. Supplied as a flat pack, price £12. Order Ref: 12P3.
TELEPHONE EXTENSION LEAD. Nicely made and BT approved. Has the plug into BT socket one end and the telephone socket the other end, total length 12m, £2. Order Ref: 2P338.
INSULATION TESTER WITH MULTIMETER. Internally generates voltages which enable you to read insulation directly in megohms. The multimeter has four ranges, AC/DC volts, 3 ranges DC milliamps, 3 ranges resistance and 5 amp range. Ex-British Telecom but in very good condition, tested and guaranteed, probably cost at least £50 each, yours for only £7.50 with leads, carrying case £2 extra. Order Ref: 7.5P4.
REPAIRABLE METERS. We have some of the above testers but faulty, not working on all ranges, should be repairable, we supply diagram, £3. Order Ref: 3P176.
PIANO ON KEY CHAIN. Although it is quite small, only 20mm long, it will play any tune. Instructions with it tell you which keys to press for 'Happy Birthday', 'Twinkle Twinkle Little Star', 'Jingle Bells' and 'London Bridge'. It is also a light, it has a little lamp which can be operated by the end switch. Battery operated (not included), price £1.50. Order Ref: 1.5P39.
12V RECHARGEABLE YUASA BATTERY. Sealed so usable in any position – suit golf trolley, lawn mower, portable lights, etc., etc., only £3.50. Order Ref: 3.5P11.
CHARGER FOR YUASA BATTERY. This battery charger plugs into a 13A socket, charges at approximately 1/2A so it would charge this battery overnight. Complete with croc clips, ready to go, £5. Order Ref: 5P269.
8mm PROJECTORS. With zoom lens, brand new and perfect, complete with one reel and handbook. Regular price over £100, yours for £39. Order Ref: 39P1.
Ditto but with sound as well and a mike, £49. Order Ref: 49P1. The zoom lens alone is worth more.



SOLDERING IRON. Super mains powered with long life ceramic element, heavy duty 40W for the extra special job. Complete with plated wire stand and 245mm lead, £3. Order Ref: 3P221.
DYNAMIC MICROPHONE. 500 ohm, plastic body with black mesh head, on/off switch, good length lead and terminated with audio plug, £2. Order Ref: 2P220.

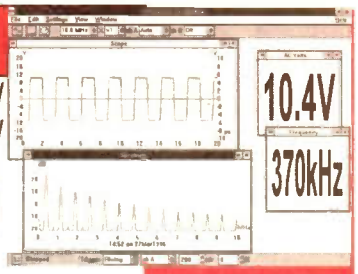
1/10th HORSEPOWER 12V MOTOR. Made by Smiths, the body length of this is approximately 3in., the diameter 3in. and the spindle 5/16in. diameter. Quite a powerful little motor which revs at 2000rpm. Price £6. Order Ref: 6P47.
MINI BLOW HEATER. 1kW, ideal for under desk or airing cupboard, etc. Needs only a simple mounting frame, price £5. Order Ref: 5P23.

TERMS

Send cash, PO, cheque or quote credit card number – orders under £25 add £3.50 service charge.

J & N FACTORS
Pilgrim Works (Dept. E.E.)
Stairbridge Lane, Bolney,
Sussex RH17 5PA
Telephone: 01444 881965

The Alternative Oscilloscope



Pico Technology provides an alternative to costly, bulky and complicated oscilloscopes. The ADC range of virtual instrumentation enables your PC to perform as an oscilloscope, spectrum analyser and digital multimeter.

- Upto 100 MS/s sampling and 50 MHz spectrum analysis
- A fraction of the price of comparable benchtop DSOs
- Simple Windows based user interface

The practical alternative

Connection to a PC gives virtual instruments the edge over traditional oscilloscopes: the ability to print and save waveforms is just one example. Advanced trigger modes, such as save to disk on trigger, make tracking down elusive intermittent faults easy. Combining several instruments into one small unit means it is lighter and more portable. When used with a notebook computer, field engineers can carry a complete electronics lab in their PC.

"...the most powerful, flexible test equipment in my lab."

The simple alternative

Virtual instruments eradicate the need for bewildering arrays of switches and dials associated with traditional 'benchtop' scopes. The units are supplied with PicoScope for Windows software.

Controlled using the standard Windows interface, the software is easy to use with full on line help. Installation is easy and no configuration is required; simply plug into the parallel port and it is ready to go. We provide a two year guarantee and free technical support via phone, fax or E-mail.

FROM £59

The low cost alternative

The Pico range of PC based oscilloscopes work with your PC - anything from a dustbin-ready 8086 to the latest pentium. The PicoScope software utilises your monitor to display data. This gives you a larger, clearer display than any scope, at a fraction of the price.

The savings don't stop there: All those expensive upgrades needed for traditional oscilloscopes: such as FFT maths, disk drives and printers are already built into your computer. The PC has made computing affordable, now Pico has made test equipment affordable too.

Seeing is understanding

Call for a FREE demo disk or visit our web site.

Fax: (0)1954 211880 Tel: (0)1954 211716

E:mail: post@picotech.co.uk http:www.picotech.com

Broadway House 149-151 St Neots Road Hardwick Cambridge CB3 7QJ UK

pico Technology Limited

The complete monitoring system

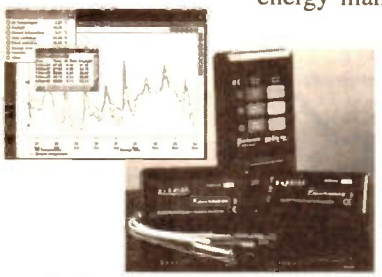
Temperature

Open Door

Humidity

Light

The *EnviroMon* system, from Pico Technology is one of the most versatile and cost effective monitoring systems on the market today. It can measure temperatures from -55 to 300°C, check light and humidity levels or record the position of a switched system. Its applications are endless; from food storage & preparation to energy management.



At the core of the system is the logger, which stores up to 15,000 readings and displays them from each sensor in turn. Reports can be printed on a stand-alone printer or data sent to a PC for long term storage and graphical analysis using the powerful supplied software, EnviroMon for Windows.

The EnviroMon system records data 24 hours a day, 365 days a year, even if the mains power fails. Should a parameter goes out of range, it alerts you with various alarms or a telephone message.

***EnviroMon* Starter kit . . . . . £395** + VAT

Call for full product range *and* FREE demo disk or visit our web site.

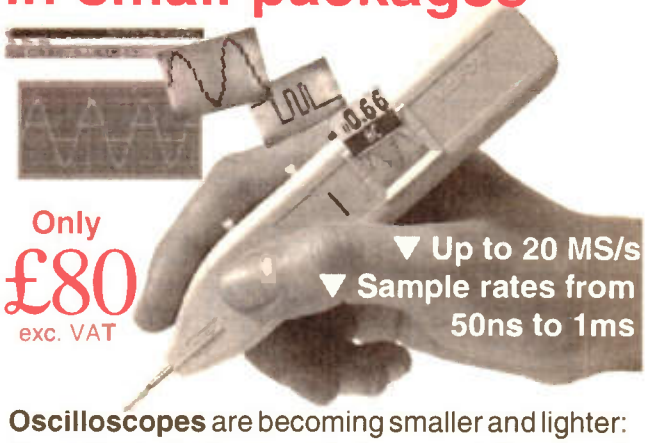
Pico Technology Limited, Broadway House, 149-151 St. Neots Rd, Hardwick, Cambridge, CB3 7QJ UK

Tel: 01954 -211716 Fax: 01954 -211880

E-mail: post@picotech.co.uk http:www.picotech.com

pico Technology Limited

The best things come in small packages



Only £80 exc. VAT

▼ Up to 20 MS/s
▼ Sample rates from 50ns to 1ms

Oscilloscopes are becoming smaller and lighter: Now Pico Technology brings you the latest development, the **osziFOX** hand held scope.

Despite its small size, its performance can match that of a service oscilloscope. With sampling rates of up to 20 MSs, even signals in microprocessor circuits can be measured.

The osziFOX is ideal for taking measurements in digital circuits, telephone installations. hobby electronics, production line tests and on-the-spot measuring.It provides the ultimate in portability and flexibility.

As with the rest of the Pico Technology range, the PC link gives the osziFOX the edge: the ability to print and save waveforms is just one example.

Complete price £98.11 including VAT + P&P (UK), cables and software included.

Tel: 01954 -211716 Fax: 01954 -211880

E-mail: post@picotech.co.uk

Visit our web site: www.picotech.com

Pico Technology Limited, Broadway House, 149-151 St. Neots Rd, Hardwick, Cambridge, CB3 7QJ

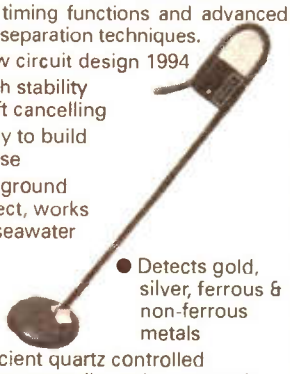
MAGENTA ELECTRONICS LTD

EE198 135 Hunter Street, Burton-on-Trent, Staffs. DE14 2ST
Tel 01283 565435 Fax 546932
E-mail: Magenta_Electronics@compuserve.com
Homepage: http://ourworld.compuserve.com/homepages/Magenta_Electronics
All Prices include V.A.T. Add £3.00 per order p&p. £6.99 next day

MAIL ORDER ONLY ● CALLERS BY APPOINTMENT

EPE MICROCONTROLLER P.I. TREASURE HUNTER

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



- New circuit design 1994
- 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

PIC PIPE DESCALER

- 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

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.....£28.51

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

SUPER BAT DETECTOR

NEW!

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 peformance superheterodyne design.

KIT 861.....£24.99
ALSO AVAILABLE Built & Tested £39.99

PORTABLE ULTRASONIC PEsT SCARER

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

KIT 842.....£22.56

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

SUPER ACOUSTIC PROBE

Our very popular project – now with ready built probe assembly and diecast box. Picks up vibrations amplifies, and drives headphones. Sounds from engines, watches, and speech through walls can be heard clearly. Useful for mechanics, instrument engineers and nosey parkers! A very useful piece of kit.

KIT 865.....£29.95

★ 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

E.E. TREASURE HUNTER P.I. METAL DETECTOR MKI

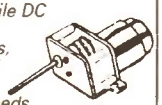
Magenta's highly developed & acclaimed design. Quartz crystal controlled circuit MOSFET coil drive. D.C. coupled amplification. Full kit includes PCB, handle, case & search coil.

- KIT INC. HEADPHONES
- EFFICIENT CMOS DESIGN
- POWERFUL COIL DRIVE
- DETECTS FERROUS AND NON-FERROUS METAL – GOLD, SILVER, COPPER ETC.
- 190mm SEARCH COIL
- NO 'GROUND EFFECT'

KIT 815.....£45.95

DC Motor/Gearboxes

Our Popular and Versatile DC motor/Gearbox sets. Ideal for Models, Robots, Buggies etc. 1·5 to 4·5V Multi ratio gearbox gives wide range of speeds.



LARGE TYPE – MGL £6.95
SMALL – MGS – £4.77

Stepping Motors

MD38...Mini 48 step...£8.65
MD35...Std 48 step...£9.99
MD200...200 step...£12.99
MD24...Large 200 step...£22.95

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

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

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

Kit No. 845.....£64.95

3-NOTE DOORCHIME

IDEAL BEGINNERS PROJECT

Uses SAB0600 chip to produce natural sounding 3-note chime. Adjustable pitch – so that two can be used for front and back doors.
Kit includes P.C.B., all parts and instructions. No case or battery

KIT 869.....£5.99

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
- UP TO 4 METRES RANGE
- COMPLETELY INAUDIBLE TO HUMANS
- LOW CURRENT DRAIN

KIT 812.....£14.81

SIMPLE PIC PROGRAMMER

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

INCLUDES 1-PIC16C84 CHIP SOFTWARE DISK, LEAD CONNECTOR, PROFESSIONAL PC BOARD & INSTRUCTIONS

Power Supply £3.99

EXTRA CHIPS: PIC 16C84 £4.84

Based on the design in February '96 *EPE* article, Magenta have made a proper PCB and kit for this project. PCB has 'reset' switch, Program switch, 5V regulator and test L.E.D.s. There are also extra connection points for access to all A and B port pins.

PIC16C84 LCD DISPLAY DRIVER

INCLUDES 1-PIC16C84 WITH DEMO PROGRAM SOFTWARE DISK, PCB, INSTRUCTIONS AND 24-CHARACTER 2-LINE **LCD DISPLAY**

Kit 860 **£19.99**

Power Supply £3.99

FULL PROGRAM SOURCE CODE SUPPLIED – DEVELOP YOUR OWN APPLICATION!

Another super PIC project from Magenta. Supplied with PCB, industry standard 2-LINE x 24-character display, data, all components, and software to include in your own programs. Ideal develpment base for meters, terminals, calculators, counters, timers – Just waiting for your application!

★ Chip is pre-programmed with demo display ★

PIC16C84 MAINS POWER 4-CHANNEL CONTROLLER & LIGHT CHASER

- WITH PROGRAMMED 16C84 AND DISK WITH SOURCE CODE IN MPASM
- ZERO VOLT SWITCHING – 10 CHASE PATTERNS
- OPTO ISOLATED
- 4 X 3 KEYPAD CONTROL
- SPEED CONTROL POT.
- HARD FIRED TRIACS
- 4 CHANNELS @5 AMPS

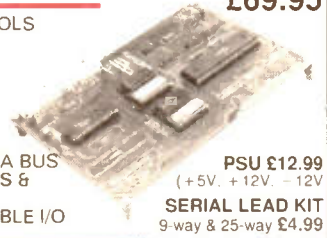
Now features full 4-channel chaser software on DISK and pre-programmed PIC16C84 chip. Easily re-programmed for your own applications. Software source code is fully 'commented' so that it can be followed easily.

Kit 855 **£39.95** LOTS OF OTHER APPLICATIONS

68000 DEVELOPMENT AND TRAINING KIT

KIT 601 £69.95

- USED WORLDWIDE IN SCHOOLS & COLLEGES
- FULL FEATURED MONITOR, LINE ASSEMBLER & CROSS ASSEMBLER DISK
- NOW WITH EXPANDED RAM & ROM
- FULL 8MHz 68000 16-BIT DATA BUS
- FULL MANUAL, DATA COMMS & SOFTWARE DISK
- 2 SERIAL PORTS & EXPANDABLE I/O



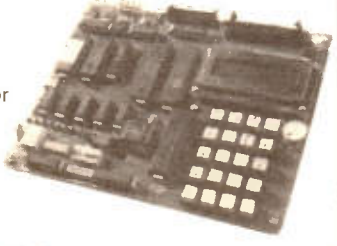
PSU £12.99 (+5V, +12V, −12V)

SERIAL LEAD KIT 9-way & 25-way £4.99

Mini-Lab & Micro Lab Electronics Teach-In 7

As featured in *EPE* and now published as Teach-In 7. All parts are supplied by Magenta. *Teach-In 7* is £3.95 from us or *EPE*

Full Mini Lab Kit – £119.95 –
Power supply extra – £22.55
Full Micro Lab Kit – £155.95
Built Micro Lab – £189.95



EPE PIC Tutorial

NEW!

At Last! A Real, Practical, Hands-On Series 3-Part Series – Starting March '98

- **Learn Programming from scratch**
- **Uses Re-Programmable PIC16C84 Chip**
- **Start by lighting an l.e.d. and work up through over 30 tutorials to Sound Generation, Data Display, and a Security System**
- **PIC TUTOR Board has Input Switches, Output l.e.d.s, and on board programmer**

PIC TUTOR BOARD KIT

Includes: PIC16C84 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 – With Software and Connection details **£7.99**
LED Display – Including Software.....**£6.99**

PIC TOOLKIT

NEW!

- PROGRAMS PIC16C84 and 16F84
- ACCEPTS TASM AND MPASM CODE

Full kit includes PIC16C84 chip, top quality p.c.b. printed with component layout, turned pin PIC socket, all components and software* *Needs QBASIC or QUICKBASIC

KIT 871 . . . £13.99. Built and tested **£21.99**

SUPER PIC PROGRAMMER

- READS, PROGRAMS, AND VERIFIES
- WINDOWS™ SOFTWARE
- PIC16C6X, 7X, AND 8X
- USES ANY PC PARALLEL PORT
- USES STANDARD MICROCHIP • HEX FILES
- OPTIONAL DISASSEMBLER SOFTWARE (EXTRA)
- PCB, LEAD, ALL COMPONENTS, TURNED PIN SOCKETS FOR 18, 28, AND 40 PIN ICs.

• 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, PIC16C84 WITH DEMO PROGRAM, SOFTWARE DISK, INSTRUCTIONS AND MOTOR.

Kit 863 **£18.99**

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

Another NEW 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

All pricesinclude VAT. Add £3.00 p&p. Next Day £6.99

Tel: 01283 565435 Fax: 01283 546932 E-mail: Magenta_Electronics@compuserve.com

Station Road, Cullercoats, Tyne & Wear, NE30 4PQ

All Major Credit cards Accepted

Prices Exclude Vat @17½%. Add £1.25 carriage & Vat to all orders. Cheques / Postal orders payable to ESR Electronic Components.

See Next / Last Months Ad. for COMPONENT ACCESSORIES

4000 Series

4000	£0.17
4001	£0.18
4002	£0.17
4006	£0.40
4007	£0.18
4008	£0.23
4009	£0.19
4010	£0.23
4011	£0.18
4012	£0.16
4013	£0.20
4014	£0.30
4015	£0.24
4016	£0.28
4017	£0.24
4018	£0.27
4019	£0.48
4020	£0.36
4021	£0.31
4022	£0.32
4023	£0.16
4024	£0.32
4025	£0.15
4026	£0.78
4027	£0.25
4028	£0.34
4029	£0.40
4030	£0.17
4031	£0.61
4034	£1.24
4035	£0.31
4040	£0.32
4041	£0.31
4042	£0.22
4043	£0.28
4044	£0.35
4046	£0.54
4047	£0.32
4048	£0.28
4049	£0.22
4050	£0.26
4051	£0.34
4052	£0.32
4053	£0.29
4054	£0.56
4055	£0.34
4060	£0.31
4063	£0.29
4066	£0.19
4067	£2.20
4068	£0.16
4069	£0.19
4070	£0.25
4071	£0.23
4072	£0.17
4073	£0.17
4075	£0.17
4076	£0.30
4077	£0.28
4078	£0.20
4081	£0.21
4082	£0.21
4085	£0.28
4086	£0.26
4089	£0.55
4093	£0.23
4094	£0.29
4095	£0.56
4097	£1.20
4098	£0.48
4099	£0.38
4502	£0.32
4503	£0.40
4508	£1.40
4510	£0.36
4511	£0.38
4512	£0.32
4514	£0.77
4515	£0.99
4516	£0.44
4518	£0.44
4520	£0.41
4521	£0.62
4526	£0.40
4527	£0.40
4528	£0.40
4529	£0.44
4532	£0.32
4534	£3.24
4536	£1.00
4538	£0.37
4541	£0.33
4543	£0.49
4555	£0.32
4556	£0.40
4560	£1.18
4566	£1.96
4572	£0.25
4584	£0.24
4585	£0.47
4724	£0.94
40106	£0.24
40109	£0.58
40163	£0.46
40174	£0.46
40175	£0.36
40193	£0.60

74 Series

7407	£0.40

74HC Series

74HC00	£0.19
74HC02	£0.21
74HC03	£0.21
74HC04	£0.17
74HC08	£0.21
74HC10	£0.16
74HC11	£0.20
74HC14	£0.22
74HC20	£0.28
74HC27	£0.16
74HC30	£0.22
74HC32	£0.20
74HC42	£0.36
74HC73	£0.40
74HC74	£0.22
74HC75	£0.40
74HC76	£0.20
74HC85	£0.24
74HC86	£0.22
74HC107	£0.40
74HC123	£0.33
74HC125	£0.26
74HC126	£0.46
74HC132	£0.37
74HC133	£0.29
74HC138	£0.25
74HC139	£0.31
74HC151	£0.33
74HC153	£0.27
74HC154	£0.85
74HC157	£0.40
74HC158	£0.23
74HC160	£0.64
74HC161	£0.28
74HC162	£0.45
74HC163	£0.26
74HC164	£0.35
74HC165	£0.35
74HC173	£0.38
74HC174	£0.27
74HC175	£0.35
74HC192	£0.72
74HC195	£0.32
74HC240	£0.37
74HC241	£0.37
74HC243	£0.48
74HC244	£0.42
74HC245	£0.46
74HC251	£0.30
74HC253	£0.25
74HC257	£0.25
74HC259	£0.57
74HC273	£0.32
74HC299	£0.64
74HC356	£0.45
74HC365	£0.34
74HC367	£0.25
74HC368	£0.25
74HC373	£0.35
74HC374	£0.40
74HC390	£0.52
74HC393	£0.38
74HC423	£0.37
74HC553	£0.42
74HC563	£0.56
74HC564	£0.48
74HC573	£0.38
74HC574	£0.45
74HC595	£0.39
74HC640	£0.73
74HC688	£0.64
74HC4002	£0.31
74HC4017	£0.64
74HC4020	£0.36
74HC4040	£0.36
74HC4049	£0.31
74HC4050	£0.25
74HC4051	£0.40
74HC4060	£0.44
74HC4075	£0.27
74HC4078	£0.32
74HC4511	£0.64
74HC4514	£0.84
74HC4538	£0.41
74HC4543	£0.90

74LS Series

74LS00	£0.23
74LS01	£0.14
74LS02	£0.26
74LS03	£0.29
74LS04	£0.21
74LS05	£0.14
74LS08	£0.23
74LS09	£0.14
74LS10	£0.14
74LS11	£0.17
74LS12	£0.14
74LS13	£0.29
74LS14	£0.21
74LS15	£0.14
74LS20	£0.25
74LS21	£0.14
74LS22	£0.14
74LS26	£0.14
74LS27	£0.14
74LS30	£0.20
74LS32	£0.21
74LS37	£0.14
74LS38	£0.19
74LS40	£0.14
74LS42	£0.42
74LS47	£0.58
74LS51	£0.24
74LS73	£0.40
74LS74	£0.32
74LS75	£0.30
74LS76	£0.40
74LS83	£0.38
74LS85	£0.48
74LS86	£0.25
74LS90	£0.48
74LS92	£0.45
74LS93	£0.42
74LS107	£0.30
74LS109	£0.21
74LS112	£0.24
74LS113	£0.21
74LS114	£0.36
74LS122	£0.31
74LS123	£0.31
74LS125	£0.27
74LS126	£0.25
74LS132	£0.26
74LS133	£0.36
74LS136	£0.23
74LS138	£0.40
74LS139	£0.24
74LS145	£0.56
74LS148	£0.64
74LS151	£0.25
74LS153	£0.40
74LS154	£0.70
74LS155	£0.25
74LS156	£0.36
74LS157	£0.22
74LS158	£0.21
74LS160	£0.48
74LS161	£0.32
74LS162	£0.44
74LS163	£0.32
74LS164	£0.24
74LS165	£0.48
74LS170	£0.30
74LS173	£0.24
74LS174	£0.24
74LS175	£0.24
74LS190	£0.60
74LS191	£0.24
74LS192	£0.60
74LS193	£0.24
74LS195	£0.24
74LS196	£0.24
74LS197	£0.24
74LS221	£0.40
74LS240	£0.32
74LS241	£0.32
74LS242	£0.32
74LS243	£0.30
74LS244	£0.32
74LS245	£0.36
74LS247	£0.32
74LS251	£0.24
74LS257	£0.24
74LS258	£0.24
74LS266	£0.14
74LS273	£0.32
74LS279	£0.25
74LS365	£0.21
74LS367	£0.21
74LS368	£0.21
74LS373	£0.33
74LS374	£0.34
74LS375	£0.34
74LS377	£0.32
74LS378	£0.62
74LS390	£0.25
74LS393	£0.33
74LS395	£0.26
74LS399	£0.62
74LS670	£0.69

Linear ICs

AD524AD	£23.04
AD548JN	£1.62
AD590JH	£5.28
AD592AN	£4.52
AD595AQ	£12.65
AD620AN	£9.88
AD625JN	£16.20
AD633JN	£8.09
AD648JN	£2.57
AD654JN	£6.73
AD708JN	£5.69
AD711JN	£1.51
AD712JN	£2.38
AD736JN	£8.75
AD797AN	£8.69
AD811N	£5.85
AD812AN	£6.32
AD817AN	£3.85
AD820AN	£3.20
AD822AN	£5.20
AD829JN	£6.41
AD830AN	£5.99
AD847JN	£5.71
AD9696KN	£7.73
ADEL2020A	£5.06
ADM222AH	£3.55
ADM232AA	£3.55
ADM485JN	£2.97
ADM690AN	£5.13
ADM691AN	£6.48
ADM695AN	£6.48
ADM699AN	£3.58
CA741CE	£0.24
CA747CE	£0.39
CA3046	£0.37
CA3059	£1.33
CA3080E	£0.73
CA3130E	£0.87
CA3140E	£0.49
CA3189E	£1.22
CA3240E	£1.12
DG211CJ	£1.55
DG212CJ	£1.55
DG411DJ	£3.11
ICL7106	£2.95
ICL7611DCP	£0.75
ICL7621	£0.96
ICL7660SCP	£1.68
ICL8038	£3.84
ICM7555	£0.34
ICM7556	£0.98
L165V	£2.72
L272M	£1.86
L293E	£4.35
L297	£5.71
L298	£6.26
L6219	£4.48
LF347N	£0.46
LF351N	£0.43
LF353N	£0.40
LF356	£0.84
LM301A	£0.25
LM308N	£0.58
LM311N-8	£0.25
LM318	£0.98
LM319N-14	£0.90
LM324	£0.26
LM335Z	£1.08
LM339N	£0.24
LM348N	£0.31
LM358N	£0.27
LM380N	£0.88
LM381N	£2.64
LM386	£0.79
LM392N	£0.79
LM393N	£0.21
LM709T	£0.79
LM748CN-8	£0.37
LM1458	£0.32
LM1881	£3.92
LM2917N8	£3.10
LM3900N	£0.72
LM3909N	£0.72
LM3914	£2.16
LM3915	£2.70
LM13600	£1.66
LMC660CN	£1.44
LMC6032IN	£1.55
LP311N	£0.74
LP324N	£0.67
LP339N	£0.73
LT1013CN8	£3.94
MAX202CPE	£2.97
MAX208CN	£6.99
MAX220CPE	£5.06
MAX222CPE	£5.06
MAX232CPE	£1.80
MAX483CP	£3.13
MAX485CP	£2.56
MAX631ACP	£4.99
MAX635ACP	£4.99
MAX1232CP	£2.96
MC1488	£0.39
MC1489	£0.39
MC3302	£0.56
MC3340P	£1.60
MC4558P	£0.33
MV601DP	£2.97
NE521N	£6.39
NE555N	£0.21
NE556N	£0.36
NE565	£1.84
NE566N	£0.90
NE567N	£0.39
NE571N	£2.47
NE592	£0.62
NE5532N	£0.45
NE5534N	£0.64
NE5539N	£4.35
OP07CN	£1.42
OP27CN	£2.90
OP77GP	£1.99
OP90GP	£3.11
OP97FP	£2.43
OP113GP	£3.44
OP176GP	£2.09
OP177GP	£1.89
OP200GP	£5.60
OP213FP	£5.20
OP275GP	£2.57
OP282GP	£2.27
OP283GP	£5.20
OP290GP	£5.40
OP297GP	£5.74
OP400GP	£11.81
OP495GP	£8.69
RC4136	£1.00
SAA1027	£4.49
SG3524N	£0.96
SG3543	£6.88
SSM2017P	£3.38
SSM2131P	£4.19
SSM2141P	£4.21
SSM2142P	£6.16
SSM2143P	£3.78
TBA120S	£0.90
TBA800	£0.70
TBA810S	£0.64
TBA820M	£0.40
TDA1170S	£4.80
TDA2004	£3.11
TDA2030	£1.18
TDA2050V	£3.12
TDA2611A	£1.88
TDA2822A	£0.86
TED3718DP	£5.03
TEA5115	£3.11
TL061CP	£0.35
TL062CP	£0.60
TL064CN	£0.72
TL071CP	£0.39
TL072CP	£0.32
TL074CN	£0.48
TL081	£0.29
TL082CP	£0.54
TL084CN	£0.50
TL494CN	£1.46
TL7705ACP	£1.62
TLC271	£0.54
TLC272	£0.88
TMP01FP	£5.60
ULN2003	£0.52
ULN2004A	£0.48
ULN2803	£0.60
ULN2804A	£1.64
XR2206	£3.60

EPROM's

2716	£4.74
2732	£4.84
2764-20	£4.26
27C64-25	£2.88
27128-20	£4.08
27C128-15	£3.02
27256-20	£4.85
27C256-20	£3.68
27C512-15	£2.56
27C1001-20	£3.02
27C4001-120	£9.76

RAM

4164-15	£1.90
6116-10	£1.56
6264-10	£3.16
41256-10	£2.80
62256-10	£3.20
514256-8	£6.80

A/D Converters

Data Acquisition

AD420AN	£25.38
AD557JN	£8.75
AD574AJN	£18.48
AD775JN	£18.48
AD7528JN	£11.42
AD7545AKN	£14.04
AD7828KN	£20.33
DAC0800	£2.72
ICL7109CPL	£7.75
TLC549IP	£3.04
ZN427E	£9.25
ZN448E	£7.34

µControllers

AT89C2051	£6.43
12C508-04P	£1.22
16C54A04P	£3.07
16C54JW	£12.48
16C56-04P	£2.05
16C71-04P	£4.88
16C71JW	£17.34
16F84-04P	£3.40

PHONE FOR OTHER DEVICES

Voltage Regulators

7805	£0.29
7806	£0.32
7808	£0.35
7812	£0.38
7815	£0.38
78L05	£0.23
78L06	£0.32
78L08	£0.23
78L12	£0.23
78L15	£0.24
78L24	£0.39
78S05	£0.70
78S12	£0.70
78S15	£0.98
7905	£0.40
7912	£0.30
7915	£0.38
7924	£0.38
79L05	£0.23
79L12	£0.23
79L15	£0.28
79L24	£0.30
ADM666AN	£3.44
L200CV	£1.30
L296	£6.87
L387A	£3.24
LM2940CT	£2.30
LM317LZ	£0.30
LM317T	£0.48
LM323K	£2.84
LM334Z	£1.35
LM337T	£0.68
LM338K	£5.52
LM338T	£1.48
LM723	£0.29
LP2950CZ	£2.70
REF01CP	£3.44
REF02CP	£4.66
REF12Z	£1.28
REF195GP	£4.72
REF25Z	£1.24
REF50Z	£1.22
TL431CP	£0.45
ZN423	£0.82
ZN458B	£1.89

Diodes

1N914	£0.06
1N916	£0.06
1N4001	£0.04
1N4002	£0.04
1N4003	£0.04
1N4004	£0.04
1N4005	£0.04
1N4006	£0.04
1N4007	£0.05
1N4148	£0.05
1N4149	£0.06
1N5400	£0.09
1N5401	£0.08
1N5402	£0.08
1N5404	£0.09
1N5406	£0.10
1N5407	£0.10
1N5408	£0.11
6A05	£0.27
6A1	£0.27
6A2	£0.27
6A4	£0.28
6A6	£0.29
6A8	£0.30
6A10	£0.37
BA157	£0.10
BA158	£0.10
BA159	£0.10
BAT41	£0.12
BAT42	£0.10
BAT46	£0.20
BAT49	£0.36
BAT85	£0.17
BAV21	£0.07
BAW62	£0.07
BAX13	£0.05
BAX16	£0.05
BB405B	£0.26
BB909A	£0.36
BB909B	£0.36
BY126	£0.13
BY127	£0.18
BY133	£0.10
OA47	£0.24
OA90	£0.07
OA91	£0.26
OA200	£0.56
OA202	£0.29

Zeners 2.7 to 33V

500mW	£0.08
1.3W	£0.14

Bridge Rectifiers

1.5A 50V	£0.19
1.5A 200V	£0.20
1.5A 400V	£0.22
1.5A 600V	£0.22
1.5A 800V	£0.27
1.5A 1kV	£0.24
3A 200V	£0.36
3A 400V	£0.40
3A 600V	£0.33
6A 200V	£0.70
6A 800V	£0.59
10A 400V	£1.39
25A 200V	£1.68
25A 600V	£1.80

Thyristors

C106D	£0.30
PO102AA	£0.30
TIC116D	£0.66
TIC126D	£0.77

Triacs

ZO105DA	£0.42
TIC206D	£0.55
TIC226D	£0.94
BTA08-600B	£0.88
TIC236D	£1.12

Diac, Si. Switch

DB3, 32V	£0.16
BRY39	£1.30

Transistors

2N1613	£0.31
2N1711	£0.26
2N1893	£0.29
2N2218A	£0.28
2N2219A	£0.25
2N2222A	£0.18
2N2646	£1.12
2N2904A	£0.25
2N2905A	£0.25
2N2907A	£0.17
2N2926	£0.16
2N3053	£0.27
2N3054	£0.85
2N3055	£0.58
2N3439	£0.62
2N3440	£0.50
2N3702	£0.09
2N3703	£0.10
2N3704	£0.10
2N3705	£0.10
2N3706	£0.10
2N3771	£1.44
2N3772	£1.55
2N3773	£1.70
2N3819	£0.34
2N3820	£0.66
2N3904	£0.10
2N3905	£0.10
2N3906	£0.10
2N4036	£0.34
2N5245	£0.80
2N5296	£0.57
2N5401	£0.12
2N5460	£0.54
2N5551	£0.11
2N6107	£0.60
2N6491	£1.58
2SB548	£0.30
2SD1730	£1.44
AC126	£0.44
AC127	£0.50
AC128	£0.72
AC187	£0.68
AC188	£0.96
ACY17	£3.84
AD149	£1.67
AD161	£0.92
AD162	£0.92
BC107	£0.16
BC107B	£0.17
BC108	£0.14
BC108B	£0.16
BC108C	£0.15
BC109	£0.17
BC109C	£0.17
BC114	£0.19
BC115	£0.41
BC116	£0.41
BC118	£0.41
BC132	£0.36
BC134	£0.36
BC135	£0.36
BC140	£0.25
BC141	£0.27
BC142	£0.34
BC143	£0.38
BC149	£0.21
BC154	£0.36
BC157	£0.12
BC159	£0.17
BC160	£0.28
BC170	£0.16
BC170B	£0.16
BC171	£0.11
BC171B	£0.16
BC172	£0.13
BC172B	£0.13
BC177	£0.18
BC178	£0.18
BC179	£0.18
BC179A	£0.17
BC182	£0.11
BC182A	£0.11
BC182B	£0.12
BC182L	£0.08
BC182LB	£0.10
BC183	£0.08
BC183L	£0.08
BC183LB	£0.08
BC184	£0.08
BC184L	£0.08
BC186	£0.33
BC204C	£0.72
BC206B	£0.72
BC208	£0.72
BC209A	£0.72
BC212	£0.08
BC212L	£0.08
BC212LB	£0.08
BC213	£0.08
BC213B	£0.08
BC213LC	£0.08
BC214	£0.08
BC214L	£0.08
BC225	£0.15
BC237B	£0.09
BC238B	£0.09
BC238C	£0.09
BC239C	£0.10
BC250A	£0.15
BC252	£0.13
BC261B	£0.30
BC262B	£0.24
BC267B	£0.30
BC307	£0.10
BC308	£0.10
BC319C	£0.13
BC327	£0.10
BC327-25	£0.10
BC328	£0.10
BC328-16	£0.10
BC337	£0.10
BC337-25	£0.10
BC338	£0.10
BC338-25	£0.10
BC348B	£0.14
BC357	£0.25
BC393	£0.73
BC441	£0.40
BC461	£0.46
BC463	£0.29
BC478	£0.32
BC479	£0.32
BC516	£0.21
BC517	£0.17
BC527	£0.20
BC528	£0.20
BC537	£0.20
BC546B	£0.08
BC546C	£0.08
BC547B	£0.09
BC547C	£0.09
BC548C	£0.08
BC549C	£0.10
BC550C	£0.10
BC556A	£0.08
BC557B	£0.08
BC557C	£0.08
BC558B	£0.08
BC559C	£0.08
BC560A	£0.09
BC560B	£0.09
BC637	£0.21
BC638	£0.21
BC639	£0.21
BC640	£0.13
BCY70	£0.22
BCY71	£0.20
BCY72	£0.20
BD124P	£6.86
BD131	£0.52
BD135	£0.21
BD136	£0.21
BD137	£0.23
BD138	£0.22
BD139	£0.25
BD140	£0.25
BD150C	£0.82
BD165	£0.42
BD166	£0.35
BD187	£0.39
BD201	£0.40
BD202	£0.70
BD203	£0.40
BD204	£0.40
BD225	£0.42
BD232	£0.50
BD237	£0.32
BD238	£0.44
BD240C	£0.37
BD244A	£0.53
BD245C	£1.18
BD246	£1.18
BD246C	£1.18
BD283	£0.61
BD284	£0.61
BD400	£0.79
BD441	£0.41
BD442	£0.37
BD534	£0.47
BD535	£0.50
BD536	£0.65
BD581	£0.62
BD597	£0.92
BD646	£0.52
BD648	£0.52
BD650	£0.53
BD807	£0.80
BDX32	£1.78
BDX33C	£0.56
BDX34C	£0.50
BDX53C	£0.47
BDX54C	£0.50
BF180	£0.31
BF182	£0.31
BF185	£0.58
BF194	£0.31
BF194B	£0.19
BF195	£0.14
BF244	£0.35
BF244B	£0.35
BF244C	£0.35
BF257	£0.33
BF259	£0.33
BF337	£0.40
BF355	£0.38
BF423	£0.13
BF451	£0.19
BF459	£0.33
BF469	£0.36
BFX29	£0.29
BFX84	£0.31
BFX85	£0.32
BFY50	£0.30
BFY51	£0.24
BFY52	£0.28
BS107	£0.21
BS170	£0.23
BSW66	£1.35
BU126	£1.32
BU205	£1.41
BU208A	£1.24
BU326A	£1.40
BU500	£1.54
BU508A	£1.30
BU508D	£0.98
BU526	£1.74
BU806	£1.06
BUT11A	£0.57
BUT11AF	£1.14
BUX84	£0.78
IRF530	£0.48
IRF540	£1.26
IRF740	£1.88
MJ2501	£1.60
MJ3001	£1.80
MJ11015	£2.45
MJ11016	£2.56
MJE340	£0.40
MJE350	£0.48
MPSA05	£0.14
MPSA06	£0.11
MPSA13	£0.12
MPSA42	£0.17
MRF475	£7.28
TIP29C	£0.31
TIP30C	£0.37
TIP31C	£0.41
TIP32C	£0.41
TIP33C	£0.72
TIP41A	£0.38
TIP42C	£0.39
TIP47	£0.48
TIP48	£0.62
TIP50	£0.53
TIP121	£0.45
TIP122	£0.46
TIP125	£0.46
TIP127	£0.40
TIP132	£0.46
TIP137	£0.56
TIP142	£1.30
TIP147	£1.12
TIP2955	£0.97
TIP3055	£0.70
VN10KM	£0.48
ZTX300	£0.16
ZTX500	£0.16
ZTX653	£0.33

No Minimum Order Value

Electrolytic Radial

µF	16v	25v	40v	63v	100v
0.47	---	---	---	£0.05	---
1.0	---	---	---	£0.05	£0.05
2.2	---	---	---	£0.05	---
4.7	---	---	£0.05	£0.05	£0.05
10	£0.05	£0.05	£0.05	£0.05	£0.09
22	£0.05	£0.05	£0.05	£0.07	£0.11
33	£0.05	---	£0.05	---	---
47	£0.05	£0.05	£0.07	£0.10	£0.19
100	£0.06	£0.06	£0.10	£0.13	£0.26
220	£0.08	£0.09	£0.13	£0.25	---
330	£0.09	---	£0.19	---	---
470	£0.12	£0.17	£0.24	£0.33	---
1000	£0.21	£0.33	£0.34	£0.75	---
2200	£0.27	£0.55	£0.70	---	---
3300	---	£0.94	---	---	---
4700	£0.67	£1.05	---	---	---

Electrolytic Axial

µF	16v	25v	40v	63v	100v	250v	450v
0.47	---	---	---	---	---	---	---
1.0	---	---	---	£0.13	---	---	£0.22
2.2	---	---	---	£0.13	---	---	£0.30
4.7	---	---	---	£0.13	---	---	£0.41
10	£0.12	---	£0.12	£0.13	£0.17	£0.40	£0.67
22	£0.12	£0.13	£0.14	£0.15	£0.21	£0.52	£1.06
33	---	---	---	---	---	---	---
47	£0.13	£0.13	£0.15	£0.19	£0.32	£0.57	---
100	£0.14	£0.16	£0.19	£0.26	£0.44	---	---
220	£0.19	£0.20	£0.27	£0.39	£0.48	---	---
330	---	---	---	---	---	---	---
470	£0.24	£0.28	£0.43	£0.53	---	---	---
1000	£0.33	£0.43	£0.59	£1.08	---	---	---
2200	£0.53	£0.66	£1.11	£1.55	---	---	---
3300	---	---	---	---	---	---	---
4700	£0.86	£1.11	---	---	---	---	---

We carry a large range of capacitors in stock, including:
Ceramic Mini Disc, Dipped Ceramic Multilayer, Dipped & Boxed Polyester, Mylar Film, Polystyrene, MKT Polyester, Tantalum Bead, Sub-miniature Radial, 105°C Radial, Low Leakage Radial, Non Polarised Radial, PCB Can Electrolytics, Polypropylene & Ceramic Trimmers and Tuning, Dilecon & O Type Variable capacitors. Full technical details available.

Resistors - Please State Value Required

per 100 of one value only

1.8W Carbon Film 5%	E12 Series	10Ω-1M0	£0.02 Each, £0.80 per 100
¼W Carbon Film 5%	E12 Series	1Ω-10M	£0.02 Each, £0.60 per 100
¼W Metal Film 1%	E24 Series	10Ω-1M	£0.04 Each, £1.72 per 100
½W Carbon Film 5%	E12 Series	1Ω-10M	£0.02 Each, £0.95 per 100
2.5W Wirewound 5%	E12 Series	0Ω1-220Ω	£0.23 Each

1W & 2W Carbon Film in stock - selected values only, contact sales dept. for details.

Preset Resistors - Please State Value Required

Enclosed, 10mm Square Horz / Vert.	100Ω - 1M0 0.15W	£0.15 Each
Skeleton, 10mm Dia. Horizontal.	100Ω - 1M0 0.1W	£0.11 Each
Sub-min, 6mm Dia. Horizontal	E3 200Ω-1M0 0.1W	£0.19 Each
Multiturn, 10mm Square, Top Adjust.	E3 100Ω-1M0 0.5W	£0.89 Each
Multiturn, 19mm Long, End Adjust.	E3 50Ω-1M0 0.5W	£0.60 Each

Potentiometers - Please State Value Required

Single Gang ¼" Shaft, 25mm Dia.	470Ω-2M2 Linear	£0.49 Each
Single Gang ¼" Shaft, 25mm Dia. 4k7,10k,47k,100k,1M,2M2 Log		£0.49 Each
Dual Gang ¼" Shaft, 20mm Dia.	1K0-2M2 Linear	£1.62 Each
Dual Gang ¼" Shaft, 20mm Dia.	1K0-2M2 Logarithmic	£1.71 Each
Switched ¼" Shaft, 20mm Dia.	1K0-2M2 Linear	£1.56 Each
Switched ¼" Shaft, 20mm Dia.	1K0-2M2 Logarithmic	£1.69 Each
PCB Mount, Splined Shaft, 16mm Dia.	470Ω-1M0 Linear	£0.42 Each
PCB Mount, Splined Shaft, 16mm Dia.	470Ω,4k7,100k,1M0 Log	£0.42 Each
Dual PCB, Splined Shaft, 16mm Dia.	10k,50k100k,500k Lin	£0.85 Each
Dual PCB, Splined Shaft, 16mm Dia.	10k,50k,100k,500k Log	£0.85 Each

EVERYDAY
PRACTICAL
ELECTRONICS

VOL. 28 No. 2 FEBRUARY '99

Editorial Offices:
EVERYDAY PRACTICAL ELECTRONICS EDITORIAL
ALLEN HOUSE, EAST BOROUGH, WIMBORNE
DORSET BH21 1PF
Phone: Wimborne (01202) 881749
Fax: (01202) 841692. **Due to the cost we cannot reply to overseas orders or queries by Fax.**
E-mail: editorial@epemag.wimborne.co.uk
Web Site: http://www.epemag.wimborne.co.uk
See notes on **Readers' Enquiries** below – we regret lengthy technical enquiries cannot be answered over the telephone.
Advertisement Offices:
EVERYDAY PRACTICAL ELECTRONICS
ADVERTISEMENTS
MILL LODGE, MILL LANE
THORPE-LE-SOKEN, ESSEX CO16 0ED
Phone/Fax: (01255) 861161

EELONGATED LOGO

With the merger of *Everyday Electronics* and *Practical Electronics* back in November 1992 we have been saddled with the cumbersome title of *Everyday Practical Electronics*. Whilst it was *EE* that bought out *PE*, the *PE* title had a longer history and many loyal readers, so we wanted to keep both names. Over the years there have been a number of editorial discussions on whether or not we should change it to something rather less of a mouthful – it doesn't roll off the tongue, does it? We have never actually reached a decision on this so things were simply left alone. However, I guess we are about to be forced into making a move quite soon.

Why? Because we have just purchased *Electronics Today International (ETI)* and from next month we will be merging that into *EPE*. For at least a few months you will be seeing both the *EPE* and *ETI* logos on our front cover, and elsewhere through the magazine, but it will clearly be silly to call ourselves "Everyday Practical Electronics and Electronics Today International", or even EPETI so perhaps we could go for some shorter combination – your suggestions would be of interest.

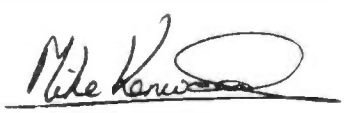
Personally, I favour dropping back to just the initials of *EPE*, perhaps with the word International underneath – maybe we could use a dynamic new logo like the one for *EPE Online* – see page 129. Or perhaps we should become EPEI, or PEI, or EEI or even EPEI – the list goes on.

CHANGE BUT NO CHANGE

One thing all this does mean is that your copy of *EPE* will *not* change dramatically – you will still find all the regular news, features, projects, theory and help that we bring you each month; although you will probably notice a couple of small changes to titles of things like our *Innovations* pages or *Techniques*, just to make sure those readers coming to us from *ETI* feel at home. We also hope to add to our range of advertisers so that there will be a greater selection of things to buy in each issue. In fact all that will happen is that *EPE* will become an even stronger magazine with the ability to bring you even better projects and features.

We will, of course, go on packing every page full of information and bringing you the widest range of full constructional projects plus news, features, theory, etc. and not forgetting all our regulars like *IU*, *Circuit Surgery*, *Techniques*, *Readout*, *News* and *Network*.

Make sure you don't miss out on your copy. We suggest you place an **order now** as demand is bound to be very high. Details of the content of the March issue can be found on page 75. Don't worry, we won't be putting up the price of your magazine.



AVAILABILITY

Copies of *EPE* are available on subscription anywhere in the world (see right), from all UK newsagents (distributed by Seymour) and from the following UK electronic component retailers: Maplin – all stores throughout the UK (and in S. Africa); Greenweld Electronics; Omni Electronics. *EPE* can also be purchased from retail magazine outlets around the world. An on-line version can be purchased from **www.epemag.com**

SUBSCRIPTIONS

Annual subscriptions for delivery direct to any address in the UK: £26.50. Overseas: £32.50 standard air service, £50 express airmail. Cheques or bank drafts (**in £ sterling only**) payable to *Everyday Practical Electronics* and sent to EPE Subscriptions Dept., Allen House, East Borough, Wimborne, Dorset BH21 1PF. Tel: 01202 881749. Fax: 01202 841692. **E-mail:** subs@epemag.wimborne.co.uk. Subscriptions start with the next available issue. We accept MasterCard or Visa. (For past issues see the *Back Issues* page.)

BINDERS

Binders to hold one volume (12 issues) are available from the above address. These are finished in blue p.v.c., printed with the magazine logo in gold on the spine. Price £5.95 plus £3.50 post and packing (for overseas readers the postage is £6.00 to everywhere except Australia and Papua New Guinea which cost £10.50). *Normally sent within seven days but please allow 28 days for delivery – more for overseas orders.*

Payment in £ sterling only please. Visa and MasterCard accepted, minimum credit card order £5. Send, fax or phone your card number and card expiry date with your name, address etc. Or order on our* secure server *via our web site. Overseas customers – your credit card will be charged by the card provider in your local currency at the existing exchange rate.

Editor: MIKE KENWARD
Secretary: PAM BROWN
Deputy Editor: DAVID BARRINGTON
Technical Editor: JOHN BECKER
On-Line Editor: ALAN WINSTANLEY
Business Manager: DAVID J. LEAVER
Subscriptions: MARILYN GOLDBERG
Editorial: Wimborne (01202) 881749
Advertisement Manager:
PETER J. MEW, Frinton (01255) 861161
Advertisement Copy Controller:
PETER SHERIDAN, Wimborne (01202) 882299

READERS' ENQUIRIES

E-mail: techdept@epemag.wimborne.co.uk
We are unable to offer any advice on the use, purchase, repair or modification of commercial equipment or the incorporation or modification of designs published in the magazine. We regret that we cannot provide data or answer queries on articles or projects that are more than five years old. Letters requiring a personal reply *must* be accompanied by a **stamped self-addressed envelope or a self-addressed envelope and international reply coupons. Due to the cost we cannot reply to overseas queries by Fax.**

All reasonable precautions are taken to ensure that the advice and data given to readers is reliable. We cannot, however, guarantee it and we cannot accept legal responsibility for it.

COMPONENT SUPPLIES

We do not supply electronic components or kits for building the projects featured, these can be supplied by advertisers (see *Shoptalk*).

We advise readers to check that all parts are still available before commencing any project in a back-dated issue.

ADVERTISEMENTS

E-mail: adverts@epemag.wimborne.co.uk
Although the proprietors and staff of EVERYDAY PRACTICAL ELECTRONICS take reasonable precautions to protect the interests of readers by ensuring as far as practicable that advertisements are *bona fide*, the magazine and its Publishers cannot give any undertakings in respect of statements or claims made by advertisers, whether these advertisements are printed as part of the magazine, or in inserts.

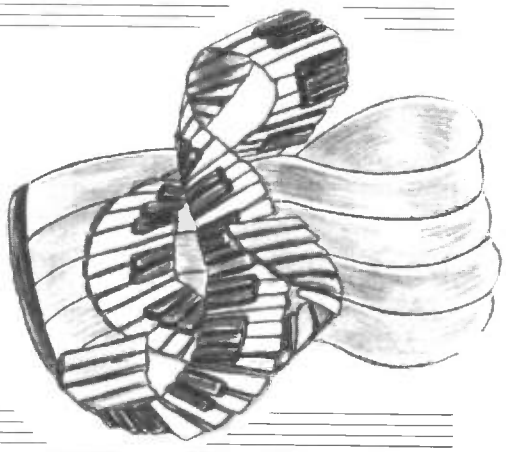
The Publishers regret that under no circumstances will the magazine accept liability for non-receipt of goods ordered, or for late delivery, or for faults in manufacture. Legal remedies are available in respect of some of these circumstances, and readers who have complaints should first address them to the advertiser.

TRANSMITTERS/BUGS/TELEPHONE EQUIPMENT

We advise readers that certain items of radio transmitting and telephone equipment which may be advertised in our pages cannot be legally used in the UK. Readers should check the law before buying any transmitting or telephone equipment as a fine, confiscation of equipment and/or imprisonment can result from illegal use or ownership. The laws vary from country to country; overseas readers should check local laws.

Constructional Project

PIC MIDI SUSTAIN PEDAL



ROBERT PENFOLD

Take your PIC from sustain to glissando effect with this low-cost MIDI pedal.

IN THE pre-MIDI era it was common for synthesisers, electronic pianos, etc. to have a socket for a pedal-operated switch. The footswitch normally functioned as a sustain pedal, with the last note or notes played being held on for as long as the pedal was operated.

This is similar to, but not quite the same as the sustain pedal of a piano. A few instruments had sockets for other types of pedal, or could switch the single pedal input to a different function.

VERSATILE PIC

In the post MIDI era this type of input is virtually extinct, and functions such as sustain and swell pedals are handled via the MIDI input. This offers great versatility, and in many ways is a step forward, but it brings a major drawback in that simple switches are no longer sufficient. In order to add even simple pedal functions such as sustain and portamento it is necessary to have some fairly complex and expensive electronics to produce the proper signals to drive a MIDI input.

This problem has now been mitigated to a large extent by the availability of inexpensive microcontrollers such as the PIC range of processors. A MIDI Sustain Pedal was described in the May 1995 issue of *EPE*, and this used a UART plus 10 other integrated circuits.

The PIC based design featured here can be switched to operate as either a Sustain Pedal or a Portamento type, and uses no integrated circuits other than the PIC microcontroller itself. Unlike its predecessor, this unit uses so few components that it is suitable for those having limited experience at electronic project construction, including complete beginners.

MIDI BASICS

MIDI (Musical Instruments Digital Interface) is a form of serial signal, and it is in many ways similar to the ordinary RS232C system used in computing and other applications. It is different to the RS232C system in several respects though, and one of these is the nature of the signals generated.

The RS232C system uses voltages of about plus and minus 12V to represent the two logic levels, whereas MIDI utilizes a current loop system. A switching transistor at the output of a sending device is switched off to represent logic 1, and turned on to represent logic 0. MIDI uses normal eight-bit bytes, and each byte is sent one bit at a time.

TIMING

The use of standard baud rates is the main aid to accurate synchronisation. MIDI operates at 31250 baud, which simply means that a continuous stream of signals would be sent at a rate of 31250 bits per second. This rate may seem to be an odd choice, but it is easily implemented using standard 1MHz, 2MHz, and 4MHz crystals in the clock oscillator (1MHz divided by 32 = 31250Hz).

There is another aid to accurate synchronisation in the form of additional bits sent with each byte of data. The most important of these is the *Start bit*.

Under standby conditions the output transistor is switched off, but to indicate the start of a byte it is switched on for a duration that is equal to the length of one data bit (31·25ms). This indicates to the receiving device that it must read in the first data bit about 46·87µs later, which is about half way through the first data bit.

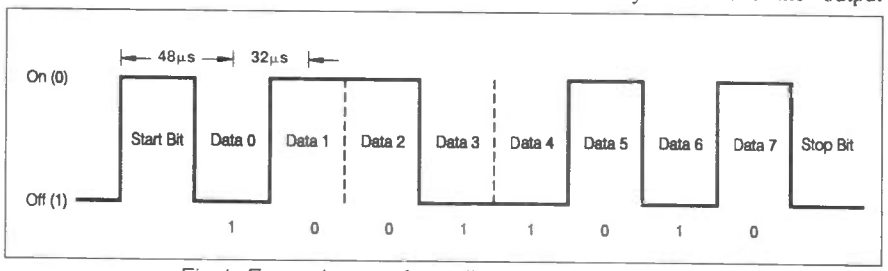
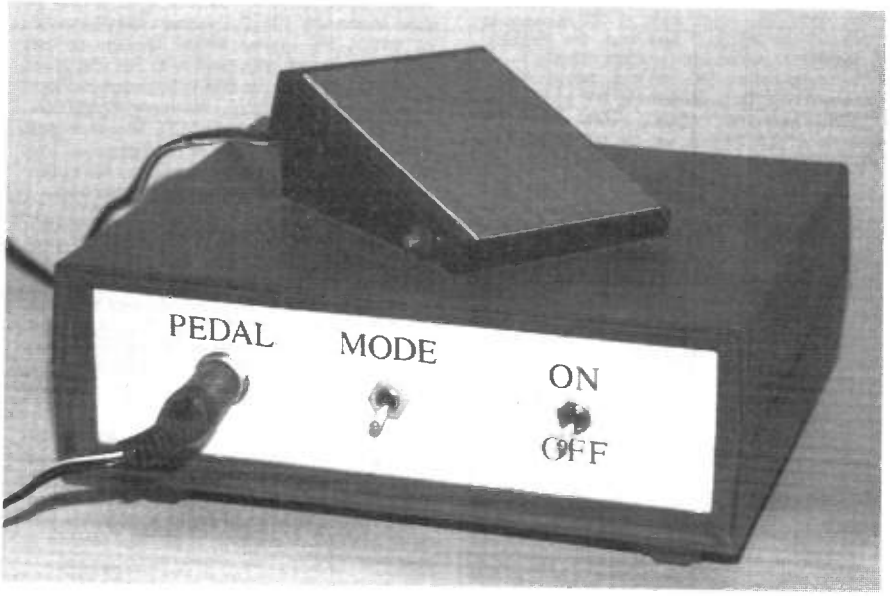


Fig.1. Example waveform diagram for a MIDI byte.

With this serial approach to exchanging signals it is essential that the transmitting and sending devices remain accurately synchronised. Otherwise the receiving device will be reading bit 5 when the transmitting device is actually sending bit 4 or 6!



The other data bits are then read in at 31·25µs intervals. The least significant bit is sent first, working through to the most significant bit.

Finally, the Stop bit is sent, but this is really just placing a small gap between the end of one byte and the beginning of the next. This gives the receiving device time to digest one byte of data before the next is commenced. This general scheme of things is demonstrated by the example waveform of Fig.1.

GETTING THE MESSAGE

Normal MIDI messages are coded into one, two, or three bytes, and in this case we are using control change messages that have three bytes. The first byte is the Status byte, and this has to be considered as two nibbles, which have separate functions.

The four most significant bits indicate the type of message that is being sent. In this case the message is a control change type, and this has the binary code 1011.

The least significant nibble carries the channel number, and is from 0000 (channel 1) to 1111 (channel 16). In an application of this type the channel used is not usually of any significance, and the convention is for channel 1 to be used.

The second byte carries the control number, and indicates which control must be altered. MIDI status bytes always have the most significant bit set at 1, while data bytes have this bit set to 0. This means that data bytes can only contain values from 0 to 127 (decimal).

Most of the available control numbers have been assigned to specific controls or to special functions. Here we are controlling the sustain and portamento functions, which are respectively control numbers 64 and 63.

The third byte carries the new setting for the control, and under the old scheme of things it could only be 0 (off) or 127 (on). The current system is more easy-going, with values from 0 to 63 switching a control off, and values from 64 to 127 switching it on.

As there is a large amount of MIDI equipment still in use that predates the current MIDI specification, it is essential to use values of 127 to switch on a control and 0 to turn it off.

In order to give the desired effect the PIC MIDI Sustain Pedal must generate a three byte message to switch on the Sustain or Portamento function, and a slightly different message when the pedal is released in order to switch it off again. The three byte message required to switch ON the sustain effect (top), and the slightly different message needed to switch it OFF is shown in Fig.2. The only difference is that the final byte is 127 in the first message, and 0 in the second.

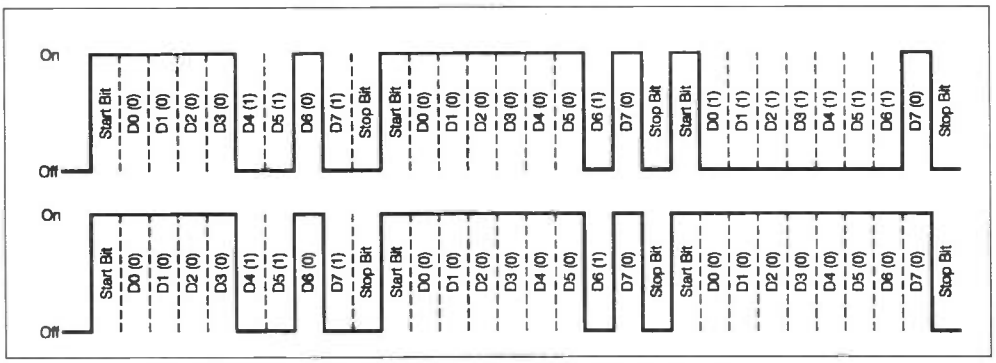


Fig.2. MIDI sustain ON (top) and sustain OFF (bottom) messages.

CIRCUIT OPERATION

The circuit diagram for the PIC MIDI Sustain Pedal is shown in Fig.3. The circuit is based on a PIC16C54 microcontroller, IC1, and in order to guarantee the accurate timing required in this application a crystal controlled clock circuit, formed by capacitors C2, C3 and crystal X1, is used. A 4MHz clock frequency is the maximum that the 16C54-XT/P can handle, but is more than adequate to give good timing accuracy.

Only two lines of port B are used, and these monitor switches S1 and S2. S1 is the Pedal footswitch and it is monitored by RB0, at IC1 pin 6. Line RB1, at IC1 pin 7, monitors S2, which is the Mode switch.

The output signal is generated on RA0 (IC1 pin 17), which drives the common emitter switching transistor TR1. This transistor drives the internal l.e.d. in an opto-isolator at the input of the receiving device. This opto-isolation helps to avoid problems with earth loops, and also reduces problems with digital noise finding its way into the audio stages of MIDI instruments.

The screen of the connecting cable connects to pin 2 of SK2, and it is therefore earthed to the 0V supply of the Pedal Unit. However, it is *not* connected to anything at the receiving unit, and there is no direct electrical connection between the Pedal Unit and the MIDI device that it controls. Resistors R4 and R5 provide current limiting d.c. points that, together with a resistor in the receiving device, set the l.e.d. current at approximately the required figure of 5mA.

A supply potential of about 4V to 5V is required, and a 4·5V battery pack is probably the most practical power source. Even though a relatively high clock frequency of 4MHz is used, the current consumption of the circuit is typically just under 2mA, which should give around 1000 to 2000 hours of operation from each AA-cell battery pack.

SOFTWARE

As with many PIC based projects, the hardware is ridiculously simple because the software is doing most of the work. Only a brief operating description follows, but the software is available from the Editorial Office on a 3·5in. disk, see *PCB Service* page. If you have access to the Internet it can be downloaded free. See *Shoptalk* page for details of obtaining a ready-programmed PIC16C54-XT/P microcontroller.

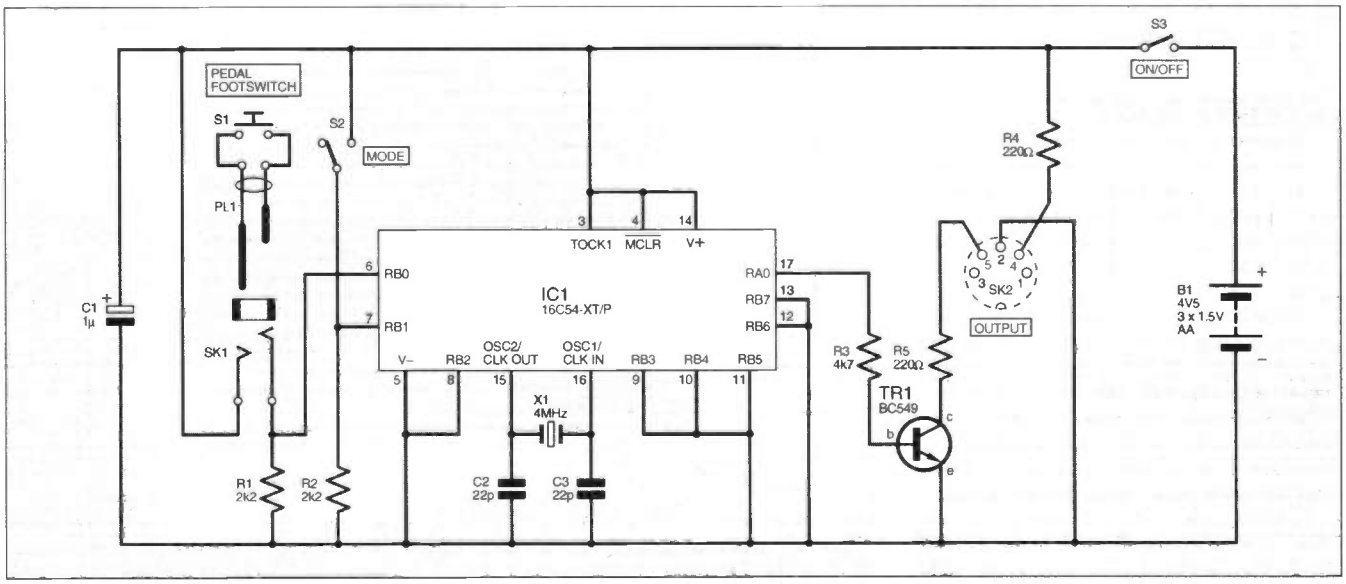


Fig.3. Full circuit diagram for the PIC MIDI Sustain Pedal.

MAIN LOOP

The main program loop monitors Pedal switch S1, and calls a series of three subroutines when S1 is pressed. These subroutines each generate one byte of the message that switches on the appropriate control. There is a slight complication here, because the control number used in the message must be 63 or 64 (Portamento or Sustain), depending on the setting of Mode switch S2.

The simple solution is to include both subroutines in the main loop, but with each one preceded by a bit test instruction that results in the subroutine being skipped if switch S2 is at the wrong setting. This results in a control number of 63 being used if S2 is *open*, or a control number of 64 being used if it is *closed*.

Once the three subroutines have been called and the "control on" message has been sent, switch S1 is monitored again. There is no need for a delay here to provide contact de-bouncing, because this is effectively provided by the millisecond or so that it takes to send the first MIDI message.

CONTROL OFF

When S1 is released, the main loop calls three subroutines that generate the "control off" message. This operates in exactly the same manner as before, but a different subroutine is used for the third byte.

This generates a data byte containing a value of 0 rather than 127, so that the control is switched off instead of being switched on. The program then loops back to the beginning and monitors S1 again.

The subroutines generate the serial bytes using the same basic process. A bit set or bit clear instruction is used to set RA0 high or low, as required, and a simple delay loop then provides a suitable delay before the next bit is generated. This process is repeated ten times, once for each bit (eight data bits plus start and stop bits).

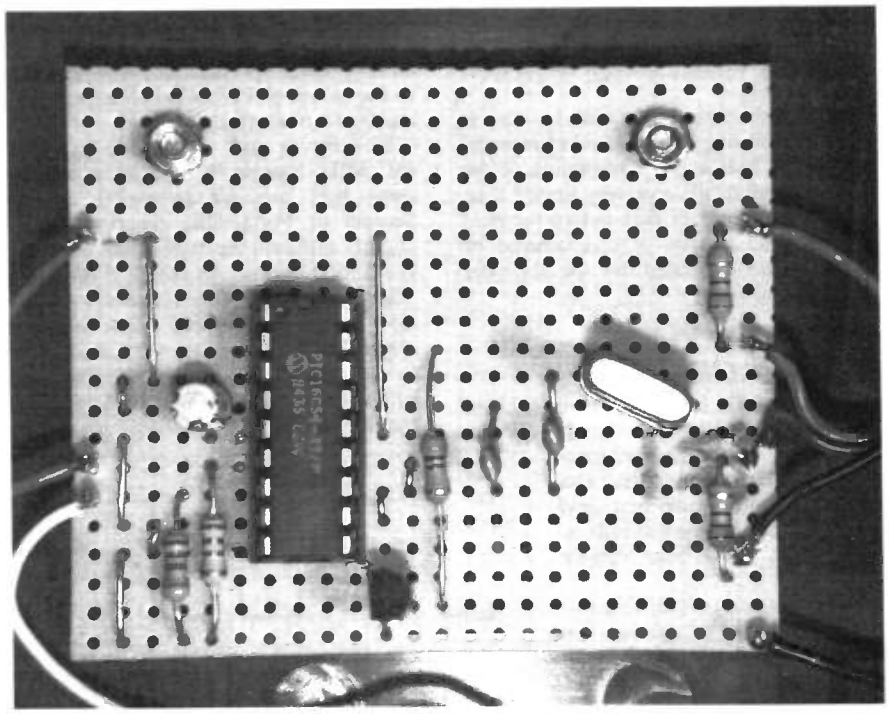
Although it is a rather long-winded way of handling things, this method does make it easy for the experimenter to change the value of any bit in any byte. It is merely necessary to change the appropriate BSF message to a BCF type, or vice versa.

CONSTRUCTION

Details of the stripboard component layout and the hard wiring are provided in Fig.4. The underside view of the board showing the required breaks in the copper strips also appears in this diagram. The board measures 24 holes by 20 copper strips.

With very few components and link-wires to deal with, construction of the board is quite simple. However, bear in mind that the PIC microcontroller is a CMOS device, and that it therefore requires the usual anti-static handling precautions. It must be fitted in a d.i.l. socket and not soldered directly into the board.

Do not plug it into its socket until the unit is complete in all other respects, and try to handle the pins as little as possible when plugging it into the holder. The PIC chip should be stored in its anti-static packing and kept well away from any potential sources of static electricity. Crystal X1 must be a miniature wire-ended type if it is to fit easily into this layout.



Layout of components on the completed stripboard. Make sure you include the four very small link wires.

ASSEMBLY

This unit can take one of two general forms. The obvious approach is to build it as a sort of pseudo effects pedal, complete with a built-in foot-operated switch on the top panel.

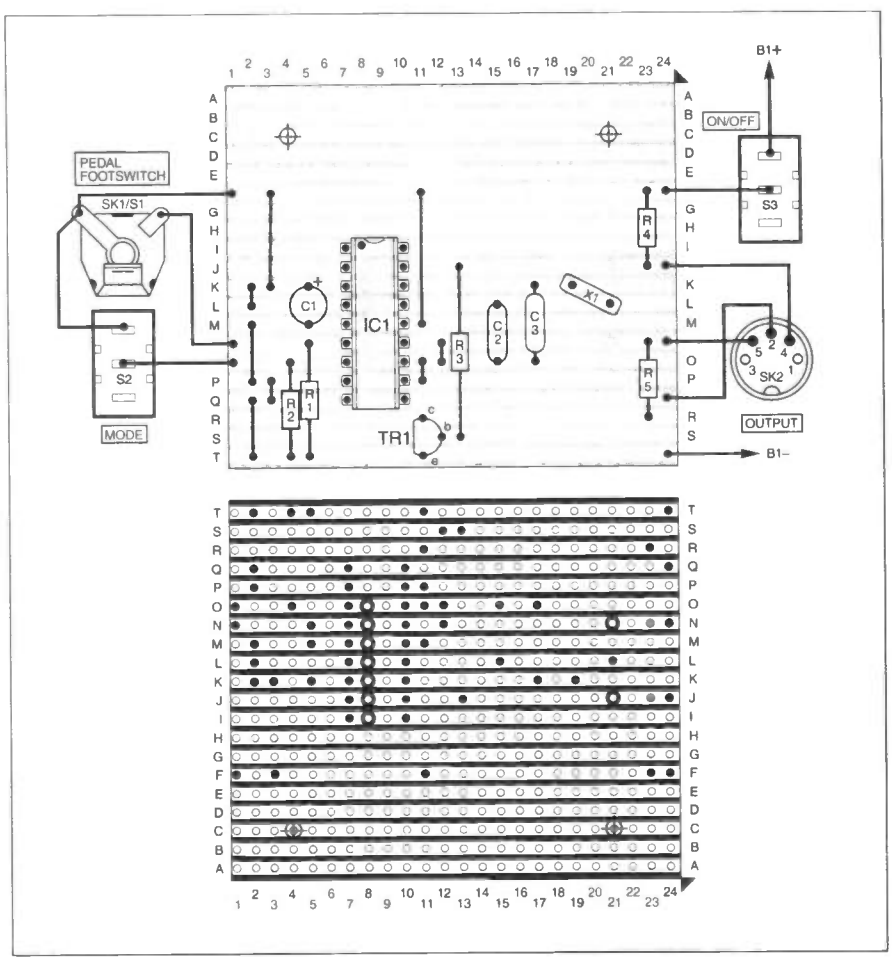


Fig.4. Stripboard topside component layout, interwiring to off-board components and underside view of the copper tracks showing locations of breaks required in the strips.

COMPONENTS

Resistors

R1, R2	2k2 (2 off)	See SHOP TALK Page
R3	4k7	
R4, R5	220Ω (2 off)	
All 0·25W 5% carbon film		

Capacitors

C1	1μ radial elect. 50V
C2, C3	22p ceramic plate (2 off)

Semiconductors

TR1	BC549 *npn* silicon transistor
IC1	PIC16C54-XT/P pre-programmed microcontroller (see text)

Miscellaneous

S1	foot-operated or pushbutton switch; push-to-make, release-to-break (see text)
S2, S3	s.p.s.t. min toggle switch (2 off)
SK1	standard mono jack socket, with matching plug (see text)
SK2	5-way 180° panel mounting DIN socket
B1	4·5V battery pack (3 x AA size cells in holder)
X1	4MHz miniature wire-ended crystal

Metal case, type and size to choice (see text); 0·1 inch matrix stripboard, measuring 24 holes by 20 strips; 18-pin d.i.l. socket; battery connector (PP3 type); MIDI lead; multistrand connecting wire; solder pins; solder, etc.

Approx Cost Guidance Only **£14**

excl. case, pedal switch & batts.

If you take this route it is essential to use a suitably strong case. A die-cast aluminium box is a popular choice for this type of thing, and cases of this type are very tough indeed.

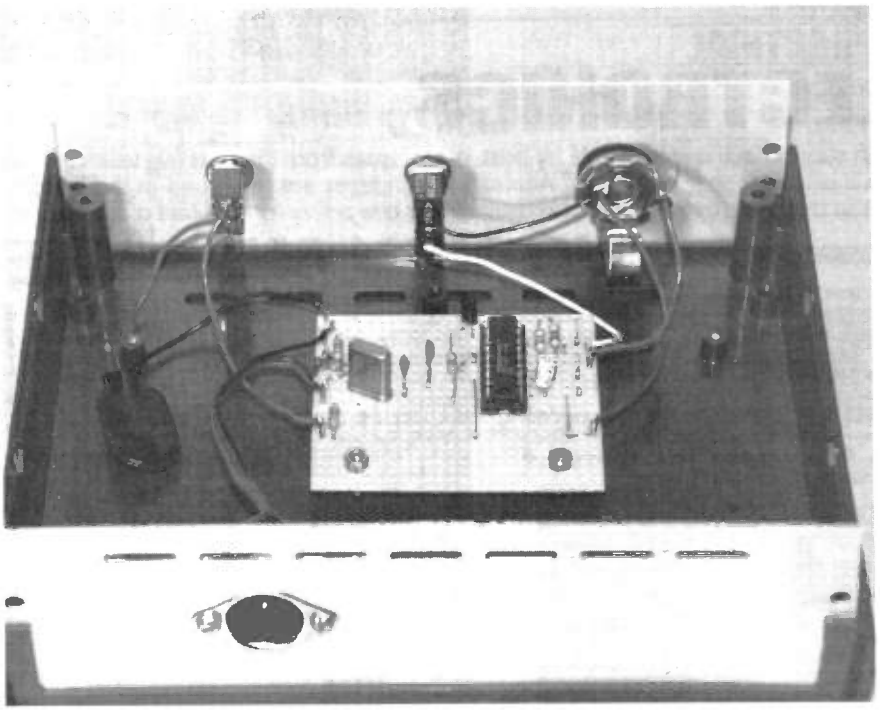
A simple folded aluminium box should be strong enough though, and represents a much cheaper alternative. Most plastic cases are not well suited to this application.

FOOTSWITCH

The switch used for S1 must be a fairly tough component having a large button that can be easily operated by foot. A small pushbutton switch of the "cheap and cheerful" variety would be very difficult to operate and would probably not stand up to the rough treatment likely to occur in this application. It must be a simple push-to-make, release-to-break type, and not one that toggles state each time it is operated.

The popular alternative approach, and the one used for the prototype, is to build the unit as a conventional project, and to use a separate "custom" pedal switch for S1. Switches of this type are usually fitted with a lead about one metre long terminated in a standard jack plug.

Therefore, if this method is used, a standard jack socket is fitted to the case and connected in place of S1, as shown in Fig.4. Again, the switch used for S1 must have a simple push/release action, and not some form of successive operation.



Positioning of the circuit board inside the prototype metal instrument case and wiring to the front panel mounted switches and "pedal" jack socket. The MIDI 5-way DIN connector is mounted on the rear panel.

IN USE

Using a crystal controlled clock avoids the need for any setting up. Provided socket SK2 is a 5-way (180 degree) DIN socket connected in the manner shown in Fig.4, the unit can be connected to the synthesiser or other MIDI instrument using a standard MIDI lead.

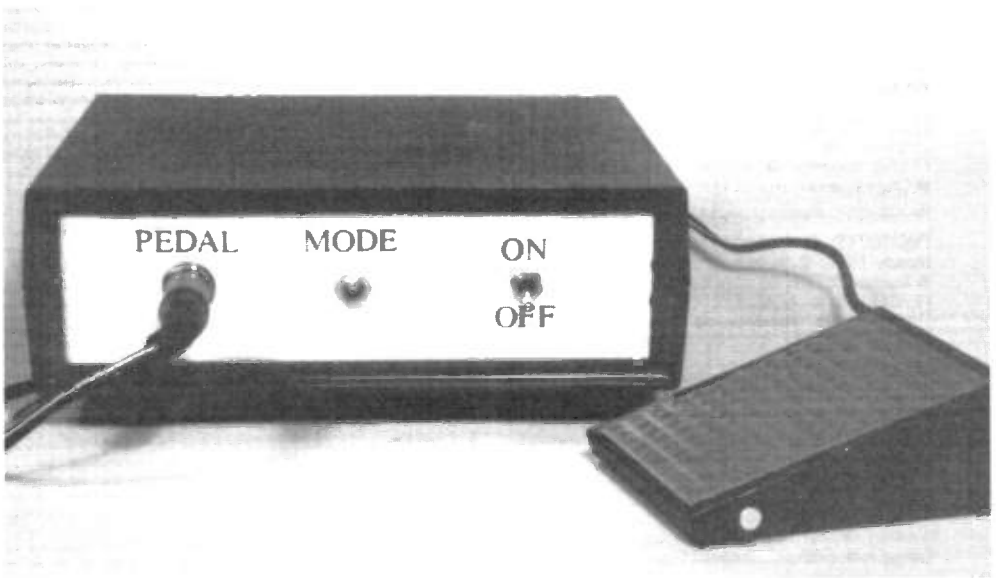
This has so-called straight connection, with pin 2 on one plug connecting to pin 2 on the other, pin 4 connecting to pin 4, and pin 5 connecting to pin 5. Note that some 5-way DIN audio leads have cross coupling of the pins, and that they are unsuitable for use with MIDI equipment.

It is probably best to start with the Sustain effect (S2 open), as this one is implemented by most MIDI instruments. Notes should hold on indefinitely with S1 pressed, but the MIDI instrument will only respond properly if it is set up correctly. Where appropriate, the MIDI interface must be enabled, and the instrument must either be set to receive on channel 1 or set to Omni mode so that it will respond to messages on any channel.

With the unit switched to the Portamento mode (S1 closed) the instrument will "glide" from one note to the next giving a glissando effect, rather than jumping in pitch from one note to the next. Unfortunately, this control is not implemented on many instruments.

A check of the MIDI implementation charts for your instruments will show which particular control numbers are implemented. There is obviously no point in building this project unless at least one of your instruments responds to control number 63 or 64.

Completed PIC MIDI Sustain Pedal with a typical pedal type footswitch plugged into the front panel jack socket.



EVERYDAY PRACTICAL ELECTRONICS

BACK ISSUES

We can supply back issues of *EPE* by post, most issues from the past five years are available. An index for the last five years is also available – see order form. Alternatively, indexes are published in the December issue for that year. Where we are unable to provide a back issue a photostat of any *one article* (or *one part* of a series) can be purchased for the same price.

DID YOU MISS THESE?

SEPT '97

PROJECTS ● PIC-Noughts & Crosses Game ● Ironing Safety Device ● Active Receiving Antenna ● Soldering Iron Controller ● Micropower PIR Detector – 3.
FEATURES ● Ingenuity Unlimited ● Raising the Pressure – RC4190 Switch-Mode I.C. ● Circuit Surgery ● Techniques – Actually Doing It ● Great Experimenters – 5 ● Net Work.

OCT '97

PROJECTS ●PIC Water Descaler ● Remote Control Finder ● Multi-Station Quiz Monitor ● Rechargeable Handlamp.
FEATURES ● Ingenuity Unlimited ● It's Probably Murphy's Law ● Interface ● Circuit Surgery ● Kanda PIC Explorer Review ● Network

NOV '97

PROJECTS ● Portable 12V PSU/Charger ● Case Alarm ● Auto-Dim Bedlight ● *EPE* Time Machine.
FEATURES ● Satellite Celebration ● Ingenuity Unlimited ● TEACH-IN '98 – An Introduction to Digital Electronics–1 ● Techniques – Actually Doing It ● Circuit Surgery ● Net Work ● Free Greenweld Catalogue.

DEC '97

PROJECTS ● Safe and Sound – Security Bleeper ● Active Microphone ● Car Immobiliser ● Mini Organ.
FEATURES ● TEACH-IN '98 – An Introduction to Digital Electronics–2 ● Circuit Surgery ● Interface ● B² Spice Review ● Ingenuity Unlimited ● Alternative and Future Technologies–1 ● Net Work – The Internet ● *Free* Giant Data Chart – Formulae.

JAN '98

PROJECTS ● Disco Lights Flasher ● Simple M.W. Radio ● EPE Virtual Scope–1 ● Surface Thermometer.
FEATURES ● TEACH-IN '98 – An Introduction to Digital Electronics–3 ● Circuit Surgery ● Ingenuity Unlimited ● Alternative and Future Technologies–2 ● Net Work – The Internet ● *Free* – Giant PIC Data Chart.

FEB '98

PROJECTS ● Water Wizard ● Kissometer ● Waa-Waa Effects Pedal ● EPE Virtual Scope – 2.
FEATURES ● TEACH-IN '98 – 4 ● Ingenuity Unlimited ● Techniques–Actually Doing It ● Circuit Surgery ● Net Work – The Internet ● Chip Special – HT7630 PIR Controller.

MAR '98 Photostats Only

PROJECTS ● Lighting-Up Reminder ● The Handy Thing ● Switch-Activated Burglar Alarm ● Audio System Remote Controller.
FEATURES ● TEACH-IN '98 – 5 ● Ingenuity Unlimited ● Interface ● Stripboard Magic Review ● Circuit Surgery ● Net Work ● *EPE* PIC Tutorial Supplement 1

APRIL '98

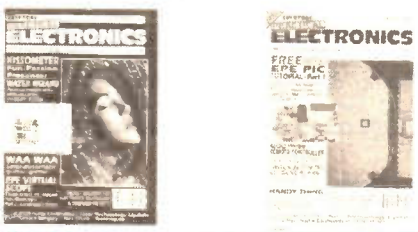
PROJECTS ● Simple Metal Detector ● Single or Dual Tracking Power Supply ● Experimental Piezo-Cable Projects – Distributed Microphone – Vibration Alarm ● RC-Meter.
FEATURES ● Ingenuity Unlimited ● Patent Your Invention ● TEACH-IN '98 – 6 ● Circuit Surgery ● Net Work ● Techniques – Actually Doing It ● *EPE* PIC Tutorial Supplement 2

MAY '98

PROJECTS ● Dice Lott ● Security Auto-Light ● Stereo Tone Control plus 20W Stereo Amplifier ● Improved Infra-Red Remote Repeater.
FEATURES ● TEACH-IN '98 – 7 ● Net Work ● *EPE* PIC Tutorial Supplement 3

JUNE '98

PROJECTS ● EPE Mood Changer ● Simple SW Receiver ● Atmel AT89C2051/1051 Programmer ● Reaction Timer.
FEATURES ● 8051-based EEPROM Microcontrollers ● TEACH-IN '98 – An Introduction to Digital Electronics – 8 ● Circuit Surgery ● Techniques – Actually Doing It ● Ingenuity Unlimited



JULY '98

PROJECTS ● PIC16x84 Toolkit ● Noise Cancelling Unit ● Low Battery Indicator ● Greenhouse Computer – 1.
FEATURES ● Using the L200CV Voltage Regulator ● TEACH-IN '98 – 9 ● Ingenuity Unlimited ● Circuit Surgery ● Net Work.

AUG '98

PROJECTS ● Lightbulb Saver ● Float Charger ● PC Transistor Tester ● Greenhouse Computer – 2 ● Time Machine Update.
FEATURES ● TEACH-IN '98 – 10 ● Circuit Surgery ● Techniques – Actually Doing It ● Ingenuity Unlimited ● New Technology Update ● Net Work ● IVEX PCB Cad Review.

SEPT '98

PROJECTS ● Mains Socket Tester ● Personal Stereo Amplifier ● Greenhouse Radio Link ● PIC Altimeter.
FEATURES ● TEACH-IN '98 – 11 ● Ingenuity Unlimited ● Circuit Surgery ● Interface ● Net Work ● Crocodile Clips Review.

OCT '98

PROJECTS ● Voice Processor ● Digiserv R/C Channel Expander ● Reliable Infra-Red Remote Control ● PC Capacitance Meter.
FEATURES ● Easy PCB Making ● Using LM335 and LM35 Temperature Sensors ● Circuit Surgery ● Ingenuity Unlimited ● Net Work ● Electronics Principles 5.0 Review.

NOV '98

PROJECTS ● PIC Tape Measure ● T-Stat Electronic Thermostat – 1 ● PhizzyB Computers – 1 ● 15-way Infra-Red Remote Control.
FEATURES ● Circuit Surgery ● Ingenuity Unlimited ● New Technology Update ● Net Work – The Internet ● Easy PC for Windows 95 Review ● *FREE* EPE CD-ROM No.1.

DEC '98

PROJECTS ● EPE Mind PICkler–1 ● Fading Christmas Lights ● Handheld Function Generator ● Damp Stat Electronic Thermostat ● PhizzyB Computers–2.
FEATURES ● PhizzyB Computers–2 Understanding Computers ● Circuit Surgery ● Ingenuity Unlimited ● Interface ● Net Work – The Internet ● 1998 Index ● *FREE* 48-page Understanding Passive Components booklet.

JAN '99

PROJECTS ● Alternative Courtesy Light Controller ● Twinkle Twinkle Reaction Game ● Volume Compressor ● PhizzyB Computers–3 ● EPE Mind PICkler–2.
FEATURES ● New Technology Update ● From Russia With Love ● Circuit Surgery ● PhizzyB Computers–3 ● Net Work.

BACK ISSUES ONLY £2.75 each inc. UK p&p.
Overseas prices £3.35 each surface mail, £4.35 each airmail.

We can also supply issues from earlier years: 1990 (**except** Jan., March, April, Oct. and Dec.), 1991 (**except** May, June, Aug., Sept. and Nov.), 1992 (**except** April and Dec.), 1993 (**except** Jan. to May and Dec.), 1994 (**except** April, May, June and Nov.), 1995 (**except** Jan., March, May, June, July, Aug., Sept., Nov. and Dec.), 1996 (**except** Feb., April, May, July, Aug., Nov.), 1997.
Please note we are not able to supply copies (or 'stats of articles) of *Practical Electronics* prior to the merger of the two magazines in November 1992.
Where we do not have an issue a photostat of any *one article* or *one part* of a series can be provided at the same price.

ORDER FORM – BACK ISSUES – PHOTOSTATS – INDEXES

☐ Send back issues dated .....

☐ Send photostats of (article title and issue date) .....

☐ Send copies of last five years indexes (£2.75 for five inc. p&p – Overseas £3.35 surface, £4.35 airmail)

Name .....

Address .....

.....

☐ I enclose cheque/P.O./bank draft to the value of £.....

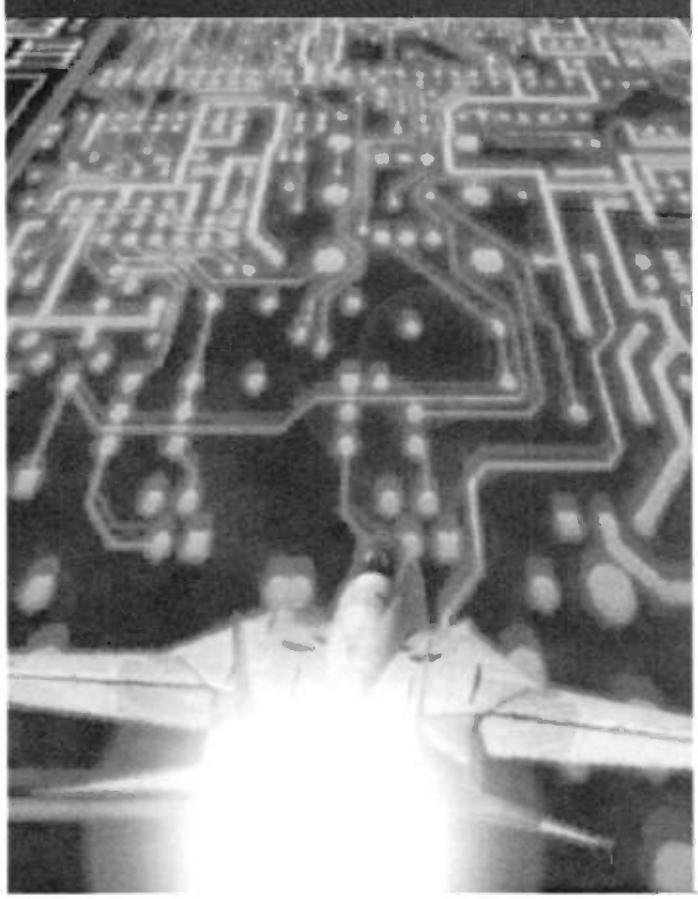
☐ Please charge my Visa/Mastercard £.....

Card No. ..... Card Expiry Date .....

Note: Minimum order for credit cards £5. Please supply name and address of cardholder if different from that shown above.
SEND TO: **Everyday Practical Electronics, Allen House, East Borough, Wimborne, Dorset BH21 1PF.**
Tel: 01202 881749. Fax: 01202 841692. (Due to the cost we cannot reply to overseas queries or orders by Fax.)
E-mail: orders@epemag.wimborne.co.uk
Payments must be in £ sterling – cheque or bank draft drawn on a UK bank. Normally supplied within seven days of receipt of order.
Send a copy of this form, or order by letter if you do not wish to cut your issue. M2/99

QUICKROUTE

THE QUICKROUTE



Simulation Circuit Capture PCB Autorouting CADCAM

Imagine an electronics design system that lets you draw schematics onto the screen and then simulate them at the touch of a button. Now imagine pressing another button and seeing the schematic replaced with a PCB rats-nest. Pressing another button starts the autorouter, and finally you can click on File then Save As to create a complete set of CADCAM files.

Too easy? We hope so. Quickroute has always been designed first and foremost to be easy to use. That's why simulation, circuit capture, PCB autorouting and CADCAM support are all integrated into **one** package, So that you only have to learn **one** package.

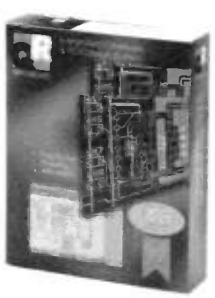
But it doesn't end there. We have included a wide range of features in Quickroute to help you work effectively. For example our Gerber import facility lets you check your CADCAM files before sending them to your manufacturer.

We have also introduced a major new PLUGIN module called the SymbolWizard that actually creates custom symbol designs for you. Simply select a template, specify pad and spacing properties and SymbolWizard creates the schematic and PCB symbols for you!

If you would like to find out more about Quickroute, why not call us on FREEphone 0800 731 28 24, or visit our web site on www.quickroute.co.uk. Prices start at under £100 including UK P&P and VAT for a complete system.

"modern, powerful and easy to use"

Elektor Electronics 97



FREE*phone*

0800 731 28 24

Int +44 161 476 0202 Fax 0161 476 0505
Web www.quickroute.co.uk

30 DAY MONEY BACK GUARANTEE

CAD RECOMMENDED

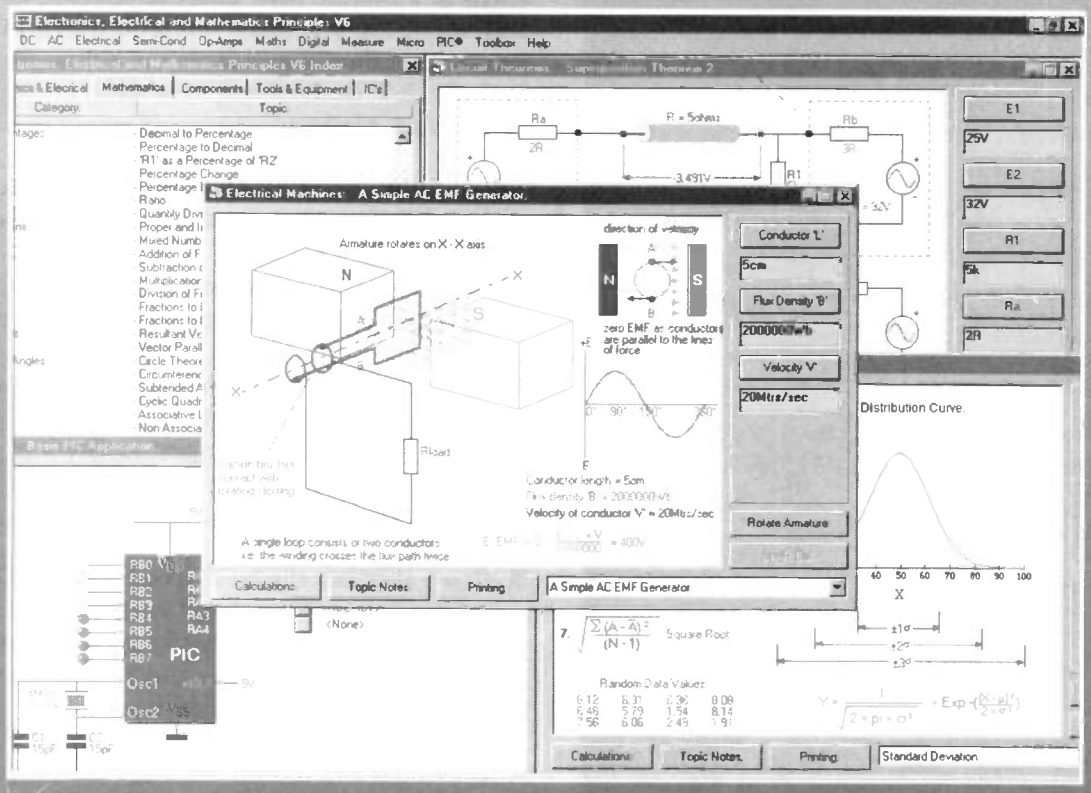
DATA

TEP

Copyright (c) 1998 Quickroute Systems Ltd Regent House Heaton Lane Stockport SK4 1BS UK

Electronics, Electrical & Mathematics Principles V6

If you are looking for an easy and enjoyable way of studying or improving your knowledge of electronics and maths then this is the software for you.



"Electronics Principles is a well thought out and comprehensive program that is also easy to install and stable in operation. It can be wholeheartedly recommended."
Robert Penfold. Everyday Practical Electronics magazine. October 1998.

By Clive W. Humphris.

Currently used in hundreds of UK and overseas schools and colleges to support GCSE, A Level, City and Guilds, BTEC, GNVQ's and University courses.

A COMPLETE PC BASED ELECTRONICS AND MATHEMATICS COURSE, where the colourful interactive graphics make it ideally suited for both personal study and a more enjoyable way of revising.

And now upgraded to V6 a 32-bit package for Windows '95, '98 & NT. It's bigger, faster and better.

Additions include:- Circuit theorems, Norton, Thevenin's & Superposition...Magnetism & Electromagnetism...Motors, Generators & Transformers..Three phase systems....More on complex numbers.....A beginners introduction to PIC's..... Statistics...
PLUS: all the Electronics Toolbox routines, along with an Illustrated Components, Tools & Equipment Dictionary. A total of over 900 main menu selections.

Windows 3.1, 3.11 users please enquire.

Multi-user site licence additional £500*

Complete Package still only £99.95*

EPT Educational Software. Pump House, Lockram Lane, Witham, Essex. UK. CM8 2BJ.
Tel/Fax: 01376 514008. sales@eptsoft.demon.co.uk http://www.eptsoft.demon.co.uk
*UK and EC countries add £2 per order for post & packing. VAT should be added to the total.
Outside Europe £3.50 for air mail postage by return.
Switch, Delta, Visa and Mastercard orders accepted - please give card number and expiry date.
Cheques & Postal Orders should be made payable to EPT Educational software.

Innovations

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

CLOSING THE NET

Barry Fox reports that media moguls now have their eyes on the Net.

RUPERT Murdoch now wants to create his own, closed, Internet. The media magnate's satellite broadcast company BSkyB is working with British Telecom, the Midland Bank and Matsushita (Panasonic) to offer an all-electronic trading infrastructure called Open which uses proprietary technology to deny users open access to the Internet.

The joint venture, British Interactive Broadcasting, is heavily subsidising the cost of digital satellite receivers which have been designed to let viewers progress seamlessly from watching movies and sport to purchasing goods and services from firms which will pay BIB a commission of up to 20 per cent.

Retail chains including Woolworths, Iceland and Great Universal Stores have already pledged to offer home shopping on BIB's Open service, the Midland Bank will provide on-line banking and Ford, Unilever and Coca Cola will inject their adverts. There will also be a games site. After trials starting late this year, Open will ramp up to a full consumer launch in the third quarter of 1999.

Subsidies from BIB currently halve the cost of Sky's digital satellite set-top boxes, to under £200. Sky's fitters install the necessary dishes free. The viewer only has to agree to let the fitter connect the receiver to a phone line. The fitter will even lay extension phone wires free if necessary. Over 100,000 people have signed up since Sky launched its digital TV service on 1 October '98.

The moment the receiver box is connected, its internal 28·8 kilobits/second modem automatically dials BIB's central computer to register the box's serial number. The modem then dials out to report when the box owner watches pay-per-view movies or sports events. Even if no PPV charges are incurred, the modem dials out intermittently to confirm it is still connected. If the viewer unplugs the phone, Sky can send signals over the air which stop the receiver working and then claim back the subsidy.

The box has on-board memory which stores the electronic programme guide software developed by US company OpenTV to tell viewers what TV programmes are available. As BIB's Open rolls out, Sky will transmit a series of software upgrades by satellite which automatically download to convert all receivers in the country into interactive terminals.

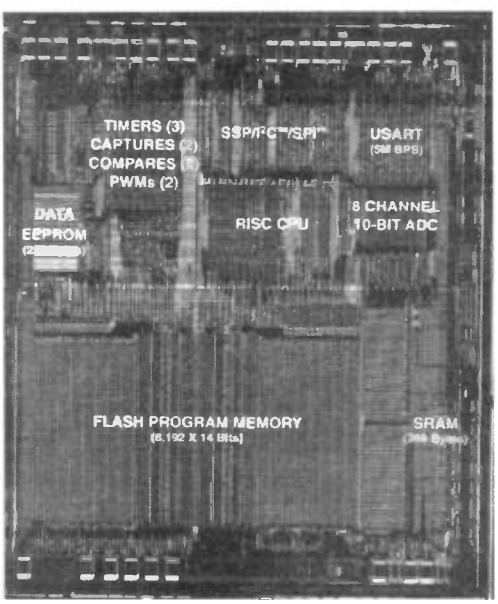
The upgraded software will allow E-mail for personal messages and targeted mailshots, but it cannot access the Internet and display HTML pages. Instead, the satellite will continuously deliver information at a rate of 68Mbit/s. The viewer browses this, going on line only when a transaction is carried out or a game played.

The infra-red eye on the satellite receiver, currently used with a remote control to switch TV channels, can interface with a keyboard. "It's like a shopping mall" says BIB's Chief Executive James Ackerman "Businesses will lease space. It will be much cheaper for them than running a shop".

Ackerman hopes to reach 14 million shoppers within five years, with data capacity from the satellite trebling to cater for up to ten virtual shops, half a dozen information providers, a games site and financial services. BIB is planning online gambling.

If viewers use their TVs to access the Open service, instead of paying a Service Provider to connect to the open Internet by PC, BSkyB and BIB can build and control a new electronic marketplace. But since BIB was formed in May 1997, Dixons has launched Freeserve which offers open access to the entire Internet at no charge, in return for a personal shopping profile of the user.

NEW FLASH PICS



We have been expecting it for some time, and now Microchip have sent it – information on the introduction of two new 8-bit flash microcontrollers.

What is significant about the PIC16F876 and PIC16F877 is that they are, in effect, greater-capacity versions of the renowned PIC16F84 (and PIC16C84) devices. These, as so many of you are aware, can be re-programmed again and again without the need for u.v. erasure (in other words, they can be regarded as EEPROM devices). This makes them ideal microcontrollers to use for project development.

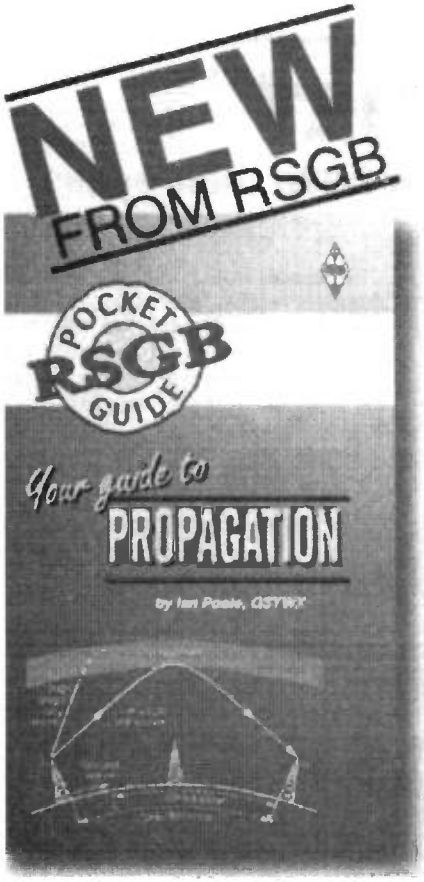
These new RISC-based flash devices are also the first to use Microchip's innovative Migratable Memory technology, which provides socket and software compatibility among all equivalent ROM, OTP and flash memory controllers.

The PIC16F876 and PIC16F877 feature 8K × 14 bits of *Enhanced* Flash program memory, 256 bytes of EEPROM data memory, and operate between 2V and 5·5V. Additionally (and importantly) they include integral 5- to 8-channel 10-bit A/D converters, RS485-type UART, and up to 5MIPS performance at 20MHz.

We shall be investigating these new and long-awaited devices a.s.a.p. There are more due to be introduced as well. We intend to upgrade our *PIC16x84* programmer to cater for these PICs – watch our pages!

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

PROPAGATION



THE Radio Society of Great Britain (RSGB) has published a new book – *Your Guide to Propagation*. Whatever your interest in radio (says the press release), understanding the propagation of signals is of great importance. If you wish to hear or work DX stations around the world, it's vital to know not only the characteristics of each band, but how other influences, such as time of day and state of the sun, can affect it.

To help non-scientists get the most out of their radios, the RSGB has produced this handy, easy-to-read guide which is packed with information. Moreover, it's written by Ian Poole G3YWX who, of course, is the respected author of our monthly *Technology Update* column.

The chapter titles are: Introduction to Radio Wave Propagation; Radio Waves; The Atmosphere and the Sun; Ionospheric Propagation; Ionospheric Storms and Aurora; Predicting, Assessing and Using HF Propagation; Other Ionospheric Modes; Tropospheric Propagation; Meteor Scatter; Appendix.

The book costs £6.99 (excl p&p). It has 88 pages (177mm×111mm). ISBN: 1-872309-69-6.

For more information contact: Radio Society of Great Britain, Lambda House, Cranborne Road, Potters Bar, Herts EN6 3JE. Tel: 01707 659015. Web: www.rsgb.org.

E.O.C.S. PICS UP

READING through the Electronic Organ Constructors Society (E.O.C.S.) latest magazine (Nov '98), we were pleased to see that they too are interested in PIC microcontrollers. Indeed, it appears to have been our *PIC Tutorial* series (Mar-May '98) that has helped to get them involved.

Honorary Secretary Don Bray, we are told through the magazine's pages, held the South Coast Branch meeting at his home in October. Amongst other things of importance to such a society, he also demonstrated PIC Tut and its board to the gathered members.

The report continues, "Don explained how useful and interesting he found the course and some of the things he hoped to do with suitably programmed chips in his instrument. Most people (but not everyone present) seemed to recognise and feel able to share his enthusiasm".

Qualified praise it may be (*not everyone?!*), but it's still praise! Good luck to you all at the E.O.C.S. with your endeavours – perhaps with this latest mention of you from us (bribed, of course, by your mention of PIC Tut!) some more of our readers might care to join you.

Anyone with an interest in electronic organs and such things is encouraged to join this active society. It has branches around the country – and has had for decades.

More details from Don Bray, 34 Etherton Way, Seaford, Sussex BN25 3QB (tel: 01323 894909) – tell him *EPE* told you to ask!

SQUIRES TOOL CAT

SQUIRES' 1999 model and craft tools catalogue has landed on the News Desk with a thump! It must be the biggest yet – over 330 A4 pages of all the tools that any hobbyist who loves making things by hand would love to own and use. And, let's face it, all of us who find enormous pleasure in making something always want as many tools around as funds permit (indeed, many of us delight in owning tools just for the sake of it – one day, we think, we'll need them!).

So, Squires's cat really ought to be on your workroom bookshelf – there's so much in it (too much to itemise but we doubt if you'll spot many omissions) to tempt you. It's all well illustrated, priced and indexed.

Squires also exhibit around Britain at various craft exhibitions and fairs – we'll be surprised if you haven't already met them if you enjoy such outings.

For more information, contact Squires Model & Craft Tools, Dept EPE, 100 London Road, Bognor Regis, PO21 1DD. Tel: 01243 842424. Fax: 01243 842525.

CROSSPAD

CIT, Computerised Information Technology Ltd, have sent us information on CrossPad which, with its revolutionary handwriting recognition software, is "an innovative product at its best".

This sleek and lightweight machine is just slightly bigger than an A4 pad. It can save around 50 pages of your handwritten notes, transport them to your PC, convert them all to ASCII text. As a PC file you can search, store, save, re-organise, cut and paste, E-mail and fax all your notes in handwritten form or ASCII text.

CrossPad is compatible with virtually all Windows 95 applications.

For more information, contact Computerised Information Technology Ltd., Dept EPE, 20 Potters Lane, Kiln Farm, Milton Keynes, Bucks MK11 3HF. Tel: 01908 260082. Fax: 01908 260084. E-mail: info@cituk.com.

BANNING JUNK

AT last – the Government has issued draft regulations designed to grant consumers protection against unwanted direct marketing "junk" faxes and phone calls.

The proposals will give consumers the power to refuse all unsolicited direct marketing calls, by opting out and registering with a centralised list of subscribers who don't want to receive these calls.

Interestingly, to quote the press release from the DTI, "the Government reserves the right to amend the Regulations ... this could include introducing an *opt-in* approach, under which such calls would only be allowed to be made to consumers who had agreed to receive such calls".

What is also needed (somehow) is better protection against junk E-mails that pester those of us on the Net – including material that some people may find offensive, and possibly illegal in Britain.

MASSIVE TEST GEAR RANGE

IF you are looking for a much wider range of test gear than stocked by many suppliers, the latest Test and Measuring catalogue from PID (Professional Instrument Distributors) could well have what you want.

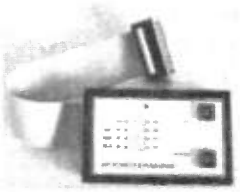
Over 600 test and measurement instruments are detailed, covering what seems to be every conceivable aspect of electronics. The 56-page full-colour catalogue is free to anyone who asks – it's a pity, though, that it does not give prices for the items illustrated. The PID covers the UK for sales, calibration, repairs and hire.

For more information contact PID, Dept EPE, 3 Brackenley Court, Embsay, North Yorks BD23 6PX. Tel: 01756 799737.

Crownhill Associates Limited

PIC12C508/509 *DEVELOPMENT SYSTEM*

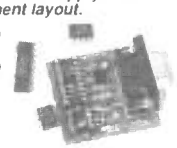
This integrated development environment offers a unique software development tool for the PIC 12C508 / 509. The package consists of 508/509 In-Circuit Emulator, Programmer, EdICE a fully integrated Assembler with trace functions & ICE508 tracer/disassembler.



The development system is supplied with MPASM assembler/disassembler and 10 projects, including circuit diagrams and unprotected source code. Projects cover subjects from simple sound effect generator through to an accurate Digital Volt Meter, Smoke Alarm, Stop Watch, LCD display driver, Keypad encoder and more
Price **£59.95** + *7.50 P&P* + *VAT*

NEW! PIC PROGRAMMER KIT

Programs the Popular PIC 16C84, 16F84 and 24xx series serial memory devices. Connects to the serial port of a PC and requires No EXTERNAL power supply. The kit includes instructions for assembly, circuit diagram and component layout.



This handy little programmer is easy to build, taking no more than 30 mins. to assemble and test. The Professional quality PCB is double-sided, through-plated with solder resist and screen printing to aid efficient assembly. It is supplied with driver software to run in DOS on a 286 PC upwards and under Windows 95 on 486 or Pentium and a Disk full of interesting projects, tips and data sheets for PIC devices, including **FREE** Assembler and Simulator (requires 9-pin D-type to 9-pin D-type cable to connect to serial port of PC).
CABLE £5 INC. VAT AND DELIVERY. COMPLETE KIT just £15.00 including Delivery and VAT (UK Only). Or READY BUILT £20.00 INCLUDING Delivery and VAT (UK ONLY)

1998 Microchip CD ROM

- *Packed with information*
- *All current data sheets*
- *Programs and Diagrams*
- *Application notes*
- *PDF Viewer*

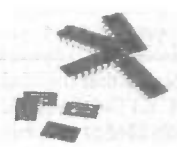
£10 inc. VAT P&P (in UK)

AMAZING LOW PRICES
PIC 84 & MEMORY

PIC16C84 /04p	
1-10	£2.00
11-100	£1.90
101-500	£1.80
24LC16	
1-50	£1.00
PIC16C620	£1.95
PIC16C621	£2.25
PIC16C622	£2.50

PIC Prices + P&P VAT

PIC 12C508/509 DIL
ALL AT 0.65p
Low Cost programmer for the above devices @ **£35.00**



PIC BASIC COMPILER

Write PIC Programs in *BASIC*

- Expanded BASIC Stamp I compatible instruction set
- True compiler provides faster program execution and longer programs than BASIC interpreters
- **I2CIN** and **I2COUT** instructions to access external serial EEPROMs and other I2C devices
- More user variables
- **Peek** and **Poke** instructions to access any PIC register from BASIC
- Serial speeds to 9600 baud
- In-line assembler and **Call** support
- Supports all most popular PICs, PIC16C55x, 6x, 7x, 8x, 92x and PIC14000 micros
- Use with any PIC programmer

Write your PIC programs in BASIC! The PicBasic Compiler converts BASIC programs into hex or binary files that can be programmed directly into a PIC microcontroller. The easy-to-use BASIC language makes PIC programming available to everyone with its English-like instruction set.
Supplied with Universal PIC CHIP Programmer, connects to Parallel port of PC and programs all popular PIC micros. Complete with programming toolkit – Editor, Assembler & Programming software.

Universal PIC CHIP programmer supports the following Microchip devices
PIC16C52, PIC16C54, PIC16C55, PIC16C56, PIC16C57, PIC16C58A, PIC16C61, PIC16C62,

PIC16C63, PIC16C64, PIC16C65, PIC16C620, PIC16C621, PIC16C622, PIC16C71, PIC16C73, PIC16C74, PIC16C84, PIC16C622, PIC16F84, PIC16F83, PIC16C554, PIC14000, PIC16C508, PIC12C509, & MEMORY CHIP24C01 TO 24LC65

Price
£49.95 + P&P + VAT

PIC BASIC PRO

The PicBasic Pro Compiler allows BASIC Stamp II commands, using pins on PORTA, C, D, E, as well as PORTB, and the capability of using more RAM and program space.
A list of the new features and commands appear below.

- Real If . . . Then . . . Else . . . Endif
- Hierarchical expression handling
- Interrupts in Basic and assembler
- Built-in LCD support
- Oscillator support from 3·56Mhz to 20Mhz
- More variable space (processor dependent)
- MPASM/ICE compatibility
- All Assembly routine for all functions are supplied and can be modified to suit your needs

Supplied with sample programs including circuit diagrams

PIC BASIC without programmer or PIC84	***£49.95 + 5.00 P&P + VAT***
PACKAGE with programmer & PIC 16x84	***£99.95 + 5.00 P&P + VAT***
PIC BASIC PRO without programmer or PIC16F84	***£150.00 + 5.00 P&P + VAT***
PIC BASIC PRO with programmer and PIC16F84	***£198.00 + 5.00 P&P + VAT***

http://www.crownhill.co.uk/picbasic

The Old Bakery, New Barns Road, Ely, Cambs
Tel: 01353 666709 Fax: 01353 666710
email: sales@crownhill.co.uk http://www.crownhill.co.uk

NOW AVAILABLE

RANGER 2 for Windows 95™

Demo Software - available from our Web Address

The Complete, Integrated Schematic & PCB Layout Package

Windows Ranger 2 £250
For Windows 95 & NT
• New Hierarchical Circuit
• Split Devices • Gate & Pin Swap
• New Edit Devices in Circuit
• Copper Fill • Power Planes
• Autorouter • Back Annotation

Ranger 2 Outputs:
Full Windows Outputs
Plus - HP-GL
Gerber
NC Drill
AutoCad DXF

Windows Ranger 2 with Specctra SP2 £600
Ranger & Specctra Autorouter provide the most cost effective PCB Design system available. A powerful, intuitive system at an outstanding price!

Windows Ranger 2 Upgrade £150
Upgrade your existing PCB Package to Windows Ranger 2.

SPECIAL OFFER **Ranger 2 Lite £35** (Prices exc VAT/P&P)

Demo Software -download from **http://biz.ukonline.co.uk/seetrax**

Call 01730 260062

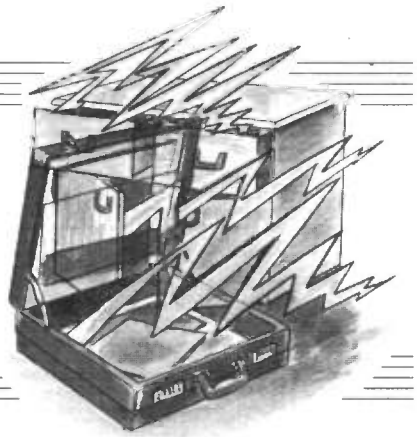
Fax 01730 267273 Old Buriton Limeworks, Kiln Lane, Buriton, Petersfield, Hants. GU31 5SJ

SEETRAX CAE
Advanced Systems & Technology for PCB Manufacture

Constructional Project

LIGHT ALARM

GAVIN CHEESEMAN



A take it with you, low-cost, pocket-sized, light-activated alarm

QUITE often, situations arise where it is useful to have a simple alarm that can be placed with personal items to alert the owner if they are being tampered with. There are many ways of producing such a device, each with its inherent advantages and disadvantages.

In this article, we look at a circuit that is triggered by the presence of light. Although relatively simple in concept, the unit has a wide variety of uses ranging from indicating when a cupboard or drawer has been opened to operating as a simple luggage alarm.

CIRCUIT DETAILS

The full circuit diagram for the Light Alarm is shown in Fig.1. It will be seen that the circuit is based around the 40106 hex Schmitt inverter, IC1. Power to the circuit is controlled by switch S1 with capacitors C2 and C6 acting as supply de-coupling.

Darlington transistor TR1, combined with capacitor C1, diode D1 and resistor R1, effectively provide a delay period after switch-on, in which the circuit is unaffected by the ambient light level. This acts as a kind of exit delay to allow you a short time after switching on before the alarm is triggered and can be useful when placing the unit in a cupboard, drawer etc.

The circuit is temporarily prevented from triggering by holding IC1a pin 1 high for the duration of the switch-on delay. Initially, when switch S1 is first closed, the voltage across capacitor C1 is negligible and enough current flows through the base (b) of TR1 to ensure that it is switched on.

As capacitor C1 begins to charge the voltage drop developed increases until a point is reached where current ceases to flow in the base of TR1. At this point TR1 turns off and the voltage at IC1 pin 1 then becomes a function of the potential divider comprising R3, VR1 and R4, a light dependent resistor (l.d.r.) as discussed later.

A Darlington transistor has been chosen for TR1 because it requires only a very small base current to switch on. Diode D1 is included to ensure that capacitor C1 is discharged at power down.

LIGHT WORK

The circuit makes use of a light dependent resistor, R4, to detect the ambient light level. This is connected in series with preset potentiometer VR1 (wired as a variable resistor) and resistor R3, forming a potential divider. The combined effect of the resistance of each element in the divider chain determines the input voltage to IC1a at pin 1.

The l.d.r. (R4) has a high resistance in the dark but this falls drastically when the device is exposed to light. As a result, the voltage at IC1a pin 1 is heavily dependent on the ambient light level, increasing in darkness and falling notably in bright light. The luminance level at which the input voltage to IC1a reaches the switching threshold can be varied by adjusting preset VR1.

In a dark environment, where the voltage at IC1a pin 1 is above the switching threshold, the output on IC1a pin 2 sits in a logic low state. In this condition the alarm output is disabled.

If the voltage at pin 1 of IC1a falls below the switching threshold (due to light falling on the sensor), this results in a logic

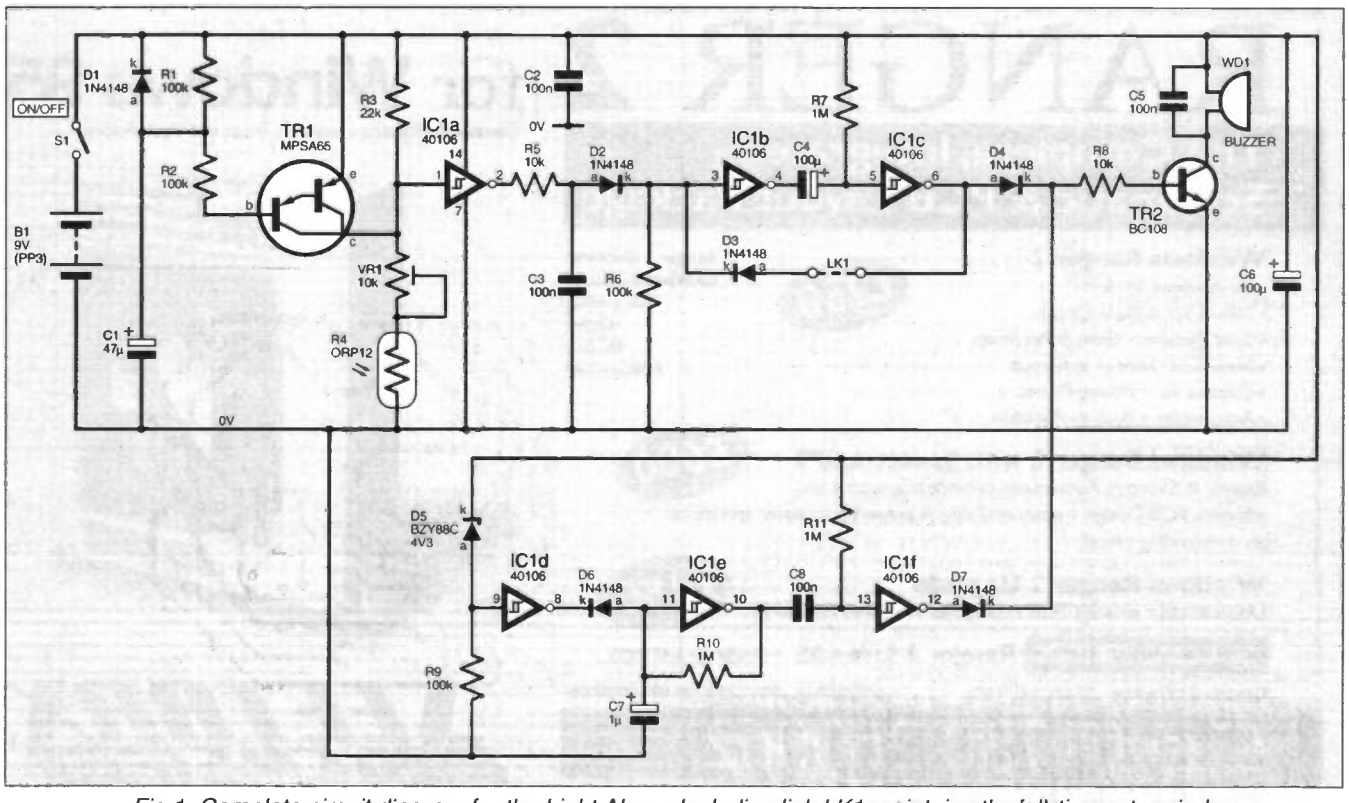


Fig.1. Complete circuit diagram for the Light Alarm. Including link LK1 maintains the full timeout period.

high at pin 2. Under this condition, D2 is forward biassed, pulling IC1b pin 3 high. As a result, pin 4 of IC1b switches to logic low and this initially applies a logic low condition to IC1c pin 5, via capacitor C4.

This causes the output at IC1c pin 6 to switch to logic high. At this point capacitor C4 starts to charge via resistor R7, resulting in an increasing voltage level at IC1c pin 5. When this voltage reaches the switching threshold, the output at pin 6 switches back to a logic low state.

If a wire link (LK1) is fitted, the output from IC1c pin 6 is connected back to pin 3 via diode D3. This has the effect of maintaining a high output at pin 6 until the timeout is complete even if the trigger event is only momentary. If the link is not fitted the output will switch high only for the period that light is falling on l.d.r. R4.

In both cases, when IC1c pin 6 switches to a high condition this turns on transistor TR2 activating buzzer WD1. Resistor R8 limits the transistor base current. Capacitor C5 helps to reduce any high frequency noise coupled onto the supply from the buzzer.

ON THE LOW SIDE

The remaining parts of the circuit serve to provide a low battery indication. The function of this part of the circuit is based on the fact that when correctly biassed, Zenor diode D5 maintains a relatively constant voltage drop independent of supply voltage.

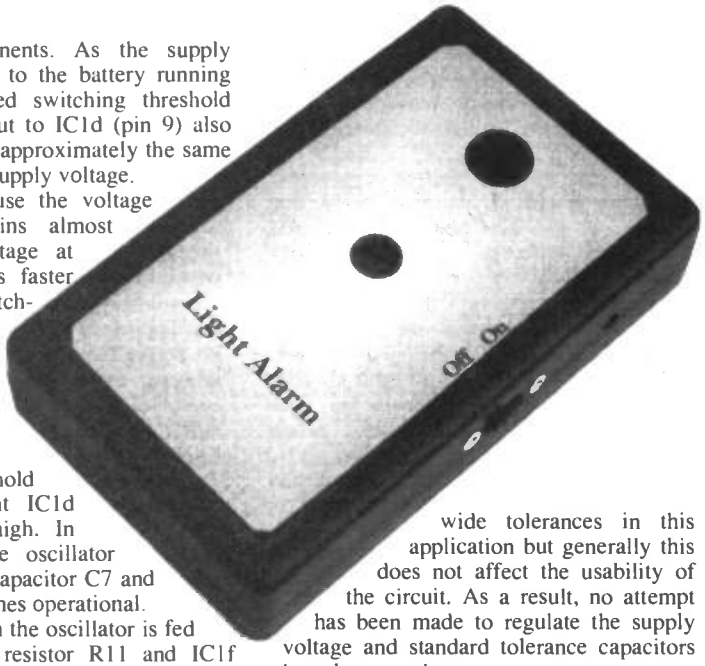
At normal supply voltages the output at IC1d pin 8 is low inhibiting the low frequency oscillator formed by IC1e and associated components. As the supply voltage drops due to the battery running down, the required switching threshold voltage at the input to IC1d (pin 9) also drops but remains approximately the same percentage of the supply voltage.

However, because the voltage across D5 remains almost constant, the voltage at IC1d pin 9 drops faster than the i.c.s switching threshold as the supply voltage drops. Eventually, a point is reached where the input voltage falls below the threshold and at this point IC1d pin 8 switches high. In this condition the oscillator formed by IC1e, capacitor C7 and resistor R10 becomes operational.

The output from the oscillator is fed to capacitor C8, resistor R11 and IC1f which effectively narrow the pulse width reducing the average current consumption of this section of the circuit when active. The output at IC1f pin 12 is fed to the base (b) of transistor TR2 via diode D7 and resistor R8.

When the low battery condition is active, the buzzer is powered up for the duration of each pulse producing a repetitive beeping sound. At normal supply voltages the output at IC1f pin 12 is low and therefore does not affect the operation of the rest of the circuit.

Circuit timings and thresholds have wide tolerances in this application but generally this does not affect the usability of the circuit. As a result, no attempt has been made to regulate the supply voltage and standard tolerance capacitors have been used.



CONSTRUCTION

All the components for the Light Alarm, except the On/Off switch and battery, are mounted on a single, small printed circuit board (p.c.b.). The component layout and full-size copper foil master are shown in Fig.2. This board is available from the *EPE PCB Service*, code 218.

Referring to the component layout in Fig.2, start construction with the low profile components, such as the resistors and diodes, working up to the larger parts.

COMPONENTS

See SHOP TALK Page

Resistors

R1, R2, R6, R9	100k (4 off)
R3	22k
R4	ORP12 light dependent resistor
R5, R8	10k (2 off)
R7, R10, R11	1M (3 off)

All 0·6W 1% metal film

Potentiometer

VR1	10k enclosed carbon preset, vertical

Capacitors

C1	47µ radial elect. 16V
C2, C3, C5 C8	100n disc ceramic (4 off)
C4, C6	100µ radial elect. 16V (2 off)
C7	1µ radial elect. 63V

Semiconductors

D1 to D4, D6, D7	1N4148 signal diode (6 off)
D5	BZY88C4V3 4·3V Zener diode
TR1	MPSA65 *pnp* Darlington transistor
TR2	BC108 *npn* transistor
IC1	40106BEY CMOS hex Schmitt inverter

Miscellaneous

S1	s.p.d.t. sub-min. slide switch
WD1	3V to 24V d.c. low-profile, p.c.b. mounting buzzer; 5mA at 12V
B1	9V PP3 type battery, with clips

Printed circuit board available from the *EPE PCB Service*, code 218; plastic case, with battery compartment, size 103mm × 62mm × 23mm; 14-pin d.i.l. socket; multistrand connecting wire; M3 3mm (1/8in.) spacers, M3 16mm (5/8in.) countersink head bolts, M3 nuts and M3 shakeproof washers (4 off each); solder pins; solder etc.

Approx Cost Guidance Only **£17** ***excluding battery***

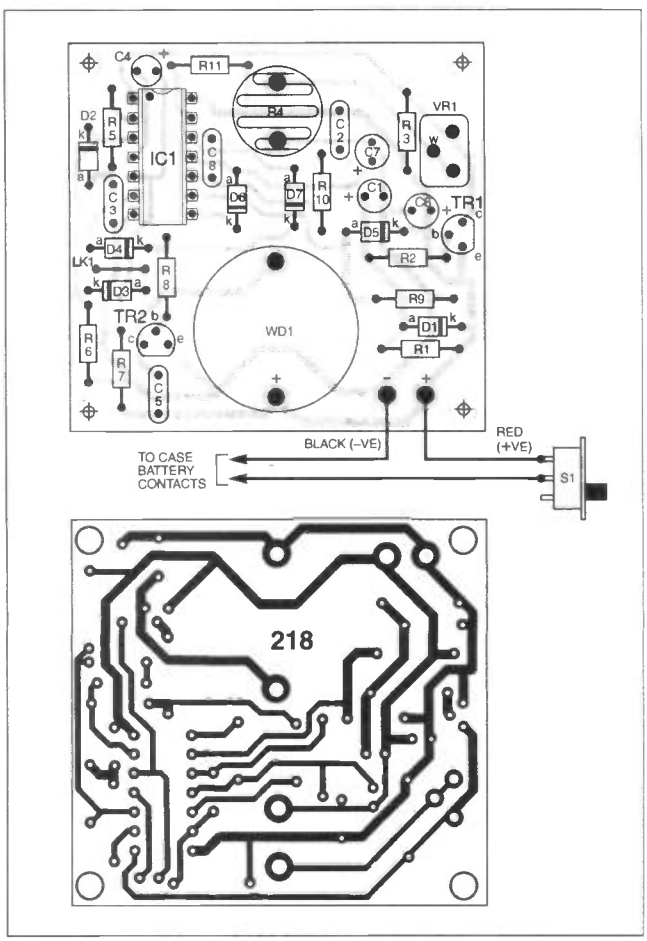


Fig.2. Light Alarm printed circuit board component layout, full-size copper foil master and wiring to the battery connector and On/Off slide switch.

It is recommended that an i.c. socket is used for IC1 to prevent any possibility of heat damage to the i.c. during soldering. Do not insert the i.c. into its socket at this stage.

Take care that all polarised components are inserted with the correct polarity. The notch on the i.c. and socket should correspond with that on the component layout.

The polarity of the electrolytic capacitors are marked on the layout diagram with a positive (+) symbol, whereas most capacitors are now marked with a negative (−) symbol on their component body. Therefore, when inserting the capacitors into the p.c.b., ensure that the lead adjacent to the negative symbol on the component is positioned in the hole furthest from the plus symbol on the overlay.

Transistors and diodes should be inserted on the board such that the shape of the component body corresponds with that on the component layout. The cathodes (k) of the diodes are indicated by a band at one end of the component. The polarity of the specified buzzer WD1 is clearly marked adjacent to its pins and the positive connection is marked with a plus symbol in the component layout diagram Fig.2.

ASSEMBLY

It is necessary to wire the battery terminals and On/Off switch S1 to the p.c.b. Ordinary hook-up wire can be used for these connections. It is recommended that you use p.c.b. solder pins to connect these leads to the board, see Fig.2. These should be inserted into the appropriate holes in the p.c.b. from the track side, and pressed into position using only a minimum amount of pressure.

When soldering the p.c.b. take care that you do not create any unwanted dry joints or solder short circuits across copper tracks/pads. Once all components are in place, and before you plug IC1 into its socket, it is best to double check your work to avoid later problems.

TESTING

It is probably best to test the Light Alarm before it is finally installed into its case. There is nothing worse than spending time tidying everything up only to find that when you test the unit some rework is required on the p.c.b. and you have to start all over again.

Snap the battery into its connector, taking care to observe the correct polarity. The circuit is designed to operate from a 9V PP3 type battery. The unit may also be powered from a bench supply set to 9V for testing purposes if this is more convenient. If you use a bench power supply, it is recommended that the output current is limited to less than 100mA, just in case there is a fault on the circuit board.

If you have a multimeter, it may be useful to temporarily connect this in series with the positive (+V) supply lead, set to measure d.c. current. Set switch S1 to the On position.

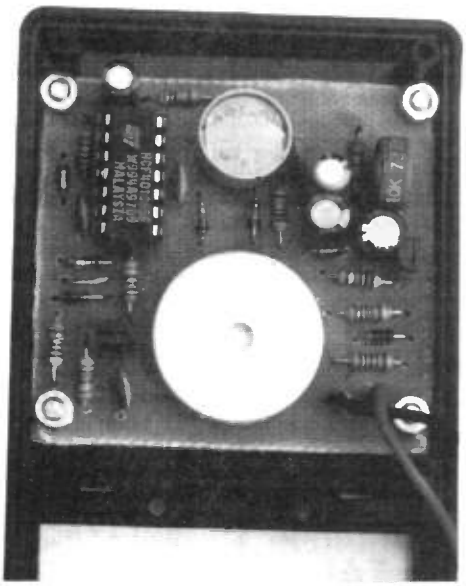
The current consumption should momentarily peak and then slowly drop as capacitors in the circuit charge. The current should settle at around 0·2mA when buzzer WD1 is silent. If the current reading exceeds 10mA at any time after the initial switch on pulse, switch off and re-check the board for short circuits or incorrectly fitted components.

SETTING UP

Set preset VR1 to about the central position of its track using an appropriate screwdriver or trimming tool. Initially, ensure that the p.c.b. is positioned such that the l.d.r. is exposed to bright light.

Assuming all is well, when power is first applied to the circuit, there should be no sound from the buzzer. After a few seconds, the switch-on delay should be complete and at this stage, if sufficient light is falling on the l.d.r., the buzzer should emit a continuous piercing tone. The buzzer should continue to operate for a few seconds until the circuit times out.

When the buzzer has stopped sounding, momentarily place your hand over the l.d.r. so as to obscure the light. When you remove your hand the buzzer should once again sound until the timeout period is complete.



Circuit board bolted into the lower half of the case.

If the link wire (LK1) is fitted, the buzzer should sound for the whole timeout period even if the l.d.r. is only exposed to light for a short period. If the link is not fitted, the sound should only continue as long as the l.d.r. is exposed to light. There is no reason why an off-board switch cannot be connected in place of the link if you prefer the operating mode to be selectable.

Adjusting preset VR1 changes the sensitivity of the circuit to light. Different settings should result in the circuit triggering at different light levels.

If you are using a variable power supply you can test the operation of the low battery indication by reducing the supply voltage. To carry out this test, either cover the l.d.r. before switching on or wait until the timeout is complete and the circuit is silent.

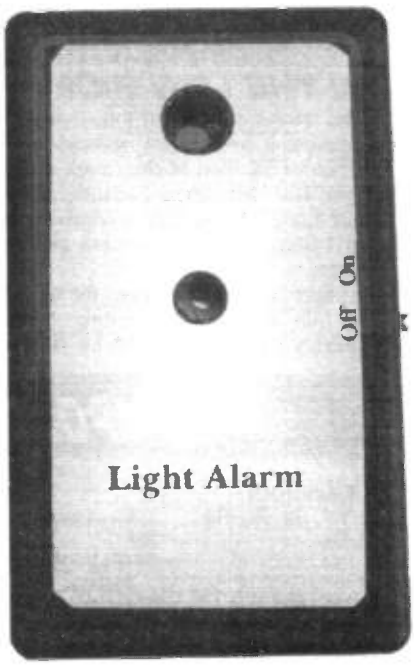
If everything is working correctly, as you reduce the supply voltage you should reach a point where the buzzer starts to emit repetitive beeps. This is the low battery indication and typically comes into operation at supply voltages below approximately 4V.

FINAL ASSEMBLY

Having completed the testing and setting up of the completed circuit board, it is time to install it into its case. The recommended case measures only 103mm × 62mm × 23mm. This case is convenient for small projects like the Light Alarm as it also has a built in battery compartment and an optional belt clip, which may be fitted if required.

It is necessary to drill several holes in the case for the p.c.b. fixings and for switch S1. The p.c.b. can be temporarily dropped into the case to provide a template for the board mounting holes. Countersink the holes for the p.c.b. and switch mounting screws so that the screw heads are level with the case when fully inserted. The case material is relatively thin so make sure that you do not over-drill the countersinks.

Holes are also required in the case immediately above the light dependent resistor (R4) and the buzzer WD1 so that these components are unobstructed. It is essential



The light "window" and sound exit holes should align with the l.d.r. and warning buzzer when the case is closed up.

to the operation of the circuit that sufficient light can fall on the l.d.r. The approximate positioning of these holes may be seen in the photographs of the finished Alarm.

Switch S1 is mounted in a convenient position on the side of the case such that it lines up with any legend on the front panel label. The switch is mounted in the front half of the case without the detachable battery cover and is fixed in position using two M2 countersink head screws, see photographs. The mounting holes of the specified switch are threaded, so there is no need to use nuts.

The p.c.b. is installed into the lower half of the case, the part with the battery cover. It should be mounted on M3 spacers and is held in place using M3 countersink head screws and M3 nuts. Do not forget to fit the shakeproof washers, as these help to prevent the screws from becoming loose due to vibration etc.

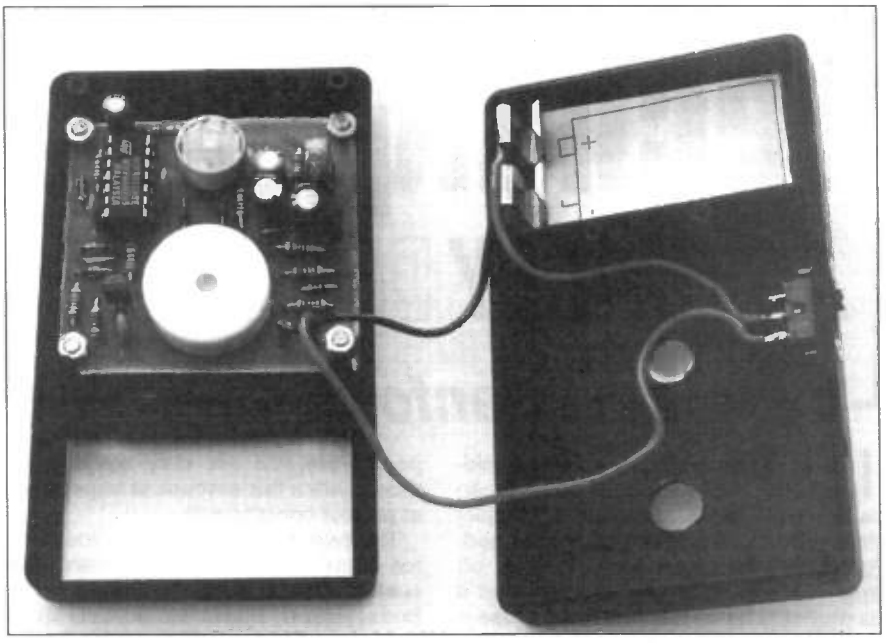
Before fitting the two halves of the case together, it is necessary to route the wires

to the battery terminals through the gap at one end of the battery compartment. When the wires are routed correctly, the case sections should fit together with ease and there should be no excessive gaps.

The two halves of the case are held together using the two screws supplied. To fit these it is necessary to remove the battery cover to expose the two fixing holes. Insert and tighten the screws until the two halves of the case are held firmly together. Do not apply excessive force as this will tend to strip the thread cut into the plastic pillar by the screw.

The battery area is intended to accept a PP3 battery. There are slight differences in size between different makes of PP3 battery and you may find some types are a fairly tight fit. However, if you have problems, do not try to force the battery cover into position as this may damage the battery or case.

A front panel label may be made up from some thin card and attached to the front of the case using a suitable adhesive. Carefully align the label with switch S1 and the edges of the case. It will, of course, be necessary to cut two holes in the label corresponding with the position of the holes drilled in the case for the l.d.r. and warning buzzer.



Wiring between the two halves of the completed Alarm case. The p.c.b. is situated in the section which takes the battery cover. Note the siting of the On/Off slide switch on the side of the case.

IN USE

The Light Alarm lends itself to a variety of different uses. A typical application would be to indicate unauthorised access to cupboards or drawers. Alternatively, the alarm could be used to give warning that your briefcase has been opened.

Of course, the alarm will only work in any application if sufficient light falls on the l.d.r. sensor when the alarm is required to trigger. The unit is not generally suitable for use as a building intruder alarm as it has limited sound output level and is relatively easily disabled.

In some cases the Light Alarm may be arranged to trigger if an item is removed. You may be able to place the object that you are trying to protect on top of or over the alarm such that significant levels of light are prevented from falling on the l.d.r. sensor. If the item is removed, light falls on the sensor and the alarm sounds.

Depending on the light level where the alarm is being used it will be necessary to adjust the setting of preset VR1 to provide the most appropriate response. A small hole can be drilled in the side of the case adjacent to the preset potentiometer to cater for this. The setting should be such that in the dark condition, the alarm is not triggered and in the light condition the unit is triggered reliably.

Positioning is also important. You need to make sure that the l.d.r. is reliably exposed to light under the conditions where it is intended that the alarm should be triggered. For example, if the unit is used in a drawer, sufficient light must fall on the sensor when the drawer is open. It is obviously no good placing the alarm under piles of paperwork, because the chances are it will just not work

TIMEOUT

Whether or not you decide to fit the link wire will depend on your application. If you are using the alarm to warn of unauthorised access, you will probably want the unit to continue to sound for its timeout period or until switched off. Therefore, in this case link LK1 will need to be fitted. However, if you are using the alarm as an audible reminder that, for example, a darkroom door is open, then link LK1 should be omitted.

If you are unhappy with the alarm timeout period, this can be changed by adjusting the value of C4 and/or R7. Alternatively, if you wish you can disable the alarm timeout entirely by fitting a link in place of C4.

IN CONSIDERATION

The Light Alarm is intended to operate at normal room temperature. Extremes of temperature may affect the operation of the alarm and should therefore be avoided.

In particular, circuit timings will be altered and the operation of IC1 may become unpredictable. Some CMOS devices can be notoriously unreliable at low temperatures. Similarly, avoid damp locations.

The light alarm is a simple project but can give surprisingly good performance when properly used. We have covered the basic applications but there are probably plenty more.

Some readers may like to experiment with a different sounder in place of WD1 to give more output or provide a different sound. This should be possible so long as you do not exceed the maximum current and power ratings for transistor TR2.

EVERYDAY PRACTICAL ELECTRONICS

SUBSCRIPTION ORDER FORM

Annual subscription rates (1999): UK £26.50.
Overseas £32.50 (surface mail) £50 (airmail)

To: Everyday Practical Electronics,
Allen House, East Borough, Wimborne, Dorset BH21 1PF
Tel: 01202 881749 Fax: 01202 841692

I enclose payment of £ ..... (cheque/PO in £ sterling only),
payable to Everyday Practical Electronics
Access or Visa No.

Signature.....

Card Ex. Date .....

Please supply name and address of cardholder if different from the subscription address shown below. **Subscriptions can only start with the next available issue.** For back numbers see the Editorial page.

Name .....

Address .....

..... Post code..... 2/99

Techniques

ACTUALLY DOING IT!

by Robert Penfold

IT IS some time since we last considered the vexed topic of what to do when your newly constructed project fails to work. Fears of the finished gadget failing to work seems to put off many would-be project builders, but it is probably fair to say that this excuse is rather less justified than it once was, and the percentage of failures is quite low these days.

Methods of construction have improved, as have many of the components. The amount of pre-publication checking for both books and articles containing electronic projects has increased over the years, and this has greatly reduced the likelihood of you being "led up the garden path"! This produces a situation where projects are actually far more complex than they used to be, but the chances of problems arising are much less.

Important Decisions

Things are still far from foolproof, but like any creative skill, electronic project construction would not be a worthwhile hobby if it posed no challenge. For beginners the most important advice is to choose projects that are within their capabilities.

Select projects that are reasonably straightforward both mechanically and electrically. Initially you will not have a detailed understanding of how projects work, but build projects where you at least understand exactly what they are supposed to do. In the past it was not unusual to receive letters from readers experiencing difficulties with projects that they clearly did not understand properly.

Fortunately, letters from readers who are "out of their depth" are relatively rare these days. Possibly readers are heeding our advice to choose something that is easy to use and understand, such as a simple car or household project, and not something like a piece of highly advanced test equipment that is only fully understood by the designer and his mother!

Perhaps people are just more down to earth these days. In any event, you can save yourself a great deal of hassle by avoiding the temptation to start with grandiose projects that are totally unsuitable for beginners.

Only construct projects that are battery powered, and therefore safe. The mains supply is potentially lethal, as are any projects that connect to it. Mains power projects are only suitable for those with a fair amount of experience at project construction.

The two main construction methods for circuit boards are stripboard and custom printed circuit boards (p.c.b.s). Both types of board are actually quite easy to use, but custom p.c.b.s represent the more foolproof method.

Stripboard is drilled with a regular matrix of holes, and in most projects less than 10 per cent of these are actually used. A custom printed circuit board, as its name suggests, is specifically designed for a particular circuit and has just one hole per leadout wire or pin. This greatly reduces the risk of making a mistake in the first place, and any mistakes that are made will usually become apparent before the circuit board is completed.

Bridge Too Far

If a newly constructed project is clearly failing to operate properly *it is not a good idea to leave it switched on*. This could result in damage to some of the components, and expensive semiconductors are particularly vulnerable.

If there is an obvious problem with a project ***switch it off at once*** and recheck the component layout, wiring, etc. Experience suggests that the vast majority of problems are due to short-circuits between copper tracks on the underside of the circuit board.

There have been problems with accidental short-circuits on printed circuit boards for as long as there have been p.c.b.s, but modern designs tend to be relatively small and intricate. This greatly exacerbates the problem, making it difficult to complete anything but the most simple of boards without producing at least one or two "solder-bridges".

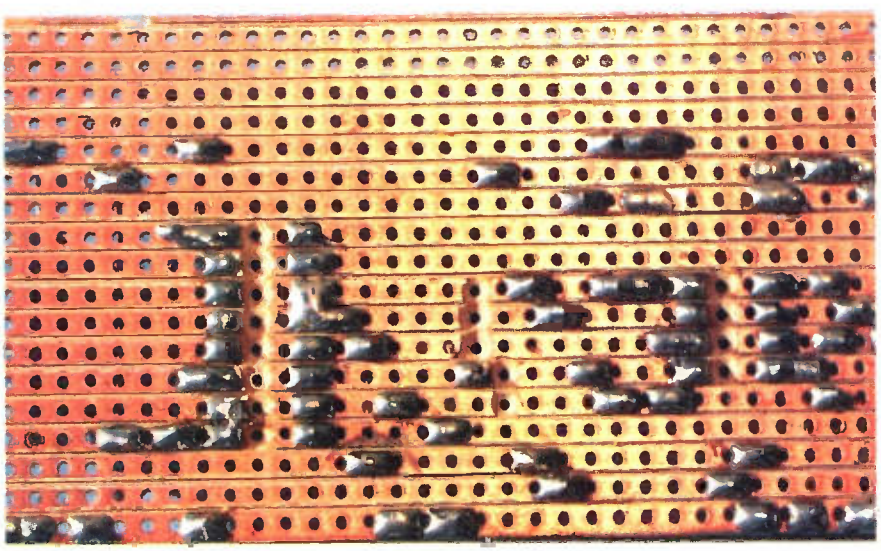
These bridges will usually be spotted while you are constructing the board, and in most cases can be "wiped" away with the bit of the soldering iron. Where there is a large amount of excess solder it is better to use a proper desoldering tool.

Clean Sweep

Some of these short-circuits are caused by minute trails of solder that are very difficult to see with the naked eye. They may actually be hidden under excess flux, and the underside of the board will have to be cleaned in order to bring them to light. There are cleaning fluids designed specifically for cleaning printed circuit boards, but a vigorous brushing with an old toothbrush seems to do the job very well.

Even if you have very keen eyesight some form of magnifier now has to be considered part of the standard toolkit for electronic project construction. Even a simple magnifying glass will make it easier to spot any solder trails, but the ideal tool for the job is an 8x or 10x loupe (also known as a lupe) of the type sold for viewing photographic slides and negatives.

With the board thoroughly cleaned, a thorough visual inspection using a powerful magnifier should soon reveal the cause of any short-circuits. This type of short-circuit is now so common that routinely cleaning boards, checking them for problems prior to testing rather than switching on and hoping for the best, is considered a *must*.



Solder bridges are most likely to occur where joints are tightly packed, especially around d.i.l. integrated circuits. The larger solder blob is a type that should be instantly spotted and rectified. The smaller one at the bottom left-hand corner of the cluster is less obvious, but should soon be spotted when giving the board a careful inspection with an "eyeglass".

Heat Of The Moment

Most beginners at electronic project construction have no previous experience of electrical soldering. Unfortunately, there is not enough space available here for a fully detailed description of soldering techniques, but this is certainly a skill that you must master before undertaking your first project. (If you are an Internet user, why not visit our web site at: **http://www.epemag.wimborne.co.uk/solderfaq.htm** for the low-down on the art of soldering.)

There are soldering kits available that include an iron, a matching stand, some solder, and a detailed instruction leaflet. These are ideal for beginners, and mostly seem to offer excellent value for money.

Soldering is not particularly difficult, but being realistic about things, you will need a certain amount of practice before becoming really proficient at it. It is worthwhile buying some stripboard and some cheap components such as resistors, and practising your soldering by fitting the components on to the board.

You will have to sacrifice a pound or two on wasted board and components, but you will learn a great deal from the exercise. A small initial outlay of time and money here can save a great deal of frustration when you start project construction in earnest.

When inspecting the underside of the board, examine the soldered joints for any abnormalities. You may be using too little solder, possibly resulting in some joints where the wire and copper pad are covered in solder but are not actually connected.

Beginners tend to make the joints rather slowly which can lead to problems with so-called "dry" joints. A joint of this type looks quite normal at a glance, but the solder does not produce a reliable electrical contact.

With modern solder and components this type of thing is now very rare. However, if a joint has an irregular appearance and the solder has a crazed finish rather than a shiny surface it would probably be worthwhile removing the old solder and re-doing the joint.

With the exception of semiconductors, modern components are reasonably heat resistant. However, if you take too long to complete joints it is still possible that damage will occur. If a component shows any physical signs of heat damage, such as a darkening in colour or if it has become slightly misshapen, replace it with a new one.

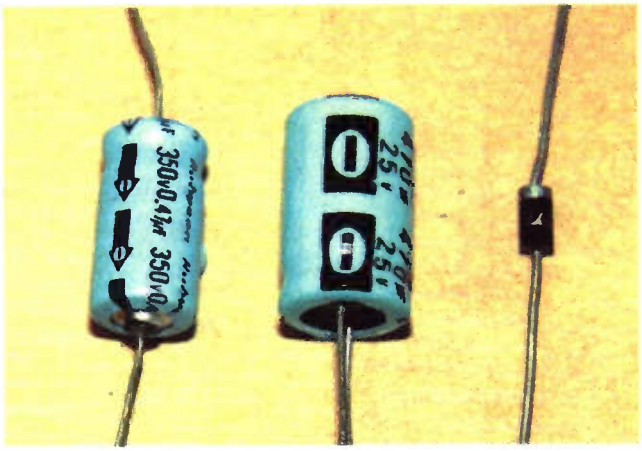
Semiconductors are mostly mounted in holders, but transistors and diodes are often soldered direct to the board. Extra care needs to be taken when fitting these in place.

It is a matter of "practice makes perfect", and you can save yourself a lot of problems by learning to solder quickly and neatly before dealing with any semiconductors.

Under Suspicion

If there are no signs of any problems on the underside of the board, or if after correcting any that are found the project still fails to work, go back and check the component layout again. First check that every component is in the right place, and that you have not accidentally swapped over two resistors.

The components that are most likely to cause problems are those that must be fitted the right way round. This mainly means semiconductors and electrolytic capacitors. Layout diagrams and the shape or markings of components normally make the correct orientation quite clear, so there are few excuses for getting it wrong.



The polarity of polarised components is clearly marked on the components themselves, and should be marked unambiguously on component layout diagrams. Note the band on the diode designating the cathode (k) end.

There is a potential cause of confusion with some d.i.l. integrated circuits that lack the usual dot and notch at the pin one end of the body. It seems to be increasingly common to have a white band across this end of the component instead.

Do not be fooled by moulding marks at the other end of the body that can look a bit like the standard notch. These marks are usually larger and less deep than the proper notch, but there should be the dot and (or) band as well, making the correct orientation unambiguous.

Hit List

Here are a few general points to try when checking a project that appears to be all right, but stubbornly refuses to work.

- Are the d.i.l. integrated circuits fitted in their holders correctly? A pin can sometimes buckle inwards or outwards so that it does not make electrical contact with the holder.

This is not always obvious from a visual inspection, particularly if the pin has buckled inwards. Remove the integrated circuits, check that the pins are all straight, and then refit them. Buckled pins can usually be straightened by pressing them against a small screwdriver blade with a fingernail.

- Give the components a firm pull. This will often bring to light any "dry" joints, soldered joints you have missed altogether, or any broken components that have detached leadout wires.
- If an l.e.d. (light-emitting diode) fails to work it is probably connected the wrong way round. The cathode (k) lead of a standard panel l.e.d. is usually indicated by having that lead shorter than the other lead, and the cathode side of the body is often flattened slightly. This method is something less than universal though, and with some of the "fancy" l.e.d.s currently on sale there is no obvious way of determining their polarity.

This leaves little option but the "suck it and see" approach. Connecting an l.e.d. round the wrong way is unlikely to damage it incidentally. Its reverse breakdown voltage may be exceeded, but the series resistor or other current limiting circuit will prevent any damage.

Is the project actually switched on? It is just a matter of time before you make the classic mistake of forgetting to switch on or overlooking that all-important component – the battery.

Battery connectors are notoriously unreliable. Try pressing the clip hard onto the battery to see if it makes the project burst into life. Slightly compressing the female connectors with pliers will usually get loose clips to operate reliably. Battery holders for AA and similar cells are also something less than completely reliable.

Make sure that the terminals of the batteries and the holder are clean, removing any corrosion with light use of fine sandpaper. An inexpensive test meter is useful for checking that the battery voltage is getting through to the circuit board.

Testing Time

A multimeter is also useful for making continuity checks on switches, which may not operate in the way you think they do. Is "on" really "on", and "off" actually "off"? Often a project seems to be working irrationally, but it is just that one or more of the switches do not function as expected, giving automatic operation when you expect the project to work in manual mode, or something of this nature.

A multimeter can also be used to check cables for short-circuits or broken leads, and to check that plugs and sockets connect together properly. It is an essential piece of test gear that newcomers should buy sooner rather than later.

Modern components are very reliable, and duds are few and far between. It helps to bear in mind that if you get everything connected together properly your projects will work. On the other hand, they will never work if you do not "take the plunge" and actually build them.

Apply a little magic with Dontronics

Pre-designed PCB's with post design flexibility

DT001	SimmStick development platform, and cheap PIC programmer. Lots of options. Designed for PIC chips, can be used for other Micros.	£ 12.96
DT003	Simmstick mini-bus, power supply, and comms port with D-9 and Max-232.	£ 5.55
DT101	A PicStic equivalent circuit on a SimmStick platform. PicStic versions 1, 2, and 3, all rolled up into one, plus a Max-232 and 24LCxx type EEprom. 1"	£ 2.96
DT103	Designed for the Atmel AVR 40 pin Micros. Can be used for non-AVR Micros	£ 4.07
DT104	Designed for the Atmel AVR 20 pin Micros. Can be used for the earlier versions such as the AT89C2051, as reset inversion is provided. 1" module	£ 2.96
DT201	One Inch Prototype board.	£ 2.96
DT202	Two Inch Prototype board	£ 4.07
DT203	24 LED's, 4/8 switches on a SimmStick platform. 2" module. Uses 1 to 3 ULN2803's, 4 momentary switches, 8 link selected switches.	£ 4.07
DT204	Expansion board for SimmStick Bus. 2" Module.	£ 4.07
DT205	Relay board for 4 relays. Carries a partial bus on to the next module so that a total of 16 relays could be used by cascading four boards	£ 5.55

Also available:

LCD text modules from **£ 6.20**

LCD graphics modules from **£39.99**

12V plug top CE approved PSU **£ 3.99**

PIC16F84-04/P new unused parts **£ 3.30**

Microchip 1998 CDROM only **£ 4.99**

All prices exclude VAT at 17.5% Subject to £3 P&P

For additional information, please call or visit the web site - www.asamicros.com

micros ltd

DELTA VISA

Tel: 01706 371695

Fax: 01706 375896

Email: sales@asamicros.com

ASA Micros Ltd.
21 Edmunds Fold
Littleborough
Lancs. OL15 9LS

Advertisement

20% discount for EPE readers

Temperature controlled soldering stations

Vann Draper Electronics Ltd
The test & measurement specialists
www.vanndraper.co.uk
Grundig, Kenwood, Hitachi, Fluke, Avo, Advance

Vann Draper is offering over 20% discount to readers of ***Everyday Practical Electronics*** on their temperature controlled soldering stations.

The SL20 bargraph display soldering station normally sells at £69.33 and is available to readers of EPE at only **£55** fully inclusive of vat & delivery.

The SL30 digital display version is normally priced at £81.08 but for readers of *EPE* the price is just **£65** fully inclusive.

Both soldering stations feature 24V 48W elements for rapid heating and have full electronic temperature control between 150°C and 450°C.

The SL20 and SL30 are supplied ready to use complete with a 48W iron, 0.8mm long-life bit, mains lead, operating instructions and a 12 month guarantee.

To order simply post the coupon to **Vann Draper Electronics Ltd** at **Unit 5, Premier Works, Canal Street, South Wigston, Leicester LE18 2PL.**
Alternatively tel 0116 2771400, fax 0116 2773945
or email sales@vanndraper.co.uk

Use this coupon for your order

Please supply me:
..... SL20 soldering station(s) at £55 inc vat & del
..... SL 30 soldering station(s) at £65 inc vat & del
..... Extra 0.8mm bit(s) at £1.65 inc vat & del
..... 1.6mm bit(s) at £1.65 inc vat & del
..... 3.2mm bit(s) at £1.65 inc vat & del

Name:

Address:

Tel No:

Total £

Cheques payable to Vann Draper Electronics Ltd or debit my visa, mastercard or switchcard.

Card type:

Card No:

Expiry date: Switch iss No:

Signature:

Overseas readers can still obtain this discount but carriage charges vary according to country. Please telephone, fax, email or write to Vann Draper.

VIDEOS ON ELECTRONICS

A range of videos (selected by EPE editorial staff) designed to provide instruction on electronics theory. Each video gives a sound introduction and grounding in a specialised area of the subject. The tapes make learning both easier and more enjoyable than pure textbook or magazine study. Each video uses a mixture of animated current flow in circuits plus text, plus cartoon instruction etc., and a very full commentary to get the points across. The tapes originate from VCR Educational Products Co, an American supplier.
(All videos are to the UK PAL standard on VHS tapes.)

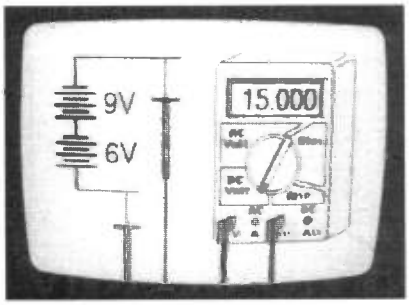
BASICS

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

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

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

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



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

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

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

£34·95 each
inc. VAT & postage
Order 8 or more get one extra FREE
Order 16 get two extra FREE

VCR MAINTENANCE

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

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

DIGITAL

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

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

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

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

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

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

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

RADIO

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

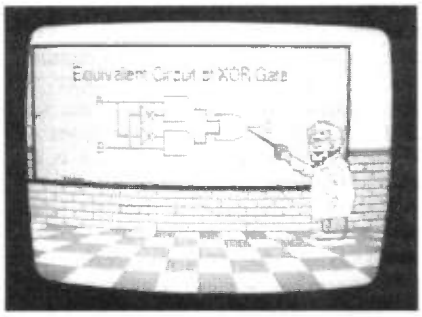
VT402 58 minutes. F.M. Radio Part 1. F.M. basics including the functional blocks of a receiver. Plus r.f. amplifier, mixer oscillator, i.f. amplifier, limiter and f.m. decoder stages of a typical f.m. receiver. **Order Code VT402**

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

MISCELLANEOUS

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

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



VIDEO ORDER FORM

Full name:.....

Address: .....

.....

..... Post code: .....Telephone No.....

Signature: .....

☐ I enclose cheque/PO payable to WIMBORNE PUBLISHING LTD

☐ Please charge my Visa/Mastercard: Card expiry date .....

Card No: .....

Please send video order codes:.....

.....

Please continue on a separate sheet of paper if necessary.

ORDERING: Price includes postage to anywhere in the world.

OVERSEAS ORDERS: We use the VAT portion of the price to pay for *airmail* postage and packing, wherever you live in the world. Just send £34.95 per tape. All payments in £ sterling only (send cheque or money order drawn on a UK bank).

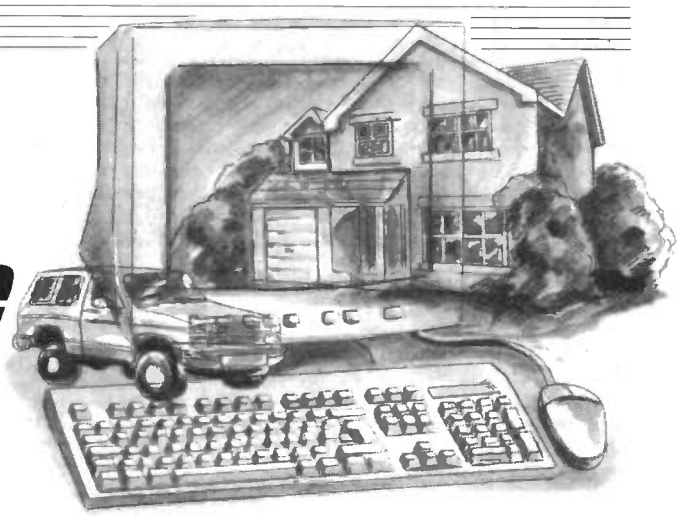
Send your order to:
Direct Book Service, 33 Gravel Hill, Merley, Wimborne, Dorset BH21 1RW (Mail Order Only)

Direct Book Service is a division of Wimborne Publishing Ltd.
Tel: 01202 881749 Fax: 01202 841692

Videos are normally sent within seven days of receipt of order.

Constructional Project

WIRELESS MONITORING SYSTEM



JAMES HUMPHRIS

Part One

Low cost radio-linked short-range data logging is now readily and simply available.

UNTIL recently, the lack of availability of low-cost data transmitters meant that the use of telecommunications within the home for hobbyists or for educational purposes was either too expensive or complicated to be practical.

Increases in the demand for such devices, along with improvements in the technology, mean that various companies are mass-producing telemetry equipment that is low cost and can legally be used in the domestic environment. This equipment usually consists of pairs of radio transmitter and receiver modules that are suited for short-range data transfer purposes.

This article describes a project that makes use of such modules in order to monitor domestic conditions or environments without the need for wires. The basic system is used with a.m. (amplitude modulated) modules, although the use of f.m. (frequency modulated) modules is discussed in Part 2.

The system is based around a PIC microcontroller and can be used to monitor the activity of virtually any number of different conditions within a small area, i.e. around a house or within a classroom or workshop. The beauty of this system is its incredible flexibility!

It has been designed to comply with Home Office regulation MPT1340 and does not need a licence for use in the UK.

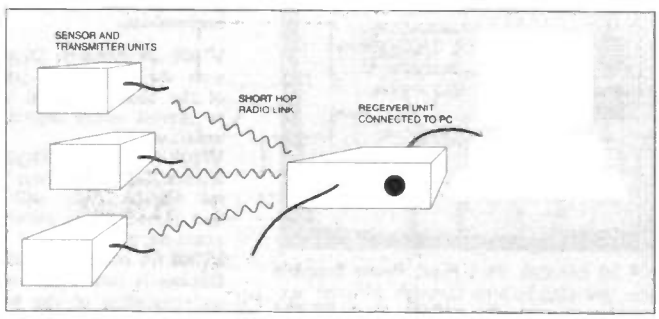


Fig.1. Block diagram of the Wireless Monitoring System.

A PC-compatible computer (running Windows 3.1, 95 or 98) is required to display the recorded data.

For compactness, surface mount devices are used for the Transmitter. The Receiver circuit board uses "standard" through-hole components.

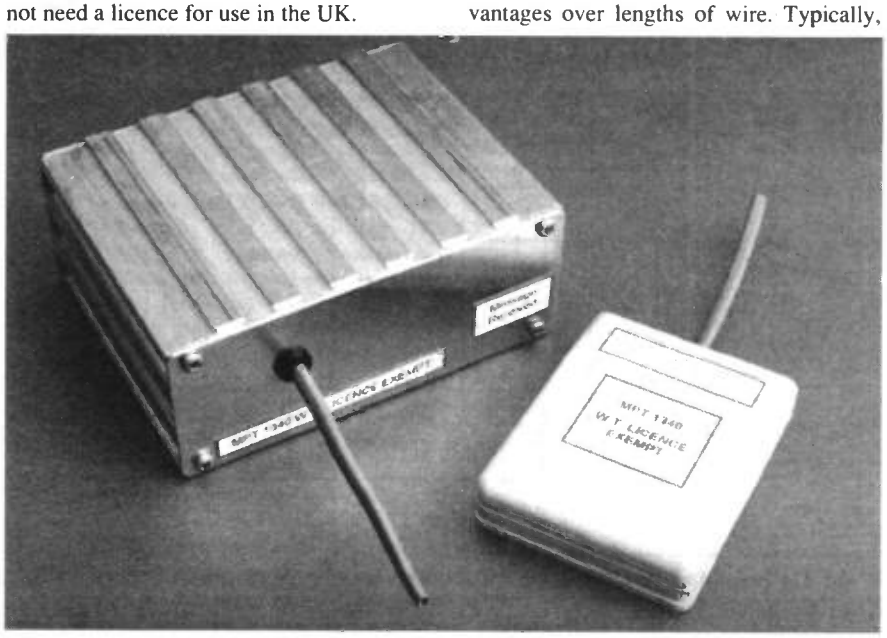
WAVES NOT WIRES

Radio waves have several distinct advantages over lengths of wire. Typically, radio waves are far more robust; they cannot be cut or broken and do not degrade over time. Sensing devices linked by radio waves tend to be less physically intrusive and more independent. Keeping the actual sensor local to the transmitter virtually eliminates any noise or degradation in the signal being monitored.

Furthermore, any hard-wired sensing interface has a limited number of inputs that need to be manually configured every time a change is required in the system configuration. Using radio waves not only increases the number of sensors that can be used, but also provides the added flexibility of being able to be brought on and off line as required.

Damage caused by faults in an r.f. (radio frequency) system is limited to the transmitting device and sensor interface at which it occurs, rather than affecting the whole system. Sensors can also be placed upon mobile equipment such as robots or vehicles and provide continuous data over a short range without trailing wires.

This project consists of a minimum of two units, a single Transmitter and a Receiver connected to a local PC-compatible computer, as shown Fig.1. As many units as are required to perform the task can be added, and information logged by the PC. Every time an output change occurs in the sensor connected to a transmitter, a message is sent to a receiver connected to the PC. The latter can then analyse and process the information.



Due to the low power radio modules used, the emphasis here is not on the physical range of operation, but more to providing increased flexibility and fewer wires!

APPLICATIONS

The transmitters have been designed to make any hardware very simple and place all of the strain on the software running them. This means that by re-programming the devices, many types of data logging can be achieved.

For example, the PIC could be programmed to collect and store information regarding a sensor signal for a long period before transmitting this information at a later time. Useful, for example, to monitor temperatures and speeds in a vehicle, downloading the data once back at base.

Alternatively, it could be programmed to transmit a message only if a sensor output fell below or rose above a predetermined level. It is due to this wide range of configurations that a specific system is described here, but advice is given to readers who may wish to reprogram their own PICs.

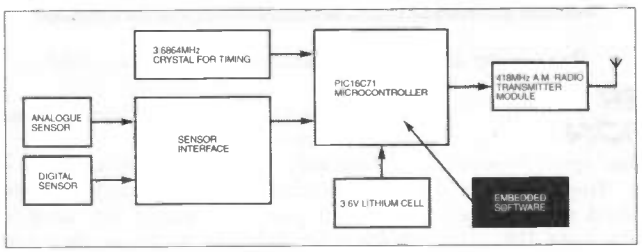


Fig.2. Transmitter block diagram.

A further advantage is that the PIC consumes a very low quiescent current. This means that the transmitter units can be battery powered and operate over very long periods without the need for any maintenance.

HOW IT WORKS

The block diagram of the transmitter unit's operation is shown in Fig.2. Two sensor interfaces provide one digital and one analogue channel. The output from the sensor interface is fed directly into the microcontroller that continuously monitors the inputs. When a change occurs in either of these levels, the radio transmitter is passed a serial message consisting of the digitised sensor information.

A single 3·6V Lithium cell is used to power the unit. It is thus completely independent in use and suffers no external interference from other equipment.

The receiver block diagram is shown in Fig.3. The radio receiver monitors all the activity on the specific radio channel to which it is tuned, and converts the presence or absence of the r.f. carrier to logic high or low respectively. This signal is monitored by the microcontroller, which determines the validity of the data stream.

If a valid data packet is detected, it is processed and re-modulated into the correct timing protocol for RS232 data. This signal is converted into RS232 levels by a line driver and is then passed on to the PC via a serial port.

Power is supplied to the receiver via a standard mains power adaptor, the output of which is regulated within the receiver to 5V. Two l.e.d.s are used to show the status of the r.f. and the RS232 channels. The modulation of the r.f. channel and RS232 line is performed entirely by the microcontroller in real time.

TRANSMITTER DESIGN

The Transmitter circuit diagram is shown in Fig.4. This design incorporates an on-board temperature sensor (R2) and tilt switch (S5), both of which can be monitored by the software.

Any change in the temperature of the air around R2, which is a negative-coefficient thermistor, causes a proportional change on the voltage at IC1 pin 2. This level is constantly digitised by an analogue-to-digital converter (ADC) inside the PIC (IC1). The PIC is an 8-bit processor and hence the converter has 256 discrete output levels.

When the output of the ADC changes, the PIC then transmits a message. In the configuration used, the minimum detectable temperature change is ±0·3°C. Each transmission lasts for 330ms which means that the maximum rate of change of temperature that is accurately measurable is one degree per second.

The output from the tilt switch S5 is fed directly to pin 1 of IC1, and is also continuously monitored for a change in state. When a high level is detected, continuous messages are transmitted.

The bit periods required for the communication across both the r.f. and RS232 channels are produced by timing routines within the PIC. This means that the hardware is kept simple, but the crystal frequency used must be a direct multiple of the frequency required. In this case, 3·6864MHz is chosen since when divided by 12288, it provides the 300-baud bit-rate used in the r.f. channel, and when divided by 384 provides the 9600-baud bit-rate required for RS232 communication.

Dual-in-line (d.i.l.) switches S1 to S3 can be used to allow software options to be chosen without needing to reprogram the PIC. However, the software provided does not make use of this feature and

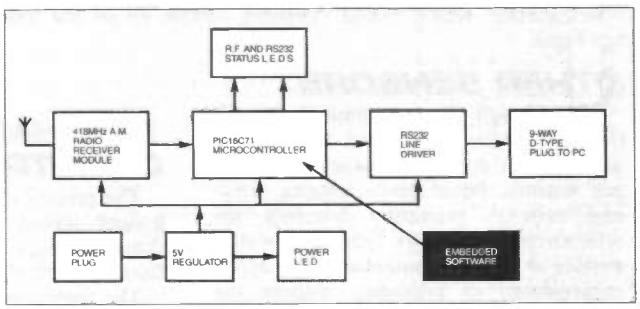


Fig.3. Block schematic diagram for the Receiver.

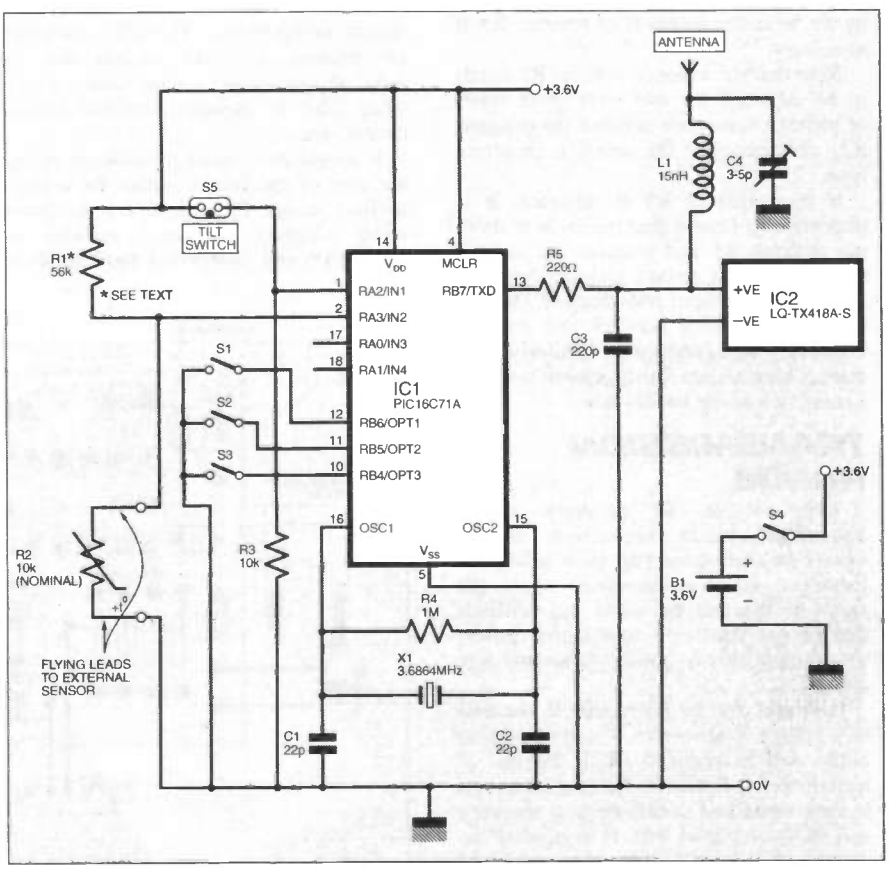


Fig.4. Complete circuit diagram for the Transmitter. Note that switches S1 to S4 are d.i.l. slide types.

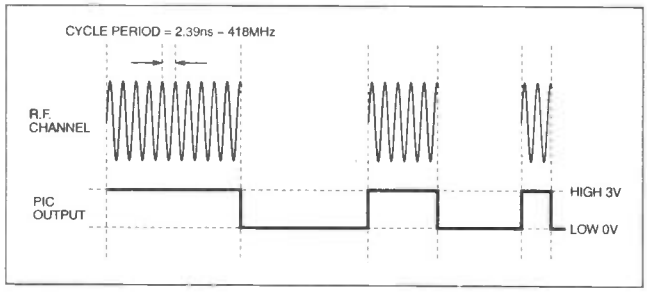


Fig.5. Using a PIC to control transmitter r.f. modulation.

therefore small wire links or zero ohm resistors must be soldered across the pads to effectively connect all of the switches permanently closed.

When a high level is present at pin 13 of IC1, transmitter module IC2 is switched on. Resistor R5 and capacitor C3 are used to limit the current and minimise the slew rate of the signal that drives IC2. The positive pin of IC2 is modulated by a 418MHz carrier wave that excites the inductor L1 and variable capacitor C4 that provides the r.f. signal to the antenna.

This provides a very simple modulation scheme where free space is radiated by r.f. when a high level output is produced by the PIC and not radiated when a low output is produced. This method has the advantage of consuming current for only part of the transmitted data word rather than using a constantly modulated carrier, which would consume current all of the time. See Fig.5.

OTHER SENSORS

This design is not limited to the types of sensor shown here. Other types such as light dependent resistors (l.d.r.s), gas sensors, liquid level sensors, pressure switches, proximity detectors, accelerometers, pressure pads, humidity sensors or pressure gauges etc., can all be implemented as necessary without the need for any software change in the transmitter's PIC.

Switch sensors can be directly replaced by S5 with the removal of resistor R3 if necessary.

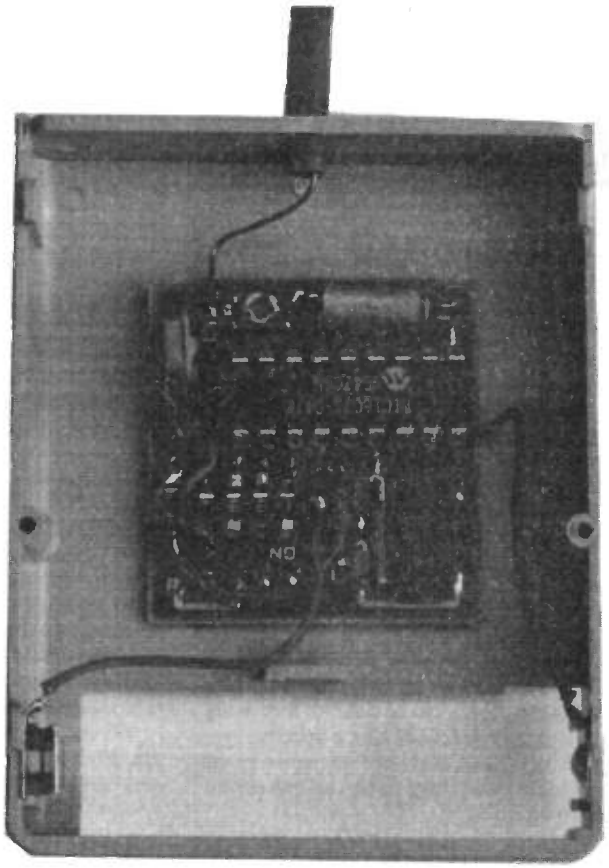
Note that the value of resistor R1 needs to be adjusted for use with other types of passive resistance sensors (in position R2), or removed if the sensor is an active type.

If the value of R1 is adjusted, it is important to ensure that the current flowing through R1 and position R2 is kept around 50μA. Currents smaller than this may cause the input resistance of the PIC to load the resistor network and produce inaccurate measurements. Similarly, any current higher than this level will result in a reduction of the battery life.

TRANSMISSION RANGE

When it is all properly tuned, transmitter/receiver separation of 10 metres in free space has been achieved. However, in an environment where the signal is blocked by walls and ceilings, due to the relatively low signal power transmitted, this is limited to around five metres.

It should also be noted that as the battery charge deteriorates, the transmitting range will be reduced. With the use of lithium cells, however, this deterioration is very rapid and occurs only at the very end of their useful life. It is a good indicator of a dying battery if many errors are suddenly received in messages during reception.



Positioning of the p.c.b. inside the Transmitter case.

TRANSMITTER CONSTRUCTION

The printed circuit board (p.c.b.) component layout for the Transmitter is shown in Fig.6. This board is available from the *EPE PCB Service*, code 219.

The completed board is only 33mm × 32mm square by 15mm deep (height). It is double-sided and uses a mixture of standard (through-hole) and surface mount components. The PIC, transmitter module and tilt switch are the only through-hole components, everything else is industry-standard surface mount size.

It would have been possible to reduce the size of the board further by using a surface mount PIC. However, programming adaptors for these devices are expensive and somewhat hard to come by, so a socketed d.i.l. device has been retained for simplicity.

Assembly is relatively simple. It is recommended that a fine tipped soldering iron and pair of tweezers are used to solder the smallest parts as they can easily be destroyed by excessive heat. It is important to solder resistors R4 and R5 before the socket for IC1 as they lie under this socket and are very difficult to access once it is in place.

The socket for IC1 must be soldered on both sides of the board. It is recommended that a piece of 1mm × 2mm × 30mm cardboard is inserted under the socket in order to lift the device up above the board whilst soldering the topside. This ensures that there is enough space on the top of the board to mount the socket whilst the legs are still accessible from underneath it.

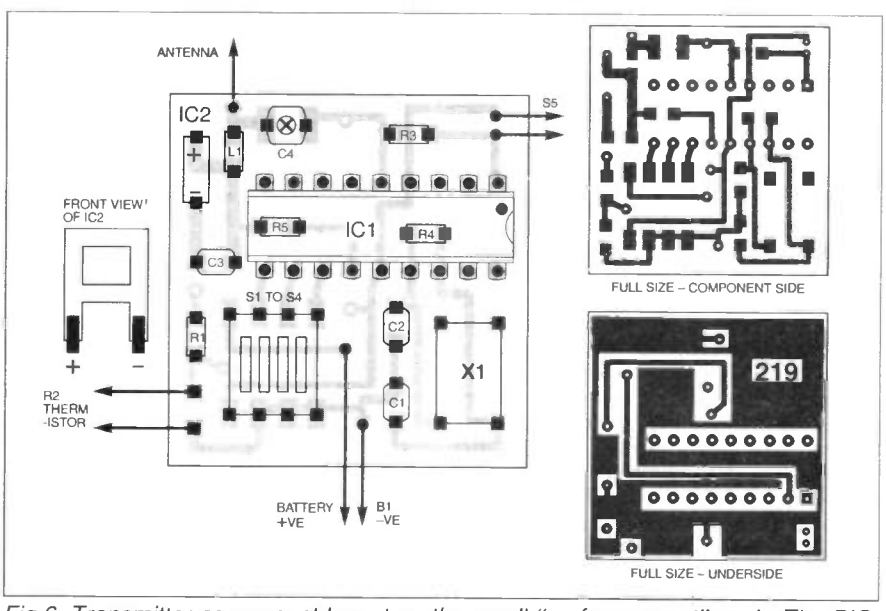


Fig.6. Transmitter component layout on the small "surface mount" p.c.b. The PIC, transmitter module and tilt switch S5 are the only non-surface mount devices.

COMPONENTS

Transmitter

Resistors

R1	56k (see text)
R2	10k thermistor bead, n.t.c.
R3	10k
R4	1M
R5	220Ω

All resistors (except R2) surface mount package 1206.

See SHOP TALK Page

Capacitors

C1, C2	22p ceramic, SM package 1206 (2 off)
C3	220p ceramic, SM package 1208
C4	3p to 5p trimmer, TZBX4, surface mount

Semiconductors

IC1	PIC16C71 microcontroller, pre-programmed (see text)
IC2	LQ-TX418A-S (a.m.) or TXM418-A (f.m.) transmitter module (see text)

Miscellaneous

B1	3·6V lithium cell, AA size
L1	15nH inductor, SM package 0805
S1 to S4	4-way d.i.l. slide switch module, surface mount
S5	tilt switch (see text)
X1	3·6864MHz crystal, surface mount

Printed circuit board available from the *EPE PCB Service*, code 219 (Transmitter); 18-pin d.i.l. socket; antenna, 0.5mm × 90mm solid-core copper wire (see text); handheld plastic case, 56mm × 71mm × 18mm, connecting wire; solder, etc.

Approx Cost Guidance Only **£29** ***excluding battery***

The only other slightly tricky part of the assembly is soldering inductor L1. This device is a surface mount 0805 type and measures only 1mm × 1mm × 2mm and is easily damaged. Care must be taken to make sure that no whiskers of solder are between the pads before soldering as removal once soldered is very difficult and will probably render it useless.

Check that the ground connection for the transmitter module is properly made on both sides of the board at every grounding point as this provides a solid ground connection throughout the copper.

Sensors R2 and S5 (temperature and tilt) can be mounted either on the board, or on flying leads as necessary for the specific application.

Finally, note that the positive lead of the transmitter module is marked with a spot. Failure to observe the polarity of this device will result in it not working and is an expensive mistake!

The antenna used is a short whip type. It is simply made from a 90mm length of solid copper wire of 0·5mm diameter with one end soldered to the junction of C4 and L1 on the p.c.b.

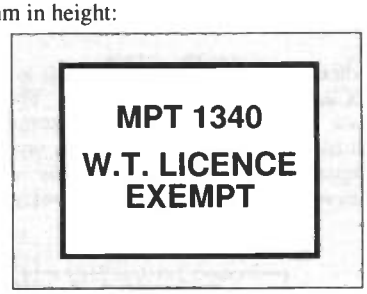
The pre-programmed PIC16C71 needs to be firmly placed into the socket without bending any of its pins! Once this is completed, a quick test is to check the current consumption of the unit with S4 switched on. This should be either 0·5mA or 25mA depending on whether or not the unit is transmitting. (A transmission can be forced by manually changing the sensor output e.g. changing the temperature around the sensor.)

The finished Transmitter is tuned using a non-metallic trimmer to adjust variable capacitor C4 for the best performance, but this needs to be completed in conjunction with the finished Receiver unit and will be discussed in Part 2.

OBSERVING MPT1340

This design uses a radio frequency that does not require a licence for use within the UK. However, in order to comply with Home Office regulation MPT1340, it is necessary to enclose the unit within a suitable box so that external adjustment cannot be made to the transmitter module. There are also restrictions on aerial use.

Both the transmitter and receiver enclosures must be clearly labelled as indicated below with lettering not less than 2mm in height:



The transmitter antenna must be of an integral type. The Radio Communications Agency (RA) defines an integral antenna as "one which is designed to be connected permanently to the transmitter or receiver without the use of an external feeder". It is important, therefore, that the antenna is not accessible from the outside world and must not be removable.

In this instance, as long as the actual antenna wire is covered by a suitable sheath, such as a length of plastic wire-cladding and sealed at one end using a suitable adhesive, then it can be considered as integral. The receiver antenna can be integral or external as required.

TRANSMITTER ENCLOSURE

Any box suited to the final application can be used to enclose the Transmitter board. The type of box used here allows the user easy access to the integral battery compartment and all switches on the p.c.b.

Flying leads connect the power to the p.c.b. from the battery holder at the bottom of the box. The positive connection is in the centre of the board and ground near the variable capacitor C4. The finished p.c.b. is simply stuck to the base of the enclosure using a sticky pad or glued with a suitable adhesive.

This enclosure also allows easy access to the PIC if any reprogramming is required, and for changing the battery when necessary.

The antenna is brought out through a small hole in the front plate of the enclosure. It must conform to MPT1340 as discussed earlier.

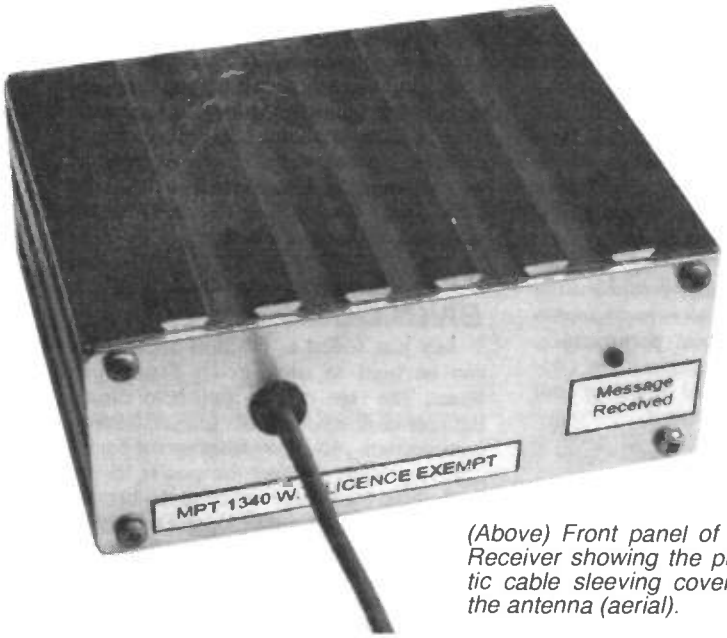
BATTERY LIFE

A single AA type Lithium cell powers the unit. This cell is non-standard with a terminal voltage of 3·6V and capacity of 2·3Ah. The transmitter has a standby current consumption of around 0·5mA and a transmitting consumption of 25mA.

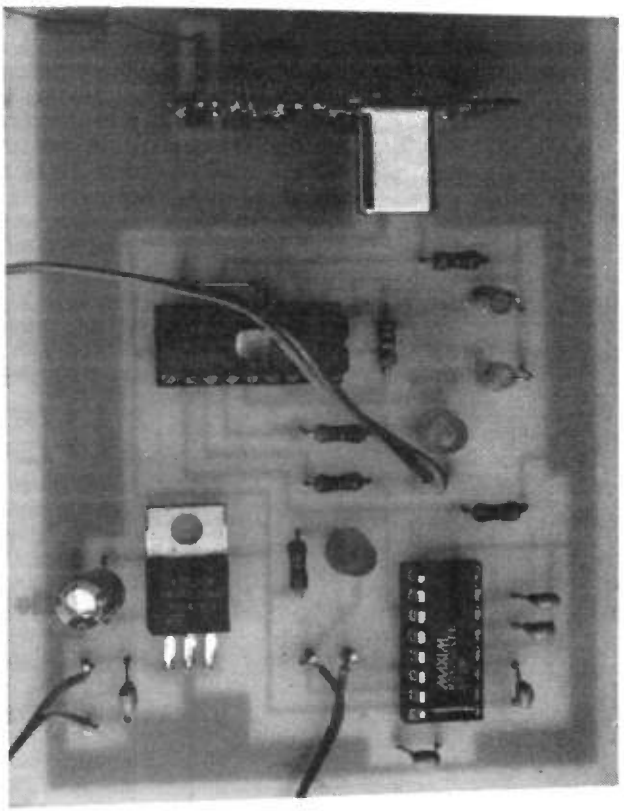
This means that each cell would theoretically last for 4600 hours (around 6·5 months) in standby mode and 92 hours (almost four days) constant transmission. In use the life of the cell will lie somewhere between these two limits, depending on the number of transmissions made.

The type of battery used is not critical, and hence the enclosure does not neces-

Two completed Transmitters. One with remote thermistor sensor and the other showing the required "licence exempt" label.



(Above) Front panel of the Receiver showing the plastic cable sleeving covering the antenna (aerial).



(Right) Layout of components on the completed Receiver p.c.b. The receiver module is shown mounted at right-angles to the board at the top.

sarily require an internal battery compartment. If required, the unit can be powered from any supply between 3V and 6V d.c. Do bear in mind, though, that a high capacity cell is required if the particular application demands that the unit be switched on for long periods at a time.

RECEIVER CIRCUIT

The full circuit diagram for the Receiver is shown in Fig.7. The receiver module (IC3) receives and decodes anything that it happens to receive on the 418MHz channel and translates this information into a logic signal on its Data pin 13.

This information is serially passed into the PIC (IC2) that tests any data for its validity. Once valid data is detected, the PIC passes a serial signal to RS232 line driver (IC4) that is used to interface to the computer.

The communication to the PC is very simple, using no handshaking and only requiring data (pin 2) and ground (pin 5) connections, via socket SK1. However, in order to use some terminal applications which require handshaking, it is necessary to link computer connections RTS (Ready to Send – pin 8) and CTS (Clear to Send – pin 7) together. This must be completed at the back of the connector in the Receiver unit.

There are three light emitting diodes (l.e.d.s) shown in the circuit, D1 to D3. Two of which are mainly used for diagnostic testing during programming, but are also useful when setting up the equipment. The status of the RS232 line is indicated by l.e.d. D1, that of the r.f. channel by D2, and D3 indicates when the unit is switched on.

Indicators D1 and D2 will flash quickly when the unit is receiving and transferring information. If the PIC has received information, but not determined it to be invalid, then D2 will flash but not D1.

The input voltage is regulated down to 5V by IC1. This allows any power supply source from 7V to 30V d.c. to be used. To use the Receiver with an input voltage of 5V or 6V, IC1 should be omitted.

Test point TP1 – connected to pin 12 of the receiver module IC3 – is used when tuning the Transmitter unit in order to achieve the best reception. This pin acts as a Relative Signal Strength Indicator (RSSI) and provides an analogue signal output that corresponds to the strength of the received carrier wave.

RECEIVER CONSTRUCTION

The Receiver uses a conventional single-sided printed circuit board and consists of all through-hole components, apart from the crystal X1. The latter is a

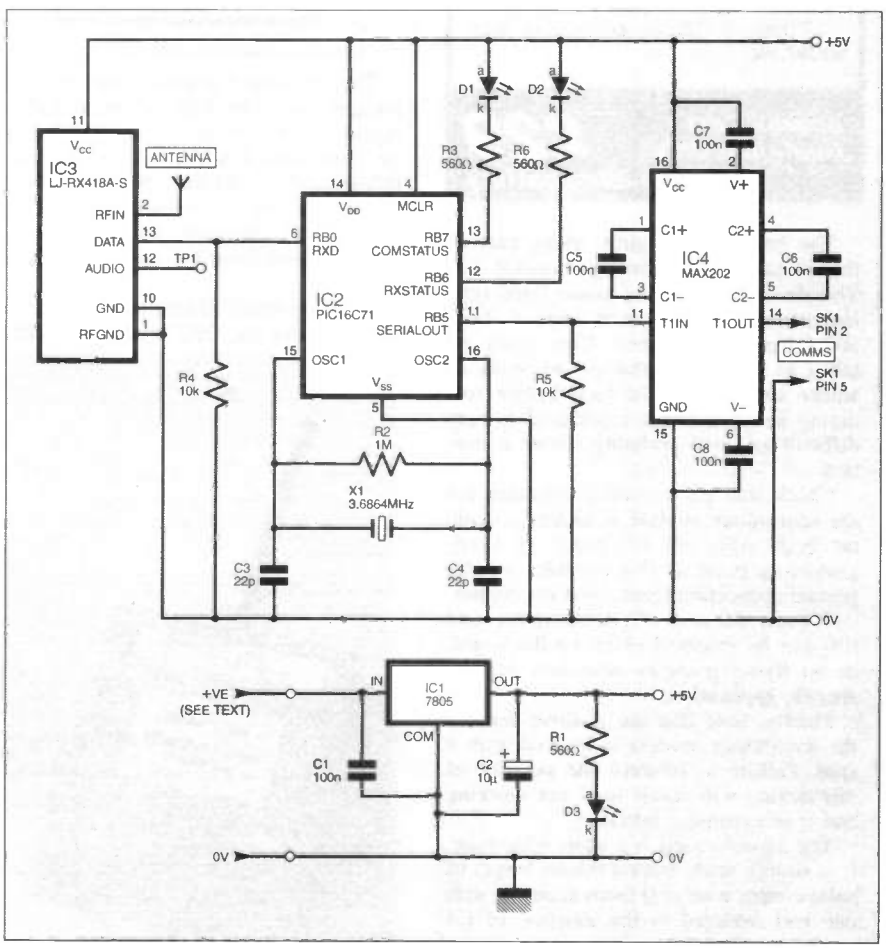


Fig.7. Full circuit diagram for the Receiver section of the Wireless Monitoring System. If the circuit is to be powered from a 5V to 6V source, IC1 can be omitted.

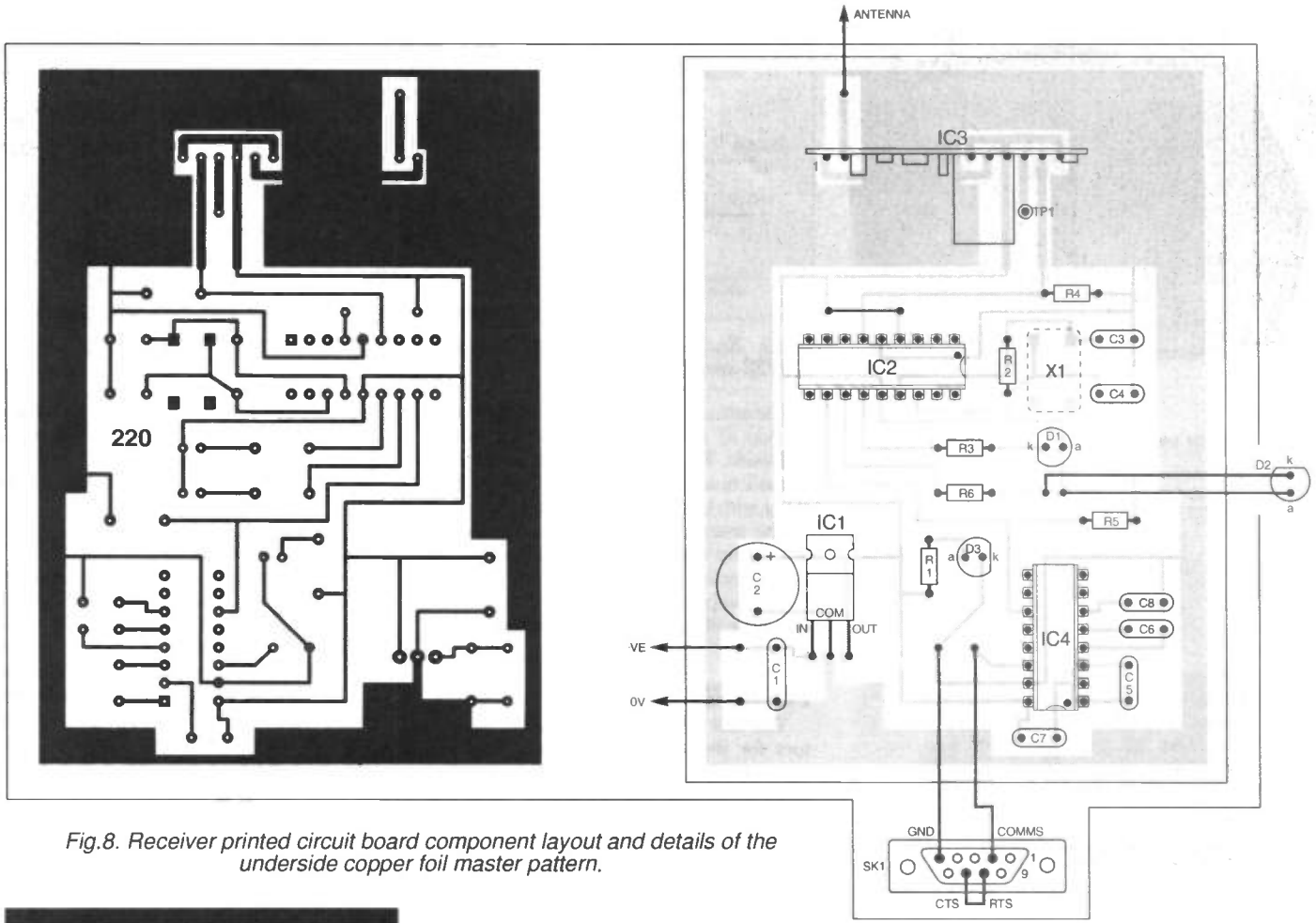


Fig.8. Receiver printed circuit board component layout and details of the underside copper foil master pattern.

COMPONENTS

Receiver

See SHOP TALK Page

Resistors

R1, R3, R6 560Ω (3 off)
R2 1M
R4, R5 10k (2 off)
R7 10k (f.m. adp. – next month)
All 0.25W 5% metal film.

Capacitors

C1, C5 to C8 100n ceramic disc (5 off)
C2 10μ elect, radial 16V
C3, C4 22p polystyrene (2 off)

Semiconductors

D1, D3 red l.e.d. (2 off)
D2 green l.e.d.
IC1 7805, 5V regulator
IC2 PIC16C71 microcontroller, pre-programmed (see text)
IC3 LJ-RX418A-S (a.m.) or SILRX-418A (f.m.) receiver module (see text)
IC4 MAX202 RS232 line driver

Miscellaneous

SK1 RS232 9-pin D-type connector
X1 crystal, 3·6864MHz, surface mount

Printed circuit board available from the *EPE PCB Service*, code 220 (Receiver); 16-pin d.i.l. socket; 18-pin d.i.l. socket; antenna, 0.5mm × 90mm solid-core copper wire; power supply socket, 2·1mm; 9V mains adaptor, 600mA; extruded aluminium case, 107mm × 84mm × 47mm; serial lead to suit; connecting wire; solder, etc.

Approx Cost Guidance Only* £39 *excl. mains adaptor

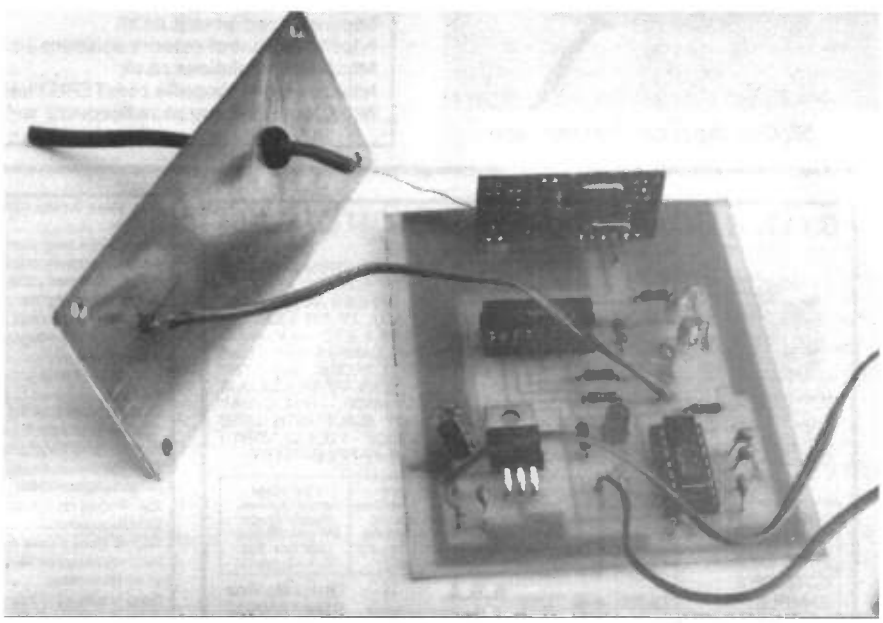
surface mount device and is mounted on the reverse, copper side, of the board. Details of the board component layout are shown in Fig.8. This board is available from the *EPE PCB Service*, code 220.

Construction is straightforward, but note that IC1 and IC4 should be mounted in sockets, Take care when handling IC3 as it is easily damaged by static electricity.

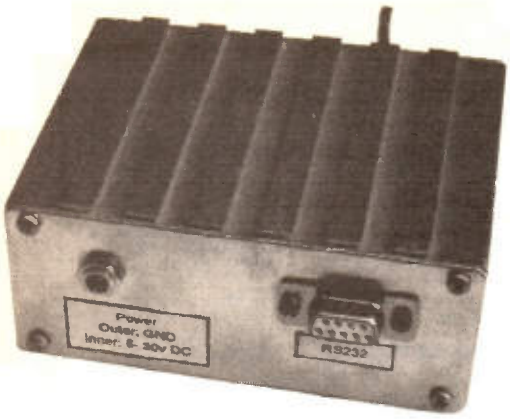
Observe the correct polarity of l.e.d.s D1 and D2. If preferred, they could be mounted on the front of the enclosure via flying leads to show diagnostic information whilst in use. They provide a useful indicator to the number of valid messages that are received.

RECEIVER ENCLOSURE

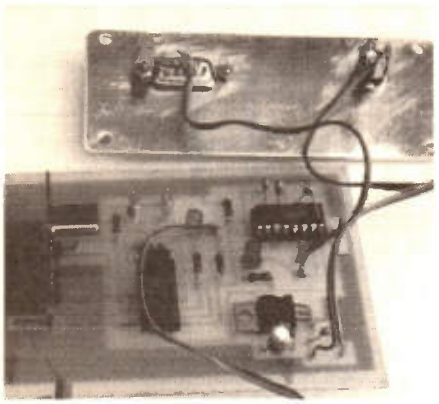
A fully enclosed metal box for the receiver is recommended as this provides good screening against radio frequency interference and improves performance significantly. The type used here is extruded aluminium with internal slots for p.c.b.s. The advantage of this box is that the two end plates can hold the connectors and the antenna whilst the p.c.b. is firmly held inside.



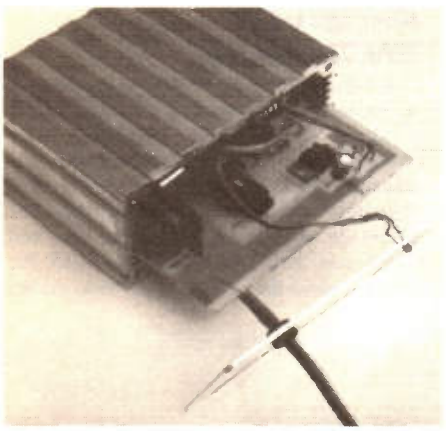
The r.f. status l.e.d. mounted and wired on the front panel. This can also be accompanied by the RS232 com status l.e.d. if preferred.



Rear view of the completed Receiver.



Wiring from the p.c.b. to the D-type connector and the power socket on the rear panel.



Slotting the p.c.b. into the case.

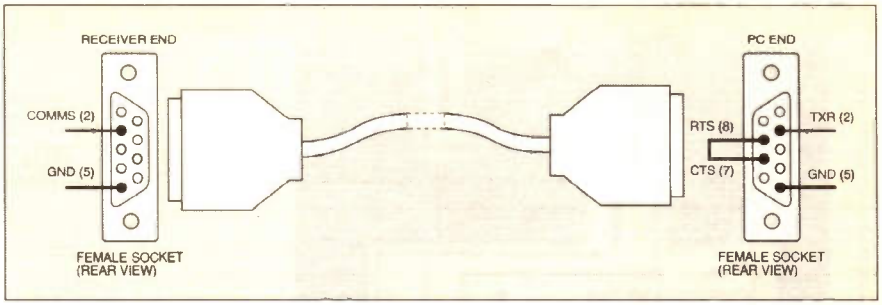


Fig.9. Serial cable interconnection details between the Receiver and the PC RS232 serial port.

The antenna should be connected through the top of the board and soldered on the underside. This can then be led out through a small hole in the front panel of the case along with l.e.d.s D1 and D2, if preferred.

The antenna can be screened inside the box before it reaches the outside world but it has been found not to provide any significant improvement in performance. There should be 90mm of antenna wire outside the enclosure.

RS232

The rear of the unit holds the connectors for the RS232 and power leads. A low voltage d.c. power connector of 2·1mm diameter is used for the power supply as this type is adopted by many of the ready-made mains adaptors to which this unit is well suited. Other power connectors may be used if required.

Note that with some adaptors the outer contact must be connected to ground as this is directly connected to the case. If a plastic socket is used, then ensure that the enclosure is connected to ground via a solder tag at one of the connector screws.

It is not essential to use a D-type connector on the rear of the unit to connect the serial cable, but this is recommended as it allows the use of ready-made serial leads. If a ready-made lead is used, make sure that it is a "straight through" type, i.e. transmit and receive are not crossed over inside the connectors. The necessary connections for the serial cable are shown in Fig.9.

RESOURCES

Software for the Wireless Monitoring System is available on a 3·5-inch PC-compatible disk from the *EPE PCB Service* (for details see that page in this issue – the software is free but there is nominal post and handling charge for the disk). It is also available for free download from our web site: **ftp://ftp.epemag.wimborne.co.uk/pub/PICS/wireless.**

Pre-programmed PIC16C71s are available, see this month's *Shop Talk* page. Information on obtaining other "special" components for this design are also given on this same page.

The transmitter boards are supplied as a pair, one for a.m. and one for the f.m. adaptor, codes 219 and 219a, respectively. The receiver boards are also supplied as a pair, again one for a.m. and one for the f.m. adaptor, codes 220 and 220a respectively. See the *EPE PCB Service* page for price details.

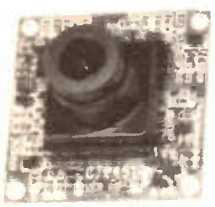
Next Month: Testing, setting-up, software and f.m. adapator details.

INTERNET REFERENCES

The following web sites may be of use to any readers interested in developing equipment based on the 418MHz frequency:

http://www.lprs.co.uk	Radio module distributor
http://www.radiometrix.co.uk	Radio module distributor
http://www.control-network-solutions.co.uk	Radio module distributor
http://www.rfsolutions.co.uk	Radio module distributor
http://www.zdwebopedia.com/TERM/t/telematics.html	Some definitions
http://www.open.gov.uk/radiocom/ra_wel.htm	MPT specifications

C.C.T.V. BOARD CAMERAS FROM £19.95 inc. VAT



MINIATURE C.C.T.V. CAMERAS FROM TOP USA MAKER. IDEAL FOR COVERT SURVEILLANCE OR SECURITY USE IN SHOPS, OFFICES AND PRIVATE HOMES. CONNECTS TO ANY TV OR VIDEO IN SECONDS – OPTIONAL CABLE ETC. AVAILABLE. OUR 1993 PRICE FOR THIS CAMERA WAS £385!! HUGE RECESSION IN ELECTRONIC INDUSTRY HAS SLASHED THESE PRICES TO RIDICULOUS LEVELS! THESE ARE USA MADE – NOT CHEAP CHINESE MODELS. READY BUILT WITH LENS ETC. BRAND NEW 1999 STOCK – FULL 12 MONTH GUARANTEE. WORKS FROM 9V-PP3 BATTERY!

ONLY 29mm x 29mm

LOTS OF 10 (Each) £19.95
LOTS OF 5 £21.50
LOTS OF 2 £23.95
SAMPLE £25.95
Add P&P £3 ANY ORDER VAT INCLUDED

Audio Model add £5.00 Pinhole Model add £4.00 Cable, p.s.u., scarts etc available. Wide angle lens included FREE! VAT included	Applications: Security, Surveillance, Nanny Watching, Machine Monitoring etc. Works alone or in any casing	1/3in. image sensor. Auto iris. Supply voltage 6V–13V. 90° wide angle lens. Size 1in. x 1in. approx.

A.S.A. (Est. 1979)
51 Cambridge Road
Middlesbrough
TS5 5NL

Order Hotline
01642 850912
Fax:
01642 823173

Quad speed Toshiba 1/3rd height SCSI cd-rom drives ..... £20 each, 6 for £100
1 meg. 30-pin parity simms ..... £3.75 each, 4 for £12
4 meg. 30-pin parity simms ..... £13 each, 4 for £50
256k pipeline burst cache ..... £4.50 each
512k pipeline burst cache ..... £9 each
Trident 512k video cards ..... £12 each
Trident 1mb VLB video cards ..... £20 each
Internal VGA leads ..... £2.50 each, 10 for £20
3-device SCSI leads ..... £3 each
IDE leads ..... £2 each
Hard and floppy drive IDE controller cards £5
14,400 internal voice/fax/data modem £15
28,800 internal voice/fax/data modem £28
3lb mixed component pack £4.95
Jumbo component pack £10
250 off mixed capacitors £4.95
250 off i.c. sockets £3.95
1000 off mixed ceramic caps £7.50*
20 off mixed crystals/filters £4.95
25 off mixed relays £3.50
Brand new 360k 5¼" floppy drive £4.50
5¼" to 3½" floppy drive converter leads £1.50*
1·2MB 5¼" floppy drive £10
12V d.c. 200 r.p.m. geared motor ..... £1.50 each, 10 for £12
SCSI 2 fast differential hard drives
1 Gig £58
2 Gig £85
4 Gig £145
1 Gigabyte laptop drives, 2½in. IDE ..... £78 each

QUANTITY DISCOUNTS AVAILABLE PLEASE RING.
We also buy all forms of electronic components, p.s.u's, disk drives etc. Lists to below address.

ALL PRICES INCLUDE V.A.T. PLEASE ADD £2.00 p&p EXCEPT ITEMS MARKED ★ WHICH ARE 50P. SAE FOR BULK BUYING LIST PAYMENT WITH ORDER TO:
Dept EE, COMPELEC,
14 Constable Road,
St. Ives, Huntingdon,
Cambs PE17 6EQ
Tel/Fax: 01480 300819

SPECIAL EPE READER OFFER

M80Si MARCATO HI-FI STEREO AMP

£100 OFF NORMAL RETAIL PRICE

EPE, in association with B.K. Electronics, are pleased to be able to bring you this exceptional offer on a British designed and built Hi-Fi Amplifier.

Don't miss out, offer ends 31 March 1999

M80Si MARCATO STEREO INTEGRATED HI-FI AMPLIFIER

A British Hi-Fi Amplifier at an exceptional price. This new 80W+80W stereo amplifier has been produced by B.K. Electronics and rivals amplifiers costing nearly twice our special offer price.

The specification of the M80Si Marcato Integrated Amplifier is:

● Output Power	80W r.m.s. per channel into 8Ω
● Input Sensitivity	150mV for full output
● Frequency Response	20Hz to 25kHz -1dB
● Distortion	0·03%
● Signal-to-Noise Ratio	90dB
● Power Requirements	230V to 240V a.c., 50Hz to 60Hz
● Dimensions (w × h × d)	435mm × 70mm × 287mm
● Weight	6·4kg
● Inputs	AV, CD, AUX, TUNER, VIDEO, TAPE, DIRECT - routed direct, thus avoiding the selector switch, IEC MAINS SOCKET
● Outputs	RECORD, HEADPHONES, LOUDSPEAKERS - four2 sets of 4mm banana sockets for conventional or bi-wired connection
● Controls	POWER (with indicator), MUTE, BALANCE, MONO, VOLUME, DIRECT, INPUT SELECTOR

The amplifier comes with a full 12 month guarantee

Offer Price **£199**

including VAT and p&p

Normally £299 plus p&p

B.K. ELECTRONICS - *EPE* SPECIAL OFFER ORDER FORM

Fill in and send with your payment, or phone or fax us with your order and credit card details

Full name: .....

Address: .....

.....

..... Post code: ..... Tel. No. .....

Signature: .....

I enclose cheque/PO in £ sterling payable to WIMBORNE PUBLISHING LTD for £.....

Please charge my Visa/Mastercard: £..... Card expiry date .....

Card No: .....

Please send: **M80Si MARCATO HI-FI STEREO AUDIO AMPLIFIER**

Offer ends 31 March 1999. Orders normally sent within 7 days

DON'T MISS THIS EXCEPTIONAL READER OFFER

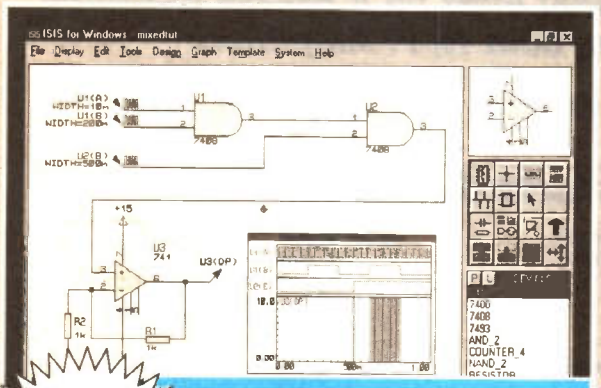
Send you order to:
EPE OFFERS, Allen House,
East Borough, Wimborne,
Dorset BH21 1PF
Tel: 01202 881749
Fax: 01202 841692

OVERSEAS ORDERS:
Price includes delivery to anywhere in the UK
Overseas orders add £5.50 for delivery
We cannot reply to overseas orders or queries by fax

PROTEUS

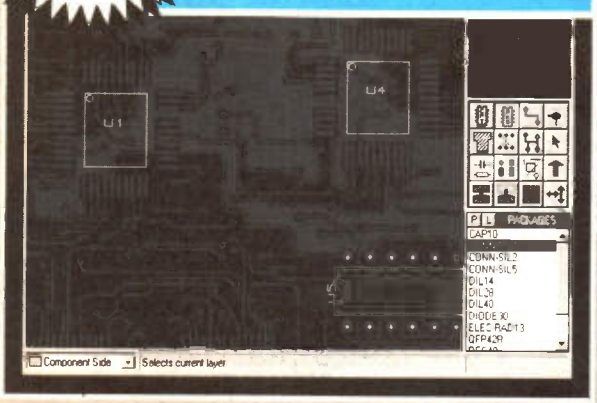
including NEW SIMULATOR

PRO SPICE 3F5



FREE SOFTWARE
ISIS & ARES Lite
Schematic & PCB Design

SHAREWARE VERSIONS AVAILABLE TO DOWNLOAD FROM OUR WEBSITE
http://www.labcenter.co.uk/



"the BEST all-round PROGRAM"
EWW CAD Review Round Up September 1998

Simulation

- Berkeley SPICE3F5 analogue simulation kernel.
- True mixed mode simulation.
- New analysis types include multi-plot sweeps, transfer curves, distortion and impedance plots.
- Active Components: Switches, Pots etc.
- Over 1000 new library parts with SPICE models.
- Greater ease of use.

"a constant high level of capability throughout"
EWW CAD Review Round Up September 1998

Schematic Capture

- Produces attractive schematics like in the magazines.
- Netlist, Parts List & ERC reports.
- Hierarchical Design.
- Full support for buses including bus pins.
- Extensive component/model libraries.
- Advanced Property Management.
- Seamless integration with simulation and PCB design.

PCB Design

- Automatic Component Placement.
- Rip-Up & Retry Autorouter with tidy pass.
- Pinswap/Gateswap Optimizer & Back-Annotation.
- 32 bit high resolution database.
- Full DRC and Connectivity Checking.
- Shape based gridless power planes.
- Gerber and DXF Import capability.

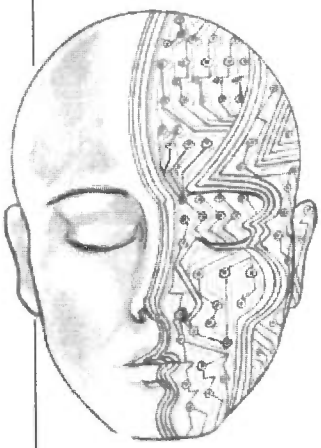
Available in 5 levels - prices from £295 to £1625 + VAT.
Call now for further information & upgrade prices.

Labcenter Electronics

Write, phone or fax for your free demo disk, or ask about our full evaluation kit.
Tel: 01756 753440. Fax: 01756 752857. EMAIL: info@labcenter.co.uk
53-55 Main St, Grassington. BD23 5AA. WWW: http://www.labcenter.co.uk

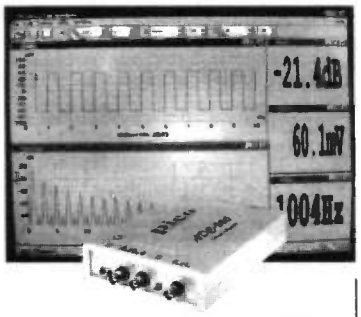
Fully interactive demo versions available for download from our WWW site.
Call for educational, multi-user and dealer pricing - new dealers always wanted.
Prices exclude VAT and delivery. All manufacturer's trademarks acknowledged.

INGENUITY UNLIMITED



Our regular round-up of readers' own circuits. We pay between £10 and £50 for all material published, depending on length and technical merit. We're looking for novel applications and circuit tips, not simply mechanical or electrical ideas. Ideas *must be the reader's own work* and **not have been submitted for publication elsewhere.** The circuits shown have NOT been proven by us. *Ingenuity Unlimited* is open to ALL abilities, but items for consideration in this column should preferably be typed or word-processed, with a brief circuit description (between 100 and 500 words maximum) and full circuit diagram showing all relevant component values. **Please draw all circuit schematics as clearly as possible.**

Send your circuit ideas to: Alan Winstanley, *Ingenuity Unlimited,* Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset BH21 1PF.
They could earn you some real cash **and a prize!**



WIN A PICO PC BASED OSCILLOSCOPE

• 50MSPS Dual Channel Storage Oscilloscope • 25MHz Spectrum Analyser • Multimeter • Frequency Meter • Signal Generator

If you have a novel circuit idea which would be of use to other readers then a Pico Technology PC based oscilloscope could be yours.

Every six months, Pico Technology will be awarding an ADC200-50 digital storage oscilloscope for the best IU submission. In addition, two single channel ADC-40s will be presented to the runners up.

Zener Diode Tester – A tap on the knee

THE PURPOSE of the circuit diagram illustrated in Fig.1 is to help in measuring the value of an unidentified Zener diode. It is centred around a common LM317 voltage regulator (IC1) which is connected in its constant-current mode. The current is set to under 5mA, being calculated by the formula $I = 1{\cdot}25V/R$ and this flows through the Zener diode being tested. A voltmeter can be connected in parallel with the Zener and the Zener voltage read directly.

By adjusting control potentiometer VR1, it is possible to vary the voltage on transistor TR1 emitter (e), which provides an adjustable voltage to the current limiter. VR1 is then adjusted until the l.e.d. D10 illuminates to indicate that current is flowing, when the test voltage may be read.

The circuit operates from a mains power supply. To measure diodes up to, say, 33V d.c. it is normally necessary to use a transformer of 30V a.c. output, but by using a voltage trebler circuit, based around diodes D1 and D2 and capacitors C1 and C2, it is easy to use a much lower secondary voltage (e.g. 10V a.c.) and raise this to a useful 42V d.c. (10V a.c. × 1·414 × 3) which is current limited to about 35mA.

Due care must be taken when working with these higher voltages, and extreme care should be exercised to ensure that all diodes and electrolytic capacitors are correctly polarised.

Gianfranco De Dominici, Greenock, Scotland.

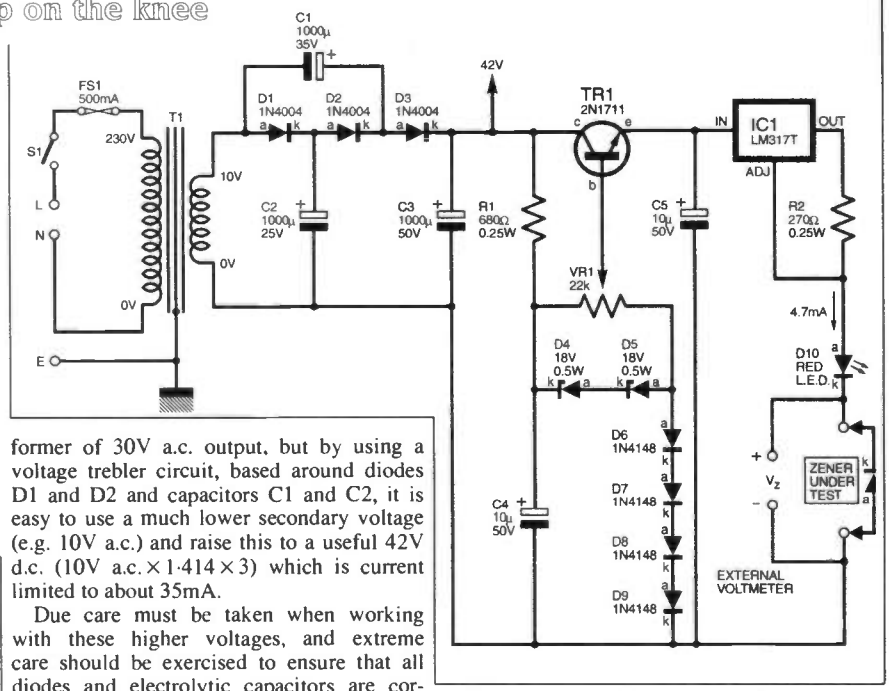


Fig.1. Zener Diode Tester.

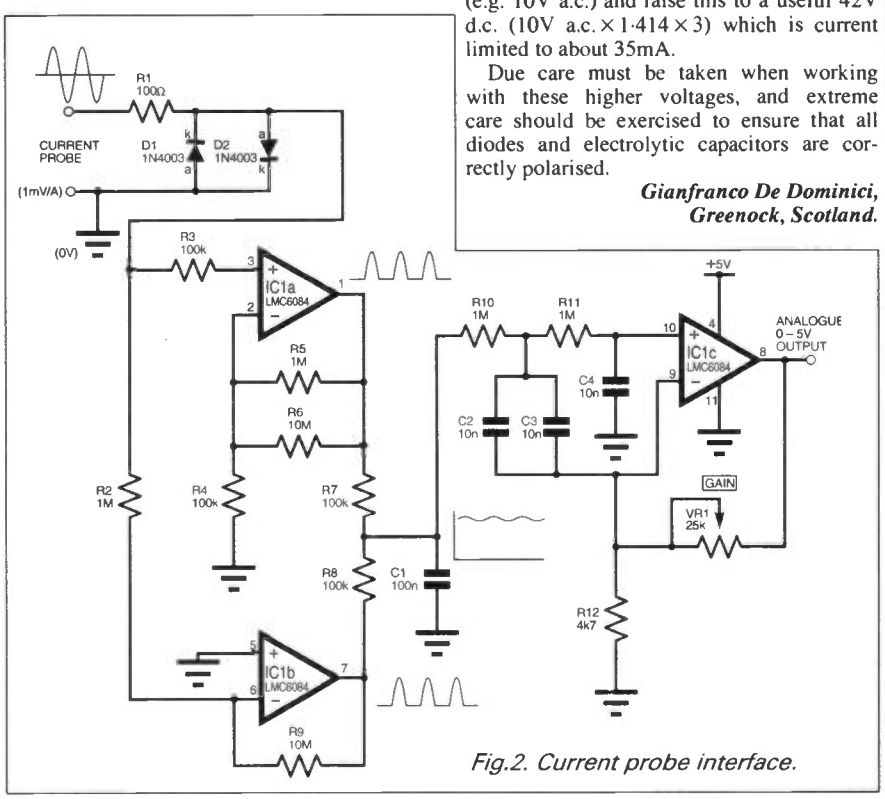


Fig.2. Current probe interface.

Microcontroller Interface for AC Monitoring – PIC the value

THE CIRCUIT of Fig.2 was designed in order to interface a PIC microcontroller to a standard clip-on DVM (digital voltmeter) current probe. The PIC device chosen must have an analogue input and the software depends on the application used.

The circuit utilises low-noise LMC6084 operational amplifiers (IC1a and IC1b) as a precision rectifier and a filter (IC1c) with presettable gain to give a response to the average current. The interface circuit requires a low impedance current probe providing 1mV per ampere to be connected to the input. The accuracy of the circuit is about as good as the 8-bit ADC used within the microcontroller when one per cent resistors are employed.

Gerard la Rooy, New Zealand.

Reverse Polarity Indicator

– Connection Protection

IN ORDER to provide reverse polarity protection for some 12V and 24V d.c. equipment, the circuit diagram of Fig.3 was devised. This uses a MOSFET power transistor, TR2, to virtually eliminate the problem of undesirable forward voltage drop, which would be apparent if ordinary rectifiers were used for protection, and the circuit even outperformed a Schottky diode in this respect.

The voltage drop is determined by the on-resistance of TR2 and the current flowing into the load. Since the MOSFET is used in its reverse-conducting mode it is feasible to expect an effective on-resistance of about 20 per cent below the manufacturer's specifications, which are usually given in forward conducting mode. Two light-emitting diodes (l.e.d.s D2 and D3) are incorporated to indicate correct or reversed polarities.

The circuit can be scaled up by paralleling MOSFETs or by placing a Schottky diode in parallel with the transistor, to get the best of both worlds. It is advisable to heatsink the MOSFET because of its significant positive temperature co-efficient.

Gerard la Rooy, New Zealand.

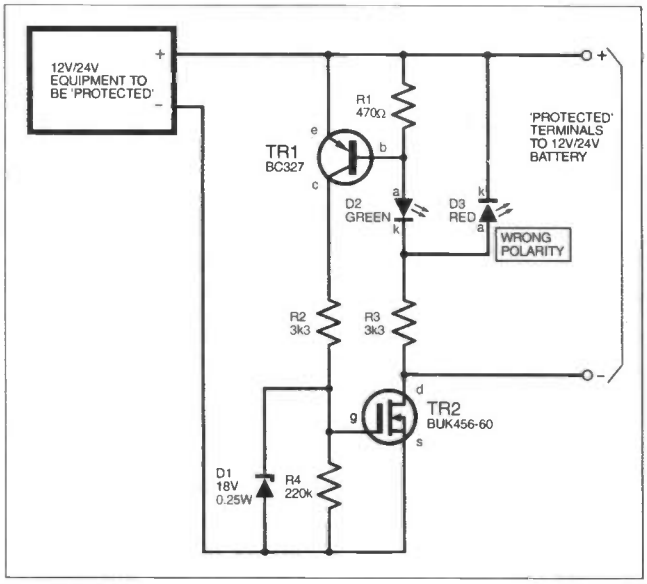


Fig.3 (right) Circuit diagram for a "low-dropout" Reverse Polarity Indicator for d.c. equipment.

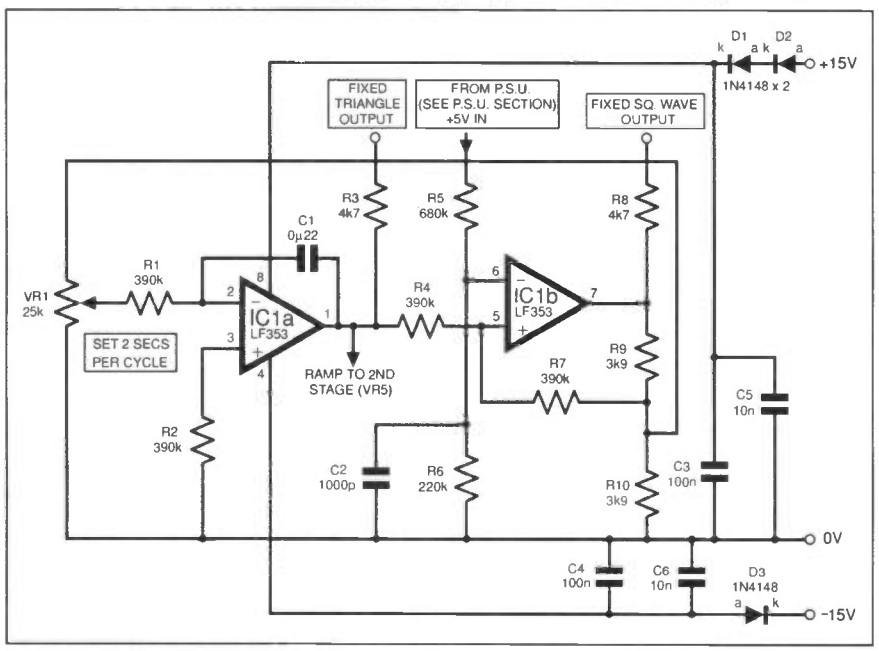


Fig.4a. A.F. Sweep Signal Generator first stage – 0V-11V-0V Ramp Generator.

A.F. Sweep Signal Generator

– More Scope

THE PURPOSE of the A.F. Sweep Generator circuit in Fig.4 (shown in stages) is to provide an audio test signal in the range of 20Hz to 20kHz. This can be set either to a single frequency or a sweep range of up to ten octaves which can be used to check the frequency response of an audio amplifier etc.

The design provides Square wave, Triangular wave and an approximate Sine wave. The output level is 0V to 6V r.m.s.

On the Ramp

The first stage of the generator gives a continuous 0V to 11V to 0V ramp which is used to sweep the audio frequency output, and may also be used as a timebase for an oscilloscope. This should be set to two seconds per cycle using VR1, as the 20Hz to 40Hz octave needs a certain amount of time to complete a few cycles. This stage also provides fixed triangle and square wave outputs.

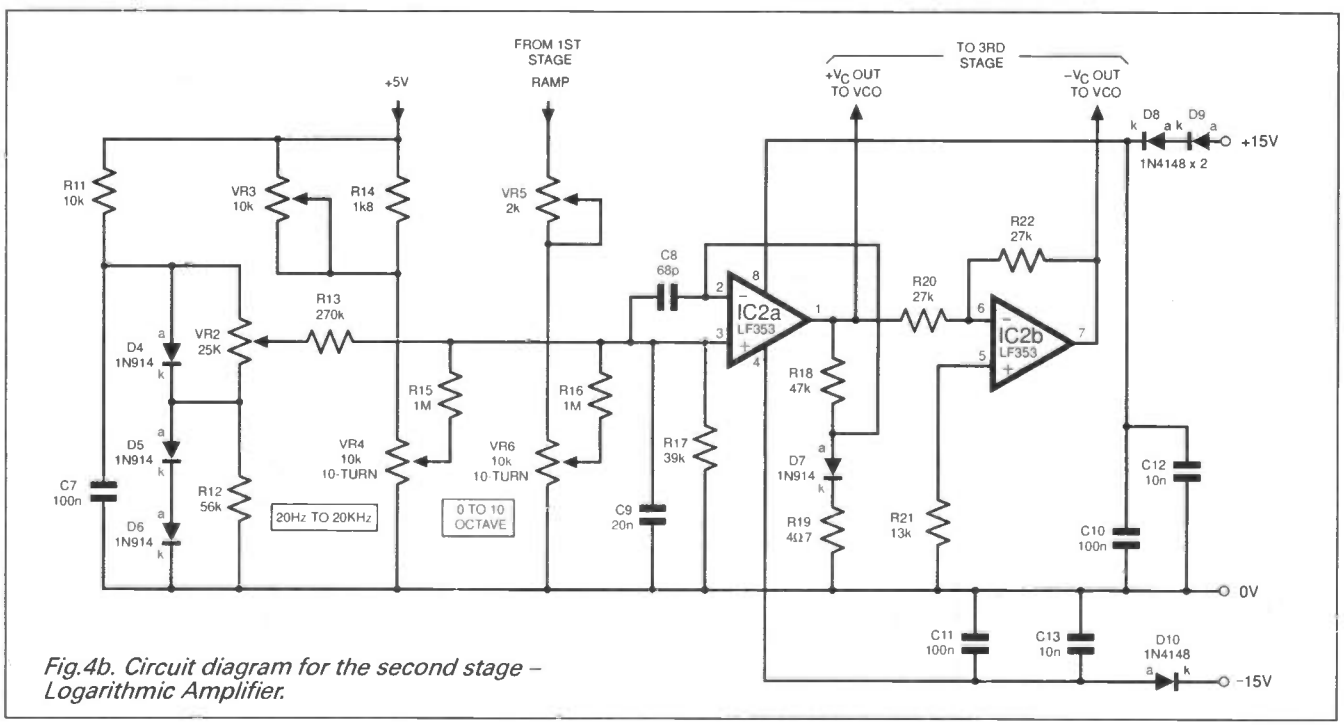


Fig.4b. Circuit diagram for the second stage – Logarithmic Amplifier.

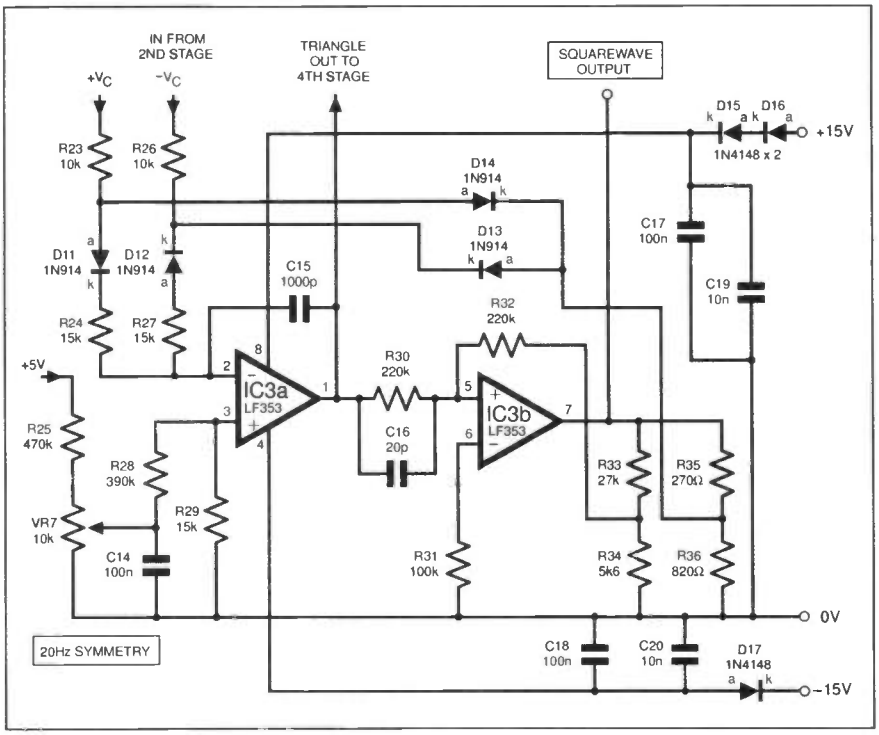


Fig.4c. Circuit for the Voltage Controlled Oscillator (v.c.o.) third stage.

An LF353 gives a fairly symmetrical positive and negative output, although it was found necessary to set a voltage differential using diodes on the positive and negative supply rails. The resulting +13·6V and −14·2V gives a fairly good ±12V output swing.

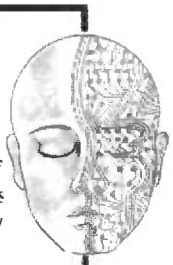
On the prototype the square, triangular and sine wave outputs were connected to a switch and a 5 kilohm potentiometer and then on to phono sockets. The ramp and square wave output signals were also brought out to front panel sockets for use as a timebase signal. The ramp can be used as channel B input for X/Y plotting, or use a slow timebase (0·1sec/div.), and trigger the oscilloscope on the falling or rising edge of the square wave.

J.D. Gray,
London N10.

INGENUITY UNLIMITED

BE INTERACTIVE

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



Sine of the Times

The second stage produces a logarithmic curve so that ten divisions across an oscilloscope tube correspond to ten octaves: 20Hz, 40Hz, 80Hz, 160Hz, 320Hz, 640Hz, 1280Hz, 2560Hz, 5120Hz, 10240Hz and 20480Hz. Its two outputs labelled +Vc and −Vc connect to the third stage which is a v.c.o. The two signal voltages required are +7V and −7V for 20kHz, 3·5V for 10kHz, 1·75V for 5kHz etc. down to about ±170mV for 20Hz. A square wave is also provided by the v.c.o.

The final stage buffers the triangle wave produced and sets it to 6V (24V pk-pk) and a non-linear impedance formed by diodes D18 to D27 and neighbouring resistors, R43 to R47, is used to generate an approximation to a sine wave. The output is also set to 6V r.m.s. (about 17V pk-pk) using VR8. It is best to use a sine wave for frequency response curves, as square or triangular waves contain odd harmonics.

Power Supply

A mains power supply provides +15V and −15V), together with a 5V reference. For the op.amps, LF353s are recommended particularly where the op.amp is used as a comparator as it has a good slew rate. This is also required to produce a reasonable triangular wave at 20kHz.

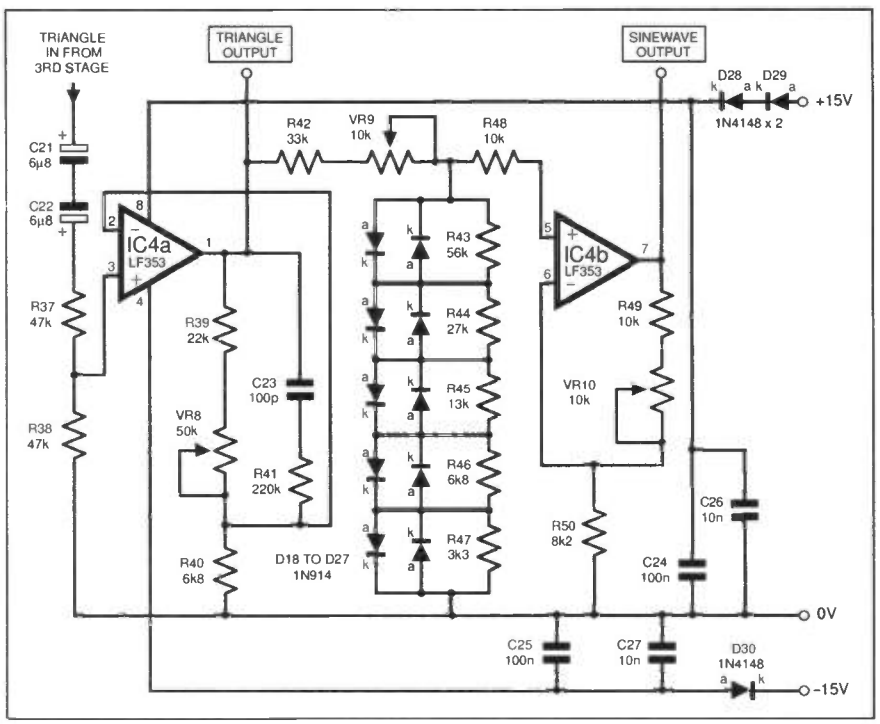


Fig.4d. Circuit diagram for the Buffer stage.

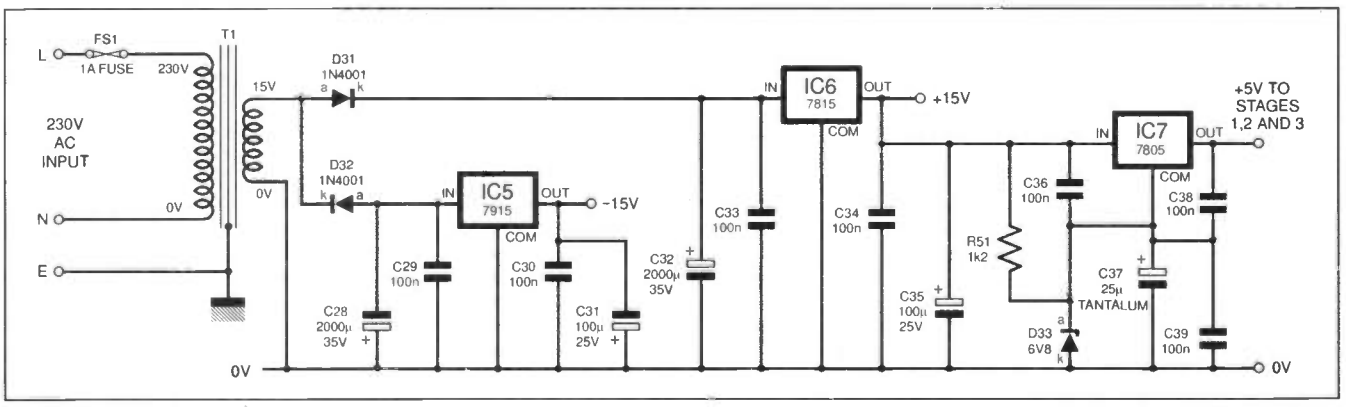


Fig.4e. Mains power supply circuit for the A.F. Sweep Signal Generator.

Special Feature

SCOLAR POWER

TERRY de VAUX-BALBIRNIE B.Sc

Schools switch on to the new government solar initiative.

SURELY everyone has heard of the greenhouse effect and its association with global warming. It comes about because all fossil fuels contain carbon – the chief offenders being coal, natural gas and oil products. As they burn, they release carbon dioxide into the atmosphere and this increases the amount occurring naturally.

A hundred years ago, there were about 300 parts per million (ppm) of carbon dioxide in the air. In recent years this has risen to some 350 ppm – an increase of nearly 17 per cent.

TIPPING THE BALANCE

The sun's high-frequency energy passes through the atmosphere fairly easily. About 30 per cent of it then reflects back into space. However, the reflected energy is at a lower frequency and it is more difficult for this to penetrate the blanket of carbon dioxide.

With the natural balance upset, and less energy flowing back into space, the average temperature of the earth's surface rises. This is very much like a garden greenhouse with the glass taking the place of carbon dioxide (see Fig.1).

Any marked increase in the earth's temperature would have catastrophic consequences in the long run. Melting of the polar ice-caps and the thermal expansion of water would both increase the volume presently occupying the oceans and this would cause large areas of low-lying land to become flooded.

In addition, the fossil fuels will eventually run out. It is therefore vital to reduce our dependence on these fuels and to obtain as much as possible of our energy needs from renewable (everlasting) sources. These include wind, waves and the direct use of solar power.

There seems to be a global wish to reduce the contribution made by nuclear energy because of its inherent danger, problems with disposal of radioactive waste and the ultimate cost of decommissioning the plants.

ON TARGET

To go some way towards reducing our need for fossil fuels, the UK government has set a target to obtain 10 per cent of the national electricity requirement from renewable sources by the year 2010.

Already, wind turbines are making a useful input. These are to be seen in coastal areas and other open places either singly or grouped into "wind farms". A typical medium-size wind turbine (aerogenerator) will produce a peak (maximum) power of some 275kW and they are useful where the amount of wind justifies their use.

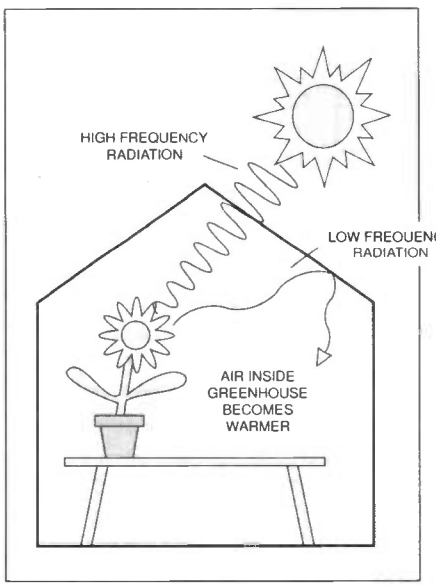


Fig.1. The greenhouse effect.

Wind turbines are an indirect way of utilising the sun's energy (since this causes the differences in temperature which make the wind blow in the first place).

PHOTOVOLTAICS

Apart from such indirect methods, solar power can be utilised directly using photovoltaic cells. These convert some of the energy striking their sensitive surface into direct current electricity. It is important to note the difference between active solar systems which generate electricity and passive ones which simply heat up water and which are less useful.

Photovoltaic cells have the advantage of having no moving parts and are therefore silent in operation and very reliable. The United Kingdom lags behind Japan, Germany, Switzerland and the USA in the use and development of photovoltaic power although it is beginning to catch up.

The photovoltaic effect was first noticed by Antoine Becquerel in 1837 when sunlight shone on one of his electrodes during an experiment involving electrolysis. However, purpose-made devices were not made until the 1870s and used the element selenium. Although selenium is still occasionally used for special purposes, silicon is almost always used today.

Photovoltaic cells are, in effect, diodes where light falls on a *p-n* junction. The energy of the photons creates electron-hole pairs in the material. The electrons can then flow through an external circuit returning to the silicon and re-combining with the holes. This process goes on indefinitely as long a light source exists.

Unfortunately, most of the electrons combine with holes directly in the material itself – that is, without flowing through the external circuit. This is why the efficiency is very low, between about five per cent and ten per cent, depending on type.

A BIT OF FORESIGHT

To raise awareness and to develop the technologies which Britain will need in the next millennium, the Government set up the Technology Foresight Challenge. Ideas were invited for innovative schemes which would fulfil that objective and funding was offered to the winners.

Out of 530 entries, the best 24 were subsequently chosen. One of these was the Scolar programme and this was established in 1996 using £1m from the Foresight Challenge fund. In this, Philip Wolfe of the Intersolar Group fulfilled a wish to raise awareness in the use of photovoltaics in the UK by providing small-scale school-based systems.

Intersolar have considerable experience in the manufacture of thin-film amorphous photovoltaic cells (one of the options used in the Scolar projects). From its factory in South Wales, the company supplies eight per cent of the world market.

Together with Intersolar, the resources of the various other photovoltaic expert groups in industry and the universities were pooled together with the assistance of various financial institutions. Contributions would be sought from the participating schools and the balance of the cost met by the group

A thin-film-silicon facade on a south facing wall – it looks good and generates power too! (Intersolar).

members and government funding. Everything taken into account, the programme total amounts to some £2·5m.

The aim of the Scolar project is to give schools and colleges an opportunity to operate a photovoltaic system of their own. Applications to participate are invited although certain criteria need to be met (interested teachers and lecturers should see the addresses at the end).

The aim is for 100 systems to be in operation by the year 2000. The data from each site will be linked via the Internet to make it available to a wide audience and to aid research into further applications for solar technology. It will also enable comparisons to be made between the different sites.

It is this Internet-based aspect which is the key to the scheme and that which makes it more innovative than many of the larger programmes presently in operation in other parts of the world.

While producing sufficient power to operate a few computers, the scheme gives a unique opportunity for the students to investigate renewable energy in general and solar energy in particular. This will be integrated with the teaching programme and forms links with the National Curriculum – notably in Science, Geography and Design and Technology (D&T).

FINDING THE MONEY

Participating schools are required to pay about one-third of the subsidised cost (about £4500) of the system of their choice. The school's contribution will probably be a mix of the proceeds of fund-raising, local authority grants and sponsorship from local industry. For its part, the school receives a fully-installed photovoltaic panel system, a dedicated computer with Internet connection and an Internet-based resource package.

There are also monitoring facilities, including a control panel which may be placed anywhere in the school (for example, the reception area). This will give a read-out of the power output at any time (in watts) plus the total amount generated (in kWh).

The photovoltaic panels themselves may be presented in a variety of architectural styles. For example, covered walkways, wall cladding or window louvres. The students are encouraged to select the most suitable design for their own environment. They also suggest the best type of panels to use.

The only fully up-and-running Scolar scheme at the time of writing (Autumn, 1998) is at the Cardinal Hinsley High School for boys in Willesden, West London and this was switched on by Energy Minister John Battle on the 14th July, 1998. He also announced a further 16 schools and colleges around the UK which had won approval to participate.

"This is precisely the kind of activity I want to encourage through the Government's Foresight Initiative," said John Battle. "The link with schools and colleges is particularly valuable as it gives first hand experience to the generation that will see this exciting technology come to fruition."

The photovoltaic panels at the school, were chosen to form a canopy over the entrance of the hut used by the Renewable Energy Club run by science teacher, George Nagle.

The club is involved in the small-scale generation of electricity by various renewable means. As well as the photovoltaic panels, the club owns several wind turbines (two of them home-made) and can even produce electricity by pedalling a bicycle coupled to a generator! The total output is collated every twelve hours and the value downloaded on to the Internet.

A "free energy eco-aware" classroom was also established where all the energy to run it (including heating and lighting) was to be obtained from the wind and photovoltaic power. The classroom seats twenty students in a laboratory-style arrangement. Children from neighbouring schools are invited to watch videos and demonstrations. They can also gain hands-on experience in investigations about renewable energy and in the construction of small wind turbines of their own.

WATT'S AVAILABLE?

On a sunny summer day in the UK, the power reaching the earth's surface from the sun is about 1kW (one thousand watts) per square metre. On a cloudy day, it is likely to be about one-tenth of this figure. Even with a conversion efficiency of only five to ten per cent, solar cells could provide between 50W and 100W per square metre peak.

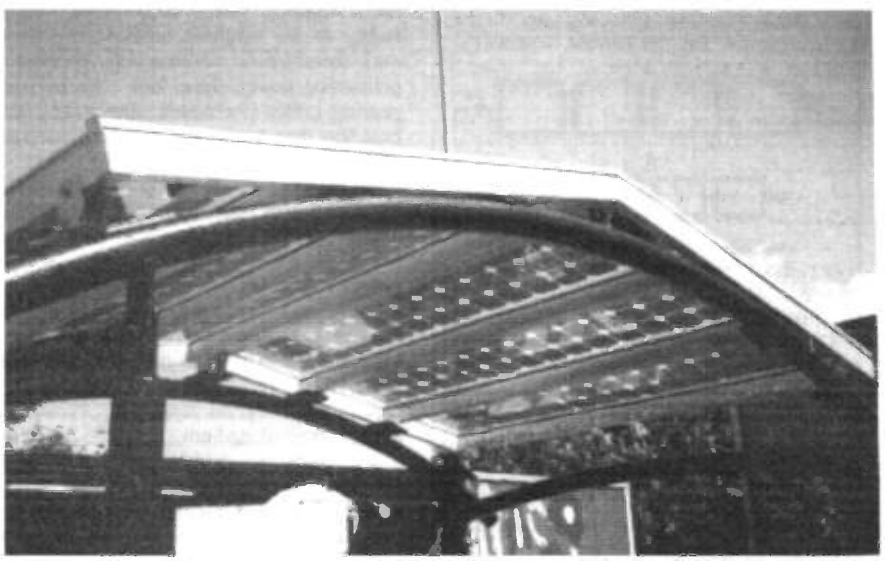
Note that, as a power source for a satellite, solar panels provide a much higher output because the sun's energy reaches them direct rather than through the atmosphere, which absorbs much of the energy.

From a purely "electronics" point of view, that fact that solar cells produce direct (rather than alternating) current seems attractive. However, since much consumer equipment is designed to operate from the mains, an inverter is usually needed to convert the output to 230V a.c. This also makes it easy to integrate the system with the mains so that it can "fill in" at times of low light or high demand.

NO PREMIUM

At the time of writing, a photovoltaic system (after inversion to provide a.c. power) cannot, with advantage, be grid connected as may be a wind turbine. The main reason is that energy cannot be sold on to the grid under the Government's non-fossil fuel obligation (NFFO).

By this scheme, the National Grid buys electricity generated by most renewable means and pays a premium price for it (a few pence more than conventionally-gener-



Crystalline silicon solar panels used at the Cardinal Hinsley school.

ated electricity). The difference is funded by the Government.

The aim is to give encouragement to near-market small-scale generators by, for example, wind, hydroelectric systems and waste-burning. "Near-market" means that the cost of production per kilowatt-hour must approach that generated by conventional means (because, at present, conventionally-generated electricity is still cheap). Without assistance, there might be little hope of these methods developing to the point where they could compete economically in the short to medium term.

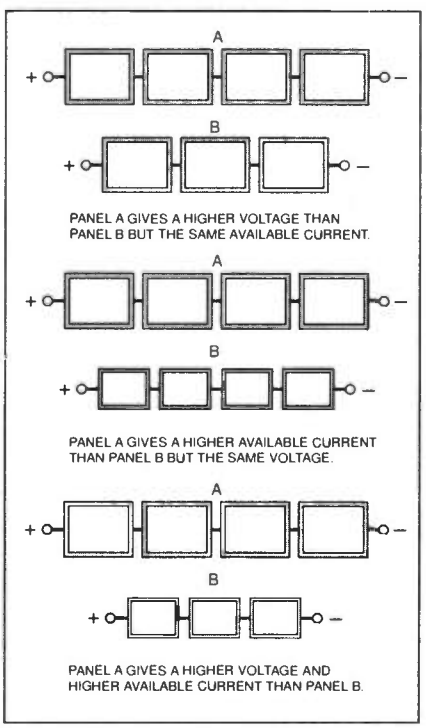
By its nature, the NFFO is aimed at generators having a worthwhile surplus over and above their own requirements (say, 1MW or more) to make the process of metering and sale worthwhile. Unfortunately, photovoltaic power at present costs some five to ten times the retail price of conventionally-generated electricity and (according to Government sources) it could be a decade or more before the prices converge.

It is therefore thought that to buy electricity under the NFFO would not achieve its purpose because the difference in price is too wide. Also, at present, photovoltaic systems are either small-scale projects or used to augment electricity generated by conventional means at a particular site such as a factory or office. There is usually no surplus.

It is interesting to note that the Government is currently reviewing its policy on photovoltaics and alternative energy in general.

GROWN AND SLICED

The Scolar project at the Cardinal Hinsley school uses crystalline silicon cells. However, it is thought that many projects will use thin-film amorphous silicon panels of the type manufactured by Intersolar. Crystalline cells consist of individual wafers of silicon which are grown, sliced and connected together to make a panel.



Different power and voltage configurations with solar cells.

Until relatively recently, this was the preferred method being largely funded by the space industry in the '60s. However, although efficient, the technology is comparatively expensive. Thin-film amorphous silicon has the advantage of being produced by a fully-automated process. This means that the technology is much cheaper per watt of power generated.

Miniature panels of this type are to be seen as the power source in "solar" calculators. They are also used to provide garden and outbuilding lighting where a small lead-acid or nickel-cadmium battery is charged during the day ready for use at night.

PROCESS TECHNIQUE

In the thin-film process, the material is vaporised and allowed to fall on glass where it forms a solid layer 0·3 microns thick. Lasers are then used to define the size of each cell. Since the individual units are produced and connected automatically, each panel has only two connecting leads. The panels are laminated between toughened glass and a rigid substrate which weatherproofs them and makes them robust enough to be handled without breakage.

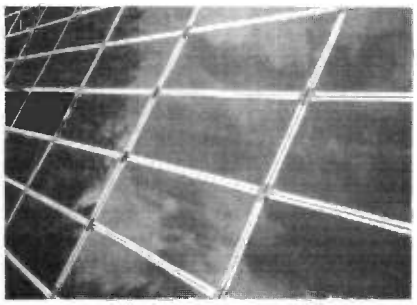
The maximum current output is proportional to the area of each cell and the amount of light falling on all of them. The voltage is proportional to the number of cells connected in series (see Fig.2). Each cell provides an open circuit voltage of about 900mV (0·9V) but, in practice when on load, it gives some 600mV. This remains substantially constant down to low light levels. Practical panels, such as those manufactured by Intersolar, are often designed to provide a nominal 12V, 24V or 48V on-load output.

The key to gaining a useful amount of energy is to use a large total area of panels. To give an idea of the practical output, a one square metre thin-film amorphous panel sited in the UK will give a peak output (that is, in full direct sunshine) of some 42 watts (say 12V at 3·5A). Some power is generated in weak light but, of course, there is virtually no output at night.

For 1kW peak output, an area of about $20m^2$ is therefore needed. Very large panels can be fabricated from smaller standard-sized units and used as the external cladding for a building. Large south-facing (north-facing in the southern hemisphere) arrays may therefore be constructed. As well as generating power, these look attractive, appearing rather like tinted glass. They also cost less than traditional cladding materials such as marble and granite.

As an example, the facade of the Building Research Centre in Watford, consists of a nominal $50m^2$ of thin-film photovoltaic panels (35 panels each 1350mm × 930mm) generating some 2·5kW peak which is the lighting load for a new energy efficient office on site. The expected annual yield is about 1500MWh. Other projects include the photovoltaic panels on a roof at the Ford factory in Bridgend and at the Newcastle United football stadium.

By contrast with these large-scale projects, the Scolar system at the Cardinal Hinsley School is much smaller. It provides only 600 watts peak with an expected annual yield of 450kWh. Even so, the output is sufficient to operate a few computers (a typical PC complete with monitor requires some 100W to 200W).



An array of thin-film silicon solar panels. Thin-film silicon is one of the design options for Scolar projects.

RAISING AWARENESS

The school-based systems are designed to raise awareness of the future possibilities of photovoltaic power and to be a teaching aid. They are not intended to generate large-scale power and those participating must not see the scheme as a cost-cutting exercise.

Unfortunately, it appears that some head teachers are mis-informed (or over-optimistic!) and have inflated ideas of the capability and little knowledge of the philosophy behind the schemes. One report in a regional newspaper seen by the author stated that there would be sufficient power to provide heating and lighting for a block of twelve classrooms! Maybe this head looked at his capital outlay and calculated how much conventionally-generated electricity could have been bought for that price!

Renewable means of generating electricity have come of age. How much photovoltaics will ultimately contribute to that generated by the wind, waves, tides, geothermal and waste-burning will depend on the rate at which the price of conventionally-generated electricity rises (due to reduced availability of fuel and any "carbon tax" which might be imposed in the future) and how much that generated by renewable means falls (as the technology develops and more people use it beneficially).

PARTICIPATION CRITERIA

Whether or not a school or college will be selected to participate in a Scolar project will depend on a number of criteria. There must be enthusiasm on the part of the students and staff and a willingness to contribute some £4500 towards the cost of the system. The school will also need a suitable south-facing site which is not shaded from mid-day sun.

Any school or college which is interested in participating should contact:

Daniel Davis, HGa Burderop Park, Swindon, Wiltshire SN4 0QD. Tel: 01793 814756. Fax: 01793 815020. E-mail: dgd@hga.co.uk

For general enquiries:

Gavin Conibeer, Environmental Exchange Unit, 11 Bevington Road, Oxford University, Oxford OX2 6NB. Tel: 01865 284690. Fax:01865 284691. E-mail: gavin.conibeer@ecu.ox.ac.uk.

There is also a web site at **www.scolar.org.uk/scolar**.

SURVEILLANCE
PROFESSIONAL QUALITY KITS

No. 1 for Kits

Whether your requirement for surveillance equipment is amateur, professional or you are just fascinated by this unique area of electronics SUMA DESIGNS has a kit to fit the bill. We have been designing electronic surveillance equipment for over 12 years and you can be sure that all our kits are very well tried, tested and proven and come complete with full instructions, circuit diagrams, assembly details and all high quality components including fibreglass PCB. Unless otherwise stated all transmitters are tuneable and can be received on an ordinary VHF FM radio.

Genuine SUMA kits available only direct from Suma Designs. Beware inferior imitations!

UTX Ultra-miniature Room Transmitter
Smallest room transmitter kit in the world! Incredible 10mm x 20mm including mic. 3V-12V operation. 500m range..... £16.45

MTX Micro-miniature Room Transmitter
Best-selling micro-miniature Room Transmitter. Just 17mm x 17mm including mic. 3V-12V operation. 1000m range..... £13.45

STX High-performance Room Transmitter
High performance transmitter with a buffered output stage for greater stability and range. Measures 22mm x 22m, including mic. 6V-12V operation, 1500m range. £15.45

VT500 High-power Room Transmitter
Powerful 250mW output providing excellent range and performance.
Size 20mm x 40mm. 9V-12V operation. 3000m range..... £16.45

VXT Voice-Activated Transmitter
Triggers only when sounds are detected. Very low standby current. Variable sensitivity and delay with LED indicator. Size 20mm x 67mm. 9V operation. 1000m range. £19.45

HVX400 Mains Powered Room Transmitter
Connects directly to 240V A.C. supply for long-term monitoring.
Size 30mm x 35mm. 500m range..... £19.45

SCRX Subcarrier Scrambled Room Transmitter
Scrambled output from this transmitter cannot be monitored without the SCDM decoder connected to the receiver. Size 20mm x 67mm. 9V operation. 1000m range..... £22.95

SCLX Subcarrier Telephone Transmitter
Connects to telephone line anywhere, requires no batteries. Output scrambled so requires SCDM connected to receiver. Size 32mm x 37mm. 1000m range..... £23.95

SCDM Subcarrier Decoder Unit for SCRX
Connects to receiver earphone socket and provides decoded audio output to headphones. Size 32mm x 70mm. 9V-12V operation..... £22.95

ATR2 Micro-Size Telephone Recording Interface
Connects between telephone line (anywhere) and cassette recorder. Switches tape automatically as phone is used. All conversations recorded. Size 16mm x 32mm. Powered from line..... £13.45

★★★ Specials ★★★

DLTX/DLRX Radio Control Switch
Remote control anything around your home or garden, outside lights, alarms, paging system etc. System consists of a small VHF transmitter with digital encoder and receiver unit with decoder and relay output, momentary or alternate, 8-way d.i.l. switches on both boards set your own unique security code. TX size 45mm x 45mm. RX size 35mmx 90mm. Both 9V operation. Range up to 200m.
Complete System (2 kits)..... £50.95
Individual Transmitter DLTX..... £19.95
Individual Receiver DLRX..... £37.95

MBX-1 Hi-Fi Micro Broadcaster
Not technically a surveillance device but a great idea! Connects to the headphone output of your Hi-Fi, tape or CD and transmits Hi-Fi quality to a nearby radio. Listen to your favourite music anywhere around the house, garden, in the bath or in the garage and you don't have to put up with the DJ's choice and boring waffle.
Size 27mm x 60mm. 9V operation. 250m range..... £20.95

UTLX Ultra-miniature Telephone Transmitter
Smallest telephone transmitter kit available. Incredible size of 10mm x 20mm! Connects to line (anywhere) and switches on and off with phone use.
All conversation transmitted. Powered from line. 500m range..... £15.95

TLX 700 Micro-miniature Telephone Transmitter
Best-selling telephone transmitter. Being 20mm x 20mm it is easier to assemble than UTLX. Connects to line (anywhere) and switches on and off with phone use. All conversations transmitted. Powered from line. 1000m range..... £13.45

STLX High-performance Telephone Transmitter
High performance transmitter with buffered output stage providing excellent stability and performance. Connects to line (anywhere) and switches on and off with phone use. All conversations transmitted. Powered from line.
Size 22mm x 22mm. 1500m range..... £16.45

TKX900 Signalling/Tracking Transmitter
Transmits a continuous stream of audio pulses with variable tone and rate. Ideal for signalling or tracking purposes. High power output giving range up to 3000m.
Size 25mm x 63mm. 9V operation..... £22.95

CD400 Pocket Bug Detector/Locator
LED and piezo bleeper pulse slowly, rate of pulse and pitch of tone increase as you approach signal. Gain control allows pinpointing of source.
Size 45mm x 54mm. 9V operation..... £30.95

CD600 Professional Bug Detector/Locator
Multicolour readout of signal strength with variable rate bleeper and variable sensitivity used to detect and locate hidden transmitters. Switch to AUDIO CONFORM mode to distinguish between localised bug transmission and normal legitimate signals such as pagers, cellular, taxis etc. Size 70mm x 100mm. 9V operation..... £50.95

QTX180 Crystal Controlled Room Transmitter
Narrow band FM transmitter for the ultimate in privacy. Operates on 180MHz and requires the use of a scanner receiver or our QRX180 kit (see catalogue).
Size 20mm x 67mm. 9V operation. 1000m range..... £40.95

QLX180 Crystal Controlled Telephone Transmitter
As per QTX180 but connects to telephone line to monitor both sides of conversations. 20mm x 67mm. 9V operation. 1000m range..... £40.95

QSX180 Line Powered Crystal Controlled Phone Transmitter
As per QLX180 but draws power requirements from line. No batteries required.
Size 32mm x 37mm. Range 500m..... £35.95

QRX 180 Crystal Controlled FM Receiver
For monitoring any of the 'Q' range transmitters. High sensitivity unit. All RF section supplied as pre-built and aligned module ready to connect on board so no difficulty setting up. Output to headphones. 60mm x 75mm. 9V operation..... £60.95

A build-up service is available on all our kits if required.

UK customers please send cheques, POs or registered cash. Please add £2.00 per order for P&P. Goods despatched ASAP allowing for cheque clearance. Overseas customers send Sterling Bank Draft and add £5.00 per order for shipment. Credit card orders welcomed on 01827 714476.

OUR LATEST CATALOGUE CONTAINING MANY MORE NEW SURVEILLANCE KITS NOW AVAILABLE. SEND TWO FIRST CLASS STAMPS OR OVERSEAS SEND TWO IRCS.

SUMA DESIGNS

DEPT. EE
THE WORKSHOPS, 95 MAIN ROAD,
BAXTERLEY, NEAR ATHERSTONE,
WARWICKSHIRE CV9 2LE
VISITORS STRICTLY BY APPOINTMENT ONLY

Tel/Fax:
01827 714476

***Everyday Practical Electronics* are pleased to be able to offer all readers these**

ELECTRONICS CD-ROMS

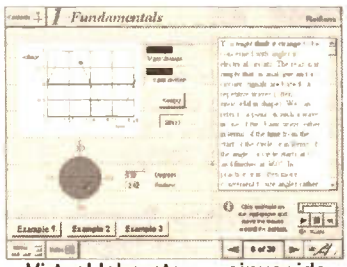
TWO APPLICATIONS ON ONE CD-ROM

ELECTRONIC CIRCUITS & COMPONENTS + THE PARTS GALLERY *by Mike Tooley*

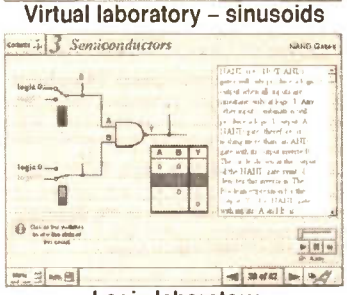
ELECTRONIC CIRCUITS & COMPONENTS

Electronic Circuits & Components 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 as they proceed through the sections on the CD-ROM. Sections on the disk include:

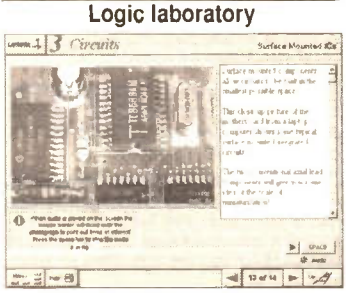
Fundamentals: units & multiples, electricity, electric circuits, alternating circuits.
Passive Components: resistors, capacitors, inductors, transformers.
Semiconductors: diodes, transistors, op.amps, logic gates.
Passive Circuits
Active Circuits



Virtual laboratory – sinusoids



Logic laboratory



Circuit technology screen

THE PARTS GALLERY

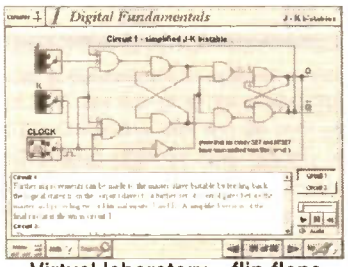
Many students have a good understanding of electronic theory but still have difficulty in recognising the vast number of different types of electronic components and symbols. *The Parts Gallery* helps overcome this problem; it will help students to recognise common electronic components and their corresponding symbols in circuit diagrams. Selections on the disk include:

Components
Components Quiz
Symbols
Symbols Quiz
Circuit Technology

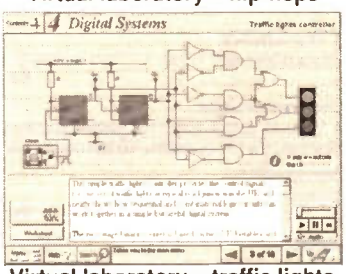
Hobbyist/Student ..... £34 inc VAT
Institutional (Schools/HE/FE/Industry) .....£89 *plus* VAT
Institutional 10 user (Network Licence) ..... £169 *plus* VAT

DIGITAL ELECTRONICS *by Mike Tooley*

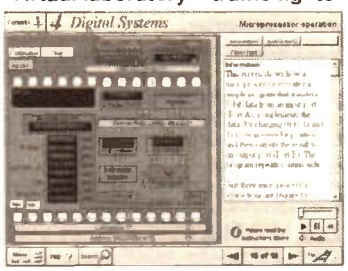
Digital Electronics builds on the knowledge of logic gates covered in *Electronic Circuits & Components,* and takes users through the subject of digital electronics up to the operation and architecture of microprocessors. The virtual laboratories allow users to operate many circuits on screen.



Virtual laboratory – flip-flops



Virtual laboratory – traffic lights



Microprocessor

FUNDAMENTALS

Fundamentals introduces the basics of digital electronics including binary and hexadecimal numbering systems, ASCII, basic logic gates and their operation, monostable action and circuits, and bistables – including JK and D-type flip-flops

COMBINATIONAL LOGIC

Multiple gate circuits, equivalent logic functions and specialised logic functions such as majority vote, parity checker, scrambler, half and full adders. Includes fully interactive virtual laboratories for all circuits

SEQUENTIAL LOGIC

Introduces sequential logic including clocks and clock circuitry, counters, binary coded decimal and shift registers.

DIGITAL SYSTEMS

A/D and D/A converters and their parameters, traffic light controllers, memories and microprocessors – architecture, bus systems and their arithmetic logic unit.

GALLERY

A catalogue of commonly used IC schematics taken from the 74xx and 40xx series. Also includes photographs of common digital integrated circuits and circuit technology.

Hobbyist/Student ..... £45 inc VAT
Institutional (Schools/HE/FE Industry) .....£99 *plus* VAT
Institutional 10 user (Network Licence) ..... £199 *plus* VAT

NEW

MODULAR CIRCUIT DESIGN *by Max Horsey* and *Philip Clayton*

This CD-ROM has been developed from Max Horsey's *Teach-In* series *A Guide to Modular Circuit Design* (*EPE* Nov '95 to Aug '96). This highly acclaimed series presented a range of tried and tested analogue and digital circuit modules, together with the knowledge to use and interface them. Thus allowing anyone with a basic understanding of circuit symbols to design and build their own projects.

Essential information for anyone undertaking GCSE or "A" level electronics or technology and for hobbists who want to get to grips with project design.

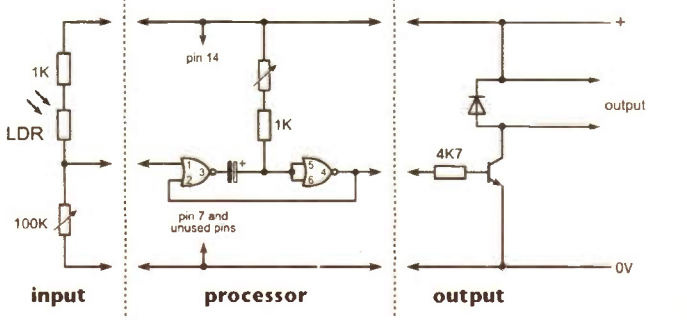
Over seventy different Input, Processor and Output modules are illustrated and fully described together with detailed information on construction, fault finding and components, including circuit symbols, pinouts, power supplies, decoupling etc. A full contents list and alphabetical index are provided and, at every stage, alternative modules are offered.

Written by a highly experienced author and teacher (Max is Head of Electronics at Radley College), this CD brings it all together for all students of electronics.

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

designing your circuit

simply select your modules from the wide choice available, read how they work and join them up to make your circuit



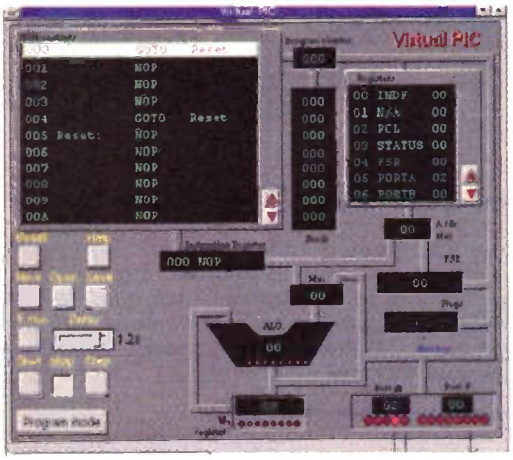
"I found that I could design a circuit without my teacher's help. And it worked! Everything was to hand - which chips to use - and which pins did what."
Andrew Preston (GCSE student)

A Web Browser is required for Modular Circuit Design – one is provided on the *EPE CD-ROM No.1* (see opposite) but most modern computers are supplied with one.

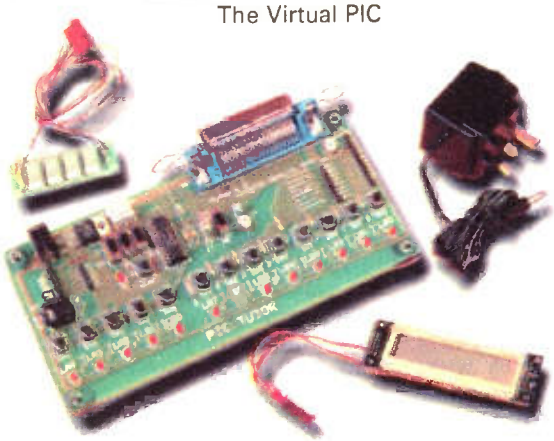
Interested in programming PIC microcontrollers?

PICtutor *by John Becker*

NEW



The Virtual PIC



Deluxe PICtutor Hardware

Developed from our famous and incredibly popular *EPE PIC Tutorial* series by John Becker (*EPE* March to May '98) this CD-ROM, together with the PICtutor experimental and development board, will teach you how to use PIC microcontrollers with special emphasis on the PICx84 devices. The board will also act as a development test bed and programmer for future projects as your programming skills develop.

This interactive presentation uses the specially developed Virtual PIC simulator to show exactly what is happening as you run, or step through, a program. In this way the CD brings the *EPE PIC Tutorial* series to life and provides the easiest and best ever introduction to the subject.

Nearly 40 tutorials cover almost every aspect of PIC programming in an easy to follow logical sequence.

HARDWARE

Whilst the CD-ROM can be used on its own, the physical demonstration provided by the PICtutor Development Kit, plus the ability to program and test your own PIC16x84s, really reinforces the lessons learned. The hardware will also be an invaluable development and programming tool for future work once you have mastered PIC software writing.

Two levels of PICtutor hardware are available – Standard and Deluxe. The Standard unit comes with a battery holder, a reduced number of switches and no displays. This version will allow users to complete 25 of the 39 Tutorials – it can be upgraded to Deluxe at a later date, by adding components, if required.

The Deluxe Development Kit is supplied with a plug-top power supply (the Export Version has a battery holder), all switches for both PIC ports plus l.c.d. and 4-digit 7-segment l.e.d. displays. It allows users to program and control all functions and both ports of the PIC and to follow the 39 tutorials on the CD-ROM.

All hardware is supplied **fully built and tested** and includes a PIC16F84 electrically erasable programmable microcontroller.

CD-ROM

Hobbyist/Student ..... £45 inc. VAT
Institutional (Schools/HE/FE Industry) ..... £99 *plus* VAT
Institutional 10 user (Network Licence) ..... £199 *plus* VAT

HARDWARE

Standard PICtutor Development Kit..... £47 inc. VAT
Deluxe PICtutor Development Kit..... £99 *plus* VAT
Deluxe Export Version ..... £96 *plus* VAT

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

Minimum system requirements for these CD-ROMs: PC with 486/33MHz, VGA+256 colours, CD-ROM drive, 8MB RAM, 8MB hard disk space. Windows 3.1/95/98/NT, mouse, sound card (not required for PICtutor or Modular Circuit Design).

CD-ROM ORDER FORM

Please send me:

- ☐ **Electronic Circuits & Components + The Parts Gallery**
- ☐ **Digital Electronics**
- ☐ **PICtutor**

Version required:

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

- ☐ **PICtutor Development Kit – Standard**
- ☐ **PICtutor Development Kit – Deluxe** ☐ **Deluxe Export**

- ☐ **Modular Circuit Design – Single User**
- ☐ **Modular Circuit Design – Multiple User**

Full name:.....

Address:.....

.....

..... Post code:..... Tel. No:.....

Signature:.....

☐ I enclose cheque/PO in £ sterling payable to WIMBORNE PUBLISHING LTD for £.....

☐ Please charge my Visa/Mastercard: £ ..... Card expiry date:.....

Card No:.....

Please supply name and address of card holder if different to the delivery address.

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

OVERSEAS ORDERS: 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 country, then add 17½% VAT or provide your official VAT registration number).

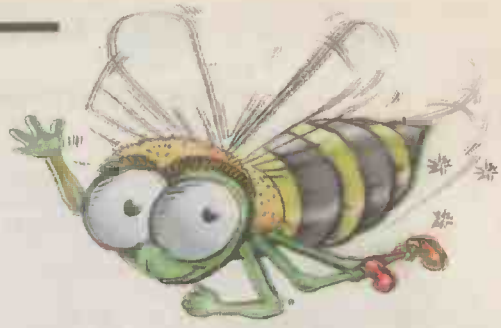
Send your order to:
Direct Book Service
33 Gravel Hill, Merley Wimborne
Dorset BH21 1RW
(Mail Order Only)

Direct Book Service is a division of Wimborne Publishing Ltd. To order by phone ring
01202 881749. Fax: 01202 841692
We cannot reply to overseas orders by Fax
Goods are normally sent within seven days

EE50

Demos (not Modular Circuit Design) available on the ***EPE CD-ROM No.1*** (Free with the November '98 issue) – send £2 for this CD-ROM if you require the demos. For Modular Circuit Design demo send £6.95 for cut down version (£5 refunded if you buy full version). **Minimum order** for credit card payment is £5.

PhizzyB COMPUTERS



Part 4: Polling vs Interrupt

Clive "Max" Maxfield and Alvin Brown

So, here we are already at the fourth instalment of our really unique and exciting electronics and computing project. And, from what we hear, you're getting on well with it – oh, all right, some of you have had a few system problems, but we've sorted them out for you, haven't we? Fun, isn't it – a really unique mix of methods to show how computers work.

Now, we enter the second phase of the tale about our phantasmagorical little rascal, getting ready to drive the world (or at least, our buggy) buzzing with excitement – yes, folks the PhizzyBot robotic wheelie is fast approaching. You too can drive it, without needing to know too much about electronics (although you do know a bit about PCs, don't you?).

Hi there Phizzyphiles. As you will recall, last month we revealed our master plan, which is to eventually use the PhizzyB as the "brain" of a simple robot called the PhizzyBot. (We'll call this Plan A so that no one gets confused).

Well, in this month's PhizzyB construction article, Alan Winstanley describes how to build two new input devices. These devices can be used for a variety of purposes, including (as we shall see) collision detection for the forthcoming PhizzyBot.

One interesting point before we start is that the earlier articles in this series were focused more towards the PhizzyB Simulator CD ROM on your Windows PC, as opposed to the PhizzyB computer itself. This was intended to build your familiarity with the simulator, but things are about to change.

Although our forthcoming experiments can (and should) be performed on the simulator, you'll discover that having access to a real PhizzyB is going to be extremely advantageous from this point onwards.

EXPERIMENT 1

The polled device

First of all, we're assuming that you've already built the two input devices described in this month's practical PhizzyB construction article. We'll commence with the simpler of the two boards – the 8-bit Switch module – which we will call the "polled" device (we'll explain the significance of the term *polled* later).

Connect this board to the PhizzyB's input port at address $F011 using a standard PhizzyB ribbon cable. As you know, we can emulate this device in the simulation world using the corresponding generic input board (Fig.1).

This board essentially consists of eight push-button switches, each of which drives one of the PhizzyB's input port bits. Each switch has an associated pull-up resistor and capacitor connected to it. The pull-up resistors serve to connect the input bits to "weak" logic 1 (+5V) values. When a switch is closed, it connects that input bit to a "strong" logic 0 (0V).

When we activate a switch, we tend to think of it transitioning smoothly from an Off to an On condition (or vice versa). In reality, we can expect to see a condition called "switch bounce", in which the contacts inside the switch bounce together making several momentary contacts before providing a good connection.

Switch bounce isn't particularly troublesome in the case of a light switch in your house, but it can cause problems when a switch is connected to a computer, because a computer is so fast that it may well assume that the switch has been pressed multiple times and respond accordingly.

This is why we associated a capacitor with each switch. The *RC* time constant of the resistor-capacitor combination serves in a simple way to smooth transitions between logic states and to remove the effects of switch bounce, although other more sophisticated digital methods can be used.

Invoke the PhizzyB Simulator, activate the assembler, and enter the program shown in Listing 1 (remember that anything to the right of a hash "#" character is a comment, which will be ignored by the assembler). As we see, this program simply loops around reading from the switch board we just connected to the input port at address $F011, and writing any values it finds there to the 8-bit l.e.d. bargraph display connected to the output port at address $F030.

Now use the **File –> Save As** command to save this program as **ccexp1.asm**, and assemble it to generate the corresponding **ccexp1.ram** file.

Activate the PBLink utility, open the **ccexp1.ram** file you just created, download this file to your real PhizzyB, and use the PhizzyB's Run switch (or the appropriate PBLink toolbar icon or function key) to set the program running.

The first thing we note is that all the l.e.d.s on the bargraph display light up. Now try pressing (and holding) one of the buttons on the new input module, and observe that the corresponding l.e.d. on the bargraph display turns off. Similarly, as soon as you release this button that same

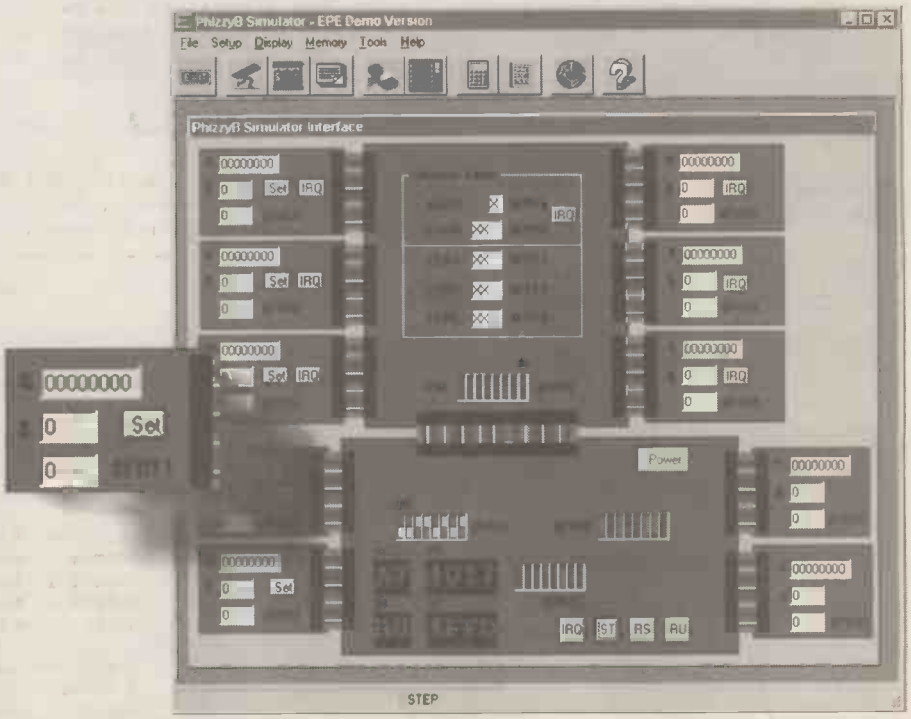


Fig.1. The PhizzyB Simulator interface, which simulates a real PhizzyB interconnected by ribbon cables to a variety of expansion boards.

Listing 1

```
INPORT1:    .EQU  $F011      #Assign a label to input port $F011
OUTPORT0:   .EQU  $F030      #Assign a label to output port $F030

            .ORG  $4000      #Set start address to $4000
LOOP:        LDA [INPORT1]   #Load accumulator from I/P port 1
             STA [OUTPORT0]  #Store accumulator to O/P port 0
             JMP [LOOP]      #Jump to LOOP and do it all again
            .END
```

l.e.d. turns on again. (Verify that all of the buttons work by pressing and releasing them in turn.)

Initially, this may seem to be counter-intuitive, because we typically expect that pressing a switch will cause a light to turn on. But our input board is behaving exactly as it was designed, because its pull-up resistors hold the inputs at logic 1, and pressing a switch connects that input to a logic 0.

We could have wired our input board the opposite way around had we wished – but we didn't! Why not? Well one very good reason was that wiring the board the way we did allowed us to introduce a very important point, which is that logic 0s and 1s mean whatever we want them to mean at any particular time.

Before we proceed, reset your PhizzyB and dismiss the PBLink utility (as we noted in Part 3, whilst the PBLink utility is active it will slow your PC, because it's constantly bouncing packets of information back and forth to your PhizzyB).

If you don't have a real PhizzyB, you can replicate this experiment on your simulator. Use the **Memory -> Load RAM** command to load **ccexp1.ram** into the simulator's memory and then set this program running.

Enter a value of 11111111 into the binary field on the generic input board at address $F011 (the binary field is the one indicated by a percent "%" character). Don't forget to click that board's Set button to present this value to the input port, at which time all of the l.e.d.s on the bargraph display will light up.

Now enter the following values to represent the effects of pressing the switches in the real world:

Value	Switch
11111110	0
11111101	1
11111011	2
11110111	3
11101111	4
11011111	5
10111111	6
01111111	7
11111111	None

When you've finished, reset the simulator, and proceed to the second experiment.

EXPERIMENT 2

Inverting the inputs

As we just discussed, we typically expect that pressing a switch will cause a light to turn on rather than turn off. However, one of the great things about computers is that we can use software (programs) to modify the way things work in hardware (the physical bits and pieces in the real world). Let's examine an example of this.

Use the assembler to load your **ccexp1.asm** program and save it out as **ccexp2.asm**. Now add an **XOR %11111111** instruction between the existing **LDA** (load accumulator) and the **STA** (store accumulator) instructions as follows:

```
LDA [INPORT1]
XOR %11111111
STA [OUTPORT0]
```

From earlier articles in this series we know that XORing a bit with a logic 1 has the same effect as inverting that bit. In this case we're XORing the contents of our 8-bit accumulator with eight 1s, which will invert each bit in the accumulator. (We could have achieved exactly the same effect using XOR $FF in hexadecimal or XOR 255 in decimal.)

So this new program will loop around loading a value from the input port into the accumulator, inverting all of the bits in the accumulator, and writing this new value to the output port.

Assemble this program to generate the corresponding **ccexp2.ram** file, then use your PBLink utility to download this program to the PhizzyB and set the little rascal running. As you see, the l.e.d.s on the bargraph display now go out, and it's only when you press one of the switches that the related l.e.d. turns on. (Verify that all of the buttons work by pressing and releasing them in turn.)

When you've finished playing, reset your PhizzyB and dismiss the PBLink utility. Note that you can test this new program on the PhizzyB Simulator using exactly the same input values that you used before.

EXPERIMENT 3

CMPA Instruction

One instruction we haven't looked at before is **CMPA** (compare accumulator), which allows us to compare the numerical value of the current contents of the accumulator to some other numerical value. In order to investigate this instruction, use your assembler to save the **ccexp2.asm** program as **ccexp3.asm**, and then modify this program as shown in Listing 2.

Don't Panic! This isn't as complicated as it looks. We commence with an **LDA** to load a value from the switches into the accumulator, and we follow this with an **XOR** to invert the contents of the accumulator. Now we use a **JZ** (jump if zero) to test whether the accumulator contains zero – if it does we jump back to the **LOOP** label. Thus, this portion of the program simply loops around waiting for us to press one of the switches.

As soon as we do press a switch, the **JZ** instruction fails and we "drop through" to the **CMPA** instruction. One thing you need to know is that the **CMPA** instruction assumes that both values being compared are unsigned binary numbers. (The concepts of signed and unsigned binary numbers were discussed in last month's PhizzyB Bonus Article.)

The way the **CMPA** instruction works is that it compares the current value in the accumulator with another value that we specify. If the value in the accumulator is the bigger, the Carry flag is set to 1 and the Zero flag is cleared to 0. If the two values are equal, the Zero flag is set to 1 and the Carry flag is cleared to 0. And if the value in the accumulator is the smaller, then both the Carry and Zero flags are cleared to zero.

In this particular program, we're comparing the value in the accumulator (which reflects the switch we just pressed) with a binary value of 00001000. So if the value in the accumulator is the bigger, this means that we must have pressed one of the switches numbered 4, 5, 6 or 7.

Alternatively, if the value in the accumulator is not the bigger, then we must have pressed one of switches numbered 0, 1, 2 or 3. (With regard to the previous sentence, note that we specifically didn't say "... if the value in the accumulator is the smaller...". This is because if we press switch 3 the two values will be equal – you have to be very precise when you're talking about the actions of programs.)

Thus, following the **CMPA**, a **JC** (jump if carry) instruction is used to decide what we do. If the carry flag is set, we know that the value in the accumulator was the bigger, and we jump to label **IS7TO4**

Listing 2

```
INPORT1:    .EQU   $F011      #Assign a label to input port $F011
OUTPORT0:   .EQU   $F030      #Assign a label to output port $F030

            .ORG   $4000      #Set start address to $4000
LOOP:        LDA   [INPORT1]  #Load accumulator from I/P port 1
             XOR   %11111111  #Invert contents of accumulator
             JZ    [LOOP]     #If ACC = 0 jump back to LOOP

             CMPA  %00001000  #Otherwise compare accumulator
             JC    [IS7TO4]]  #Jump to IS7TO4
IS3TO0:      LDA   %00001111  #Load ACC with 00001111
             STA   [OUTPORT0] #Store accumulator to O/P port 0
             JMP   [LOOP]     #Jump to LOOP and do it all again

IS7TO4:      LDA   %11110000  #Load ACC with 11110000
             STA   [OUTPORT0] #Store accumulator to O/P port 0
             JMP   [LOOP]     #Jump to LOOP and do it all again
            .END
```

(meaning "this switch is one of those numbered 7 to 4").

At this point we load the accumulator with a binary value of 11110000, store it to the output port, and jump back to **LOOP** to wait for another switch to be pressed. Note that the 11110000 value we load into the accumulator has no particular significance – it's just something we'll recognize when it appears on the l.e.d.s.

Of course, if the value in the accumulator isn't the bigger when we perform the **CMPA**, then the Carry flag will be cleared to zero, the **JC** instruction will fail, and the program will "drop through" to the **IS3TO0** label (meaning "this switch is one of those numbered 3 to 0") – be careful not to get the letter "O" of "TO" confused with the number "0" at the end of this label.

In this case we load the accumulator with a binary value of 00001111, store it to the output port, and jump back to **LOOP** to wait for another switch to be pressed (again, this 00001111 value has no particular significance).

So let's assemble this program to generate the corresponding **ccexp3.ram** file, use the PBLink utility to download this file to your PhizzyB, and run the program. Try pressing one of the 0 to 3 switches and observe the right-most four l.e.d.s light up, then try pressing one of the 4 to 7 switches and note the left-most four l.e.d.s light up.

Continue to experiment with this program until your heart stops pounding, then reset the PhizzyB, dismiss the PBLink utility, and proceed to the next section. (You can also replicate this experiment on your simulator if you wish – remember to use the binary patterns 11111110 through 01111111 to represent the action of pressing switches 0 through 7, respectively.)

POLLING PROBLEMS

The previous experiment relied on the program looping around reading from the input port and waiting for something to happen. This technique is referred to as *polling*, and it tends to occupy a lot of the CPU's time and resources. Using the polling technique was perfectly acceptable in the case of Experiment 3, because we weren't using the CPU to do anything else anyway, but what if we did want to use the CPU for another purpose?

As an example, here's an experiment you can perform for yourself. Take the simple l.e.d. output board you created in Part 2 and plug it into the external output port at address $F031. Now write a program that performs a simple binary count and displays it on this output board. In fact you can use the **test1.asm** file that was supplied with your PhizzyB Simulator as a basis for this program, but remember to save it out under another name.

Also, you'll have to change the address of the output port to $F031 and the label associated with this port to **OUTPORT1** (remember to change this label wherever it is used throughout the program).

You'll also note that this program contains a simple subroutine called **WAIT**, which is used to slow the count sequence down so that you can see what's happening (subroutines were introduced in Part 3).

Once you have this program running, modify it such that every time it performs a count, it also checks our new polling switch device connected to input port $F011. If none of the switches are pressed, then make the program return to performing its binary count. But if one of the switches is pressed, then make the program perform the same comparison and display the same values to the output port at $F030 as we did in Experiment 3 above (and then let it return to performing its binary count).

As you'll discover, one big problem we find when we try to combine this polling technique with the binary count is that we're trying to do two very distinct things, but that the code for both these things becomes somewhat intermeshed. This makes it difficult to write the program, and also to understand it and modify it later.

Even worse, suppose that you press and release a switch whilst the program is executing the **WAIT** subroutine. In this case your program might not even notice that you'd pressed the switch at all! All of these points mean that the polling technique has to be used with discretion. One alternative is to use a technique caller *interrupt-driven I/O* as discussed presently.

Note that if you find creating the program discussed in this section to be a little too taxing and/or time-consuming, you'll be happy to know that we've created one for you to peruse and ponder, **ccextra1.asm**. It's on the PhizzyB Bonus disk we'll discuss later.

IRQ AND IACK

As discussed in the previous section, there are a number of problems associated with a polling strategy. What we would like to do is to create a program that can concentrate on the task for which it was intended (performing a binary count in this case), without being obliged to constantly keep on checking to see if we've pressed a switch on our input device.

However, when we do press a switch, we want the CPU to respond as quickly as it can by performing the comparison, displaying the result on output port $F030, and returning to its binary count.

To facilitate this sort of thing, the CPU has a special input called the **IRQ** (interrupt request) and a special output called the **IACK** (interrupt acknowledge), as shown in Fig.2.

For a number of reasons (mostly historical), control signals are usually active-low (that is, their active state is a logic 0), and the **IRQ** is no exception. What this means is that we usually maintain the **IRQ** signal at a logic 1, so pulling it to a logic 0 tells the CPU that something interesting is happening (this request is stored inside the CPU in a register called the *interrupt latch*).

Similarly, when the CPU starts to respond to an interrupt (as discussed in a moment), it places its **IACK** output into an active-low state to tell devices in the outside world that it's doing something. (Note that we won't be using the **IACK** output at this time.)

INTERRUPT MASK

Thus far we've introduced four status flags: Z (Zero), C (Carry), O (Overflow), and N (Negative). In fact there is a fifth flag called I (Interrupt Mask). The interrupt mask is somewhat different to the other status flags, in that it is not set as the result of a logical or arithmetic instruction or condition. Instead, the interrupt mask is used to tell the CPU whether of not it is allowed to respond to interrupts.

Following a power-up or reset condition, the interrupt mask flag is initialized to its inactive state (a logic 0 in the case of the PhizzyB). This means that, by default, the PhizzyB will NOT respond to interrupts. Thus, in order for the PhizzyB to accept an interrupt request, we first have to use a **SETIM** (set interrupt mask) instruction, which loads the I flag with a logic 1.

The way this works is that the CPU checks the state of the interrupt mask every time it completes an instruction (Fig.3). If the mask is inactive the CPU proceeds to the next instruction, otherwise it checks the interrupt latch to see if an interrupt has been requested. If no interrupt was requested the CPU again proceeds to the next instruction, otherwise it jumps to a special subroutine called an *interrupt service* routine (discussed a little later).

INTERRUPT BOARD

In order to understand how all of this works, let's consider the second input board described in this month's construction article, the Interrupt Switch board. This board also contains eight switches that are wired in much the same way as the first board. However, in this case the outputs from the switches are used to drive the inputs of an 8-bit register.

The outputs from the switches are also used to drive an 8-input NAND gate. We know that the outputs from the switches are

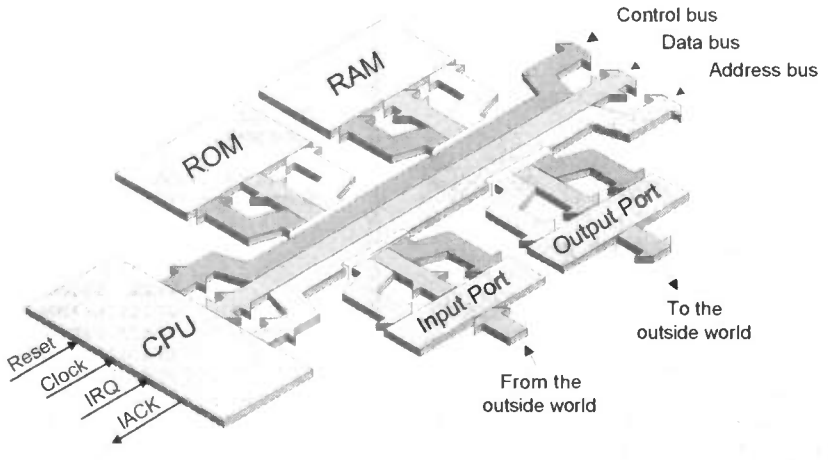


Fig.2. The CPU has a special Interrupt (IRQ) input *and Interrupt Acknowledge (IACK)* output.

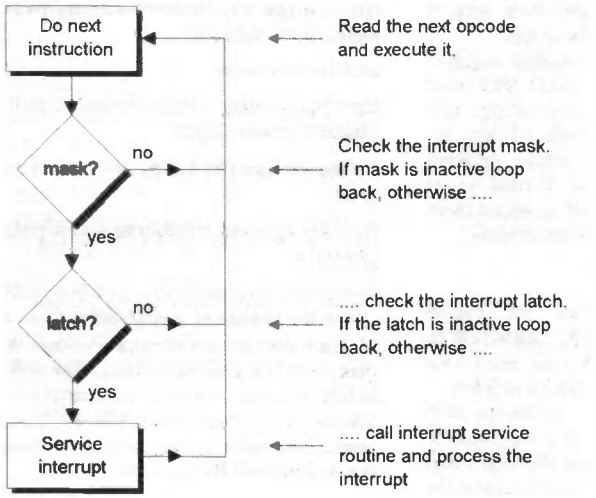


Fig.3. Interrupts handling flow-chart.

usually at logic 1 (due to the pull-up resistors), which means that the output from the NAND gate is usually at logic 0. When any of the switches are pressed, the output from the NAND gate transitions from a logic 0 to a logic 1. This "rising edge" is used to load the 8-bit register with the current values on the switches.

Furthermore, the output from the NAND gate is inverted by another chip to generate an IRQ signal. This means that when a switch is pressed, the resulting logic 1 coming out of the NAND is converted into a logic 0 on the IRQ signal (where this logic 0 is the IRQ's active state).

Let's proceed to an experiment that will let us sink our teeth into all of this ...

EXPERIMENT 4

Interrupt-driven I/O

Before we start, power down the PhizzyB, unplug the polled switch module from the input port at address $F011, and replace it with the interrupt-driven switch board. Also, take the l.e.d. output module you created in Part 2, and plug it in to the output port at address $F031. Now use the assembler to create the program shown in Listing 3 and save this as **ccexp4a.asm**.

The main body of this program loops around writing out a simple pattern to the l.e.d. module. Every time the program goes around the loop it calls a subroutine called **WAIT** that adds an element of delay so that we can see what's happening.

Assemble this program to generate the corresponding **ccexp4a.ram** file. Power-up your PhizzyB, download this program into it, run it to make sure that it works as expected, then reset PhizzyB.

Now save your program as **ccexp4b.asm**, then add the interrupt service routine shown in Listing 4. Add it just after the end of the **WAIT** subroutine and just before the **.END** directive.

This interrupt service routine is very similar to the program from Experiment 3. The first thing we do when we enter the routine is to push the current value in the accumulator onto the stack so that we can preserve it for later. Next we load the accumulator with the value from the switch device and perform the **CMPA** instruction.

Once we've finished comparing the accumulator and storing one or other of our patterns to the output port at $F030, we use a **POPA** (discussed in Part 3) to reload the accumulator's original value from the stack, followed by an **RTI** (return from interrupt).

The **RTI** acts like the **RTS** (return from subroutine) instruction we considered in Part 3, in that it returns the CPU to the point in the program it was at when the interrupt was originally called. (In fact the **RTI** is a little different to the **RTS**, but we won't go into that here – see also the Further Reading section at the end of this article).

But how is this interrupt service routine called? Well, we need to add two more instructions at the beginning of the program following the **BLDSP**, so that it becomes:

```
.ORG $4000
BLDSP $4FFF
BLDIV COMPARE
SETIM
```

The **BLDIV** (big load interrupt vector) instruction is used to load a special 16-bit addressing register – the Interrupt Vector – inside the CPU with the address of the interrupt service routine. In this case, we've used the **BLDIV COMPARE** statement, because we know that the assembler will automatically substitute the label COMPARE with its associated address (pretty cunning eh?).

Following the **BLDIV**, we use a **SETIM** instruction to set the interrupt mask to its active state, which will allow the CPU to see future interrupt requests.

What this means is that when we run this program, the CPU will happily concentrate on the main body of the program, which displays our simple rotating bit pattern on the display module connected to output port $F031. However, whenever we press one of the switches on the interrupt-driven switch board, that board will activate the **IRQ** signal, and the CPU will jump to the interrupt service routine.

Thus we see that there are a number of advantages of this interrupt-driven scheme over a polling approach. First, the main body of the program doesn't have to keep on checking the value on the input device. Second, the two functions are kept very separate and distinct, which makes understanding them and modifying them much easier. Third, even if we press a

Listing 3

```
INPORT1:   .EQU   $F011      #Assign a label to input port $F011
OUTPORT0:  .EQU   $F030      #Assign a label to output port $F030
OUTPORT1:  .EQU   $F031      #Assign a label to output port $F031

           .ORG   $4000      #Set start address to $4000
           BLDSP $4FFF       #Load the stack pointer with $4FFF

### Start of main body of program
           LDA   $03         #Load the accumulator with 3
LOOPA:     STA  [OUTPORT1]   #Store ACC to O/P port 1
           ROLC              #Rotate ACC one bit left
           JSR  [WAIT]       #Jump to the WAIT subroutine
           JMP  [LOOPA]
### End of main body of program

### Start of Delay Subroutine
WAIT:      PUSHA             #Store current ACC onto the stack
           LDA   $0F         #Load ACC with a delay value
LOOPW:     DECA              #Decrement the ACC
           JNZ  [LOOPW]      #If ACC != 0 jump back to LOOPW
           POPA              # else get original ACC from stack
           RTS
### END of Delay Subroutine

           .END
```

Listing 4

```
### Start of interrupt service routine
COMPARE:    PUSHA            #Store current ACC onto the stack
            LDA  [INPORT1]   #Load ACC with value from switches
            XOR   %11111111  #Invert the value in the ACC
            CMPA  %00001000  #Compare ACC to %00001000
            JC   [IS7TO4]    #Jump if carry to IS7TO4
IS3TO0:     LDA   %00001111  #Load ACC with 00001111
            STA  [OUTPORT0]  #Store accumulator to O/P port 0
            POPA             #Get original ACC from stack
            RTI              #Return from interrupt routine
IS7TO4:     LDA   %11110000  #Load ACC with 11110000
            STA  [OUTPORT0]  #Store accumulator to O/P port 0
            POPA             #Get original ACC from stack
            RTI              #Return from interrupt routine
### End of interrupt service routine
```

switch while the program is in the **WAIT** subroutine the interrupt will still occur, which means that we won't miss a switch-press.

So let's assemble this program to generate the corresponding **ccexp4b.ram** file, download it to the PhizzyB, and set it running. Observe the program driving the display at $F031 as before. Now try clicking one of the 0 to 3 switches followed by one of the 4 to 7 switches and observe that the $F030 display updates as we expect, and the $F031 display then continues with no perceivable interruption.

ANOTHER BONUS ARTICLE

What? Another bonus article? The problem is that there's just so much good stuff to tell you, yet so little time (and space) in which to tell you it all. So what we've done is to write a second bonus article that describes how to use the PhizzyB to time something and to display the result on the simple liquid crystal display (l.c.d.) output device we described in Part 3.

Quite apart from anything else, this new bonus article will also introduce you to the 16-bit addition, subtraction, multiplication, and division subroutines we supplied with your PhizzyB Simulator (you can use the assembler to peruse the **add16.asm, sub16.asm**, and suchlike files that you'll find in your data directory).

For your delectation and delight, this second bonus article is available as an Adobe Acrobat PDF file on the *EPE* web site and on disk. See the Bonus Resources section at the end for details on getting this article.

ADDITIONAL EXPERIMENTS

You will have noted that both of the switch input boards discussed this month have an additional 16-pin header, comprising eight signal pins and eight ground pins. This allows you to bypass the switches on the board, and to connect external switches. For example, in the fullness of time we will be attaching microswitches around the periphery of our forthcoming PhizzyBot.

We will then be connecting these switches to one or other of our input switch boards via these 16-pin headers, and using them to detect when the PhizzyBot bumps into something.

But you shouldn't limit yourself to our experiments, because there are a whole lot of things you can do yourself. For example, you might decide to create a model of a road junction with traffic lights. In this case you could easily use the PhizzyB to control the model traffic lights.

Furthermore, you could mount small magnets to the underside of your model cars, and also attach magnetically operated reed-switches under the entrances to the junction. These reed-switches could then be connected to the 16-pin headers on our input switch boards.

As another example, you could create a ramp with one microswitch at the top and another at the bottom, such that rolling a ball down the ramp will trigger one switch and then the other. Coupling this with the l.c.d. module described in our second bonus article would allow you to implement a simple event timer that times how long it takes the ball to roll down the slope.

Obviously these are just simple suggestions. If these experiments don't take your fancy, there are numerous other things you can do. In fact, if you think of any interesting experiments you could perform using these devices, please E-mail us at **info@maxmon.com** and tell us about them and we'll share them with other readers.

SHIFTY BUGS

In PhizzyB Part 3, Jan '99, Fig.2b showed the SHR (shift right) instruction as copying the **MS** bit back into itself (we show the same thing in the bonus article).

This diagram reflects an "arithmetic shift right" and this is the way it's supposed to work (and it *is* the way that the real PhizzyB works), but for some weird reason the simulator actually performs a "*logical* shift right" which means that it shifts a zero into the **MS** bit.

The simplest fix is to force the real PhizzyB to act like the simulator. This can be achieved by following a **SHR** instruction with an **AND** as follows:

```
<instruction>
<instruction>
    :
SHR
AND %01111111
    :
<instruction>
<instruction>
```

This forces the **MS** bit to be a logic 0 (which is what the simulator does incorrectly anyway).

Unfortunately, forcing the simulator to perform an *arithmetic* shift like it's supposed to (and like the real PhizzyB does) is much more painful. There are several ways to achieve this – one of the simplest to understand is to create a **SHRA** (shift right arithmetic) subroutine as follows:

```
# Main body of program
<instruction>
<instruction>
    :
JSR [SHRA]      # Instead of a SHR
                  jump to SHRA
                  subroutine
    :
<instruction>
<instruction>
```

In the subroutine we use a **JN** (Jump if negative) instruction to decide whether or not to set the **MS** bit to 1 as follows:

```
### Start of subroutine SHRA
SHRA:  JN [SHR1]      # If MS bit is 1
                        jump to SHR1
SHR0:  SHR            # Otherwise just
                        shift right (logical)
       RTS            # Return from
                        subroutine
SHR1:  SHR            # Shift right
                        (logical)
       OR %10000000   # Force MS
                        Bit to 1
       RTS            # Return from
                        subroutine.
### End of subroutine
```

BONUS RESOURCES

The PhizzyB bonus articles can be downloaded via the Internet from the *EPE* FTP site. The first is at:

ftp://ftp.epemag.wimborne.co.uk/pub/phizzyb/ebonus.pdf

and the second at:

ftp://ftp.epemag.wimborne.co.uk/pub/phizzyb/ebonus2.pdf

The file **ccextra1.asm** referred to earlier is at:

ftp://ftp.epemag.wimborne.co.uk/pub/phizzyb/.

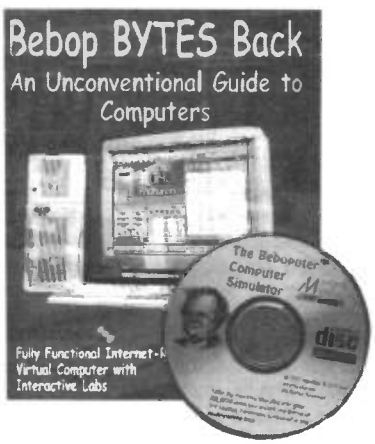
Remember to download it as a binary file.

For the benefit of non-Internet users these files are also available on a 3·5-inch floppy disk from the Editorial office. The software is free but there is a nominal charge to cover admin and postage costs: UK £2.75, Overseas £3.35 surface mail, £4.35 airmail. Order as **PhizzyB Bonus Disk**.

FURTHER READING

The basic concept of interrupts is relatively simple, but as usual there's a lot more to this subject than first meets the eye. For example, we haven't discussed what would happen if you had two input devices, both of which required the ability to trigger an interrupt. Similarly, we haven't discussed what happens if a new interrupt is requested whilst a previous interrupt is being serviced (which leads into the discussion of nested interrupts).

The bottom line is that there's much more to this topic than we can cover here. But turn that frown upside down into a smile, because all is not yet lost! If you want to know more about all of this, then one place to start is our book *Bebop BYTES Back (An Unconventional Guide to Computers)*, which is available from the *EPE Direct Book Service*.



NEXT MONTH

Next month the excitement really starts, because we'll be describing how to build the chassis for our PhizzyBot, and Alan will be describing how to construct a motor controller output board so that the PhizzyBot can go mobile.

Meanwhile we'll be using the switch devices from this month as collision detectors to allow the PhizzyBot to recognize when it's bumped into something.

BEE-LINE

Max and Alvin would love to hear from you via their web site **http://www.maxmon.com.** So, too, would we for possible inclusion on our Readout pages!

Computer Controlled Robotics

Bring Electronics to Life

3 Axis Arm £115

Carpet Rover £89

5 Axis Arm £139

Mobile Arm £179

Hexapod Walker £110

Micro Mouse £79

Technology Education Index

Telephone for our catalogue or visit our web site for further details

40 Wellington Road, Orpington, Kent BR5 4AQ

Telephone - (01689) 876880

Web Site - http://www.technologyindex.com

Prices exclude VAT and £5.00 next day carriage

VISA MasterCard

VARIABLE VOLTAGE TRANSFORMERS

INPUT 220V/240V AC 50/60 OUTPUT 0V-260V

	Price	P&P
PANEL MOUNTING		
0-5KVA 2·5 amp max	£33.00	£6.00 (£45.83 inc VAT)
1KVA 5 amp max	£45.25	£7.00 (£61.39 inc VAT)
SHROUDED		
0-5KVA 2·5 amp max	£34.00	£6.00 (£47.00 inc VAT)
1KVA 5 amp max	£46.25	£7.00 (£62.57 inc VAT)
2KVA 10 amp max	£65.00	£8.50 (£86.36 inc VAT)
3KVA 15 amp max	£86.50	£8.50 (£111.63 inc VAT)
5KVA 25 amp max	£150.00	(+ Carriage & VAT)
10KVA 45 amp max	£300.00	(+ Carriage & VAT)
6KVA 3 PHASE Star.	£205.00	(+ Carriage & VAT)

Buy direct from the Importers. Keenest prices in the country.

500VA ISOLATION TRANSFORMER
New manuf. surplus "C Core" tropicalised with top plate and solder connections. 0-240V AC. 5-0-100-110-120V & Screen Wt 10.5K.
Size: H 195 x 155 x 135mm
Price £35.00. Carr. £7.50 (£49.94 incL)

COMPREHENSIVE RANGE OF TRANSFORMERS–LT–ISOLATION & AUTO
110V-240V Auto transfer either cased with American socket and mains lead or open frame type. Available for immediate delivery.

ULTRA VIOLET BLACK LIGHT BLUE FLUORESCENT TUBES

4ft 40 watt £14.00 (callers only)	(£16.45 inc VAT)
2ft 20 watt £9.00 (callers only)	(£10.58 inc VAT)
12in 8 watt £4.80 + 75p p&p	(£6.52 inc VAT)
9in 6 watt £3.96 + 50p p&p	(£5.24 inc VAT)
6in 4 watt £3.96 + 50p p&p	(£5.24 inc VAT)

230V AC BALLAST KIT
For either 6in, 9in or 12in tubes £6.05 + £1.40 p&p (£8.75 inc VAT)
The above Tubes are 3500/4000 angst. (350-400um) ideal for detecting security markings, effects lighting & Chemical applications. Other Wavelengths of UV TUBE available for Germicidal & Photo Sensitive applications. Please telephone your enquiries.

400 WATT BLACK LIGHT BLUE UV LAMP
GES Mercury Vapour lamp suitable for use with a 400W P.F. Ballast.
Only £39.95 incl. p&p & VAT

RANGE OF XENON FLASHTUBES
Write/Phone your enquiries

SUPER HY-LIGHT STROBE KIT
Designed for Disco, Theatrical use etc.
Approx 16 joules. Adjustable speed £50.00 + £3.00 p&p (£62.28 inc VAT)
Case and reflector £24.00 + £3.00 p&p (£31.73 inc VAT).
SAE for further details including Hy-Light and Industrial Strobe Kits.

5 KVA ISOLATION TRANSFORMER
As New Ex-Equipment, fully shrouded, Line Noise Suppression, Ultra Isolation Transformer with terminal covers and knock-out cable entries. Primary 120V/240V. Secondary 120V/240V, 50/60Hz, 0·005pF Capacitance. Size, L 37cm x W 19cm x H 16cm, Weight 42 kilos. Price £120 + VAT. Ex-warehouse. Carriage on request.

24V DC SIEMENS CONTACTOR
Type 3TH8022-0B 2 x NO and 2 x NC 230V AC 10A. Contacts. Screw or Din Rail fixing. Size H 120 x W 45 x D 75mm. Brand New Price £7.63 incl. P&P and VAT.

240V AC WESTOOL SOLENIODS
TT2 Mod. 1 Rat. 1 Max. stroke ⅝in. Base mounting ½in. stroke 5lbs pull approx. TT6 Mod. 1 Rat. 1 Max. stroke 1 in. Base mounting ½in. stroke 15lbs pull approx. SERIES 400 Mod. 1 Rat. 2 Max. stroke 11/16in. Front mounting ½in. stroke 15lbs pull approx. Price incl. p&p & VAT. TT5 £5.88, TT6 £8.81, SERIES 400 £7.64.

AXIAL COOLING FAN
230V AC 120mm square x 38mm 3 blade 10 watt Low Noise fan. Price £7.29 incl. P&P and VAT.
Other voltages and sizes available from stock. Please telephone your enquires.

INSTRUMENT CASE
Brand new. Manufactured by Imhof. L 31 x H 18 x 19cm Deep. Removable front and rear panel for easy assembly of your components. Grey textured finish, complete with case feet. Price £16.45 incl. P&P and VAT. 2 off £28.20 inclusive.

DIE CAST ALUMINIUM BOX
with internal PCB guides. internal size 265 x 165 x 50mm deep. Price £9.93 incl. p&p & VAT. 2 off £17.80 incl.

230V AC SYNCHRONOUS GEARED MOTORS
Brand new Ovoid Gearbox Crouzet type motors. H 65mm x W 55m x D 35mm. 4mm dia. shaft x 10mm long. 6 RPM anti cw. £9.99 incl. p&p & VAT.
20 RPM anti cw. Depth 40mm. £11.16 incl. p&p & VAT.

SOLID STATE EHT UNIT
Input 230V/240V AC, Output approx 15KV. Producing 10mm spark. Built-in 10 sec timer. Easily modified for 20 sec, 30 sec to continuous. Designed for boiler ignition. Dozens of uses in the field of physics and electronics, e.g. supplying neon or argon tubes etc. Price less case £8.50 + £2.40 p&p (£12.81 inc VAT) NMS.

EPROM ERASURE KIT
Build your own EPROM ERASURE for a fraction of the price of a made-up unit. Kit of parts less case includes 12in 8 watt 2537 Angst Tube Ballast unit, pair of bi-pin leads, neon indicator, on/off switch, safety microswitch and circuit £15.00 + £2.00 p&p (£19.98 inc VAT)

WASHING MACHINE WATER PUMP
Brand new 240V AC fan cooled. Can be used for a variety of purposes. Inlet 1¼in., outlet 1in. dia. Price includes p&p. & VAT. £11.20 each or 2 for £20.50 inclusive.

MasterCard Open Monday/Friday

SERVICE TRADING CO
57 BRIDGMAN ROAD, CHISWICK, LONDON W4 5BB
TEL: 0181-995 1560 FAX: 0181-995 0549
ACCOUNT CUSTOMERS MIN. ORDER £10

VISA Ample Parking Space

Established 1990

QUASAR ELECTRONICS

Product data FAX back 01279 306504

NEW!

PROJECT KITS

COMBINATION LOCK Versatile electronic lock comprising main circuit & separate keypad for remote opening of lock. Relay supplied. 3029-KT *£8.95*
LIGHT ALARM Protect your valuables. Alarm sounds if circuit detects smallest amount of light. Place in cash box etc. 3008-KT *£6.50*
ALARM SIREN 110db of ear piercing noise. PCB fits in box with has 2 x 35mm piezo elements built into their own resonant cavity. Use as an alarm siren or just for fun! 6-9VDC. 3015-KT *£8.75*
LED COUNTER 3 digit basic event counter circuit on main board. Count & Reset switches & debounce circuit on 2nd. Cascade 2 or 3 kits for more digits. Box provided. 3001-KT *£12.95*
FUNCTION GENERATOR Quad Op-Amp oscillator & wave shaper circuit generates audio range square waves (6Hz-6KHz), triangle & pseudo sine outputs. 9VDC. 3023-KT *£4.25*
LOGIC PROBE tests CMOS & TTL circuits & detects fast pulses. Visual & audio indication of logic state. Full instructions supplied. 3024-KT *£7.25*
ROULETTE LED 'Ball' spins round the wheel, slows down & drops into a slot. 10 LED's, CMOS decade counter & Op-Amp. Educational & fun! 3006-KT *£9.95*
PELTIER JUNCTION HEAT PUMP Boil & freeze water instantly! Use for regulated cooling of temperature sensitive components & much more. Heatsink required. 3066-KT *£18.50*
9V XENON TUBE FLASHER Transformer circuit steps up 9V battery supply to flash the 25mm long Xenon tube. Adjustable flash rate (0.25-2 Sec's). 3022-KT *£10.95*
LM383 AUDIO AMPLIFIER Popular module for any general (Class B) audio application. Typ. output 10W @ 16V & 2W speaker; 1W @ 9V & 8W. 3047-KT *£9.25*
LED FLASHER 5 ultra bright red LED's flash in sequence or randomly. Ideal for model railways. 3052-KT *£6.50*
MULTI SEQUENCE LED FLASHER same as 3052-KT above but you have 7 patterns to choose from. 3037-KT *£4.50*
LED DICE Classic intro to electronics & circuit analysis. 7 LED's simulate dice roll, slow down & land on a number at random. 555 IC circuit. 3003-KT *£7.95*
DUAL LED DICE PIC 16C54 circuit performs similar function to 3003-KT above but two dice. Good intro to micro-controllers. Software code supplied on disk. 3071-KT *£11.95*
16C84 PIC PROGRAMMER Reads, programs & verifies. Uses any PC parallel port. All hardware, software & documentation needed to learn & test this uC provided. 3081-KT *£21.95*
STAIRWAY TO HEAVEN Tests hand-eye co-ordination. Press switch when green segment of LED lights to climb the stairway – miss & start again! Good intro to several basic circuits. 3005-KT *£7.95*
SPEED CONTROLLER for any common DC motor up to 100V/5A. Pulse width modulation gives maximum torque at all speeds. 5-15VDC. 3067-KT *£9.95*
3V/1.5V TO 9V BATTERY CONVERTER Replace expensive 9V batteries with economic 1.5V batteries. IC based circuit steps up 1 or 2 'AA' batteries to give 9V/18mA. 3035-KT *£4.75*
AM RADIO KIT Tuned Radio Frequency front-end, single chip AM radio IC & 2 stages of audio amplification. All components inc. speaker provided. PCB 32x102mm. 3063-KT *£8.95*
TRAIN SOUNDS 4 selectable sounds – whistle blowing, level crossing bell, chugging & 'clickety-clack'. All components inc. speaker supplied. SG1 *£4.50*

AUDIO TO LIGHT MODULATOR Controls intensity of one or more lights in response to an audio input. Safe, modern opto-coupler design. Mains voltage experience required. 3012-KT *£8.95*
THREE TIMER CIRCUITS in one kit! 3 PCB's & all components to make timers for a few seconds or up to 21 years! Onboard relay outputs. 3086-KT *£18.95*
8 CHANNEL IR TX/RX Controls 8 relays using IR remote control unit. 3072-KT *£44.95*
TELEPHONE ACTIVATED SWITCH Control 4 relays from anywhere in world by phone. (Not BT approved). 3086-KT *£44.95*
10W STEREO AMPLIFIER MODULE Uses TDA2009 class AB audio power amp IC designed for quality stereo applications. 3088-KT *£9.95*
17W BRIDGE AMPLIFIER 40W of 'brute' power @ 12VDC into 4W speakers. Ideal car booster amp. 3091-KT *£8.25*
STEREO VU METER shows peak music power using 2 rows of 10 LED's (green, yellow, red) moving bar display. 0-30db. 3089-KT *£10.95*
IR REMOTE TOGGLE SWITCH Use any remote control unit to switch onboard relay on/off. 3058-KT *£8.95*
12-BIT PC DATA ACQUISITION SYSTEM. Use your PC to monitor and control external events and devices through its parallel port. 3118-KT *£34.95*
PIC 16C71 FOUR SERVO MOTOR DRIVER Independently control 4 servo motors (not supplied). 3102-KT *£14.95*
UNIPOLAR STEPPER MOTOR DRIVER for any 5, 6 or 8 lead motors. 3 run modes. 3109-KT *£13.95*
LASER POINTER KIT 5mW Hitachi 670nm red laser diode. Attractive plastic case supplied. 3070-KT *£44.95*
ULTRASONIC MOVEMENT DETECTOR Xtal controlled oscillator, detector circuit & edge mounted transducers on a 75x40mm PCB. 4-7m range. Adjustable sensitivity. Outputs to drive external relay/circuits. 9VDC. 3049-KT *£12.95*

Surf on down to our **WEB SITE** See address at foot of advert

SURVEILLANCE

High performance surveillance kits. Room transmitters supplied with sensitive electret microphones & battery holders/clips. All transmitters can be received on an ordinary VHF FM radio.

MTX – Miniature 3V Transmitter
Easy to build & guaranteed to transmit 500 metres (over 1000m possible with higher voltage & better aerial). 3-9V operation. Only 45x18mm. *3007-KT.* £4.95

MRTX – Miniature 9V Room Transmitter
Our best selling 'bug'. Super sensitive, high power - 1000m range (Up to 2 miles with 18V supply & better aerial!). 9V operation. 45x19mm. *3018-KT.* £5.95

HPTX – High Power Room Transmitter
High performance, 2 stage transmitter gives greater stability & high quality reception. 1000m range with 9V battery. 6-12V operation. On/ off switch. Size 70x15mm. *3032-KT.* £6.95

VTX – Voice Activated Transmitter
Powerful 2 stage voice activated transmiter. Only operates when sounds are detected. 1km range. Low standby current – conserves battery power. Adjustable sensitivity & turn-off delay. Only 63x38mm. *3028-KT.* £7.95

TRI – Telephone Recording Interface
Connect between phone line & cassette recorder. Automatic-ally switches on tape when phone is used. Records all conversations. Powered from line. 48x32mm. *3033-KT.* £5.95

TRVS – Tape Recorder Vox Switch
Very sensitive, voice activated switch – automatically turns on cassette recorder when sounds are detected. Adjustable sensitivity & turn-off delay. 115x19mm inc. mic. *3013-KT.* £6.95

MTTX – Miniature Telephone Transmitter
Attaches anywhere to phone line. Transmits only when phone is used! Uses phone line as aerial & power source. 500m range. 45x15mm. *3016-KT.* £4.95

Two Station Intercom/Hard Wired Bug
Each unit has its own speaker, microphone & amplifier (LM386). Turn into a hard wired bug by using 4 stand ribbon cable supplied to send power from the receiving unit to the remote 'bug' unit. 9V. *3021-KT.* £11.75

Telephone Amplifier Kit
Pick-up coil & sensitive amplifier let you hear conversations without even holding the phone! Can be used for surveillance purposes. *3065-KT.* £9.25

X FACTOR PUBLICATIONS

THE EXPERTS IN RARE & UNUSUAL INFORMATION!

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

SUPER-EAR LISTENING DEVICE Complete plans to build your own parabolic dish microphone. Listen to distant voices and sounds through open windows and even walls! Made from readily available parts. *R002* £3.50
TELEPHONE BUG PLANS Build you own micro-beetle telephone bug. Suitable for any phone. Transmits over 250 metres – more with good receiver. Made from easy to obtain, cheap components. *R006* £2.50
LOCKS – How they work and how to pick them. This fact filled report will teach you more about locks and the art of lock picking than many books we have seen at 4 times the price. Packed with information and illustrations. *R008* £3.50
RADIO & TV JOKER PLANS We show you how to build three different circuits for disrupting TV picture and sound plus FM radio! May upset your neighbours & the authorities!! DISCRETION REQUIRED. *R017* £3.50
INFINITY TRANSMITTER PLANS Complete plans for building the famous Infinity Transmitter. Once installed on the target phone, device acts like a room bug. Just call the target phone & activate the unit to hear all room sounds. Great for home/office security! *R019* £3.50
THE ETHER BOX CALL INTERCEPTOR PLANS Grabs telephone calls out of thin air! No need to wire-in a phone bug. Simply place this device near the phone lines to hear the conversations taking place! *R025* £3.00

MINI CCTV CAMERA

Latest high quality IR-sensitive monochrome camera module for Video Intercom CCTV. Surveillance etc. Simply plug into scart or video. Six on-board IR LED's. Less than half the size of a cigarette packet!

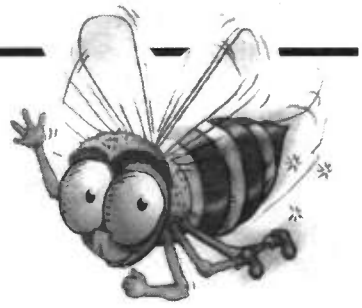
ASSEMBLED UNIT: 30A7-AS £69.95

FEATURES
*Compact & light camera PCB module. 54Wx38Lx30mmH. 33 grams
*Low power consumption 12V DC, 150mA
*Low light requirement 0.1Lux (IR LED on)
*High quality, high resolution CCIR image. 512x562 pixels
*Video output 1Vp-p/75Ω
*Lens 3.6mm, F1.8
*Field of view 74°H x 55V°
*Maintenance free
*Built-in electronically controlled auto-iris
*Internal synchronisation

plus AUDIO • EDUCATIONAL • LASER • SECURITY • TEST GEAR • BOOKS & more

Our high quality project kits are supplied with all components, fibre glass PCB's & comprehensive instructions. **FREE CATALOGUE** with order or send 2 x 1st Class stamps (refundable) for details of over 100 kits & publications. Mail order only. Please **ADD £2.00 P. & P. to all orders** (Europe £3, Rest of World £4) & make cheques/PO's payable to **Quasar Electronics**. Goods normally despatch within 5 working days but please allow 28 days for delivery. **Prices include VAT at 17·5%.**

Quasar Electronics Unit 14 Sunnningdale BISHOP'S STORTFORD Herts CM23 2PA
Tel./Fax 01279 306504 E-mail: epesales@quasar-electronics.freeserve.co.uk
Web site: http://www.quasar-electronics.freeserve.co.uk



PhizzyB COMPUTERS

Construction – 8-bit Switch and Latch

Alan Winstanley

Polling and interrupts set us on course for our super wheelie – the fabulous PhizzyBot!

THIS month's assignment is the construction of two 8-switch input devices for connection to the PhizzyB input port. The first project is a straightforward home-made keypad which hooks directly to the PhizzyB board via the standard 20-way IDC lead used previously. The second project is more ambitious, as it demonstrates how the PhizzyB can handle Interrupts generated by an external system. It incorporates some simple logic circuitry.

For one of the demonstrations, you also need the simple l.e.d. output board, constructed in Part 2.

Both of the projects are expandable. The switch boards can be utilised later on to connect to a series of external switches, including microswitches or limit switches used in robotics or buggy applications – including the forthcoming PhizzyBot, a simple motorised chassis which obeys your every command. Well, most of them. Hence the switches provide a series of simple on-off control signals which can also be utilised in more advanced systems.

Although both circuits are fairly straightforward, assembly is somewhat trickier than the modules previously described, mainly because of the need to interconnect a fair number of parts on a PhizzyB I/O board. It must be said that the interwiring is therefore quite a lot more intricate and challenging, but we give practical advice to help ensure that both modules will function first time. We think it's important that PhizzyB owners gain not only the ability to program the wee beastie, but also to roll up their sleeves and tackle the hardware aspects with confidence. Read on!

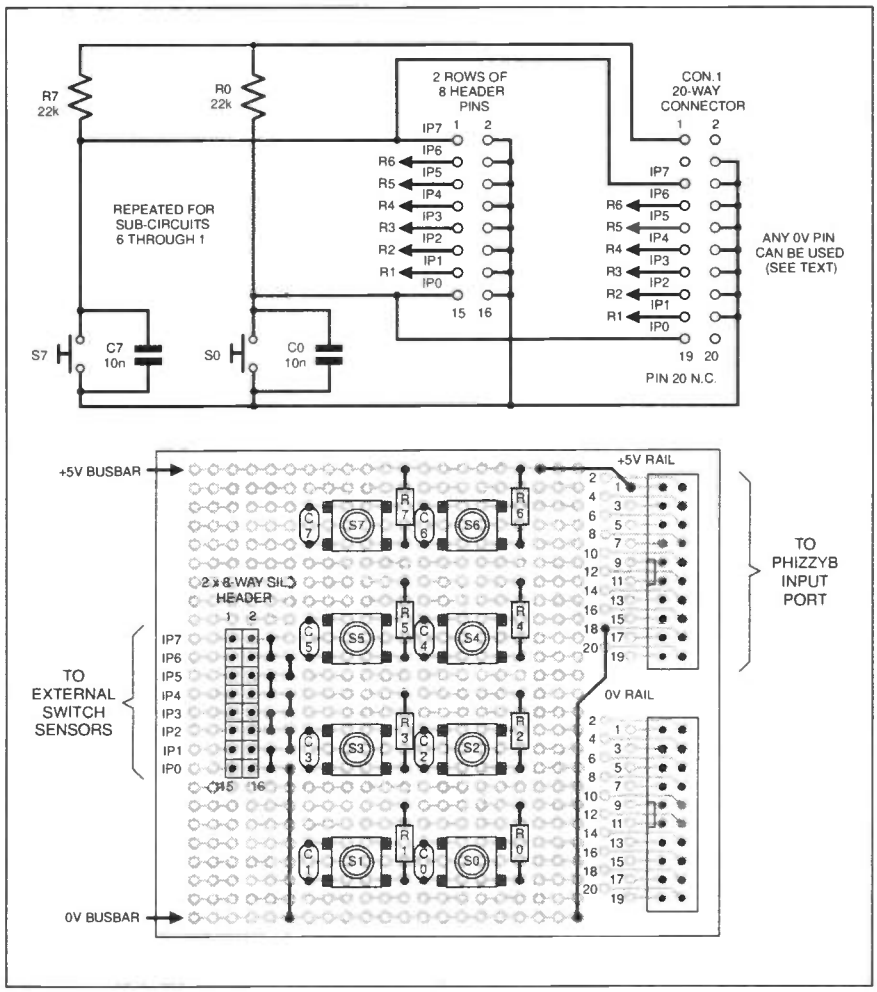


Fig.1. Circuit diagram and board layout for a simple 8-switch input "polling" module.

SIMPLE 8-BIT SWITCH

The first module is a simple 8-bit switch input unit – see Fig.1a. This contains eight switches (S0 to S7) each having a pull-up resistor (R0 to R7) and a 10nF capacitor to help reduce "noise" and switch contact bounce.

All eight switches operate in the same way. For example, by closing S7, the signal IP7 will be shorted to 0V. When the switch is opened, the IP7 signal will be pulled high again by resistor R7, because if there is no current flowing through the resistor then there is no voltage drop across it. All eight input signals connect to the standard PhizzyB IDC connector as before.

This circuit should be assembled on one half of a 4-up PhizzyB I/O board (combined sections A and B). A new board should be slit down the middle, using a Dremel cutting disk or fine hacksaw blade along the row of holes provided as a guide for this purpose (as discussed in Part 2). Both halves of the complete board will be used to assemble this month's projects.

The recommended layout of components for the 8-bit switch module is shown in Fig.1b. It is very common, when prototyping a circuit, to interwire the components using a ``point to point" technique which involves soldering the wire links on the underside of the board. This is perfectly adequate and is, in fact, the only way in which these circuits can be assembled on this board because the switches obscure the above-board holes, rendering them inaccessible.

In order to help with assembly, we've taken the unusual step of not only numbering the switches starting at S0 (instead of S1), but also the accompanying resistors and capacitors, starting at R0 and C0. Thus, all similarly numbered parts are grouped together.

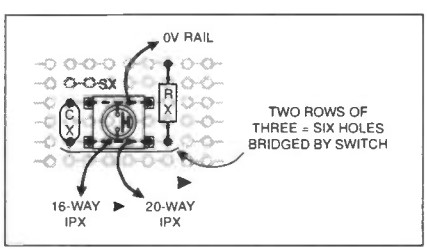
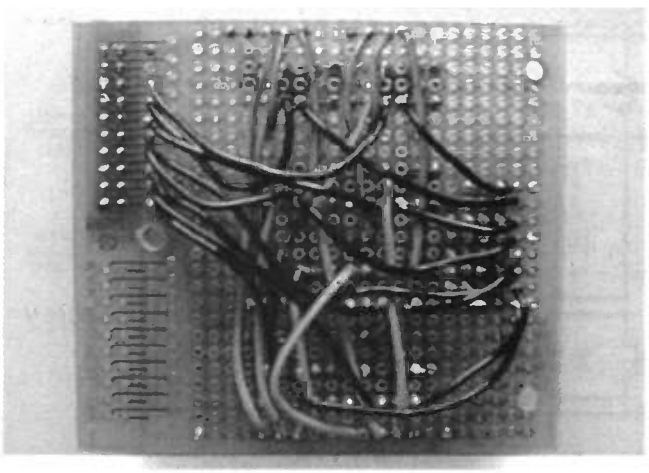


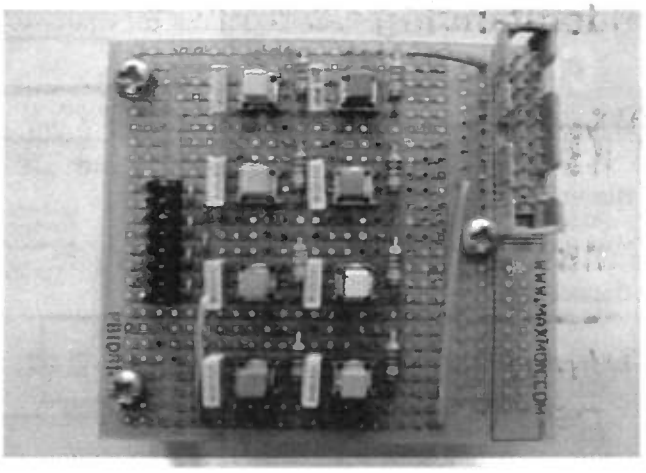
Fig.2. Switch wiring details.

ASSEMBLY

It is best to start assembly by locating the push-switches on the board. The specified types can be made to fit the board without any problems, by very slightly manipulating their pinouts. Each switch has four pins which are paired internally. This means



Under-side wiring for the 8-switch input "polling" module.



Top-side view of the 8-switch input "polling" module.

that the switch can actually be used to form a "bridge" which joins neighbouring copper strips together on the PhizzyB I/O board, see Fig.2.

Note that both busbars are used, the top one supplies +5V to the resistors, and the bottom busbar supplies 0V. Solder the resistors and capacitors into the board next to each switch as shown. Follow on with the two rows of 8-way pin headers (which can be used to hook external switches to the module), then solder the 20-way IDC box header (CON1) into place, observing the direction of the centre notch and pin 1.

With the parts in place, the interwiring should be completed on the underside (solder side) of the board. No wiring diagram is given, as all the relevant information is obtainable from the circuit diagram. Carrying out the wiring will prove straightforward provided that a methodical technique is used. Simply follow the circuit diagram and tick each wire on the drawing when you have soldered it into place.

Single core (solid core) hook-up wire should be used, and we strongly recommend purchasing a small reel of "wire-wrapping" silver-plated Kynar wire (size 1/0.25mm, 33s.w.g. or 30a.w.g.). Although it is very thin diameter, it has heat resistant insulation which won't melt during soldering. A fine diameter soldering bit is essential on the iron, and fine gauge solder will help. Fine gauge wire strippers will be needed as well.

Notice that the six in-line holes at the "top" of each switch, as shown in Fig.2, should be connected to 0V. Similarly, the six in-line holes at the "bottom" of the switch are used to carry the IP signals to the 20-way connector and 16-way header.

You will soon develop your own wiring technique, but remember that the secret is to be really methodical and don't lose your place! The author found it best to strip the insulation from the end of the wire, insert the bared end into the relevant hole and then apply 1mm or so of solder to fill the solder pad and make the connection. Then the wire was cut from the reel and the other end stripped and soldered.

A systematic technique evolved from this and the board was soon completed. Also remember to wire the +5V and 0V rails as per the drawing. To finish off with, a spray-on coating of p.c.b. lacquer on the solder side will protect the soldering from deterioration.

CHECK-IN

Hook the newly constructed switch input module to port $F011 on the PhizzyB. Then the following test program should be run:

```
# Start of program for Board 1
        .org $4000
loop:   lda [$F011]
        sta [$F030]
        jmp [loop]
        .end
# End of program for Board 1
```

Enter it via your keyboard, then assemble and save it as **board1test.asm**, after which load the resulting **.ram** file into the PhizzyB.

When you run this routine (press the Run button on the PhizzyB) all eight "internal" l.e.d.s on the PhizzyB board at port address $F030 will light up. Whenever you press (and hold) one of the switches on

COMPONENTS

8-BIT SWITCH MODULE

Resistors
R0 to R7 22k (8 off)
All 0.25W 5% carbon film.

Capacitors
C0 to C7 10n polyester (8 off)

Miscellaneous
S0 to S7 push-to-make switch, p.c.b. mounting (8 off)
20-way IDC box header (see text); 8-way p.c.b. box header (2 off); half of PhizzyB I/O board (combined sections A and B); Kynar hook-up wire (see text); solder.

Approx. Cost Guidance Only **£12**

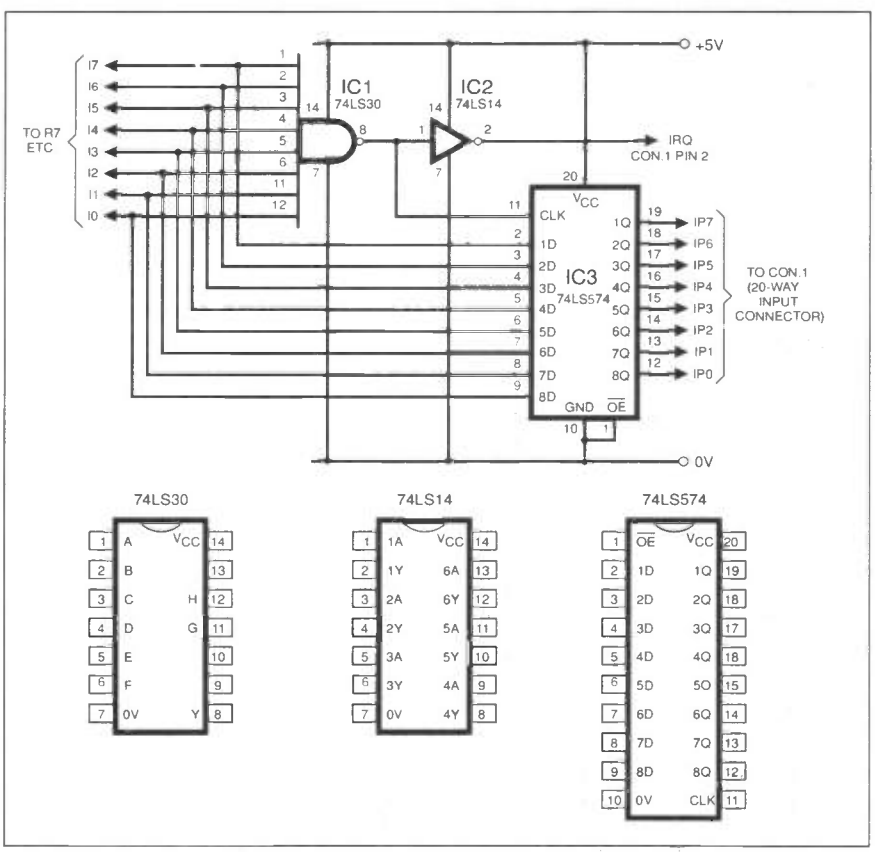


Fig.3(a). Basic circuit diagram of the 8-bit latch and (b) the pinouts of the associated i.c.s.

COMPONENTS

INTERRUPT MODULE

Resistors

R0 to R7	22k (8 off)

All 0.25W 5% carbon film.

Capacitors

C0 to C7	10n polyester (8 off)

Semiconductors

IC1	74LS30 8-input NAND gate
IC2	Schmitt inverter
IC3	74LS574 or 74HCT574 octal latch

Miscellaneous

S0 to S7	push-to-make switch, p.c.b. mounting (8 off)

20-way IDC box header (see text); 8-pin p.c.b. header (2 off); half of PhizzyB I/O board (combined sections A and B); 14-pin d.i.l. socket (2 off); 20-pin d.i.l. socket; Kynar hook-up wire (see text); solder.

Approx. Cost Guidance Only **£15**

your newly assembled switch module, that corresponding l.e.d. will go out. Release the switch to restore the l.e.d. Test all eight switches this way. There is every chance that the system will work first time. Give yourself a well-deserved pat on the back!

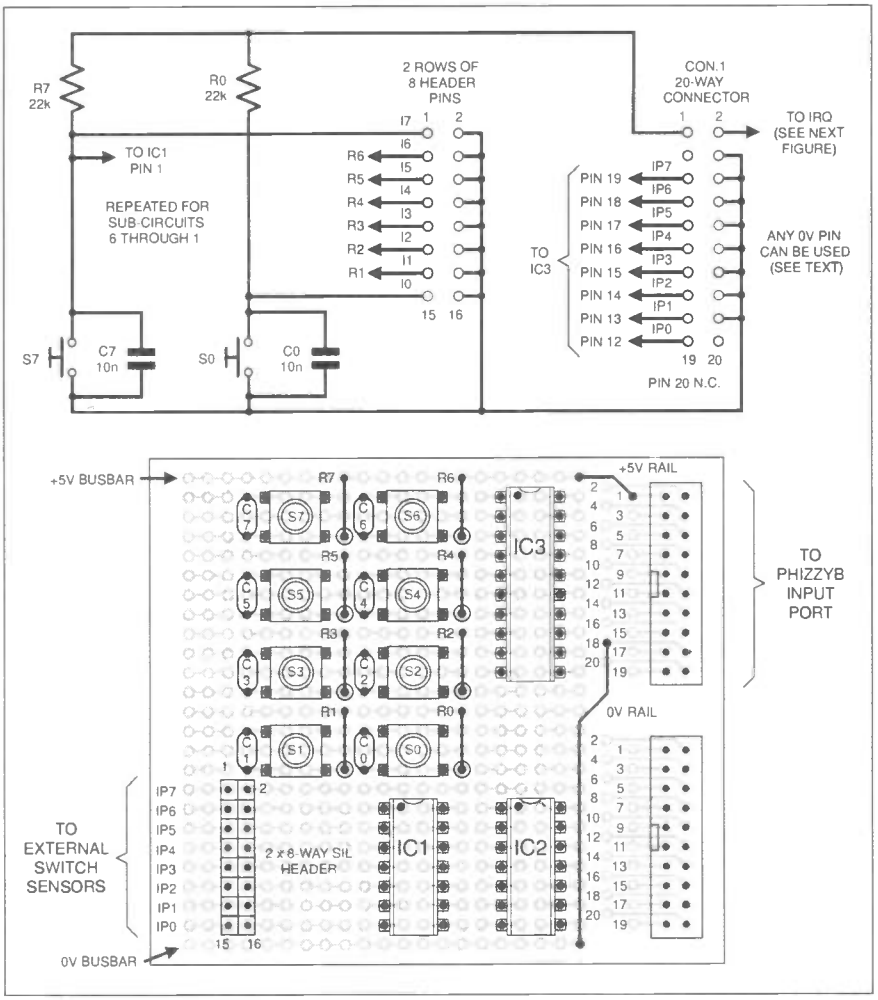


Fig.4. Switch circuit diagram and board layout for the 8-bit interrupt latch.

INTERRUPT BOARD

The second board is considerably more challenging, and we recommend that you allow at least two hours to work through the circuit methodically. The use of narrow-gauge wire-wrapping wire is necessary to accommodate the higher density of the interwiring.

The circuit diagram detailing the interconnection of logic chips used on this board is shown in Fig.3a, with the pinouts of the chips shown in Fig.3b. In Fig.4a, the logic of the switch interwiring to the chips is shown in a similar simplified fashion to that used in Fig.1.

The status of any of the switches S0 to S7 (are they on or off – high or low) is fed jointly to the 8-input NAND gate IC1, and to the 8-bit latch IC3.

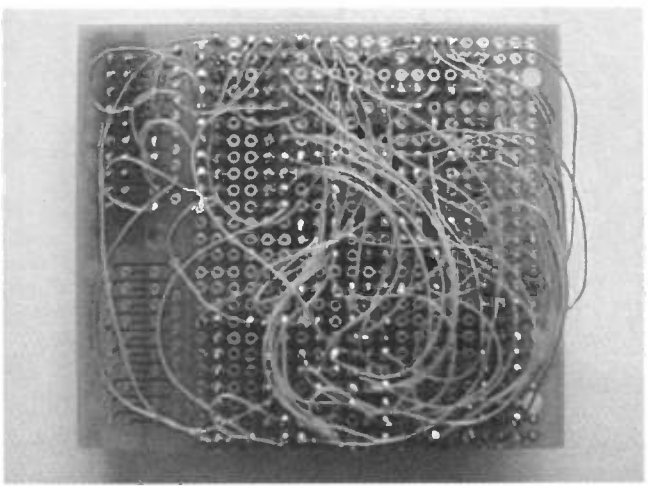
Normally, all the switch outputs are held high by their respective resistors (R0 to R7), and so the output of the NAND gate is low. If one or more of the switches is pressed, the NAND gate output goes high. IC2 inverts the output level from IC1, and the change in level can be used as an interrupt signal (IRQ) by other circuits, including PhizzyB itself.

The output from IC1 also controls the latch IC3. When the CLK pin 11 goes high the data on the other inputs (pins 2 to 9) is copied to the outputs (pins 19 to 12). When the CLK input goes low again, the data now within IC3 remains stored (latched) on the outputs until the next positive-going change on the CLK pin.

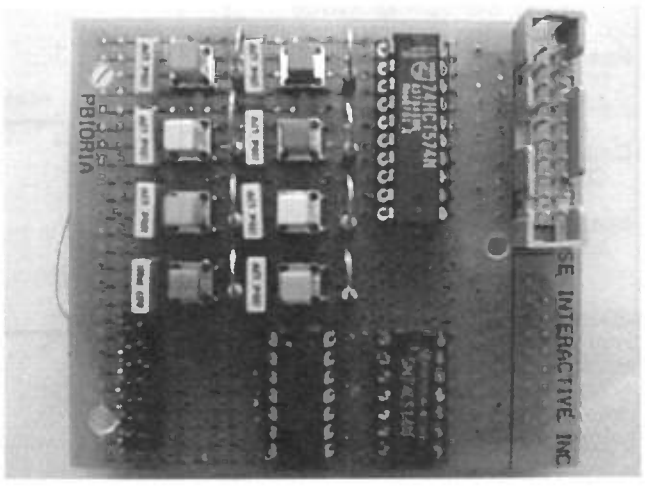
MORE ASSEMBLY

The layout of the components on the board is illustrated in Fig.4b. The assembly routine is the same as before, starting with the switches and surrounding discrete components, noting that this time the resistors should be mounted vertically (bend one wire around the shaft of a screwdriver). It is wise to use dual-in-line sockets to carry the three integrated circuits, which should be retained in their packaging until ready for insertion.

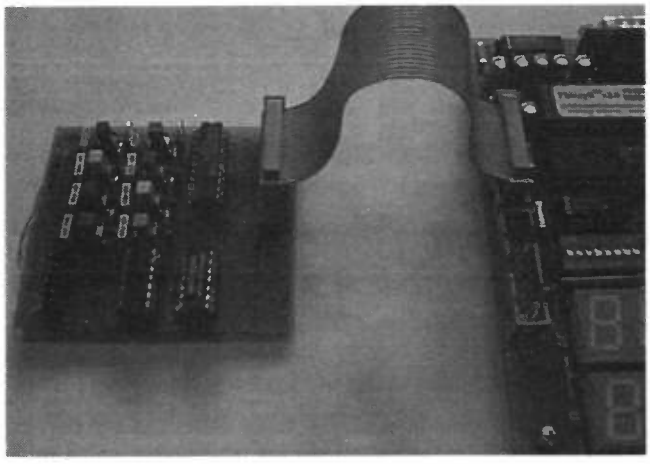
As with the previous board, provided that a completely methodical wiring approach is adopted, there is an excellent chance that the assembled board will work first time. As before, simply take your time



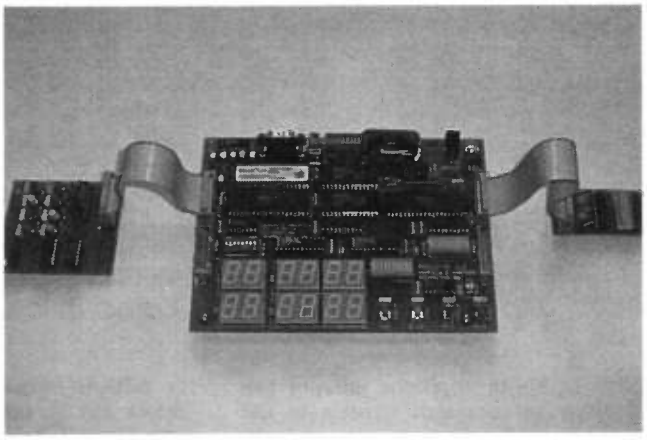
Underside wiring for the 8-bit interrupt latch.



Topside view of the 8-bit interrupt latch.



The 8-bit interrupt latch connected to PhizzyB.



The interrupt latch and l.e.d. output modules connected to PhizzyB.

and don't lose your place. (Lock the door at this point if you have to!)

Once again, the switch is used to bridge neighbouring copper strips in the printed circuit board, to produce strips of six holes. The "top" row of the switch's track is again wired to 0V, as before. This time, though, use the "lower" row of holes under the switch to connect to the 16-way header as well as one input of the NAND gate IC1.

The need to work on the underside of the board can be awfully confusing for beginners, especially with regard to the i.c. sockets, where some mental gymnastics with the pin numbers may be required!

Work through the entire circuit using point-to-point soldering as before. It is very easy to lose one's place when completing the interwiring, so use the same technique as previously, and ticking off each wire in the circuit diagram after it has been installed.

Continue with the 16-pin header: the author soldered a length of bare wire along one set of headers to link them to the 0V bus. Solder the 20-way IDC connector.

It can be tedious trying to double-check the wiring, but you should at least inspect the wiring for any obvious mistakes (dry joints, or wires touching each other). If you are happy that everything seems to be connected correctly (and before you insert the chips), then a practical approach involves simply switching on and see what happens!

If all is well, and after switching off, insert each chip into its corresponding socket.

Finally, a coating of spray-on p.c.b. lacquer will be of great benefit in protecting the rather delicate wiring on the solder side.

INTERRUPT TESTING

In order to demonstrate how a computer program can respond to an externally generated Interrupt signal, the test routine for the Interrupt switch module uses the l.e.d. display board (constructed in Part 2) on PhizzyB output port $F031. The newly-built Interrupt switch board should be connected to the $F011 input port.

The following program is needed to test the board:

```
# Start of program for Board 2
.org $4000
            bldsp $4FFF
            bldiv IRRUPT
            setim
            lda $00
loop:       sta [$F031]
            inca
            jmp [loop]
IRRUPT:     pusha
            lda [$F011]
            sta [$F030]
            popa
            rti
            .end
# end of program for Board 2
```

Enter it via your keyboard, assemble and save it as **board2test.asm**, and load the resulting **.ram** file into the PhizzyB.

Now run the program. The program will display a binary count on the external 8-bit l.e.d. module connected to output port $F031. When you press a switch on the new Interrupt board, this "latches" the values of all the switches into the 8-bit latch IC3, and it simultaneously generates an interrupt signal at the output of IC2.

The interrupt routine IRRUPT loads the value from $F011, outputs it to the internal 8-bit l.e.d. module at $F030 on the main PhizzyB board, and then returns control to the body of the program, which resumes the binary count on the external l.e.d.s. The process happens instantaneously as far as the observer is concerned.

When the first switch is pressed, all of the l.e.d.s at $F030 on the PhizzyB will light up except the l.e.d. corresponding to the switch you pressed. When you release the switch this pattern stays – and it will stay like that until you press another switch. By pressing the Interrupt switches in turn, starting with S7, an l.e.d. will be seen to extinguish on the PhizzyB l.e.d. output port $F030, starting with the most-significant bit (the left-most).

If you have problems, test the simple things first. Check with a voltmeter that all three chips on the Interrupt board are powered with 5V. Are the supplies to the busbars wired? Also look closely to see if any bare wires are accidentally touching each other. The author confesses to having omitted one wire (the clock feed) which, after connection, resulted in the board working exactly as described. The missing wire was easily detected because it had not been ticked off in the circuit diagram!

In the next instalment: we will describe the PhizzyBot, a simple motorised buggy which will respond to the computerised commands of the PhizzyB.

Buy your magazine on-line. *EPE,* the first magazine in the world to be available to buy from the web. $3.95 per issue, $23.95 for a year's subscription.

TAKE A LOOK, A FREE ISSUE IS AVAILABLE

New Technology Update

Ian Poole looks at the latest technologies employed in radio frequency semiconductors used in cellular phones

THE CELLULAR telephone industry has given an enormous impetus to the development of radio frequency semiconductors in recent years. Now a variety of new and improved devices are beginning to make their mark, many of which may not be familiar to those more used to digital or lower frequencies.

However, these devices are widely used in phones and base stations. In view of the enormous volumes being produced, they are not nearly as expensive as they were even a few years ago.

MESFETs

Today the MESFET can be considered as the workhorse for many r.f. applications. As well as being used for many discrete components, the technology also forms the basis of many of the monolithic microwave i.c.s that are used in the cellular industry today.

The name MESFET stands for metal-semiconductor field effect transistor. Surprisingly, these devices were first reported as early as 1966 and the first ones demonstrated in 1967 when FET technology was in its comparative infancy.

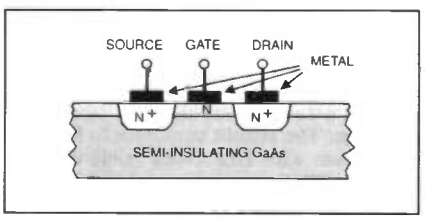


Fig.1. Construction of a MESFET device.

The devices feature gates formed by metal-semiconductor Schottky barrier junctions. The semiconductor material is normally gallium arsenide and the substrate is made to be semi-insulating to reduce parasitic capacitance. Above this is a very thin active layer that is often created using ion implantation, see Fig.1.

Although this is probably the cheapest method of creating the channel, an epitaxially grown one is normally able to give a higher performance because the crystal structure is left more intact. Typically, channel depth is only about 0·2μm and doped to give an *n*-type material. The choice of material and *n*-type doping are made to give the maximum carrier mobility required to enable good high frequency performance.

The small dimensions for the channel are critical to the correct operation of the device, and therefore they have to be accurately controlled. The source and drain regions are normally fabricated using ion implantation.

The contacts for the source and drain are often made from gold-germanium alloys for gallium arsenide devices. The gate contact can be made from a variety of materials including aluminium, platinum, or a complex titanium, platinum, gold layered structure.

Gate length is the key to many of the performance figures, and especially that of the high frequency limit. The standard MESFET processes produce gate lengths of around 0·5μm and this relates to a top operating frequency of about 18GHz. Where higher frequencies are required, a more refined process can produce a gate length of around 0·25μm which enables operation up to frequencies around 25GHz.

One of the main disadvantages of the depletion mode MESFET, the type that is most commonly used, is that it requires a negative voltage on the gate. Whilst this can be derived by placing a resistor in the drain/source circuit, this utilises valuable voltage and means that a separate negative supply is required.

PHEMT

To achieve improved performance, but at a cost, a device called a PHEMT (pseudomorphic high electron mobility transistor) can be used. In the past these devices were only associated with frequencies well into the microwave region. However, they have a number of advantages that have lead to the technology becoming somewhat cheaper and open to use in the cellular phone industry.

These devices possess a heterojunction, i.e. a junction in which not only does the doping change to give *p*-type and *n*-type materials, but also the base material changes. Typically the two materials might be aluminium gallium arsenide (AlGaAs) and gallium arsenide (GaAs). The structure of a PHEMT device is shown in Fig.2.

The key to the operation of the PHEMT lies in the heterojunction. At the junction of the two materials there is a very thin buffer region. This is typically only 30Å to 60Å.

Here the carriers are spacially separated from those in the doped region. This results in the carriers in this region having an exceedingly high mobility, allowing very high levels of performance to be achieved.

However, this performance is at a cost. PHEMT technology requires costly GaAs epitaxial wafers and is one reason why these devices are not as cheap as other devices being targetted at this area of the market.

The higher frequency performance of the PHEMT gives it some advantages in operation, but the key one for cellular telephone use is the fact that it can operate at a lower supply voltage than its MESFET counterpart. Typically these devices can operate down to 3V against 4V for MESFETs.

This is crucial in a market where portability is essential and battery life, size and weight are key factors in determining the success of a product. All of these are dependent upon the current drawn by the product.

Naturally, performance is not everything. Cost is a key driver in the decision about whether to use a device or not and fractions of a penny can lead to significant savings where large quantities are to be used.

In some manufacturing sites production is measured in integer millions. This means that even a penny saved on each unit can result in a cost saving of £10,000 per million units made.

To ensure that the PHEMT is viable to use it must produce the most cost effective design. Unfortunately there are comparatively few manufacturers, unlike MESFETs for which there are far more. Even then, some only manufacture for the more traditional microwave region.

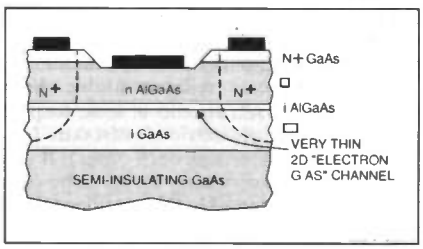


Fig.2. Internal structure of a PHEMT.

However, with the technology for PHEMTs becoming cheaper, and the vast possibilities for sales of these devices into the cellular industry, more companies are entering the market.

HBT

Another device generating a large amount of interest is the HBT or heterojunction transistor. This is a modified bipolar transistor where the emitter and base utilise different materials.

This has the effect of allowing electrons and not holes to be injected into the base region. By utilising this factor in conjunction with careful design of the transistor itself to reduce transit times and minority carrier storage, the response of the transistor can be improved significantly over more traditional approaches.

Those devices that have been targetted at this area of the industry have a flat response to over 3GHz. In addition to this the other advantage of the HBT is that it can run from a single supply rather than the dual supply normally employed for MESFETs and PHEMTs.

The final advantage of the HBT is that it is manufactured with a vertical structure. Because of the topology, it is found that vertical structures support a higher power density than lateral devices which include MESFETs and PHEMTs. This makes them ideal for power amplifier applications.

Whilst it may seem that the HBT has impressive credentials, it is not the ideal device it may appear at first sight. The high material cost of this device is a major set back in an industry that is fiercely price sensitive because of the highly competitive nature of the business. This alone will considerably reduce its usage.

To overcome this, manufacturers are looking carefully at the fabrication techniques used for the device. The tolerances are far less than those for more common devices like MESFETs where an emitter width of only 2μm is quite common.

It is also possible to fabricate more HBTs than MESFETs on a particular sized die. This should mean that it will be possible to reduce the cost of these devices considerably as processes are improved.

The other problem that has dogged the HBT is its reliability record. It is thought that this has mainly resulted from the manufacturing process. This is being addressed by the manufacturers of these devices and already a ten-fold improvement has been seen.

With further improvements a certainty, it should be possible to bring these devices into line with the requirements of the industry. Even then it may take a while for the devices to be fully accepted as they will still have a reputation to change. Fortunately in an industry changing as fast as the cellular phone industry this should not be a major problem.

Golden Oldies

Whilst many look at the new and upcoming technologies, there is still a lot of life left in the more traditional devices. Ordinary bipolar junction transistor technology can still provide excellent performance at a low price. MOSFET technology can also give a good account of itself.

However, it is likely that in the coming years there will be a steady change from the more traditional technologies to the newer ones like MESFETs, PHEMTs and HBTs.

SHOP TALK with David Barrington

Wireless Monitoring System

Under normal circumstances sourcing and locating parts for the *Wireless Monitoring System* could have been quite a nightmare, particularly regarding the use of surface mount devices to obtain such a compact design for the Transmitter. Thanks to the guidance of the author, James Humphris, in highlighting some of the "specials", the task has been eased quite considerably.

Starting with the Transmitter. The grey palm-sized plastic case came from the M-series stocked by **Farnell** (☎ ***0113 263 6311*** or **http://www.farnell.com**), code 775-629. Next, the 2-pin a.m. 418MHz transmitter module type LQ-TX418A is stocked by **Maplin**, code NV08J. It is also possibly stocked by **Radio-Tech** (☎ ***01992 576107***), but not shown in their advert. Check both for prices.

The following surface and non-surface mount devices are all listed by Farnell or Maplin. Murata TZBX4 series trimmer capacitor; F-code 499-432 (min 10 off); M-code VI65V (blue). Siemens 15nH SM inductor, F-code 200-566 (min 10 off); 3·6864MHz crystal (surface mount), F-code 699-822; 4-way surface mount d.i.l. switch, F-code 693-730.

Due to the dangers associated with mercury, we prefer to recommend that readers use the non-toxic version of the tilt switch listed by Maplin, code DP50. This should cost just over £1.

The Receiver should not cause anywhere near as much concern as the only surface mount device here is the 3·6864MHz crystal. This is listed by Farnell, code 699-822.

However, the only source we have found for the extruded aluminium case is from the CCN range stocked by **Maplin** (**http://www.maplin.co.uk**), code YN50E (CCN80). Just in case you have trouble finding the MAX202 RS232 line driver chip, this can also be ordered from the above, code VQ46A.

The Receiver module carries the model designation LJ-RX418A-S and was also obtained from Maplin, code NV09K. Again, try Radio-Tech for alternative price.

This only leaves us with the easy bit, the Trans/Rec PIC chips, software and printed circuit boards.

Those readers unable to program their own PICs can purchase ready-programmed PIC16C71s for the Transmitter and Receiver from **Magenta Electronics** (☎ ***01283 565435*** or **http://www.magenta2000.co.uk**) for the inclusive price of £5.90 **each** (overseas add £1 for p&p). There are two versions of the Transmitter software; one for the Tilt sensor, and one for the Temperature sensor. Please indicate version(s) required when ordering pre-programmed transmitter PICs.

Software for the *Wireless Monitoring System* is available on a 3·5in. PC-compatible disk from the *EPE PCB Service*, see page 140. There is a nominal admin charge of £2.75 each (UK), the actual software is *Free*. For overseas readers, the charge is £3.35 surface mail and £4.35 air mail. If you are an Internet user, it can be downloaded *Free* from our FTP site: **ftp://ftp.epemag.wimborne.co.uk/pub/PICS/wireless**.

The transmitter printed circuit boards are supplied as a pair, one for a.m. and one for the f.m. adaptor (next month), codes 219 and 219a. The receiver boards are also supplied as a pair, again one for a.m. and one for the f.m. adaptor, codes 220 and 220a respectively. See the *EPE PCB Service* page 140 for price details.

PIC MIDI Sustain Pedal

Apart from a ready-programmed PIC, if you are not into "blowing your own", then the rest of the parts required to knock together the *PIC MIDI Sustain Pedal* should be shelf items.

The neat looking footpedal depicted in the article came from **Maplin** (**http:\www.maplin.co.uk**), code DU99H. It must be a simple push-to-make, release-to-break type and not one that toggles state each time it is operated. The MIDI lead also came from the same company, code YZ26D.

For those readers who do not have the facilities or time to program their own PIC chips, a pre-programmed PIC16C54-XTP microcontroller is available from **Magenta Electronics** (☎ ***01283 565435*** *or* ***http://www.magenta2000.co.uk***) for the all inclusive sum of £5.90 (overseas add £1 for p&p). *(We understand they will be supplying the 84 version.)*

If you do intend to do your own programming, the software listing is available from the Editorial Offices on a 3·5in. PC-compatible disk, see *EPE PCB Service* page 140. There is a nominal admin charge of £2.75 each (UK), the actual software is *Free*. For overseas readers the charge is £3.35 surface mail and £4.35 airmail. If you are an Internet user, it can be downloaded *Free* from our FTP site: **ftp://ftp.epemag.wimborne.co.uk/pub/PICS/MIDIpedal**.

PhizzyB – 8-bit Switch and Interrupt Modules

Although component sourcing should not be a problem, you will certainly need lots of patience when you transform this month's *PhizzyB* circuits into working projects.

Selection of the "keypad" switches is the most important factor to consider when putting parts together for the *8-bit Switch* and *Interrupt* circuits. These must be 4-pin 6mm × 6mm p.c.b. mounting types, with each contact connected to two pins (parallel) for easy mounting. This arrangement is used to "bridge" tracks on the p.c.b.

Be careful, some "tactile" switches seem OK but dimensions may vary slightly. The ones used in our modules were ordered from **Farnell** (☎ ***0113 263 6311*** or **http://www.farnell.com**), code 176-433. Switch caps if required, 262-419.

Kynar solid-core hook-up wire is used extensively in "wirewrapping" applications in industry and should be available from most of our component advertisers. A small reel should only set you back just over £2. The semiconductor devices should also be widely stocked.

Experience of purchasing the headers and multi-way cable should have been gained when sourcing previous parts. If you have not already purchased the 4-section p.c.b. this is available from the *EPE PCB Service*, code 216 (see page 140).

Light Alarm

There is not a lot of room inside the case of the *Light Alarm* when all the components have been installed, so the selection of a "sub-miniature" type for the power on/off switch does make a difference. The threaded-fixing one in the model was purchased from **Maplin**, code FF77J. They also supplied the handheld case, with battery compartment and contacts, (code KC954D) and the 3V to 24V d.c. (5mA at 12V) low-profile, p.c.b. mounting buzzer, code KU58N.

If you ask for the light dependent resistor simply by quoting "one ORP12 please", most advertisers should recognise it and come up with the device or a suitable equivalent that will function in this circuit.

The small printed circuit board is available from the *EPE PCB Service*, code 218.

READOUT

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

WIN A DIGITAL MULTIMETER

The DMT-1010 is a 3½ digit pocket-sized l.c.d. multimeter which measures a.c. and d.c. voltage, d.c. current and resistance. It can also test diodes and bipolar transistors.

Every month we will give a DMT-1010 Digital Multimeter to the author of the best *Readout* letter.

★ LETTER OF THE MONTH ★

ARROWS

Dear EPE,

Having what I consider to be a strong "mechanical bent", I fell into the same hole that a lot of "rank amateurs" fall into when understanding arrows on semiconductor schematics (diodes and transistors) versus electron flow. Some have suggested changing the convention, but I feel there is a better way.

When teaching somebody new about current flow, never mention that years ago they got it wrong, it is not important in the beginning. Electrons flow from negative to positive, like-poles repel, and so on.

When it comes to understanding circuit theory and symbols, refer to the arrow as being a pointer to the cathode on a semiconductor in the same way a diode is banded at the cathode end. After that it falls into place faster. Don't mention the arrow as a flow indicator but rather as a pointer on a symbol and you don't get confusion.

My second point is about PLCs. I read with interest the discussions on them over the last few years and understand that they (as a subject) would not fit into your magazine format.

They are, however, one of the first hands-on contacts that fitters, plumbers and electricians have with electronic control systems and certainly were responsible for getting me involved in this rewarding and educating field (I don't miss stamp collecting).

Surely a solution would be to build one as a project using a PIC or similar. Say eight I/O with an I²C capability, relay-capable outputs and D-to-A facilities. Future add-on projects could be high speed counters, digital readout etc.

As well as being a great training aid and the next step in PIC multi-function applications. it would be ready to be put into burglar alarms, pulse counters and flow meters, level controllers, and so on.

A few screw terminals and it would be a useful module or building block, as well as filling the desire of some readers to understand modern PLC control systems.

Top mag, highly educational and I get a lot of pleasure from it every month.

Carl S. Wilde,
Acacia Ridge, Queensland, Australia

Certainly, I absolutely agree that historical references to current/electron flow are immaterial to understanding electronics. Personally, I don't care which way either flow, as long they do so somewhere and are predictable. My own early entry into electronics (many decades ago) was aided by simply thinking that in a circuit diagram "electricity/power" was required across the top and bottom, and that "signals" flowed from left to right.

The arrows, where they existed (the rectifier symbol was the only one I recall that used an arrow – the modern diode symbol), simply told me that a "one-way" street existed and that, as with traffic, "electricity" and "signals" must follow in the direction the arrows pointed. Concepts of "anode" and "cathode" were utterly alien to me for a long time – it was the arrow that mattered. Indeed, the rectifier symbol used + and – notations where we now use "k" and "a" (cathode and anode).

There was (and still is), of course, the anomaly that some symbols use arrows that have nothing to do with electrical flow direction. They merely indicate that the value of the component is variable – as with potentiometers and tuning capacitors, for example.

I find it interesting to recall my understanding of the valves I played around with in the early '60s. My concept was of signals flowing left to right into the grid of the valve, up the tube and out the top and to the right again. There was no thought of anything flowing down through the tube, but there were no arrows on valves to indicate flow of anything.

Nowadays, we are given at least some guidance on flow of "something" by the arrows on diodes and transistors. Again it is the symbol that is important to the basic understanding rather than the names given to the various points of contact at the symbol. Names are only a convenience used to allow easier communication of common meaning between people. They don't necessarily affect the mental image of a situation when looking at a symbol. Indeed, it can be argued that symbols should never include names, the symbol itself containing all the information required to understand its meaning.

Hence a symbol that includes wording for its meaning to be understood is, surely, a bad or inadequate symbol (it is accepted that some i.c.s are too complex for their function to be adequately symbolised). For instance, I hate the British Standards (BS) symbols for logic gates – identical rectangles with additional "wording" within them (1, &, ≥1), to denote their function! It must have been a committee of mathematicians that invented them rather than a team of working electronics engineers (you've heard the rumour that the camel is a horse invented by committee, haven't you?). Does anyone know the origin of the BS symbols?

The American (MIL/ANSI) system of logic gate symbols (as used in EPE) is far more informative of meaning at a glance. We have the same attitude towards resistor symbols – zig-zags rather than rectangles (even though rectangles are simpler to draw on a CAD package).

Mind you, one could take this argument to extremes and propose that we should all use Chinese for written communication – symbols that originate in the portrayal of individual concepts rather than using (as most other languages do) groupings of symbols (alphanumerics) that represent the spoken interpretation of concepts – a double translation in effect. However, memorising all the symbols must be a problem (although the Chinese obviously manage it), and what about typewriter/computer keyboards? A major difficulty! (Views from readers of oriental origin invited!)

On your other point, PLCs (programmable logic controllers), we still feel that instruction in these is beyond our "charter". However, again views are invited.

BT ON-LINE – HOW?

Dear EPE,

At an average cost per month of £10 to get on-line, my Scottish Ancestry baulked and my Old Age Pension went into decline, so I was surprised when included with my telephone bill (7 Sept) were brief details of BT Click.

I telephoned the freefone number but the young lady didn't know what this was and suggested I ring back in about a fortnight (?). Which I did. The second young lady didn't know anything either. The comment about the freefone number fell on stony ground.

I gave it a couple of days and phoned again. The third young lady was a bit more helpful and took all my details and said someone would call back. Thirteen days later I was phoned back and the caller spent almost ten minutes trying to answer my simple questions like "Will it run on Windows 3.11?" and "How much will it cost?". He promised to send CD-ROM or a Floppy Disk – he didn't know which.

Nothing had arrived by 26 Oct so I wrote to London BT HQ which brought not even an acknowledgment. Then I saw *Sunday Times* quarter page advert with a different freefone number. Telephoned Monday morning. The man said I had got the wrong number.

I shouldn't have said all those things about incompetence etc, etc, but the line went dead. Then a brief ringing tone and I then spoke more or less rationally to another young man who said it needed 16MB of RAM (which it doesn't), but said he would send a CD-ROM.

Two months after my first enquiry (at 75 you're not sure how many more months there are still to enjoy) the CD-ROM arrived. Made all the connections, wires trailing across the floors, and opened up the disk. A little window appeared with the message "This programme needs a '486' or Pentium".

I've only just upgraded to 386, for goodness sake. I'm afraid the doubtful delights of the Internet and digital highway are not for me.

Peter McBeath,
Morpeth, Northumberland

This reminds me of the sort of corporate competence on which our renowned columnist Barry Fox so often comments! Ironically, we are all so used to receiving (and probably turning down) all-too-frequent tele-sales offers for double-glazing, kitchens and so on, we probably assume that tele-marketing is an effective way of doing business.

Naturally, then, when it is we who actually want to initiate a tele-purchase, we expect to achieve what we want without difficulty. How frustrating that, in this instance, it's the line operators themselves who effectively turned you down through apparently not knowing their own product.

AIR THEM!

Whatever your views on electronics and allied subjects, air them in public, either through *Readout* or our *Chat Zone* via www.epemag.wimborne.co.uk

BOARDER LINE

Dear EPE,

What are the minimum recommended track widths and separations to use when designing p.c.b.s, with relation to voltage and current?

Also, what are the recommended u.v. exposure times for photo-sensitive boards (I exposed two 100mm × 160mm single-sided boards separately for four minutes. One board etched OK but the other had about 1cm of copper left on either side.

Are there any books you can recommend on these subjects?

Stuart Pearson, via the Net

Our On-line Editor, Alan, received these queries and replied direct to Stuart as follows (I'll add a few words in a moment):

Assuming 1oz (about 35 microns I think) copper and assuming 15°C above ambient is acceptable and the board won't burst into flames (!), then a track width of 8mm relates to 30 amps absolute maximum. You can reduce the track width pro-rata from this, and guesstimate/adjust for heavier gauge copper foils.

The recommended track separation with relation to voltage is:

Up to 50V	0·5mm
51V to 100V	0·7mm
101V to 170V	1·0mm
171V to 250V	1·2mm
251V to 500V	3·0mm

Over 500V – dodgy!

Exposure time depends a lot on different brands of u.v. etch-resist lacquer. I usually go for 15 to 20 minutes for pre-coated boards. Seldom have I found over-exposure to cause damage unless the board has very fine tracks. As I expect you know, it is impossible to re-expose for a further period, so I tend to be generous with the u.v. time.

You need to do some dummy test strips to see how the boards react to different exposures, because it also depends on how "fresh" your u.v. tubes are, how close they are to the copper, etc.

If you spray on the lacquer yourself by aerosol, it's very much harder to get consistent results in the u.v. stage. This is because the coating is not uniform thickness. I buy pre-coated boards for this reason.

Book-wise, there's a bit of info (but not much) in the *Art of Electronics* (Horowitz and Hill). It should be good enough to get you off the ground (as it were).

You might also care to read my series of *Build Your Own Projects* (Nov '96 to Mar '97) – it includes a lot about making p.c.b.s and project assembly. (See our *Back Issues* page.)

Alan Winstanley

And, of course, Robert Penfold's book How to Design and Make Your Own P.C.B.s *is also a worthy source of info (BP121, available through our* Direct Book Service).

Alan's experience with exposure is interesting! Having had many years professional p.c.b. manufacturing experience, my own is somewhat different. I still use the u.v. equipment I bought over 20 years ago and (amazingly) it still has the same u.v. tubes that it came with. They appear to be just as brilliant as they were then since exposure times are still around the same period for given materials. The u.v. unit's exposure area measures about 21 inches by 12 inches (53cm × 30cm) and has six 15 watt tubes, at a distance (estimated) of about 2 inches (5cm) below the image glass. The unit has a foam-padded clip-down lid to ensure adequate pressure between the board and its image master.

These days I buy my photo-resist boards from three sources, Mega Electronics of Saffron Walden, RS Components and Farnell Components (depending on what I else I need to order). Mega, by the way, specialise in printed circuit making equipment and materials, with a strong emphasis on supplying to educational establishments.

Typically, Mega and RS materials require an exposure time of two and half minutes with celluloid (photograph film) images created via a plate camera. Images on translucent drafting film using a 24-pin dot matrix printer and a computer require about four minutes 15 seconds. Farnell's materials used with the same image types are typically just under twice as long.

Development is in a solution made from pure caustic soda crystals (bought from a chemist as 100 per cent pure) diluted 25gms to one litre of water. Ideally, I prefer the temperature to be at the "photographic room-temperature" of 20°C (68°F), at which the development time is two minutes.

It is important in the development process that the solution is agitated by gently rocking it backwards and forwards in the tray. Don't be too vigorous, though. As you do so, the unrequired etch-resist will be seen to float way from the board. At the end of the two minutes, the copper should be nice and clear in the non-track regions, leaving a good clean-edged image (usually dark-blue) of the tracks themselves.

Now wash the board in luke-warm water to remove the caustic soda solution. It's recommended that you should use rubber household gloves while handling the caustic soda – although I don't bother just for the few seconds my hands are in contact with it, giving them a thorough wash in running water after completion (some people might be unusually sensitive, however).

The board can then be etched in the usual way (for this I do use gloves – usually – of the heavy-duty nearly elbow-length type). Avoid contact with the track image until after etching is complete. The etch-resist, although fairly hard, can be damaged if rubbed, the effect of which may not be apparent until after etching, when over-etched (and possibly absent) tracks might be seen!

An important point to note is that the caustic soda solution should not be too weak, which will result in an unclean image – tracks surrounded by speckled areas where the developing is incomplete. A similar effect can occur if the exposure time is too short.

In fact, provided the solution is mixed up to the recommended strength, this should not normally become a problem for a long time. I make two litres a time and, as a calculated guess, probably develop around two square metres of board a year. Following development, I return the solution to its bottle, which is made of dark-brown glass. It is stored (well-stoppered and well-labelled!) in a cupboard in the workroom, and there's probably a year to 18 months between renewals. The usual sign that it's reaching exhaustion is when development times begin to extend to three minutes at 20°C. This is normally preceded by sediment appearing at the bottom of the bottle.

Contrary to Alan's experience, I do find that over-exposing the image in the u.v. unit is problematic. However dense the image, and however good the contact is between the board and the translucent/transparent master, the u.v. light tends to seep in around the edge of the track images. Normally (correct exposure time) this is not apparent on the final result. However, if exposure is too long the effect becomes noticeable as imprecise edges to the tracks. In extreme cases, thin tracks (those between i.c. pads, for example – typically 10 to 15 thou) can cease to exist. It is essential, of course, that you ensure the image and board are in perfect contact, and remain well sandwiched together throughout the exposure period.

Readers having less-powerful u.v. units will find that their exposure times will be longer than mine, and it could be that an apparent tolerance to overexposure does exist – although the ratio of tolerance may still be about the same relative to the optimum exposure period.

I re-iterate Alan's advice about doing tests for optimum u.v. exposure times. This should be done for each new batch of photo-sensitised board, from whatever source. All you need to do is use a few small cut-offs, exposing them and a selected area of the image required for different periods and developing each after exposure. Timings to within the nearest 15 seconds are normally satisfactory.

Exposure tests should also be done if you change the material on which the master image is printed, i.e. from one batch of drafting film to another. It should also be done if you suspect that the density of the master image itself is different to normal (a printer ribbon getting a bit thin, perhaps – I keep one ribbon solely for p.c.b. image making).

It is also worth noting that photo-sensitised boards have a shelf-life (use before date). I have variously found this to be quoted between six months and a year from date of purchase.

Incidentally, I have heard of people suspending u.v. bulbs over the image/p.c.b./glass sandwich. I dread to think about what inconsistencies this must generate. For a start, it is believed that many so-called u.v. bulbs are little more than ordinary tungsten bulbs with a u.v. filter coating and so the exposure times must be horrendously long. Further more, the evenness of illumination must be nearly non-existent, being brighter at the centre of the illumination, falling off rapidly at the edges, a situation aggravated by the closeness at which the bulbs are to the sandwich. Such bulbs should be confined to discos!

Like Alan, I would not even consider pre-coating boards myself – instinctively feeling that I could never achieve consistency with them. Would any readers care to offer comments on their experience with this method?

Finally, remember that there are three key words when it comes to good p.c.b. imaging – Time, Temperature and Ingredients. Relate them consistently and you too will achieve good results (my wife says this is also the requirement for cooking, so why can't her husband cook?)!

SLASHED PIC SITE

Dear EPE,

I have just noticed that in my letter published in *Readout* of Aug '98, my web site mentioned is incorrectly printed – a dot has been printed instead of slash. The correct address is **http://members.aol.com/LearnPIC**.

John Morton, via the Net

Sorry John! Readers, John has set up his site for PIC users, especially beginners. It was originally set up to supplement his book PIC Beginners Guide *published in May '98 by Butterworth-Heinemann, although it is completely general in scope and does not rely in any way on knowledge of the book.*

HIGH LANGUAGE

Dear EPE,

I note with interest the letter (Dec '98) regarding the use of higher level languages for programmes used in computer type projects. It would be nice to see some projects using C, for example. However, there may be difficulties.

The standard C compilers, such as Borland C V5 and Microsoft Visual C, do not allow I/O ports to be accessed directly as in the older Turbo C and MS C V5.0. They have been designed for the 32-bit operating systems of Win 98 and NT and as such you cannot specify an actual I/O port as an address.

The means of accessing I/O ports is via Windows programming techniques and treating ports as files. The programmes would be very complicated for many non-professionals and I feel would be beyond the scope of your magazine.

The depth of coverage you provide is excellent and I would not like to see the content diluted for the sake of fashion in the IT world.

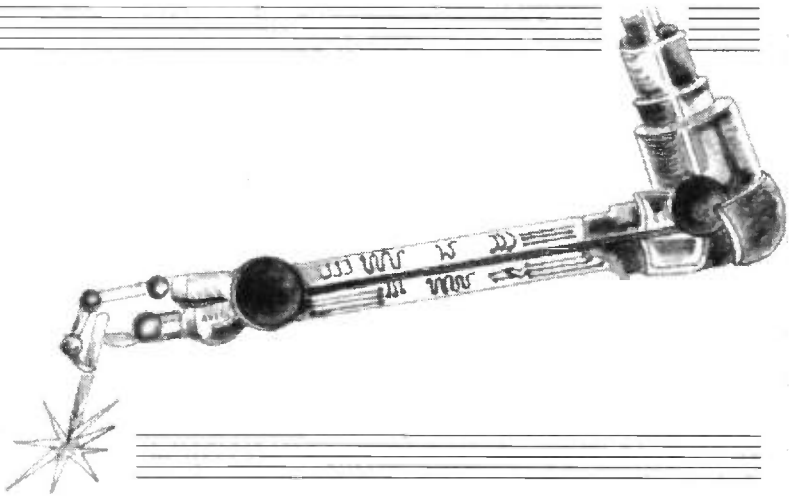
Ken Brown, Ireland, via the Net

Thanks, useful comments – but alarming. Whilst I have not used a '98 machine I do write in machine code for the '95, accessing ports directly through register addresses. Am I to understand that '98 does not allow this? That would make many of my programs unworkable in a machine having '98 installed, which would be a great shame since most will run on any machine from an 8086 upwards to a Pentium (with '95 installed).

More feedback on this requested, please!

Regular Clinic

CIRCUIT SURGERY



ALAN WINSTANLEY

This month our electronic agony uncle, armed with Dremel in hand, dissects an electret microphone capsule to see what makes it tick. We also follow up on relay contact ratings and make a heartfelt plea on behalf of a Singapore reader in need of some non-corrosive etchant!

Electret "Mics."

My thanks and greetings to regular reader ***Mike Howell*** of Westville, South Africa who writes:

Firstly, congratulations on your excellent Circuit Surgery *columns – my only complaint is that* EPE *can't give you more space!*

Can you help with a question on the correct use of electret microphones? An old constructional project called the Acoustic Probe *by Andy Flind (EE Nov. 1987) is a personal favourite, but having searched through my Back Issues all the way back to 1977, I can't seem to find any information on electrets.*

The Acoustic Probe used a crystal microphone in its design which I hope to substitute the microphone for an electret type. It was so good that I made up a second board, this time using a fibreglass parabola for listening to bird and animal noises out here in the Bush! (The acoustic probe is also invaluable when looking for lost cats!)

PS – In circuit diagrams, what on earth is meant by V_{cc}, V_{dd}, V_{xx} etc.?

The *Acoustic Probe* is one of those memorable constructional projects which lives on and on, and I'm pleased to say that it is still available today in kit form from Magenta Electronics (**www.magenta2000.co.uk**). The project is a form of electronic stethoscope which can be used to listen to ticking watches, or diagnose engine faults. (Readers, please note that we cannot supply Back Issues dating back so far but Magenta do include a reprint of all the constructional details with each kit.)

Andy is well known to regular readers for producing some fascinating designs, including our *Mind Machines* and *TENS Units*. The *Acoustic Probe* design used a crystal microphone insert which was hooked to a junction f.e.t., see the circuit extract in Fig. 1.

The microphone was actually incorporated into a special probe assembly which could be touched onto the object to be monitored (e.g. near the crankshaft of an engine block, or onto the bearings of a motor) and an amplifier then reproduced the audio signal over a pair of headphones.

A crystal microphone is a high impedance sound transducer which generates a tiny electric signal in response to the sound waves that impinge on the crystal insert. This is as a result of the *piezoelectric effect* (many say *pee-ay-tzo*, others, including myself, say *peet-zo-electric*.) The piezoelectric effect is used in some cigarette or barbecue lighters in which a tiny crystal is struck and the resulting electrical impulse is used to create a spark.

Since the crystal has a very high impedance – several megohms – then it is necessary to ensure that the impedance of the following stage is high enough so it will not load the signal. In this design the circuit used a 2N3819 junction f.e.t. as the first stage to match the input impedance.

In the circuit extract of Fig. 1, the f.e.t. (field effect transistor) TR1 is biased as a source follower which tracks the signal on its gate (g) terminal. The resulting a.c. signal is fed to an i.c. amplifier which drives the headphones. The main point is that the crystal microphone generates a signal itself and requires no biasing.

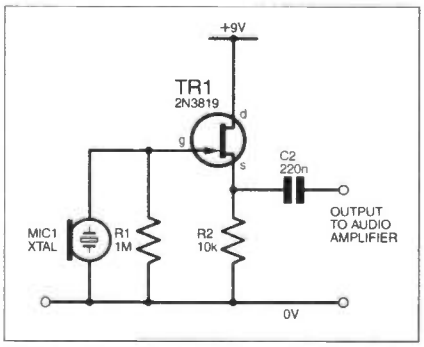


Fig.1. Crystal amplifier circuit of the Acoustic Probe.

Micro Surgery

As for how an electret microphone works, well it did not take too long to find out by applying a little "circuit surgery", which involved slicing one open with a Dremel!

Some readers will know that the electret is also known as an electret "condenser" microphone. Younger readers won't be aware that *condenser* is actually the old-fashioned word for **capacitor**, which yields a clue as to the operation of an electret capsule.

The result of examining the internal components of a typical electret condenser microphone insert is shown in Fig.2. I sacrificed a type EU6 electret microphone ordered from ElectroValue Ltd.

A little bit of reverse engineering on the resulting debris revealed that there were two electronic components inside. Firstly a transistor which was marked only as "K596" – I couldn't find this in my data library but some detective work on the Internet (on the Motorola web site: **http://mot2.mot-sps.com/ppd/html/smsignalxref.html**) indicates this is probably a KSK596, for which Motorola suggest a 2N5484 as an alternative.

A further check on the National Semiconductor web site (**www.natsemi.com**) on this latter number gave a general description of an "*n*-channel r.f. amplifier designed primarily for electronic switching applications such as low on-resistance analogue switching" – which instantly identifies the device as a MOSFET transistor (as I would expect).

The electret microphone also incorporated a single one-eighth watt discrete resistor, which didn't quite withstand the onslaught of my Dremel. It is soldered onto the tiny p.c.b. which forms the underside solder contacts of the microphone. So where is this "capacitor" in this condenser microphone – where does the audio signal come from?

Mind the Gap

The answer is soon revealed by separating the microphone into its individual parts, see Fig.2. A wafer-thin metal disc forms a *diaphragm* which vibrates when struck by sound waves. A plastic ring underneath acts as a separator and an insulator. Underneath that insulator is a second steel disc which is tack-welded directly to the gate terminal wire of the MOSFET transistor.

A gap is therefore created in the centre of the plastic ring: in other words, an air-spaced capacitor is formed. So the encapsulated air acts as the capacitor *dielectric* and the two metal discs act as capacitor "plates". Mystery solved, Mike!

Sound waves enter the module through a hole on top of the capsule, which means the microphone is omni-directional in nature – its sound response does not depend on the direction in which it is pointed. (A unidirectional microphone is more sensitive to sound in one direction.) The sound pressure waves cause the metal diaphragm to compress the airspace underneath, creating a variation in the tiny capacitance (a few picofarads I would guess) which is relative to the sound pressure and frequency.

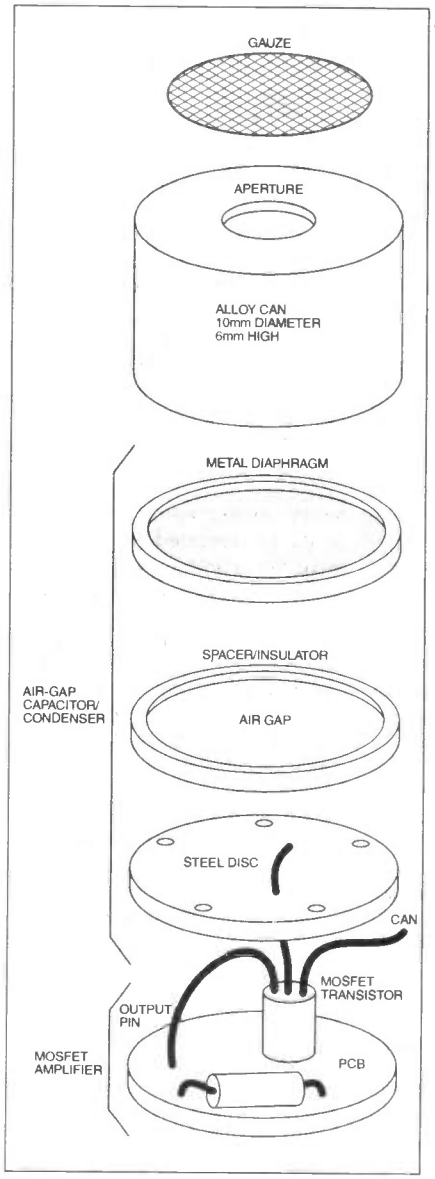


Fig.2. Exploded view of an electret "condenser" microphone. (A plastic internal moulding is not shown.)

This "capacitor" has an extremely high impedance or capacitive reactance, hence the need for a built-in MOSFET transistor immediately behind the resonating chamber to act as a buffer. The internal resistor biases the transistor.

Finally, the whole assembly is crimped into an aluminium can. I noted that there are 2-pin and 3-pin microphones available, but the only real difference is the screening arrangement for the capsule.

One difference between the electret and a crystal microphone is, of course, that the electret's built-in MOSFET requires an external supply voltage. Typically a 1·5V cell can be used but roughly 5V is suggested along with a resistor.

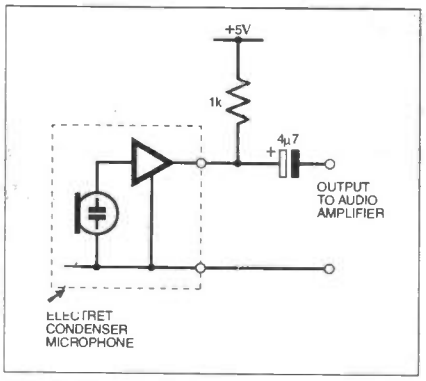


Fig.3. Circuit for a simple microphone stage using an electret condenser capsule.

We are not talking hifi and there is no rocket-science involved here. You could try a configuration such as that shown in Fig. 3. You will need to experiment, but don't be afraid of the device – there is very little to them as you can see!

Textbook Voltage

To answer your second question on the subject of voltage designations used in diagrams and data sheets; historically the terminology V_{CC}, V_{BB} etc. relates to the biasing arrangements of bipolar transistors. They are terms which are taken for granted and I can understand the puzzlement: textbooks often introduce expressions such as "$+V_{CC}$" out of nowhere.

A voltage V_{CC} is that which biases the collector(s) of a transistor circuit, and V_{EE} biases the emitter(s). V_{BB} would be the base bias voltage. The term "$+V_{CC}$" has fallen into common use to denote the positive supply rail in a bipolar transistor circuit, and V_{EE} the 0V or negative rail

The same nomenclature can be used to designate the voltages *between two terminals* of a transistor. You will see these used a lot in manufacturer's transistor data sheets or in catalogues. Look especially for:

V_{CEO} – the maximum permissible collector-emitter voltage with the base "open"

V_{CBO} – the maximum voltage allowed between collector and base

V_{EBO} – the maximum emitter-base voltage.

As examples, the BC548 is rated at V_{CEO} 30V, V_{CBO} 30V and V_{EBO} 5V. Notice that the V_{EBO} specification is often very low in comparison – usually just a few volts – and is one to keep an eye on when designing circuits.

The same kind of designation is used in the field of digital integrated circuits. V_{DD} and V_{SS} describe MOS digital circuit supply voltages. In fact engineers use the terms with reference to the individual transistors within the chip.

For example, in last month's issue I described the internal circuitry of a typical 4017 Johnson Counter chip. Obviously, I didn't resolve right down to the individual transistors fabricated in the die.

Since MOSFET transistors are used internally, the 4017 pinout data shows V_{DD} and V_{SS} for the power supplies pins – this time they relate to the *drain* voltages ($+V_{DD}$, the positive supply rail) and the MOSFET *source* voltages (V_{SS} or 0V rail) for the "transistor" circuit within. I hope this clears up any confusion.

Relays – More Contacts

In the December 98 issue I gave a comprehensive low-down on the meaning of relay specifications. I'm grateful to ***John Rastall*** who followed up on my piece about relay contact ratings:

You wrote that you weren't too sure why minimum switching current was sometimes specified, though you guessed it was about overcoming contact resistance. Well, you're right – almost!

Most good relay contacts are silver-plated to improve their performance. Higher-spec. relays have gold-plated contacts instead. However, silver does oxidise, albeit slowly, so they tarnish over time. This acts as an insulator and introduces a resistance.

A relay producer has two ways of overcoming this – either design the moving contact so it wipes across the surface of the fixed contact with every operation (thereby self-cleaning the contacts – but only with regular use) or, ensure that the current broken by the contacts when they open is large enough to generate a small arc. This will burn off any deposits. Hence the minimum switching capacity you see in some catalogues.

Thanks for sending the extra information, John.

PCB Facilities in Singapore

I receive E-mail from all over the world and the following item comes from ***Nelson Ng*** in Singapore, who writes with a heartfelt plea:

I have been an electronics hobbyist for over two years, however, I have been unable to find any etching solutions for the development of printed circuit boards here in Singapore. The main reason is that, because of high population densities, Singapore has a considerable number of high-rise flats, and drainage is through copper piping.

Many years ago, when Ferric Chloride was freely available, some hobbyists tended to abuse it by pouring the used solution down the drains . . . you can guess the rest. Under the Corrosive Substance Act the sale of this compound was banned to individuals, and factories must be licenced to purchase it.

Therefore, the only way to develop printed circuit boards is to use commercial developers and pay quite a price for it, so we hobbyists are restricted to stripboard (Veroboard, tripad, wire-wrapping, point-

to-point soldering and so on). Is there any way to develop low-volume, say one or two, printed circuit boards at a time? Moreover, is there an alternative to Ferric Chloride which could be legally available.

What a fascinating insight into the problems faced by our international readership. On the topic of p.c.b. production, I often recount the story told by the late Alan Sproxton of Home Radio (Components), a former Surrey-based distributor who used to write for *Everyday Electronics* many years ago.

In mixing some Ferric Chloride solution, he once wrote, he tipped a whole jar of Ferric Chloride compound into a shallow tray full of water. The heat generated by the exothermic reaction caused the compound to melt a hole in the tray, which was made of plastic . . . (However he was correct to add the compound to the water, and not the other way round.)

Etchants can be extremely unpleasant to use and must always be treated with respect. The subject of the disposal of used etchant is an equally difficult one to handle responsibly.

In the Bag

Unfortunately, corrosive agents are a necessary part of p.c.b. production. For hobby use I always recommend the Seno GS Etch-in-a-Bag system which is available from several advertisers.

This uses a (nearly) sealed system whereby the etchant is retained in a heavy-gauge polythene bag and is released over the board using a simple system of removable seals. When the etchant is exhausted, a neutraliser powder (supplied) can be added and the whole lot thrown in the domestic refuse. I find it is the best product for etching boards at home.

If Ferric Chloride has been banned in your country, one alternative etchant is sodium persulphate, e.g. as produced for "Press'n'Peel" (Maplin MC49D). The product is designed to address the special problems of the electronics industry, including uniformity of etching and lack of staining (it says here). It is classified as an oxidising agent. Check your local regulations to see if such a compound would be permissible.

Buy the Net

It is possible to produce printed circuit boards "by Internet" – i.e. by E-mailing the design files to manufacturers, they will turn them round and send back the finished thing. (A gentleman can buy a made-to-measure suit the same way: a tailor in Yorkshire, UK modems the measurements through to the maker in Belgium and the suit is then delivered from mainland Europe by air freight!)

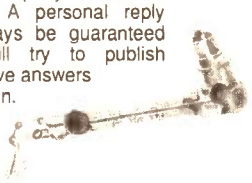
Elizabeth Nolan of Beta Layout in Ireland (**www.pcb-pool.com**) offered to help you with one-off printed circuit boards. They operate on a prototype p.c.b. "pooling" principle where set-up costs are amortised amongst a number of designers. thus bringing down the traditionally high tooling, set-up, and film costs which would otherwise be charged for a one-off prototype.

This is an excellent way of reducing start-up costs but unfortunately the typical figures I received won't appeal to the hobbyist: a prototype p.c.b. from scratch (e.g. a standard Eurocard 160mm × 100mm) weighed in at roughly £49, although that did include all origination and set-up costs. Mr. Ng commented that such a cost is approximately 10 per cent of an average monthly salary in Singapore!

Commercial users might bear this system in mind though, check for more details from Beta Layout's web site. Meantime if any readers anywhere can produce a solution to this thorny problem I will gladly pass ideas on.

CIRCUIT THERAPY

Circuit Surgery is your column. If you have any queries or comments, please write to: Alan Winstanley, *Circuit Surgery*, Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset, BH21 1PF, United Kingdom. E-mail **alan@epemag.demon.co.uk**. Please indicate if your query is not for publication. A personal reply cannot always be guaranteed but we will try to publish representative answers in this column.



ENTER THE CHAT ZONE

The *EPE Chat Zone* on our web site is now open as a way for readers to exchange information, views, hints and tips in virtually real time.

http://www.epemag.wimborne.co.uk
wwwboard

HOW DOES YOUR EQUIPMENT MEASURE UP? AT STEWART OF READING THERE'S ALWAYS 'SCOPE' FOR IMPROVEMENT!

PHILIPS PM3217 – Dual Trace 50MHz Delay. This is really a very good oscilloscope including 2 probes. Pouch & Front cover. ONLY £300

GOULD OS300 Dual Trace 20MHz Light weight. Very good value ONLY £160

THIS IS THE BEST CHEAP SCOPE YOU WILL EVER BUY!!!

GOULD OS1100 – Dual Trace. 30MHz Delay. Very bright. supplied with manual and two probes £200

TEKTRONIX 2215 – Dual Trace 60MHz. Sweep Delay. Includes 2 probes. ONLY £350

TEKTRONIX 400 SERIES

468 Digital Storage Dual Trace 100MHz Delay £550
466 Analogue Storage Dual Trace 100MHz Delay £250
485 Dual Trace 350MHz Delay Sweep £750
475 Dual Trace 200MHz Delay Sweep £450
465 Dual Trace 100MHz Delay Sweep £350

HC3502 Dual Trace 20MHz. 5mV 20V Div. 0·2u secs 0·5 Sec Div. X-Y. X5 Magnifier. TV Sync etc. UNUSED £180

PHILIPS PM3296A dual trace 400MHz dual TB delay cursors IEEE £2250
TEKTRONIC 2465A 4-ch dual trace 350MHz delay sweep cursors etc £2500
TEKTRONIX 2445 2445A/B 4-ch 150MHz delay sweep cursors etc From £900
TEKTRONIX TAS465 dual trace 100MHz delay cursors £900
TEKTRONIX 2235 dual trace 100MHz delay cursors £700
IWATSU SS5711 4-ch 100MHz delay sweep £550
PHILIPS 3055 2 – 1-ch 50MHz dual TB £475

NOW THIS IS RIDICULOUS!

MARCONI 2019 synthesised AM/FM signal gen 80kHz-1040MHz. l.c.d. display. keyboard entry ONLY £900

MARCONI 2017 phase lock AM/FM signal gen 10kHz-1024MHz £1200
MARCONI 2022A C synthesised AM/FM signal generator 10KHz-1GHz From £1500
H.P. 8672A synthesised signal generator. 2·18 GHz £6000

H.P. 8640A AM/FM Signal Gen 500kHz-1024 MHz 500kHz-512 MHz version £450 £250

FARNELL PSG1000 Syn AM/FM signal gen 10KHz-1GHz £995
FARNELL PSG520 Syn AM/FM sig gen 10-520MHz port £450
RACAL 9081 Syn Am FM sig gen 5-520MHz £400
MARCONI TF2015 AM FM sig gen 10-520MHz £175
MARCONI 6311 programmable sweep gen 10MHz-20GHz £4000
HP 3325A syn function gen 21MHz £950
PHILIPS PM5134 sweep function gen 0·001Hz 20MHz £300
PHILIPS PM5132 sweep func gen 0·1Hz-2MHz £200
MARCONI 2305 modulation meter 500KHz-2GHz From £1200
FARNELL AMM2000 automatic mod meter 10Hz-2·4GHz unused £1250
RACAL 9008 automatic mod meter 1·5MHz-2GHz £200

SPECTRUM ANALYSERS

H.P. 8562A synthesised 1KHz-22GHz £10,000
H.P. 8565A 0·01-22GHz £3500
H.P. 8590A 10KHz-1·8GHz (75 ohms) £2500
H.P. 8559A with main frame 0·01-21GHz £2500
H.P. 8558B with main frame 100KHz-1500MHz £1500
ADVANTEST TR4131 10KHz-3·5GHz £3500
ADVANTEST TR4132 100KHz-1Ghz £1200
MARCONI 2382 100Hz-400MHz high resolution £1200
MARCONI 2370 30Hz-110MHz From £500
H.P.141 Systems:
8553 1KHz-110MHz From £500
8554 500KHz-1250MHz From £750
8555 10MHz-18GHz From £1000

FARNELL LF1 Sine/Sq Oscillator 10Hz-1MHz ONLY £75

LEVELL TG200DMP RC Oscillator 1Hz-1MHz Sine/Square meter battery operated (Batteries not supplied) £50

Classic AVO Meter. A Digital AVO DA116 3·5 digit. Complete with Batteries & Leads ONLY £30

METROHM 9A – 500V Battery Meggar (a useful back-up for fault finding) Complete with Batteries & Leads ONLY £35

Solatron 7045 – 4·5 Dig. Bench Multimeter with leads £45

Solatron 7150 DDMM 6·5 digit True RMS IEEE £300

WAYNE KERR AMM255 Automatic Modulation Meter AM FM 1·5MHz-2GHz 3·5 digit Unused £500

GOODWILL GFC 8010G FREQUENCY COUNTER Range 1HZ-120MHz 8 Digit Display 15mV RMS Sensitivity Unused £75

ANALOGUE MULTIMETER Model HC260TR AC DC Volts D.C current 10 Amps 17 Ranges Continuity Buzzer. Transistor Tester Unused £15

LOOK!!! BRAND NEW OSCILLOSCOPES – NEVER USED – LIMITED STOCK

DMS 3850A Digital Storage DMM. Handheld LCD display 2 channel 50ms/s auto range. 4-digit DMM capacitance/frequency counter. battery operation or external 7·5V-9·5V d.c. i.e a.c. adaptor (not supplied). RS232. comes in black carrying pouch complete with 2 scope probes. DMM leads. Manual FOR ONLY £400

DTS 40 Digital Storage. Dual Trace 40MHz 20ms/s storage. cursors and on-screen readout. sweep delay. interface etc. etc. Supplied unused in original box complete with 2 probes and manual AMAZING VALUE AT £400

DTA 20 Dual Trace 20MHz. Alt Mag TV Trig etc. Unused & Boxed with 2 probes and manual £225

100KHz-100MHz FM 0-100KHz Output – 19dB-99dB AM 0-60% 32 preset memory. digital display frequency and output Used £450 Unused £750

KENWOOD FL180A WOW/FLUTTER METER. 0·003%-10% freq 3kHz/3·15kHz RMS/AVERAGE/PEAK. Weighted Filters. Digital Display of rpm. 4-digit Freq. Counter 0·01kHz-9·999kHz 0·01kHz-55kHz. Used £400, Unused £500

POWER SUPPLY Model HSP3010 0-30V 0-10 Amps current limiting 2 meters. Used £160 Unused £200

GOODWILL GVT427 DUAL CHANNEL A.C MILLIVOLTMETER 10μV 300V in 12 ranges. Frequency 10Hz-1MHz. Used £100 Unused £125

STEWART of READING
110 WYKEHAM ROAD, READING, BERKS. RG6 1PL
Telephone: (0118) 9268041. Fax: (0118) 9351696
Callers welcome 9am-5·30pm Monday to Friday (other times by arrangement)

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

DIRECT BOOK SERVICE

EPE BOOKS

ELECTRONICS TEACH-IN 88/89
INTRODUCING MICROPROCESSORS
Mike Tooley B.A. (published by *Everyday Practical Electronics*)
A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303). The book contains everything you need to know including full details on registering for assessment, etc.

Sections cover Microcomputer Systems, Microprocessors, Memories, Input/Output, Interfacing and Programming. There are various practical assignments and eight Data Pages covering popular microprocessors.

And excellent introduction to the subject even for those who do not wish to take the City and Guilds assessment.

80 pages **Order code TI-88/89** **£2.45**

TEACH-IN No. 7. plus FREE SOFTWARE
ANALOGUE AND DIGITAL ELECTRONICS COURSE
(published by *Everyday Practical Electronics*)
Alan Winstanley and Keith Dye B.Eng(Tech)AMIEE
This highly acclaimed *EPE Teach-In series, which included the construction and use of the Mini Lab* and *Micro Lab* test and development units, has been put together in book form. Additionally, EPT Educational Software have developed a GCSE Electronics software program to compliment the course and a **FREE DISK** covering the first two parts of the course is included with the book.

An interesting and thorough tutorial series aimed specifically at the novice or complete beginner in electronics. The series is designed to support those undertaking either GCSE Electronics or GCE Advanced Levels, and starts with fundamental principles.

If you are taking electronics or technology at school or college, this book is for you. If you just want to learn the basics of electronics or technology you must make sure you see it. *Teach-In No. 7* will be invaluable if you are considering a career in electronics or even if you are already training in one. The Mini Lab and software enable the construction and testing of both demonstration and development circuits. These learning aids bring electronics to life in an enjoyable and interesting way: you will both see and hear the electron in action! The Micro Lab microprocessor add-on system will appeal to higher level students and those developing microprocessor projects.

160 pages **Order code TI7** **£3.95**

ELECTRONIC PROJECTS BOOK 1
(published by *Everyday Practical Electronics* in association with Magenta Electronics)
Contains twenty projects from previous issues of *EE* each backed with a kit of components. The projects are: Seashell Sea Synthesizer, EE Treasure Hunter, Mini Strobe, Digital Capacitance Meter, Three-Channel Sound to Light, BBC 16K sideways RAM, Simple Short Wave Radio, Insulation Tester, Stepper Motor Interface, Eprom Eraser, 200MHz Digital Frequency Meter, Infra Red Alarm, EE Equaliser, Ioniser, Bat Detector, Acoustic Probe, Mainstester and Fuse Finder, Light Rider – (Lapel Badge, Disco Lights, Chaser Light), Musical Doorbell, Function Generator, Tilt Alarm, 10W Audio Amplifier, EE Buccaneer Induction Balance Metal Detector, BBC Midi Interface, Variable Bench Power Supply, Pet Scarer, Audio Signal Generator.

128 pages **Order code EP1** **£2.45**

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

FOR A FURTHER SELECTION OF BOOKS SEE THE NEXT TWO ISSUES OF EPE.

Note our UK postage costs just £1.50 no matter how many books you order!

PROJECT CONSTRUCTION

PRACTICAL REMOTE CONTROL PROJECTS
Owen Bishop
Provides a wealth of circuits and circuit modules for use in remote control systems of all kinds; ultrasonic, infrared, optical fibre, cable and radio. There are instructions for building fourteen novel and practical remote control projects. But this is not all, as each of these projects provides a model for building dozens of other related circuits by simply modifying parts of the design slightly to suit your own requirements. This book tells you how.

Also included are techniques for connecting a PC to a remote control system, the use of a microcontroller in remote control, as exemplified by the BASIC Stamp, and the application of ready-made type-approved 418MHz radio transmitter and receiver modules to remote control systems.

160 pages **Order code BP413** **£5.99**

PRACTICAL ELECTRONIC MODEL RAILWAY PROJECTS
R. A. Penfold
The aim of this book is to provide the model railway enthusiast with a number of useful but reasonably simple projects that are easily constructed from readily available components. Stripboard layouts and wiring diagrams are provided for each project. The projects covered include: constant voltage controller; pulsed controller; pushbutton pulsed controller; pulsed controller with simulated inertia, momentum and braking; automatic signals; steam whistle sound effect; two-tone horn sound effect; automatic two-tone horn effect; automatic chuffer.

The final chapter covers the increasingly popular subject of using a computer to control a model railway layout, including circuits for computer-based controllers and signalling systems.

151 pages **Order code BP384** **£4.99**

A PRACTICAL INTRODUCTION TO SURFACE MOUNT DEVICES
Bill Mooney
This book takes you from the simplest possible starting point to a high level of competence in handworking with surface mount devices (SMD's). The wider subject of SM technology is also introduced, so giving a feeling for its depth and fascination.

Subjects such as p.c.b. design, chip control, soldering techniques and specialist tools for SM are fully explained and developed as the book progresses. Some useful constructional projects are also included.

Whilst the book is mainly intended as an introduction, it is also an invaluable reference book, and the browser should find it engrossing.

120 pages **Order code BP411** **£4.99**

FAULT-FINDING ELECTRONIC PROJECTS
R. A. Penfold
Starting with mechanical faults such as dry joints, short-circuits etc, coverage includes linear circuits, using a meter to make voltage checks, signal tracing techniques and fault finding on logic circuits. The final chapter covers ways of testing a wide range of electronic components, such as resistors, capacitors, operational amplifiers, diodes, transistors, SCRs and triacs, with the aid of only a limited amount of test equipment.

The construction and use of a Tristate Continuity Tester, a Signal Tracer, a Logic Probe and a CMOS Tester are also included.

136 pages **Order code BP391** **£4.99**

TEST EQUIPMENT CONSTRUCTION
R. A. Penfold
This book describes in detail how to construct some simple and inexpensive but extremely useful, pieces of test equipment. Stripboard layouts are provided for all designs, together with wiring diagrams where appropriate, plus notes on construction and use.

The following designs are included:–
AF Generator, Capacitance Meter, Test Bench Amplifier, AF Frequency Meter, Audio Mullivoltmeter, Analogue Probe, High Resistance Voltmeter, CMOS Probe, Transistor Tester, TTL Probe.

The designs are suitable for both newcomers and more experienced hobbyists.

104 pages **Order code BP248** **£3.99**

HOW TO DESIGN AND MAKE YOUR OWN P.C.B.s
R. A. Penfold
Deals with the simple methods of copying printed circuit board designs from magazines and books, and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.

66 pages **Order code BP121** **£3.99**

AUDIO AMPLIFIER CONSTRUCTION
R. A. Penfold
The purpose of this book is to provide the reader with a wide range of preamplifier and power amplifier designs that will, it is hoped, cover most normal requirements.

The preamplifier circuits include low noise microphone and RIAA types, a tape head preamplifier, a guitar preamplifier and various tone controls. The power amplifier designs range from low power battery operation to 100W MOSFET types and also include a 12 volt bridge amplifier capable of giving up to 18W output.

All the circuits are relatively easy to construct using the p.c.b. or stripboard designs given. Where necessary any setting-up procedures are described, but in most cases no setting-up or test gear is required in order to successfully complete the project.

100 pages **Temporarily out of print**

RADIO / TV VIDEO

ELECTRONIC PROJECTS FOR VIDEO ENTHUSIASTS
R. A. Penfold
This book provides a number of practical designs for video accessories that will help you get the best results from your camcorder and VCR. All the projects use inexpensive components that are readily available, and they are easy to construct. Full construction details are provided, including stripboard layouts and wiring diagrams. Where appropriate, simple setting up procedures are described in detail; no test equipment is needed.

The projects covered in this book include: Four channel audio mixer, Four channel stereo mixer, Dynamic noise limiter (DNL), Automatic audio fader, Video faders, Video wipers, Video crispener, Mains power supply unit.

109 pages **Order code BP356** **£4.95**

SETTING UP AN AMATEUR RADIO STATION
I. D. Poole
The aim of this book is to give guidance on the decisions which have to be made when setting up any amateur radio or short wave listening station. Often the experience which is needed is learned by one's mistakes, however, this can be expensive. To help overcome this, guidance is given on many aspects of setting up and running an efficient station. It then proceeds to the steps that need to be taken in gaining a full transmitting licence.

Topics covered include: The equipment that is needed; Setting up the shack; Which aerials to use; Methods of construction; Preparing for the licence.

An essential addition to the library of all those taking their first steps in amateur radio.

86 pages **Order code BP301** **£3.95**

EXPERIMENTAL ANTENNA TOPICS
H. C. Wright
Although nearly a century has passed since Marconi's first demonstration or radio communication, there is still research and experiment to be carried out in the field of antenna design and behaviour.

The aim of the experimenter will be to make a measurement or confirm a principle, and this can be done with relatively fragile, short-life apparatus. Because of this, devices described in this book make liberal use of cardboard, cooking foil, plastic bottles, cat food tins, etc. These materials are, in general, cheap to obtain and easily worked with simple tools, encouraging the trial-and-error philosophy which leads to innovation and discovery.

Although primarily a practical book with text closely supported by diagrams, some formulae which can be used by straightforward substitution and some simple graphs have also been included.

72 pages **Order code BP278** **£3.50**

25 SIMPLE INDOOR AND WINDOW AERIALS
E. M. Noll
Many people live in flats and apartments or other types of accommodation where outdoor aerials are prohibited, or a lack of garden space etc. prevents aerials from being erected. This does not mean you have to forgo shortwave listening, for even a 20-foot length of wire stretched out along the skirting board of a room can produce acceptable results. However, with some additional effort and experimentation one may well be able to improve performance further.

This concise book tells the story, and shows the reader how to construct and use 25 indoor and window aerials that the author has proven to be sure performers.

Much information is also given on shortwave bands, aerial directivity, time zones, dimensions etc.

50 pages **Order code BP136** **£1.75**

TWO EXCITING NEW BOOKS

Specially imported by *EPE*

Bebop To The Boolean Boogie

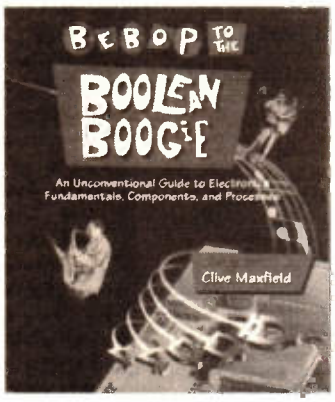
By Clive (call me Max) Maxfield

ORDER CODE BEB1 **£24.95**

An Unconventional Guide to Electronics Fundamentals, Components and Processes

The Foreword by Pete Waddell, Editor, *Printed Circuit Design*, reads:

"Personally, I think that the title of this tome alone (hmmm, a movie?) should provide some input as to what you can expect. But, for those who require a bit more: be forewarned, dear reader, you will probably learn far more than you could hope to expect from *Bebop to the Boolean Boogie*, just because of the unique approach Max has to technical material. The author will guide you from the basics through a minefield of potentially boring theoretical mish-mash, to a Nirvana of understanding. You will not suffer that fate familiar to every reader: re-reading paragraphs over and over wondering what in the world the author was trying to say. For a limey, Max shoots amazingly well and from the hip, but in a way that will keep you interested and amused. If you are not vigilant, you may not only learn something, but you may even enjoy the process. The only further advice I can give is to 'expect the unexpected'."



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. . . .

Bebop Bytes Back

By Clive "Max" Maxfield and Alvin Brown

ORDER CODE BEB2 **£29.95**

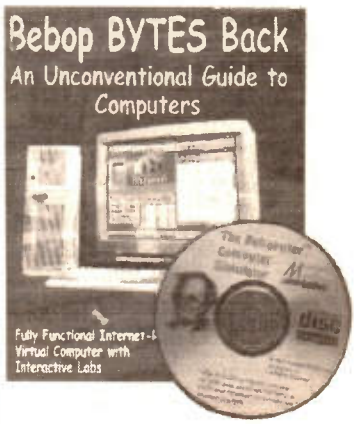
An Unconventional Guide To Computers

Plus **FREE CD-ROM** which includes: Fully Functional Internet-Ready Virtual Computer with Interactive Labs

The Foreword by Lee Felsenstein reads:

1. The more time you spend with this book and its accompanying CD-ROM, the more you'll get out of it. Skimming through it won't take you where you want to go. Paying serious attention, on the other hand, will teach you more about computers than you can imagine. (You might also see a few beautiful sunrises.)

2. The labs work on two levels: on and under the surface. When you're performing the labs you'll need to look for patterns that build up from individual events.



3. When you're done, you won't look any different. You won't get a trophy or a certificate to hang on your wall. You'll have some knowledge, and some skill, and you'll be ready to find more knowledge and develop more skill. Much of this will be recognisable only to someone who has the same knowledge and skill.

This follow-on to *Bebop to the Boolean Boogie* is a multimedia extravaganza of information about how computers work. It picks up where "Bebop I" left off, guiding you through the fascinating world of computer design . . . and you'll have a few chuckles, if not belly laughs, along the way. In addition to over 200 megabytes of mega-cool multimedia, the accompanying CD-ROM (for Windows 95 machines only) contains a virtual microcomputer, simulating the motherboard and standard computer peripherals in an extremely realistic manner. In addition to a wealth of technical information, myriad nuggets of trivia, and hundreds of carefully drawn illustrations, the book contains a set of lab experiments for the virtual microcomputer that let you recreate the experiences of early computer pioneers.

If you're the slightest bit interested in the inner workings of computers, then don't dare to miss this one!

By importing these books ourselves we have managed to make them available in the UK at an exceptional price.

Audio and Music

VALVE & TRANSISTOR AUDIO AMPLIFIERS NEW
John Linsley Hood
This is John Linsley Hood's greatest work yet, describing the milestones that have marked the development of audio amplifiers since the earliest days to the latest systems. Including classic amps with valves at their heart and exciting new designs using the latest components, this book is the complete world guide to audio amp design.

Contents: Active components; Valves or vacuum tubes; Solid-state devices; Passive components; Inductors and transformers; Capacitors, Resistors, Switches and electrical contacts; Voltage amplifier stages using valves; Valve audio amplifier layouts; Negative feedback; Valve operated power amplifiers; Solid state voltage amplifiers; Early solid-state audio amplifiers; Contemporary power amplifier designs; Preamplifiers; Power supplies (PSUs); Index.

250 pages Order code NE24 £19.99

AUDIO AMPLIFIER PROJECTS NEW
R. A. Penfold
A wide range of useful audio amplifier projects, each project features a circuit diagram, an explanation of the circuit operation and a stripboard layout diagram. All constructional details are provided along with a shopping list of components, and none of the designs requires the use of any test equipment in order to set up properly. All the projects are designed for straightforward assembly on simple circuit boards.

Circuits include: High impedance mic preamp, Low impedance mic preamp, Crystal mic preamp, Guitar and GP preamplifier, Scratch and rumble filter, RIAA preamplifier, Tape preamplifier, Audio limiter, Bass and treble tone controls, Loudness filter, Loudness control, Simple graphic equaliser, Basic audio mixer, Small (300mW) audio power amp, 6 watt audio power amp, 20/32 watt power amp and power supply, Dynamic noise limiter.

A must for audio enthusiasts with more sense than money!

116 pages Order code PC113 £9.95

MAKING MUSIC WITH DIGITAL AUDIO NEW
Ian Waugh
In this practical and clearly-written book, Ian Waugh explains all aspects of the subject from digital audio basics to putting together a system to suit your own music requirements. Using the minimum of technical language, the book explains exactly what you need to know about: Sound and digital audio, Basic digital recording principles, Sample rates and resolutions, Consumer sound cards and dedicated digital audio cards.

On a practical level you will learn about: sample editing, digital multi-tracking, digital FX processing, integrating MIDI and digital audio, using sample CDs, mastering to DAT and direct to CD, digital audio and Multimedia.

This book is for every musician who wants to be a part of the most important development in music since the invention of the gramophone. It's affordable, it's flexible, it's powerful and it's here now! It's digital and it's the future of music making.

256 pages Order code PC114 £14.95

POSTAGE

You *only pay*

£1·50

per order (UK postage)

NO MATTER HOW MANY BOOKS YOU ORDER

Overseas Readers see ORDERING DETAILS on the next page for overseas postage prices

CIRCUITS AND DESIGN

AN INTRODUCTION TO PIC MICROCONTROLLERS
Robert Penfold
Designing your own PIC based projects may seem a daunting task, but it is really not too difficult providing you have some previous experience of electronics. The PIC processors have plenty of useful features, but they are still reasonably simple and straightforward to use. This book should contain everything you need to know.

Topics covered include: the PIC register set; numbering systems; bitwise operations and rotation; the PIC instruction set; using interrupts; using the analogue to digital converter; clock circuits; using the real time clock counter (RTCC); using subroutines; driving seven segment displays.
166 pages Order code BP394 **£5.99**

PRACTICAL OSCILLATOR CIRCUITS
A. Flind
Extensive coverage is given to circuits using capacitors and resistors to control frequency. Designs using CMOS, timer i.c.s and op.amps are all described in detail, with a special chapter on "waveform generator" i.c.s. Reliable "white" and "pink" noise generator circuits are also included.

Various circuits using inductors and capacitors are covered, with emphasis on stable low frequency generation. Some of these are amazingly simple, but are still very useful signal sources.

Crystal oscillators have their own chapter. Many of the circuits shown are readily available special i.c.s for simplicity and reliability, and offer several output frequencies. Finally, complete constructional details are given for an audio sinewave generator.
133 pages Order code BP393 **£4.99**

PRACTICAL ELECTRONIC CONTROL PROJECTS
Owen Bishop
Explains electronic control theory in simple, non-mathematical terms and is illustrated by 30 practical designs suitable for the student or hobbyist to build. Shows how to use sensors as input to the control system, and how to provide output to lamps, heaters, solenoids, relays and motors.

Computer based control is explained by practical examples that can be run on a PC. For stand-alone systems, the projects use microcontrollers, such as the inexpensive and easy-to-use Stamp BASIC microcontroller. These projects are chosen to introduce and demonstrate as many aspects as possible of the programming language and techniques.
198 pages Order code BP377 **£5.99**

PRACTICAL ELECTRONICS HANDBOOK – Fourth Edition. Ian Sinclair
Contains all of the everyday information that anyone working in electronics will need.

It provides a practical and comprehensive collection of circuits, rules of thumb and design data for professional engineers, students and enthusaists, and therefore enough background to allow the understanding and development of a range of basic circuits.

Contents: Passive components, Active discrete components, Discrete component circuits, Sensing components, Linear I.C.s, Digital I.C.s, Microprocessors and microprocessor systems, Transferring digital data, Digital-analogue conversions, Computer aids in electronics, Hardware components and practical work, Standard metric wire table, Bibliography, The HEX scale, Index.
440 pages Order code NE21 **£14.99**

COIL DESIGN AND CONSTRUCTIONAL MANUAL
B. B. Babani
A complete book for the home constructor on "how to make" RF, IF, audio and power coils, chokes and transformers. Practically every possible type is discussed and calculations necessary are given and explained in detail. Although this book is now twenty years old, with the exception of toroids and pulse transformers little has changed in coil design since it was written.
96 pages Order code 160 **£3.95**

OPTOELECTRONICS CIRCUITS MANUAL
R. M. Marston
A useful single-volume guide to the optoelectronics device user, specifically aimed at the practical design engineer, technician, and the experimenter, as well as the electronics student and amateur. It deals with the subject in an easy-to-read, down-to-earth, and non-mathematical yet comprehensive manner, explaining the basic principles and characteristics of the best known devices, and presenting the reader with many practical applications and over 200 circuits. Most of the i.c.s and other devices used are inexpensive and readily available types, with universally recognised type numbers.
182 pages Order code NE14 **£14.99**

OPERATIONAL AMPLIFIER USER'S HANDBOOK
R. A. Penfold
The first part of this book covers standard operational amplifer based "building blocks" (integrator, precision rectifier, function generator, amplifiers, etc), and considers the ways in which modern devices can be used to give superior performance in each one. The second part describes a number of practical circuits that exploit modern operational amplifiers, such as high slew-rate, ultra low noise, and low input offset devices. The projects include: Low noise tape preamplifier, low noise RIAA preamplifier, audio power amplifiers, d.c. power controllers, opto-isolator audio link, audio millivolt meter, temperature monitor, low distortion audio signal generator, simple video fader, and many more.
120 pages Order code BP335 **£4.95**

A BEGINNERS GUIDE TO CMOS DIGITAL ICs
R. A. Penfold
Getting started with logic circuits can be difficult, since many of the fundamental concepts of digital design tend to seem rather abstract, and remote from obviously useful applications. This book covers the basic theory of digital electronics and the use of CMOS integrated circuits, but does not lose sight of the fact that digital electronics has numerous "real world" applications.

The topics covered in this book include: the basic concepts of logic circuits; the functions of gates, inverters and other logic "building blocks"; CMOS logic i.c. characteristics, and their advantages in practical circuit design; oscillators and monostables (timers); flip/flops, binary dividers and binary counters; decade counters and display drivers.

The emphasis is on a practical treatment of the subject, and all the circuits are based on "real" CMOS devices. A number of the circuits demonstrate the use of CMOS logic i.c.s in practical applications.
119 pages Order code BP333 **£4.95**

AUDIO AND MUSIC

INTRODUCTION TO DIGITAL AUDIO (Second Edition)
Ian Sinclair
Digital recording methods have existed for many years and have become familiar to the professional recording engineer, but the compact disc (CD) was the first device to bring audio methods into the home. The next step is the appearance of digital audio tape (DAT) equipment.

All this development has involved methods and circuits that are totally alien to the technician or keen amateur who has previously worked with audio circuits. The principles and practices of digital audio owe little or nothing to the traditional linear circuits of the past, and are much more comprehensible to today's computer engineer than the older generation of audio engineers.

This book is intended to bridge the gap of understanding for the technician and enthusiast. The principles and methods are explained, but the mathematical background and theory is avoided, other than to state the end product.
128 pages Order code PC102 **£7.95**

PROJECTS FOR THE ELECTRIC GUITAR
J. Chatwin
This book is for anyone interested in the electric guitar. It explains how the electronic functions of the instrument work together, and includes information on the various pickups and transducers that can be fitted. There are complete circuit diagrams for the major types of instrument, as well as a selection of wiring modifications and pickup switching circuits. These can be used to help you create your own custom wiring.

Along with the electric guitar, sections are also included relating to acoustic instruments. The function of specialised piezoelectric pickups is explained and there are detailed instructions on how to make your own contact and bridge transducers. The projects range from simple preamps and tone boosters, to complete active controls and equaliser units.
92 pages Order code BP368 **£4.95**

MIDI SURVIVAL GUIDE
Vic Lennard
Whether you're a beginner or a seasoned pro, the MIDI Survival Guide shows you the way. No maths, no MIDI theory, just practical advice on starting up, setting up and ending up with a working MIDI system.

Over 40 cabling diagrams. Connect synths, sound modules, sequencers, drum machines and multitracks. How to budget and buy secondhand. Using switch, thru and merger boxes. Transfer songs between different sequencers. Get the best out of General MIDI. Understand MIDI implementation charts. No MIDI theory.
104 pages **Temporarily out of print**

PRACTICAL ELECTRONIC MUSICAL EFFECTS UNITS
R. A. Penfold
This book provides practical circuits for a number of electronic musical effects units. All can be built at relatively low cost, and use standard, readily available components. The projects covered include: Waa-Waa Units; Distortion Units; Phaser; Guitar Envelope Shaper; Compressor; Tremolo Unit; Metal Effects Unit; Bass and Treble Boosters; Graphic Equaliser; Parametric Equaliser. The projects cover a range of complexities, but most are well within the capabilities of the average electronics hobbyist. None of them require the use of test equipment and several are suitable for near beginners.
102 pages Order code BP368 **£4.95**

LOUDSPEAKERS FOR MUSICIANS
Vivan Capel
This book contains all that a working musician needs to know about loudspeakers; the different types, how they work, the most suitable for different instruments, for cabaret work, and for vocals. It gives tips on constructing cabinets, wiring up, when and where to use wadding, and when not to, what fittings are available, finishing, how to ensure they travel well, how to connect multi-speaker arrays and much more.

Ten practical enclosure designs with plans and comments are given in the last chapter, but by the time you've read that far you should be able to design your own!
164 pages Order code BP297 **£4.99**

BOOK ORDERING DETAILS

Our postage price is the same no matter how many books you order, just add **£1.50** to your *total* order for postage and packing (overseas readers **add £3** for countries in the EEC, or **add £6** for all countries outside the EEC, surface mail postage) and send a PO, cheque, international money order (£ sterling only) made payable to **Direct Book Service** or credit card details, Visa or Mastercard – minimum credit card order is £5 – to:
DIRECT BOOK SERVICE, 33 GRAVEL HILL, MERLEY, WIMBORNE, DORSET BH21 1RW *(mail order only).*

Books are normally sent within seven days of receipt of your order but please allow 28 days for delivery (more for overseas orders). *Please check price and availability (see latest issue of* Everyday Practical Electronics) *before ordering from old lists.*

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

DIRECT BOOK SERVICE IS A DIVISION OF WIMBORNE PUBLISHING LTD. Tel 01202 881749 Fax 01202 841692. Due to the cost we cannot reply to overseas orders or queries by Fax. E-mail:editorial@epemag.wimborne.co.uk

BOOK ORDER FORM

Full name: .....

Address: .....

.....

..... Post code: ..... Telephone No: .....

Signature: .....

☐ I enclose cheque/PO payable to WIMBORNE PUBLISHING LTD for £ .....

☐ Please charge my Visa/Mastercard £ ..... Card expiry date .....

Card Number .....

Please send book order codes:.....

.....

Please continue on separate sheet of paper if necessary

PCB SERVICE

Printed circuit boards for certain EPE constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for airmail outside of Europe. Remittances should be sent to **The PCB Service, *Everyday Practical Electronics*, Allen House, East Borough, Wimborne, Dorset BH21 1PF. Tel: 01202 881749; Fax 01202 841692 (NOTE, we cannot reply to orders or queries by Fax); E-mail: orders@epemag.wimborne.co.uk** . Cheques should be crossed and made payable to *Everyday Practical Electronics* **(Payment in £ sterling only).**

NOTE: While 95% of our boards are held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail.

Back numbers or photostats of articles are available if required – see the *Back Issues* page for details.

Please check price and availability in the latest issue.

Boards can only be supplied on a payment with order basis.

PROJECT TITLE		Order Code	Cost
*PIC-Tock Pendulum Clock	SEPT'96	109	£6.31
Power Check		110	£6.42
Analogue Delay/Flanger		111	£7.95
Draught Detector		112	£6.22
Simple Exposure Timer		113	£6.63
Video Fade-to-White	OCT'96	114	£6.98
Direct Conversion 80m Receiver		116	£7.52
Vehicle Alert		117	£6.55
10MHz Function Generator– Main Board		118	£7.33
– PSU		119	£5.39
Tuneable Scratch Filter	NOV'96	115	£7.83
*Central Heating Controller		120	£7.85
D.C. to D.C. Converters – Negative Supply Generator		122	£5.96
– Step-Down Regulator		123	£6.01
– Step-Up Regulator		124	£6.12
*PIC Digital/Analogue Tachometer	DEC'96	127	£7.23
Stereo Cassette Recorder			
Playback/PSU		128	£7.94
Record/Erase		129	£9.04
*Earth Resistivity Meter	JAN'97		
Current Gen. – Amp/Rect.		131/132 (pr)	£12.70
Theremin MIDI/CV Interface (double-sided p.t.h.)		130 (set)	£40.00
Mains Failure Warning		126	£6.77
Pacific Waves	FEB'97	136	£9.00
PsiCom Experimental Controller		137	£6.78
Oil Check Reminder	MAR'97	125	£7.16
Video Negative Viewer		135	£6.75
Tri-Colour NiCad Checker		138	£6.45
Dual-Output TENS Unit (plus Free TENS info.)		139	£7.20
*PIC-Agoras – Wheelie Meter	APRIL'97	141	£6.90
418MHz Remote Control – Transmitter		142	£5.36
– Receiver		143	£6.04
Puppy Puddle Probe		145	£6.10
MIDI Matrix – PSU		147	£5.42
– Interface		148	£5.91
Quasi-Bell Door Alert	MAY'97	133	£6.59
2M F.M. Receiver		144	£7.69
*PIC-A-Tuner		149	£7.83
Window Closer – Trigger		150	£4.91
– Closer		151	£4.47
Child Minder Protection Zone	JUN'97		
– Transmitter		153	£6.58
– Receiver		154	£6.42
Pyrotechnic Controller		155	£6.93
*PIC Digilogue Clock		156	£7.39
Narrow Range Thermometer		158	£6.37
Micropower PIR Detector – 1	JULY'97	152	£6.69
Infra-Red Remote Control Repeater			
(Multi-project P.C.B.)		932	£3.00
Karaoke Echo Unit – Echo Board		159	£6.40
– Mixer Board		160	£6.75
Computer Dual User Interface		161	£6.70
*PEsT Scarer		162	£6.60
Variable Bench Power Supply	AUG'97	932	£3.00
Universal Input Amplifier		146	£6.55
Micropower PIR Detector – 2 Controller		163	£6.72
*PIC-OLO		164	£7.02
Active Receiving Antenna	SEPT'97	140	£6.59
Soldering Iron Controller		157	£6.63
*PIC Noughts & Crosses Game		165	£7.82
Micropower PIR Detector – 3			
Alarm Disarm/Reset Switch		166	£5.72
Ironing Safety Device		167	£5.12
Remote Control Finder	OCT'97	168	£6.32
Rechargeable Handlamp		169	£6.23
*PIC Water Descaler		170	£6.90
*EPE Time Machine	NOV'97	171	£8.34
Auto-Dim Bedlight		172	£6.63
Portable 12V PSU/Charger		173	£6.61
Car Immobiliser	DEC'97	175	£7.00
Safe and Sound (Security Bleeper)		179	£7.32
Surface Thermometer	JAN'98	174	£7.64
Disco Lights Flasher		178	£8.30
Waa-Waa Pedal (Multi-project PCB)	FEB'98	932	£3.00
*Virtual Scope – Digital Board		176	£14.49
Analogue Board (per board)		177	£7.34
*Water Wizard		180	£7.69
Kiss Controller Tutorial	MAR'98	182	£7.00
The Handy Thing (Double-Sided)		183	£6.58
Lighting-Up Reminder		184	£5.90
*Audio System Remote Controller – PSU		185	£7.05
Main Board		186	£8.29

PROJECT TITLE		Order Code	Cost
Simple Metal Detector	APR'98		
(Multi-project PCB)		932	£3.00
Single or Dual-Tracking Power Supply		187	£7.90
*RC-Meter		188	£7.66
Security Auto-Light	MAY'98	189	£8.10
Stereo Tone Control plus 20W Stereo Amplifier			
Tone Control		190	£7.78
20W Amplifier		191	£8.58
*Dice Lott		192	£8.05
EPE Mood Changer	JUNE'98	193	£7.75
*AT89C2051/1051 Programmer			
Main Board		194	£8.50
Test Board		195	£8.69
*Reaction Timer	Software only	–	–
*PIC16x84 Toolkit	JULY'98	196	£6.96
*Greenhouse Computer			
Control Board		197	£9.08
PSU Board		198	£8.10
Float Charger	AUG'98	199	£6.59
Lightbulb Saver		202	£3.00
Personal Stereo Amplifier	SEPT'98	932	£3.00
(Multi-project PCB)			
*Greenhouse Radio Link		200	£8.32
*PIC Altimeter		201	£8.15
Voice Processor	OCT'98	203	£7.18
*Digiserv R/C Expander		204	£7.69
IR Remote Control			
Transmitter		205	£3.00
Receiver		206	£3.50
*PIC Tape Measure	NOV'98	207	£6.82
Electronic Thermostat			
T-Stat		208	£4.00
PhizzyB			£14.95
A–PCB **B**–CD-ROM **C**–Prog. Microcontroller		Bee (A)(B)(C)	**each**
15-Way IR Remote Control			
Switch Matrix		211	£3.00
15-Way Rec/Decoder		212	£4.00
Damp Stat	DEC'98	209	£4.50
Handheld Function Generator		213	£4.00
*Fading Christmas Lights		215	£5.16
PhizzyB I/O Board (4-section)		216	£3.95
Twinkle Twinkle Reaction Game	JAN'99	210	£7.55
*EPE Mind PICkler		214	£6.30
PhizzyB I/O Board (4-section)		216	£3.95
Alternative Courtesy Light Controller		217	£6.72
Light Alarm	FEB'99	218	£6.78
*Wireless Monitoring System – Transmitter		219+a	£9.92
Receiver		220+a	£8.56
*PIC MIDI Sustain Pedal	Software only	–	–

EPE SOFTWARE

Software programs for *EPE* projects marked with an asterisk * are available on 3.5 inch PC-compatible disks or *free* from our Internet site. Three disks are available: **PIC Tutorial** (Mar-May '98 issues); **PIC Disk 1** (all other software Apr '95–Dec '98 issues); **EPE Disk 2** (Jan '99 issue to current cover date). The disks are obtainable from the *EPE PCB Service* at £2.75 each (UK) to cover our admin costs (the software itself is *free*). Overseas (each): £3.35 surface mail, £4.35 each airmail. All files can be downloaded *free* from our Internet FTP site: **ftp://ftp.epemag.wimborne.co.uk.**

EPE PRINTED CIRCUIT BOARD SERVICE

Order Code **Project** **Quantity** **Price**

.....

Name.....

Address.....

.....

I enclose payment of £.....(cheque/PO in **£ sterling only**) to:

Everyday Practical Electronics

Access (MasterCard) or Visa No.

Minimum order for credit cards £5

VISA EUROCARD MasterCard

Signature.....Card Exp. Date.....

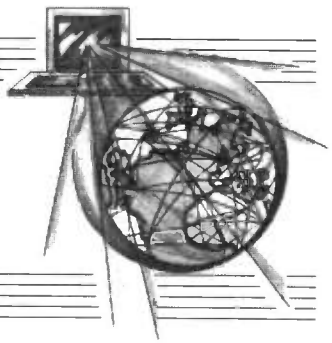
Please supply name and address of cardholder if different from the address shown

NOTE: You can order p.c.b.s via our Internet site on a *secure* server: **http://www.epemag.wimborne.co.uk**

SURFING THE INTERNET

NET WORK

ALAN WINSTANLEY



NET WORK is our monthly column specially written for readers having access to the Internet, whether at home, work, school or college. The column is designed to keep you posted with latest Internet developments here at *EPE* and to offer practical hints, tips and pointers in the ever more complex world of Internet connectivity.

The arrival of the Internet means that the *EPE* reader can, for example, obtain technical data about integrated circuits, or find out about device substitutions with barely a second thought – once you know where to look, you can have manufacturer's data or technical information delivered to your desktop in minutes. Since there has always been a long-running argument about the cost and availability of manufacturers' data books, the arrival of the world-wide web resolves them all at a stroke.

As an example, my *Circuit Surgery* column this month includes a typical example of how the Internet was used routinely to obtain some information about a mysterious transistor which as you'll read, was contained in an electret microphone. Whilst that example is quite a trivial one, it nevertheless demonstrates neatly that with just a little detective work, an experienced user can use the Internet to quickly find a solution to a particular problem at very little cost.

Freeserve Rising Fast

While AOL and Demon Internet fight it out to see who can rightly advertise the claim of being the largest service provider in the UK, last month I asked readers for feedback concerning Freeserve, the new ISP marketed by High Street retailer Dixons which is completely free, apart from local rate phone calls. Freeserve is clearly having a significant impact in the home dial-up market. Behind the scenes it is operated by Planet On-Line (**http://theplanet.net**), which itself is owned by Energis (**www.energis.co.uk**), who provide some of the routing for others including Demon Internet (now owned by Scottish Telecom). Interesting times are therefore ahead, and the dial-up sector may well have to re-align itself to cope with Dixons' new upstart, perhaps by rising above it to offer added value services designed for the more discerning power user, which is what Demon Internet would argue forms the core of their dial-up business anyway.

I received a number of very positive replies from readers about Freeserve, and one or two critical ones, but the consensus is clearly that it is free so don't knock it (I wasn't). However, I would again say that beginners should be aware of the high support costs at £1 a minute and there are a number of reported cases where browsers, newsgroup or dial-up networking settings were "taken over" by Freeserve.

It takes experience to understand the impact of any changes made to a stable setup, and more experience still to unravel them, so I would repeat that newcomers to the Internet ought to tread carefully before signing up. Alternatives such as AOL or CompuServe cost only a few pounds a month and make a good starting point, with proven software that generally works flawlessly and will get you moving.

On the other hand, anyone reasonably confident about Windows computing is likely to find a Freeserve connection very tempting, if not as a main connection then certainly to back-up an existing one. Freeserve is expanding all the time, and already includes POP3 mail and free web space with more services being slated for the future. All you have to do to retain your account is use it at least every 30 days. The take-up of Freeserve has been guesstimated at over 400,000 customers, but there was no indication of the churn rate, and given that users are at liberty to create more than one account (say, for isolated use or test purposes) and then let them expire, I would expect the fall-out rate to be high once the initial start-up feeding frenzy begins to filter through.

The general feeling voiced in some of the Freeserve newsgroups as well as the Turnpike newsgroup **demon.internet.support.turnpike** (Turnpike at **www.turnpike.com** is a useful dial-up access and mail software package suitable for the majority of UK-based ISPs – and it runs with Freeserve) is that its users welcome and appreciate the free service, and only a minority have had subsequent problems when they tried to de-install it. There are minor grumbles about connectivity and routing but I saw nothing particularly worrying.

Give it a Whirl

Yesterday, I tried Freeserve. However, I heeded the advice of some other users who commented that the free Dixons CD can be troublesome, so I avoided that altogether and signed up on-line without the need to install any special browser or even to use MSIE 4.0. The web site **www.tarrcity.demon.co.uk/tp/add-0091.htm** gives all the practical details of how to set up an initial Dial-Up Networking (DUN) "connectoid" to enable a temporary connection to be configured to the Freeserve registration server, to avoid the possibility of wrecking an existing setup (Internet Explorer 4.0 settings in particular). The web site contains tips and data that might help an experienced user avoid some pitfalls.

Having quickly configured a temporary DUN session, I dialled up the Freeserve secure server and completed the formalities in about five minutes. The online registration process involved reading through a long raft of totally indigestible Terms and Conditions with which I finally lost patience, then I also skipped through an impertinent questionnaire and selected a suitable hostname of "nwin" – hence I became the proud owner of the moniker **al@nwin.freeserve.co.uk**. I seem to remember that's how "epemag" was born when I opened the very first *EPE* E-mail account.

To be fair, the Freeserve on-line registration warns that it will change your Internet settings, and there is an option to cancel. It is at this point that the experienced user will probably say "no thanks" though others may decide to go with it. There were no further problems and a welcome E-mail from Freeserve was immediately delivered to my newly created mailbox. I now have a free backup connection which works, but it is still too soon to pass judgment on Freeserve. I must say that I have experienced several line drops after dialling in (which doubles the cost of the call), though I have not had any problems with stability or speed.

At that rate, the consumer really can't go wrong, provided that they are duly aware of the possibility of the installation messing around with their settings should they desire to remove it. Freeserve will undoubtedly cost other ISPs some lost dial-up business, though a professional user will probably not wish to be seen to be making do with a "free" address.

More to Come

In the coming months, I will be discussing more Internet services and applications which may help the *EPE* reader to get more out of the Internet. For example, I'll be looking at free web pagers that deliver messages to your desktop when you're on-line, various real-time "chat" and messaging services, and examining in-depth what is probably the world's most popular software download at the moment – ICQ, which is a real hoot to play with. According to site statistics, 600,000 people a week agree.

As usual, I have placed some ready-made links for you to click on, in the *Net Work* page of the *EPE* web site. I welcome suggestions by E-mail to **alan@epemag.demon.co.uk**. My Home Page is **http://homepages.tcp.co.uk/~alanwin** which was recently updated. See the amazing photos of my 70 m.p.h. drive down the main runway of my local airport in a Barracuda Fire Tender, courtesy of Humberside International Airport! See you next month.

EVERYDAY PRACTICAL ELECTRONICS CLASSIFIED

Everyday Practical Electronics reaches twice as many UK readers as any other independent monthly hobby electronics magazine, our audited sales figures prove it. We have been the leading independent monthly magazine in this market for the last fourteen years.

If you want your advertisements to be seen by the largest readership at the most economical price our classified and semi-display pages offer the best value. The prepaid rate for semi-display space is £8 (+VAT) per single column centimetre (minimum 2·5cm). The prepaid rate for classified adverts is 30p (+VAT) per word (minimum 12 words).

All cheques, postal orders, etc., to be made payable to Everyday Practical Electronics. **VAT must be added.** Advertisements, together with remittance, should be sent to Everyday Practical Electronics Advertisements, Mill Lodge, Mill Lane, Thorpe-le-Soken, Essex CO16 0ED. Phone/Fax (01255) 861161.

For rates and information on display and classified advertising please contact our Advertisement Manager, Peter Mew as above.

RCS VARIABLE VOLTAGE D.C. BENCH POWER SUPPLY

Up to 20 volts d.c. at 1 amp continous, 1·5 amps peak. fully variable from 1 to 20 volts. Twin Voltage and Current meters for easy read-out. 240 volt a.c. input. Fully smoothed, size 23cmx14cmx8cm.

£45 inc. VAT
Post £4

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD, CROYDON
SURREY, CR0 2HS. Tel: 0181-684 1665

Lots of transformers, high volt caps, valves, output transformers, speakers, in stock. Phone or send your wants list for quote.

ELECTRONIC KITS

- 88-108MHz FM transmitters from under £5
- Many educational and hobby electronic kits covering all technical abilities, from beginners' circuits to MCU/MPU designs
- Low cost PCB services and equipment
- Send 4x1st class stamps for catalogue

DTE MICROSYSTEMS, 112 SHOBNALL ROAD, BURTON -ON-TRENT, STAFFS DE14 2BB
PHONE or FAX: 01283 542229
http://www.btinternet.com/~dtemicrosystems

Z88 NOW AVAILABLE WITH 128K AND 512K+OZ4

BRAND NEW SINCLAIR SPECTRUM & QL PARTS

ZX MICRODRIVES £15, INTERFACE ONE £20, CARTRIDGES 10 FOR £15, 50 FOR £50.

QL BOARDS 5, 6 &7, POPULATED WITH JS ROMS, £30; UNPOPULATED, £12; MICRODRIVES £10 EACH. TOP & BOTTOM CASES £15, MEMBRANES £15.

THE P.C., MAC and QL's "Little Friend"
MAC LINK £10 - P.C. LINK £25 - QL LINK £12

CAMBRIDGE Z88 A4 NOTEBOOK COMPUTER AVAILABLE AGAIN £99, RECONDITIONED £60

ONLY 1" THICK, 4xAA BATTS. 20 HOURS WORK. LCD SCREEN, 72 Crs, 6 LINES, 32K RAM, EXTRA RAMS & EPROMS, 9 pin D SERIAL PORT, ROM HAS BBC BASIC, W/PROCESSOR, SPREADSHEET, DATA BASE, IMP/EXPORT TO PC etc, V52 TERMINAL.

W.N. RICHARDSON & CO.
PHONE/FAX 01494 871319
6 RAVENSMEAD, CHALFONT ST PETER, BUCKS, SL9 0NB.

BTEC ELECTRONICS TECHNICIAN TRAINING

GNVQ ADVANCED ENGINEERING (ELECTRONIC) – PART-TIME
HND ELECTRONICS – FULL-TIME
B.Eng FOUNDATION – FULL-TIME

Next course commences
Monday 1st February 1999
FULL PROSPECTUS FROM

LONDON ELECTRONICS COLLEGE
(Dept EPE) 20 PENYWERN ROAD
EARLS COURT, LONDON SW5 9SU
TEL: 0171-373 8721

THE BRITISH AMATEUR ELECTRONICS CLUB

exists to help electronics enthusiasts by personal contact and through a quarterly Newsletter.

For membership details, write to the Secretary:

Mr. M. P. Moses, 5 Park View, Cwmaman, Aberdare CF44 6PP

Space donated by Everyday Practical Electronics

Miscellaneous

***STEREO* FM TRANSMITTER**

Crystal controlled transmit frequency and pilot tone. Excellent quality sound, low power transmitter which is ideal for 'around the house' use. Send your favourite music to any FM radio. No frequency drift! High quality professionally made p.c.b. 3x2in. Kit **£25 inc. p&p.**

Send s.a.e. for details or see web site:
http://homepages.enterprise.net/ngough/tx.htm
N. J. Gough, 20 Earlsfield, Branston, Lincoln, LN4 1NP

VALVE ENTHUSIASTS: Capacitors and other parts in stock. For free advice/lists please ring, Geoff Davies (Radio), Tel. 01788 574774.

EX-EQUIPMENT BARGAINS! Power supplies, adjustable 30V d.c., 3A, regulated, £5; amplifier module, 20W+20W+p.s.u. and controls. £8. K.I.A., 1 Regent Road, Ilkley LS29 9EA.

HUNDREDS OF UNUSUAL ITEMS CHEAP! Send £1 coin for interesting samples and list. Grimsby Electronics, Lambert Road, Grimsby.

PROTOTYPE PRINTED CIRCUITBOARDS one offs and quantities, for details send s.a.e. to B. M. Ansbro, 38 Poynings Drive, Hove, Sussex BN3 8GR, or phone Brighton 883871, fax 01273 706670.

PRINTED CIRCUIT BOARDS – QUICK SERVICE. Prototype and Production. Artwork raised from magazines or draft designs at low cost. PCBs also designed from schematics. Production assembly also undertaken. For details send to P. Agar, Unit 5, East Belfast Enterprise Park, 308 Albertbridge Road, Belfast, BT5 4GX, or phone/fax 01232 738897.

G.C.S.E. ELECTRONIC KITS, at pocket money prices. S.A.E. for FREE catalogue. SIR-KIT Electronics, 52 Severn Road, Clacton, CO15 3RB.

NEW AND USED COMPUTERS, spares, etc. at keenest prices. e.g.: 386 min 2MB RAM. 20MB HDD, desktop case, keyboard and cables. 12in. VGA mono monitor, £55. 486 DX33 min. 8MB RAM, 120MB HDD, desk top case, keyboard and cables, 14in. VGA colour monitor, £165. Many other systems available. Whatever you need, Phone/Fax 0181 853 3374 for prices.

YOUR ADVERTISEMENT IN THIS SPACE FOR ONLY £20 + VAT

MORE READERS NEXT MONTH
Don't miss out
(see page 83 for details)

EPE NET ADDRESSES

EPE FTP site: **ftp://ftp.epemag.wimborne.co.uk**

Access the FTP site by typing the above into your web browser, or by setting up an FTP session using appropriate FTP software, then go into quoted sub-directories:

PIC-project source code files: **/pub/PICS**

PIC projects each have their own folder; navigate to the correct folder and open it, then fetch all the files contained within. *Do not try to download the folder itself!*

EPE text files: **/pub/docs**

Basic Soldering Guide: **solder.txt**

EPE TENS Unit user advice: **tens.doc** and **tens.txt**

Ingenuity Unlimited submission guidance: **ing_unlt.txt**

New readers and subscribers info: **epe_info.txt**

Newsgroups or Usenet users advice: **usenet.txt**

Ni-Cad discussion: **nicadfaq.zip** and **nicad2.zip**

UK Sources FAQ: **uksource.zip**

Writing for *EPE* advice: **write4us.txt**

On-line readers! Try the new EPE *Chat Zone* – a virtually real-time Internet "discussion board" in a simple to use web-based forum!
http://www.epemag.wimborne.co.uk/wwwboard

Or buy *EPE Online:* **www.epemag.com**

Ensure you set your FTP software to ASCII transfer when fetching text files, or they may be unreadable.

Note that any file which ends in **.zip** needs unzipping before use. Unzip utilities can be downloaded from : **http://www.winzip.com** or **http://www.pkware.com**

TRAIN TODAY FOR A BETTER FUTURE

Now you can get the skills and qualifications you need for career success with an ICS Home Study Course. Learn in the comfort of your own home at the pace and times that suit you. ICS is the world's largest, most experienced home study school. Over the past 100 years ICS have helped nearly 10 million people to improve their job prospects. Find out how we can help YOU. Post or phone today for **FREE INFORMATION** on the course of your

- Electrical Contracting & Installation
- Electrical Engineering
- C&G Basic Electronic Engineering
- C&G Basic Mechanical Engineering
- TV and Video Servicing
- Radio and Hi-Fi Servicing
- Refrigeration Heating & Air Conditioning
- Motorcycle Maintenance

FREEPHONE 0500 581 557

Or write to: International Correspondence Schools, FREEPOST 882, 8 Elliot Place, Clydeway Skypark, Glasgow, G3 8BR. Tel. 0500 581 557 or Tel/Fax: Ireland 01 285 2533.

Please send me my Free Information on your Electronics Courses.

Mr/Mrs/Ms/Miss (BLOCK CAPITALS PLEASE) Date of Birth / /

Address

Postcode

Occupation Tel. No.

From time to time we permit other carefully screened organisations to write to you about products and services. If you would prefer not to hear from such organisations please tick box ☐ Dept. ZEEE311298

SUPPLIER OF QUALITY USED TEST INSTRUMENTS

CONTACT
Cooke International
Unit Four, Fordingbridge Site, Barnham, Bognor Regis, West Sussex, PO22 0HD, U.K
Tel: (+44)01243 545111/2 Fax: (+44)01243 542457
Web: http://www.cooke-int.com
E-mail: info@cooke-int.com

OPERATING & SERVICE MANUALS

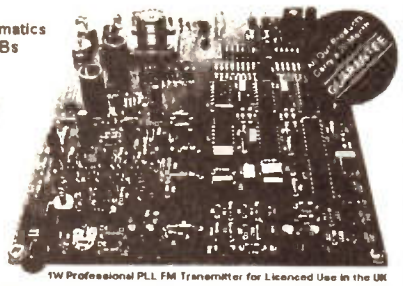
CONTACT
Cooke International
Unit Four, Fordingbridge Site, Barnham, Bognor Regis, West Sussex, PO22 0HD, U.K
Tel: (+44)01243 545111/2 Fax: (+44)01243 542457
Web: http://www.cooke-int.com
E-mail: info@cooke-int.com

Professional 88-108MHz FM Broadcasting Kits

All Our Kits Include
Detailed Instructions with Schematics
High Quality Screen Printed PCBs
High Quality Components

Our Product Range Includes
Transmitters from 0.05W to 35W
FM Stereo Coders
Audio Compressor Limiters
Antennas
RF Power Amps

Our Kits Are Also Available Fully Assembled And Tested



1W Professional PLL FM Transmitter for Licenced Use in the UK

WE DELIVER WORLD WIDE AND ACCEPT MAJOR CREDIT CARDS

Visit our Website at http://www.veronica.co.uk

Contact Us Now For A Free Brochure
Tel 01274 883434 Fax 01274 428665
email info@veronica.co.uk
Unit 5/6 1A Sandbeds/ Albert Rd Queensbury BRADFORD BD13 1AA

Veronica KITS

FML ELECTRONICS

★ NEW YEAR'S SALE ★
★ 10% OFF ALL OUR LIST PRICES DURING JANUARY 1999 ★
★ SEND A STAMPED ADDRESSED ENVELOPE FOR LISTS ★

NEW PRODUCTS NOW IN STOCK:

HT12B HOLTEK IR ENCODER TRANSMITTER	149p
HT12D HOLTEK INFRA-RED DECODER CHIP	149p

MORE SPECIAL £1 PACKS – COMPARE OUR PRICES

7 2·5MM PLUG, PLASTIC MONO	£1
6 2·5MM LINE SOCKETS, PLASTIC MONO	£1
12 2·5MM METAL CHASSIS SOCKETS, MONO	£1
10 3·5MM PLUGS, PLASTIC MONO	£1
3 3·5MM PLUGS, METAL MONO	£1
4 3·5MM LINE SOCKETS, PLASTIC MONO	£1
5 1/4IN. JACK PLUGS, PLASTIC MONO	£1
3 1/4IN. IN-LINE SOCKETS, PLASTIC MONO	£1
2 1/4IN. CHASSIS SOCKETS, SWITCHED MONO	£1
6 PHONO PLUGS, PLASTIC, RED/BLACK/MIX	£1
2 PHONO LINE SOCKETS, METAL	£1
4 SINGLE PHONO CHASSIS SOCKETS, PAX	£1
3 TWIN PHONO CHASSIS SOCKETS, PAX	£1
2 QUAD PHONO CHASSIS SOCKETS, PAX	£1
6 2-PIN DIN PLUGS, PLASTIC	£1
4 2-PIN DIN LINE SOCKETS, PLASTIC	£1
8 2-PIN DIN CHASSIS SOCKETS, PLASTIC	£1
4 3-PIN DIN PLUGS, PLASTIC	£1
3 5-PIN DIN LINE SOCKETS 180°, PLASTIC	£1
3 5-PIN DIN CHASSIS SOCKETS 240°	£1
3 7-PIN DIN PLUGS, PLASTIC	£1

NEW EPE KITS NOW AVAILABLE:
PLEASE SEND SAE FOR FURTHER DETAILS SPECIFYING THE EPE KIT THAT INTERESTS YOU

	REF.
KIT 9012 ALT. COURTESY LIGHT CONTROLLER	JAN '99
KIT 9020 TWINKLE TWINKLE REACTION GAME	JAN '99
KIT 9037 VOLUME COMPRESSOR	JAN '99
KIT 8862 FADING CHRISTMAS LIGHTS	DEC '98
KIT 8875 HANDHELD FUNCTION GENERATOR	DEC '98
KIT 8888 PHIZZYB I/O BOARD	DEC '98
KIT 8904 DAMP STAT ELECTRONIC THERMOSTAT	DEC '98

EARLIER EPE KITS:

KIT 8636 MAINS SOCKET TESTER	SEP '98
KIT 8644 PERSONAL STEREO AMPLIFIER	SEP '98
KIT 8652 PIC ALTIMETER	SEP '98
KIT 8564 LIGHTBULB SAVER	AUG '98
KIT 8574 FLOAT CHARGER	AUG '98
KIT 8603 PC TRANSISTOR TESTER	AUG '98

10% SALE DOES NOT APPLY TO ADVERTS/BARGAIN PACKS AND ALL ITEMS SUBJECT TO REMAINING AVAILABLE. PLEASE SEND LARGE SAE FOR FREE COMPONENT LISTS. RETAIL, TRADE, GOVT AND EDUCATIONAL ORDERS WELCOME.
INLAND UK P&P STILL ONLY £1 PER ORDER. NO VAT.
CHEQUES OR P.O.S WITH ORDER PLEASE TO:
FML ELECTRONICS, FREEPOST NEA3627, BEDALE, NORTH YORKSHIRE, DL8 2BR.

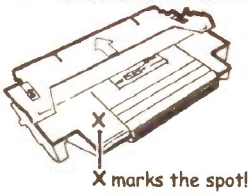
Service Manuals

Available for most equipment, from the earliest Valve Wireless to the latest Video Recorder, Television, Computer Monitor, 1 st Equipment, Satellite, all Audio, Amateur Radio, etc., etc. If you need a Service Manual give us a call or check out the full stock list now on our web site. Originals or Photostats supplied as available.
For your FREE catalogue of Technical Books and repair guides
PLUS full Floppy Disc Index of manuals available send 4 × first class stamps.

MAURITRON TECHNICAL SERVICES

8 Cherry Tree Road, Chinnor, Oxon, OX9 4QY
Tel: 01844-351694. Fax: 01844-352554.
E-mail: enquiries@mauritron.co.uk
Web site at: http://www.mauritron.co.uk/mauritron/

Cheat on toner



X marks the spot!
Cut or melt.

Refill your empty toner with the "Cut & Pour" method.
Doesn't disturb the inner workings of your cartridge.

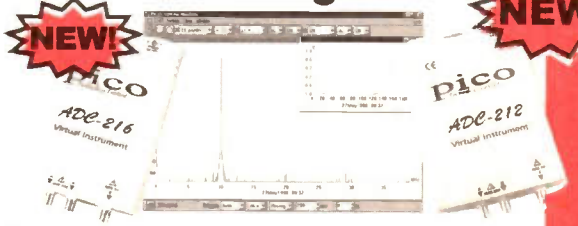
HP LaserJet 4/4M/4M Plus/5/5M/5N Refill bottle....**£12.99** ex VAT)
HP LaserJet 5L/6L/3100 Refill Bottle.....**£8.95** (ex VAT
HP LaserJet4L/4P Series Refill Bottle.....**£9.95** (ex VAT)
HP LaserJet 5P/6P Refill Bottle.....**£11.49** (ex VAT)
HP LaserJet 4000 Series Refill Bottle .....**£19.49** (ex VAT)

Many more lasers and copiers covered. FREE catalogue, FREE PHONE

0800 376 9922 (24 hrs)
Free FAX 0800 376 9955 (24 hrs) – **http://www.refilltoner.com**

High precision scopes, without the high cost

NEW! NEW!



Most digital scopes today are capable of achieving only 8 bit resolution. Pico Technology's new PC-based oscilloscopes represent a quantum improvement in digital scope technolgy. The ADC-212 offers 12 bit resolution, while its big brother, the ADC-216, is capable of 16 bit resolution. The scopes offer all the advantages associated with PC based test & measurement, such as large colour displays and a familiar Windows interface. Also, being Pico Technology products, the high performance is not matched by a high price tag.

ADC-212 / 216 **- dual channel high resolution**

Features
- Low cost
- 90 dB spectrum analyser
- 12 and 16 bit resolution
- Up to 1250 ksps
- Large buffer memory

Applications
- Audio testing and analysis
- Mains harmonics testing
- Power supply design
- Analog telephony
- Vibration and noise measurements

ADC-212.....£299 ***ADC-216***.....£499

Products supplied with software, cables and power supply. Prices exclude VAT

Call for a free demo disk or visit our web site

Tel: 01954 -211716 Fax: 01954 -211880
post@picotech.co.uk , www.picotech.com

pico Technology Limited

COVERT VIDEO CAMERAS

Black and White Pin Hole Board Cameras with Audio. Cameras in P.I.R., Radios, Clocks, Briefcases etc. Transmitting Cameras with Receivers (Wireless). Cameras as above with colour. Audio Surveillance Kits and Ready Built Units, Bug Detector etc.

A.L. ELECTRONICS

Please phone **0181 203 0161** for free catalogue.
Fax **0181 201 5359**

New DTI approved Video Transmitters and Receivers (Wireless)

Millions of quality components at lowest ever prices!

Plus anything from bankruptcy – theft recovery – frustrated orders – over production etc.

Send 45p stamped self addressed label or envelope for clearance lists.

Brian J Reed
6 Queensmead Avenue, East Ewell
Epsom, Surrey KT17 3EQ
Tel: 07775 945386
Mail order UK only.

Lists are updated and only 40 are sent out every 2 weeks. This normally ensures that orders can be fulfilled where only a few thousand of an item is available. (Payment is returned if sold out. I do not deal in credit notes). This will sometimes entail a delay of up to eight weeks – **but the prices will be worth the wait!**

N. R. BARDWELL LTD (EPE)

100	Signal diodes 1N4148	£1.00	200	Asstd. disc ceramic capacitors	£1.00
75	Rectifier Diodes 1N4001	£1.00	50	Asstd. Skel Presets (sm. stand. cermet)	£1.00
50	Rectifier Diodes 1N4007	£1.00	50	Asstd. RF chokes (inductors)	£1.00
10	W01 Bridge Rectifiers	£1.00	50	Asstd. grommets	£1.00
10	555 Timer I.C.s	£1.00	80	Asstd. solder tags, pl/conns, terminals	£1.00
4	741 Op Amps	£1.00	10	Asstd. crystals – plug in	£1.00
50	Assorted Zener Diodes 400mW	£1.00	24	Asstd. coil formers	£1.00
12	Assorted 7-segment Displays	£1.00	8	Asstd. dil switches	£1.00
25	5mm l.e.d.s, red, green or yellow	£1.00	20	Miniature slide switches sp/co	£1.00
25	3mm l.e.d.s, red, green or yellow	£1.00	10	Standard slide switches dp/dt	£1.00
50	Axial l.e.d.s, 2mcd red Diode Package	£1.00	30	Asstd. if transformers	£1.00
25	Asstd. High Brightness l.e.d.s, var cols	£1.00	100	Asstd. beads (ceramic, teflon, fish spine)	£1.00
20	BC182L Transistors	£1.00	60	Asstd. small stand offs, t/throughs etc	£1.00
25	BC212L Transistors	£1.00	30	Asstd. dil sockets up to 40 way	£1.00
30	BC237 Transistors	£1.00	10	TV coax plugs, plastic	£1.00
20	BC327 Transistors	£1.00	20	Small spring loaded terminals	£1.00
30	BC328 Transistors	£1.00	40	metres very thin connecting wire, red	£1.00
30	BC547 Transistors	£1.00	20	1in. glass reed switches	£1.00
30	BC548 Transistors	£1.00	20	Magnetic ear pips with lead and plug	£1.00
30	BC549 Transistors	£1.00	100	Any one value ¼W 5% cf resistors range 1R to 10M	£0.45
25	BC557 Transistors	£1.00			
30	BC558 Transistors	£1.00			
30	BC559 Transistors	£1.00			
20	2N3904 Transistors	£1.00			
100	50v wkg Axial Capacitors 1nf	£1.00			
100	50v wkg Axial Capacitors 4N7	£1.00			
12	1uf 250v encapsulated radial plastic cased capacitors	£1.00			
80	Asstd capacitors electrolytic	£1.00			
80	Asstd. capacitors 1nF to 1µF	£1.00			

Prices include VAT, postage £1.25. 31p stamp for Lists
288 Abbeydale Road, Sheffield S7 1FL
Phone (0114) 2552886 Fax (0114) 2500689
E-mail Bardwells@compuserve.com
Web site: http: ourworld.Compuserve.com homepages BARDWELLS

NEW SPECIAL OFFERS

Amiga genlock pcb (uncased) for titling videos it has a 23pin D lead to plug into the computer and pcb pins for composite video in and out. When no video input is connected the normal computer display is shown on the composite video out when the video input is added the white areas on the screen are replaced by the video image. The pcb is powered from the computer..... £19.98

WATCH SLIDES ON TV "Liesgang diatv" automatic slide viewer with built in high quality colour tv camera, composite video output with a BNC plug. In very good condition with few signs of use. £108.00

Board cameras all with 512x582 pixels 4.4x3.3mm sensor with composite video out. All need to be housed in your own enclosure and have fragile exposed surface mount parts and require 10 to 12vdc power supply.

47MIR size 60x36x27mm with 6 infra red leds (gives the same illumination as a small torch would) ..... £50.00+vat = £58.7540

MP size 39x38x23mm spy camera with a fixed focus pin hole lens for hiding behind a very small hole..... £57+vat = £66.98

40MC size 39x38x28mm camera for 'C' mount lens this gives a much clearer picture than with the small lenses..... £68.79

Standard 'C' mount lens F1.6 16mm for 40MC ..... £26.43+vat = £31.06

Waterproof camera with stylish tilt & swivel case £92.76 + vat = £109.00 or 10 + £89.32 + vat = £104.95

DTA:0 Hand held transistor analyser it tells you which lead is the base, the collector and emitter and if it is NPN or PNP or faulty HMA20 hand held MOSFET analyser identifies gate drain and source and if P or N channel DTA30 & HMA20 ..... £38.34 each

DCA50 component analyser with lcd readout identifies transistors mosfets diodes & LEDs lead connections..... £69.95

Speaker cabinets 2 way speaker systems with motorola tweeters

speaker dia	15"	12"	8"
power rating	250WRMS	175WRMS	100WRMS
impedance	8ohm	8ohm	8ohm
freq. range	40hz-20khz	45hz-20khz	60hz-20khz
sensitivity(1W/1M)	97dB	94dB	92dB
size in mm	500x720x340	450x640x345	315x460x230
weight	21.1kg	16.8kg	7.4kg
price each for black vinyl coating	£139.95	£99.99	£54.94
grey felt coating	£159.97**	£119.97**	£64.99

(** = not normally in stock allow 1 week for delivery)

Power amplifiers 19" rack mount with gain controls

STA150	2x160Wrms (4ohm load) 14kg	£202.11
STA300	2x190Wrms (4ohm load) 11kg	£339.00
STA900	2x490Wrms (4ohm load) 15kg	£585.00

LEDs 3mm or 5mm red or green 7p each yellow 11p each cable ties 1p each £5.95 per 1000 £49.50 per 10,000

Rechargable Batteries

AA(HP7) 500mAH	£0.99	AA 500mAH with solder tags	£1.55
AA 950mAH	£1.75	C(HP11) 1.2AH	£2.20
C 2AH with solder tags	£3.60	D(HP2) 1.2AH	£2.60
D 4AH with solder tags	£4.95	PP3 8.4V 110mAH	£4.95
1.2AA with solder tags	£1.55	Sub C with solder tags	£2.50
AAA (HP16) 180mAH	£1.75	1.3 AA with tags (philpsCTV)	£1.95

Nickel Metal Hydryde AA cells high capacity with no memory. If charged at 100ma and discharged at 250ma or less 1300mAH capacity (lower capacity for high discharge rates)..... £2.95

Special offers please check for availability stick of 4 42x16mm nicad batteries 171mmx16mm dia with red & black leads 4.8v..... £5.95

5 button cell 6V 280mAh battery with wires (Varta 5x250DK)..... £2.45

Orbitel 866 battery pack 12v 1.60AH contains 10 sub C cells with solder tags (the size most commonly used in cordless screwdrivers and drills 22 diax42mm tall) it is easy to crack open and was manufactured in 1994 ..... £8.77 each or 110.50 per box of 14

BCI box 190x106x50mm with slots to house a pcb the lid contains an edge connector (12 way 8mm pitch) and screw terminals to connect in wires and 5 slide in cable blanks..... £2.95

7segment common anode led display 12mm..... £0.45

GaAs FET low leakage current S8873 £12.95 each £9.95 10+ 7.95 100+ BC547A transistor 20 for £1.00

SL952 UHF Limiting amplifier LC 16 surface mounting package with data sheet..... £1.95

DC-DC convertor Reliability model V12P5 12v in 5v 200ma out 300v input to output Isolation with data... £4.95 each or pack of 10 £39.50

Airpax A82903-C large stepping motor 14v 7.5 step 27ohm 68mm dia body 6.3mm shaft ..... £8.95 or £200.00 for a box of 30

Polyester capacitors box type 22.5mm lead pitch 0.9uf 250vdc 18p each 14p 100+ 9p 1000+ 1uf 250Vdc 20p each 15p 100+ 10p 1000+

Polypropylene 1uf 400vdc (Wima MKP10) 27.5mm pitch 32x29x17mm case 75p each 60p 100+

Philips 123 series solid aluminium axial leads 33uf 10v & 2.2uf 40v 40p each. 25p 100+

Solid carbon resistors very low inductance ideal for RF circuits 27ohm 2W 68ohm 2W 25p each 15p each 100+ we have a range of 0.25w 0.5w 1w and 2w solid carbon resistors, please send SAE for list

MX180 Digital multimeter 17 ranges 1000vdc 750vac 2Mohm 200mA transistor Hfe 9v and 1.5v battery test £9.95

Hand held ultrasonic remote control..... £3.95

CV2486 gas relay 30x10mm dia with 3 wire terminals will also work as a neon light ..... 20p each or £8.50 per 100

Varbatim R300NH Streamer tape commonly used on nc machines and printing presses etc it looks like a normal cassette with a slot cut out of the top £4.95 each (£3.75 100+)

Heatsink compound tube..... £0.95

HV3-2405-E5 5-24v 50mA regulator ic 18-264vac input 8 pin DIL package..... £3.49 each (100+ 2.25)

All products advertised are new and unused unless otherwise stated. Wide range of CMOS TTL 74HC 74F Linear Transistors kits, rechargable batteries, capacitors, tools etc always in stock.

Please add £1.95 towards P&P (orders from the Scottish Highlands, Northern Ireland Isle of Man, Isle of Wight and overseas may be subject to higher P&P for heavy items) VAT included in all prices.

JPG ELECTRONICS

276-278 Chatsworth Road
Chesterfield S40 2BH
Access/Visa Orders:
Tel: (01246) 211202 Fax: (01246)550959
Callers welcome 9.30am to 5.30pm
Monday to Saturday

ADVERTISERS INDEX

A.L. ELECTRONICS.....144
ASA MICROS.....100
A.S.A.....108
N. R. BARDWELL.....144
B.K. ELECTRONICS.....Cover (iii)
BRIAN J. REED.....144
BULL ELECTRICAL.....Cover (ii)
COMPELEC.....108
COOKE INTERNATIONAL.....143
CROWNHILL ASSOCIATES.....93
DANNELL ELECTRONICS.....77
DISPLAY ELECTRONICS.....74
EPT EDUCATIONAL SOFTWARE.....90
ESR ELECTRONIC COMPONENTS.....82
FML ELECTRONICS.....143
GREENWELD.....77
ICS.....143
J&N FACTORS.....78
JPG ELECTRONICS.....144
LABCENTER ELECTRONICS.....110
MAGENTA ELECTRONICS.....80/81
MAPLIN ELECTRONICS.....Cover (iv)
MAURITRON.....143
NATIONAL COLLEGE OF TECH.....76
PICO TECHNOLOGY.....79/143
QUASAR ELECTRONICS.....125
QUICKROUTE SYSTEMS.....89
RADIO-TECH.....76
SEETRAX CAE.....93
SERVICE TRADING.....125
SHERWOOD ELECTRONICS.....76
SQUIRES.....76
STEWART OF READING.....136
SUMA DESIGNS.....117
TECHNOLOGY EDUCATION INDEX.....125
THE TONER WAREHOUSE UK.....143
VANN DRAPER ELECTRONICS.....100
VERONICA KITS.....143

ADVERTISEMENT MANAGER: PETER J. MEW

ADVERTISEMENT OFFICES:
EVERYDAY PRACTICAL ELECTRONICS, ADVERTISEMENTS,
MILL LODGE, MILL LANE, THORPE-LE-SOKEN,
ESSEX CO16 0ED.
Phone/Fax: (01255) 861161

For Editorial address and phone numbers see page 83.

Published on approximately the first Friday of each month by Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset BH21 1PF. Printed in England by Wiltshire (Bristol) Printers Ltd., Bristol. BS20 9XP. Distributed by Seymour, 86 Newman St., London W1P 3LD. Subscriptions INLAND £26.50 and OVERSEAS £32.50 standard air service (£50 express airmail) payable to "Everyday Practical Electronics", Subs Dept, Allen House, East Borough, Wimborne, Dorset BH21 1PF. E-mail: subs@epemag.wimborne.co.uk. EVERYDAY PRACTICAL ELECTRONICS is sold subject to the following conditions, namely that it shall not, without the written consent of the Publishers first having been given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on the cover, and that it shall not be lent, resold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

BK ELECTRONICS

POWER AMPLIFIER MODULES-LOUDSPEAKERS-MIXERS 19 INCH STEREO AMPLIFIERS-ACTIVE CROSS/OVERS.

★PRICES INCLUDE V.A.T.★PROMPT DELIVERIES
★LARGE [A4] S.A.E. 60p STAMPED FOR CATALOGUE

OMP MOS-FET POWER AMPLIFIERS
HIGH POWER, TWO CHANNEL 19 INCH RACK

1000's SOLD TO PRO USERS

THE RENOWED MXF SERIES OF POWER AMPLIFIERS

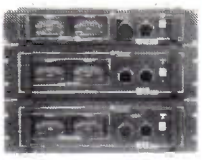
FOUR MODELS:- **MXF200** (100W + 100W) **MXF400** (200W + 200W)
MXF600 (300W + 300W) **MXF900** (450W + 450W)

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 power 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"	D14¾"	H5¼" (3U)



PRICES:- MXF200 £175.00 MXF400 £233.85
MXF600 £329.00 MXF900 £449.15

SPECIALIST CARRIER DEL. £12.50 EACH

OMP XO3-S STEREO 3-WAY ACTIVE CROSS-OVER 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 fascia allows access to the programmable DIL switches to adjust the cross-over frequency: Bass-Mid 125/250/500Hz, Mid-Top 1.8/3/5Hz, all at 24dB per octave. The 2/3 way selector switches are also accessed by removing the front fascia. Each stereo channel can be configured separately. Bass Invert Switches are incorporated on each channel. Nominal 775mV input/output. Fully compatible with OMP Rack Amplifier and Modules.

PRICE:- £117.44 + £5.00 P&P

SOUNDLAB CDJ1700 CD PLAYER VARIABLE SPEED

The new CDJ1700 now offers a tough build quality boasting an all new shockproof transport mechanism, frame accurate cueing and wide range pitch control. The CDJ1700 looks after the CD's while the operator looks after the sound.

FEATURES:
★19"X2U RACK MOUNTING ★FULLY VARIABLE PITCH CONTROL PLUS/MINUS 16% ★PITCH BLEND ★3 BEAM LASER PICKUP ★1 BIT 8 X OVERSAMPLING DAC ★CUE AND LOOP FACILITY ★TRACK SKIP WITH FF/REV ★DIGITAL AND ANALOGUE OUTPUTS ★CONTINUOUS/SINGLE TRACK PLAY ★CLEAR BACKLIT MULTIFUNCTION DISPLAY ★10 TRACK PROGRAM PLAY ★TRACK ELAPSED, TRACK REMAINING AND DISC REMAINING TIME DISPLAYS

SPECIFICATION:- Freq response..20Hz-20KHz S/N ratio..>80dB THD..<0.09%(1KHz) Channel separation..>80dB(1KHz) Max output voltage..2Vrms Power..220-240Vac 50-60Hz Size..W 482 H 88 D 250mm Weight..4.18Kg. **PRICE:-£225.00 + £5.00 P&P**

STEREO DISCO MIXER MPX-7700 ECHO & SOUND EFFECTS

★ 4 STEREO INPUT CHANNELS
★ 2 DJ MIC INPUT CHANNELS
★ 2X7 BAND GRAPHIC EQUALISERS
★ HEADPHONE MONITOR WITH PFL
★ ASSIGNABLE CROSSFADE
★ DIGITAL ECHO

STEREO DISCO MIXER WITH:- ★2X7 GRAPHIC EQUALISERS ★2 MONO MIC INPUTS ★DJ MIC WITH FADER, TALKOVER AND VOICE CHANGER ★4 STEREO CHANNELS WITH INDIVIDUAL FADERS AND ASSIGNABLE CROSSFADE ★CHANNELS SWITCHABLE, TURNTABLE (MAG CARTRIDGE), CD, LINE, TAPE, ETC. ★ECHO WITH BALANCE, REPEAT AND DELAY ★HEADPHONE MONITOR WITH PREFADE LISTEN ★CHOICE OF 6 SOUND EFFECTS ★STEREO MONO SWITCH ★2 X LED VU METERS ★MASTER FADER ★OUTPUT 775mV ★SIZE:- 482X240X115mm ★POWER:- 230V AC 50/60Hz. **PRICE:- £169.00 + £5.00 P&P**

SOUNDLAB MINI STROBE

★ IDEAL FOR USE IN DISCO'S / RAVES.
★ EDUCATIONAL EXPERIMENTS ETC.

A top quality mini strobe with high light intensity for its size and variable flash rate adjustment. Housed in a silver/black steel case with adjustable mounting bracket. ★ Flash Rate:- Adjustable from zero to ten flashes per second ★ Mains Powered complete with plugged lead ★ 230V AC 50/60Hz ★ Size:- 125 X 84 X 52mm **PRICE:- £19.99 + £2.20 P&P**

DELIVERY CHARGES:- PLEASE INCLUDE AS ABOVE TO A MAXIMUM AMOUNT £30.00. OFFICIAL ORDERS FROM SCHOOL,COLLEGES, GOVT. BODIES,PLCs ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER.CREDIT CARD ODERS ACCEPTED BY POST PHONE OR FAX

Access — BARCLAYCARD VISA

ibl FLIGHTCASED LOUDSPEAKERS

A new range of quality loudspeakers, designed to take advantage of the latest loudspeaker technology and enclosure designs. All models utilize high quality studio cast aluminium loudspeakers with factory fitted grilles, wide dispersion constant directivity horns, extruded aluminium corner protection and steel ball corners, complimented with heavy duty black covering. The enclosures are fitted as standard with top hats for optional loudspeaker stands. The FC15-300 incorporates a large 16 X 6 inch horn. All cabinets are fitted with the latest Speakon® connectors for your convenience and safety. Five models to choose from.

WEDGE MONITOR

PLEASE NOTE:- POWER RATINGS QUOTED ARE IN WATTS R.M.S. FOR EACH INDIVIDUAL CABINET. ALL ENCLOSURES ARE 8 OHM.
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

ibl IN-CAR AUDIO BASS BOX 10/100 INCREDIBLE VALUE

The new *ibl* In-Car Audio Bass Box has been designed with a sloping front to reduce internal standing waves. The bass box incorporates a 10 inch 4 ohm loudspeaker with a genuine 100 watts R.M.S. output resulting in powerful and accurate bass reproduction.

FEATURES:- ★ Cabinet manufactured from MDF and sprayed in a durable black shiny HAMMERITE finish. ★ Fitted with a 10 inch loudspeaker with rolled rubber edge and coated cone assembly ★ The top of the cabinet incorporates gold plated connection terminals. SPECIFICATION:- 100Watts R.M.S. 200 Watts Peak (Music).Ported reflex,critically tuned. Size:- H405 W455 D305mm.

PRICE:- £79.00 + £6.00P&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 i.e. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE that all models include toroidal power supply, integral heat sink, glass fibre P.C.B. and drive circuits to power a compatible Vu meter. All models are open and short circuit proof.

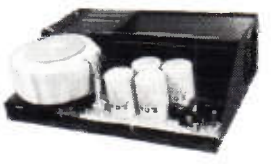
THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS

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, 725 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.002%, 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, BAND WIDTH 100KHz. OR PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BAND WIDTH 50KHz. ORDER STANDARD OR PEC

B.K. ELECTRONICS
UNIT 1 COMET WAY, SOUTHEND-ON-SEA, ESSEX, SS2 6TR.
TEL.: 01702 527572 FAX.: 01702-420243
Web:- http://www.bkelec.com E-mail:- Sales@bkelec.com

REF 1

MAPLIN ELECTRONICS

Order your catalogue now on **01702 554000** or visit and collect from one of our 48 stores nationwide. You can also purchase your catalogue from your local Maplin store, WH Smith and John Menzies.

CATALOGUE
- Over 1,000 new products
- Includes over £50 worth of discount vouchers
- Order code CA18

DOUBLE CD
- Includes FREE datasheet CD-Rom
- FREE McAfee anti-virus software
- FREE 30 day Demon Internet trial
- Order code CQ02

THE NEW CATALOGUE OUT NOW

£3.99

the key to better selection and service

Telephone 01702 554000 with your enquiry

The catalogue costs just £3.99 plus p+p* and the CD Rom is available at just £1.95 plus p+p* including free datasheet CD Rom.

*(Add 50p for P&P). Orders outside the UK please send £8.99 or 21 IRCs for Airmail in Europe or surface mail outside Europe. Send £16.04 or 37 IRCs for Airmail outside Europe to: Maplin Electronics, PO Box 777, Rayleigh, Essex, England, SS6 8LU. Prices include VAT and are subject to change. All items subject to availability. E+OE. **WHEN ORDERING PLEASE QUOTE PRIORITY CODE MA095**

IV