EVERYDAY

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MARCH 1999

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A report from the US I/ITEC Show


THE No.1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

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News • Circuit Surgery • New Technology Update • Network

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

**WINDOWS 95 CD** As supplied with Hewlet Packard PC's these CD's have all the window files on them and were intended to be used to restore windows on a PC after a crash etc £15 REF SX06

**SATELLITE MODULATOR MODULES prices from just 9p** Surface mount modulators full of components. Fitted with an F type connector and a uhf type connector. Pack of 100 £9.95 ref SS20

**PROJECT BOXES**

Another bargain for you are these smart ABS project boxes, smart two piece screw together case measuring approx 6"x5"x2" complete with panel mounted LED. Inside you will find loads of free bits, tape heads, motors, chips resistors, transistors etc. Pack of 20 £19.95 ref MD2

**REMOTE HEATING CONTROLLERS WITH 30A MAINS RELAY** from just 99p These units were designed to be plugged into a telephone socket. You then called the phone and some how it turned the heating on. Each box contains lots of bits including a mains 30A relay. pack of 20 £20 ref SS34

**.TALKING COINBOXES** Prices from just 95p These units were made to convert standard telephones into pay phones, complete with coinslot assemblies and switches etc. OFFERED TO YOU AT A BARGAIN PRICE BECAUSE WE NEED THE SPACE! Pack of 10 £19 ref SS29

**AC MOTOR BONANZA! prices from just 59p** Again we have piles and piles of these brand new mixed motors which we need to clear in bulk at ridiculous prices! Pack of 50 for £30 ref SS13

**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 SS60 These units are brand new modules designed to take "pictures" of intruders and then transmit the pictures down the telephone line. The PIR detects the intruder, fires the strobe light this ensures a perfect picture even in total darkness. The picture is stored in memory inside the module and then sent by modem (not included) down the telephone line. The units also have a nicad battery pack included presumably to maintain operation in the event of mains power failure. Output from the camera is standard b/w composite 320x240 pixels with a 90x65 degree field of view, the picture quality is excellent. Each PIR also contains a video capture and compression unit. The infra red strobe has a range of 15m The pir has a range of 12m Power supplies are 12vdc 400mA. Power supplies available at £5 ref SS60The units are supplied with connection details etc but we do not have any information on using the compression and capture unit or interfacing to modems etc. The units do have operational PIR's, strobes and camera's (camera is 12vdc and gives out standard composite 1v p-p video) how you adapt these to work together is entirely up to you!Retail price for the units was in excess of £200 each sale price £39.95ref SS81.Power supplies £5 ref SS60

**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), redial, recall 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 10 off £30 ref SS2**

**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

**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

**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 alignment. 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 electronics 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

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

**CENTRAL POINT PC TOOLS** Award winning software, 1,300 virus checker, memory optimiser, disc optimiser, file compression, low level formatting, backup scheduler, disk defragmenter, undelete, 4 calculators, D base, disc editor, over 40 viewers, remote computing, password protection, encryption, comprehensive manual supplied etc £8 ref lot 97 3.5" disks. £10 ref LOT97

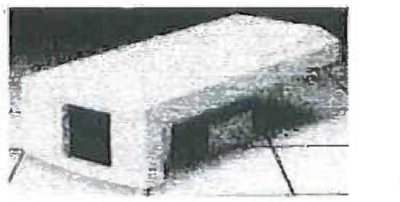
**VIDEO PROCESSOR UNITS?/6v 10AH BATTS/ 24V 8A TX** Not too sure what the function of these units is but they certainly make good strippers! Measures 390X320X120mm, on the front are controls for scan speed, scan delay, scan mode, loads of connections on the rear. Inside 2 x 6v 10AH sealed lead acid batts, pcb's and a 8A? 24v toroidal transformer (mains in). sold as seen, may have one or two broken knobs etc due to poor storage. £15.99 ref VP2

**DIFFERENTIAL THERMOSTAT KIT** Perfect for heatrecovery, solar systems, boiler efficiency etc. Two sensors will operate a relay when a temp difference (adjustable) is detected. All components and pcb. £29 ref LOT93

**SOLAR WATER HEATING PLANS £6 REF SOLP**

**PC POWER SUPPLIES PACK OF 8 £9.95**

Thats right! 8 power supplies for £9.95! These are all fan cooled (usually 12v) our choice of specs etc, and are sold as seen. But worth it for the fans alone! ref XX17



## 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.**

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**SMOKE ALARMS** Mains powered, made by the famous Gent company, easy fit next to light fittings, power point. Pack of 5 £15 ref SS23, pack of 12 £24 ref SS24

**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 fence wire. £49 ref AR2

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

**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 works direct from our 10 watt solar panel in bright sun. Max hd 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 connectors. £49.95 ref CC6J

**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**

**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 7AH, S/HAND PACK OF 4 £10 REF XX1

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

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**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 facilties 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 potentiometer. Perfect for interesting projects etc 70x55mm 12vdc operation. £6 ea ref FLS1, pack of 10 £49 ref FLS2

**NEW LASER POINTERS** 4.5mw, 75 metre range, hand held unit runs on two AA batteries (supplied) 670nm. £39 ref DEC49J

**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. £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

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

**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, XK and KA bands, speed cameras, and all known speed detection systems, 360 degree coverage, front&rear waveguides, 1.1"x2.7"x4.6" fits on visor or dash £149

**LOPTX** Made by Samsung for colour TV £3 each ref SS62

**LAPTOP LCD SCREENS** 240x175mm, £12 ref SS51

**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

**INFRA RED REMOTE CONTROLS** made for TVs but may have other uses pack of 100 £39 ref IREM

## Online web catalogue bull-electrical.com

**ELECTRONIC SPEED CONTROLLER KIT** For the above motor is £15 ref MAG17. Save £5 if you buy them both together, 1 motor plus speed controller rrp is £41, offer price £36 ref MOT5A

**SONY STEREO TV CHASSIS** assemblies comprising complete TV PCB excluding tube and scan coils. Nicam stereo, mains input. Appear to be unused but sold 'as seen' Would probably be good for spares or as a nicam stereo TV sound receiver and amplifier. For KV29F1U and KV25F1U(BE3D) PCB no's 1-659-627-12 1-659-626-14 1-711-600-11 £20 ref STV1

**RCB UNITS Inline IEC lead with fitted RC breaker. Installed in seconds. Pack of 3 £9.98 ref LOT5A**

**RADIO CONTROLLED CARS etc** No remotes but good strippers for servo's motors and receivers. Sold as is, no returns mixed types. £3 each ref RCC2

**VOICE CHANGERS** Hold one of these units over your phone mouth piece an you can adjust your voice using the controls on the unit! Battery operated £15 ref CC3

**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

**5.25" FLOPPY DISKS** pack of 500 disks £25 ref FD

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

VOL. 28 No. 3 MARCH 1999

# EVERYDAY PRACTICAL ELECTRONICS

ETI ELECTRONICS

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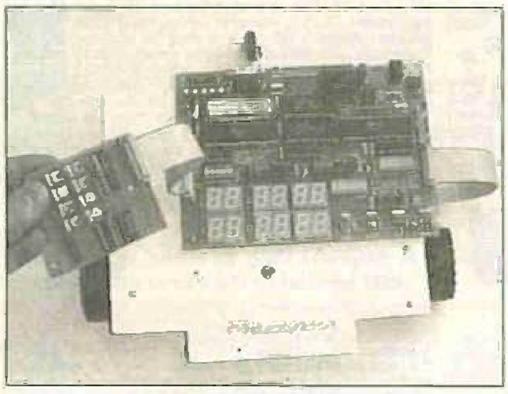
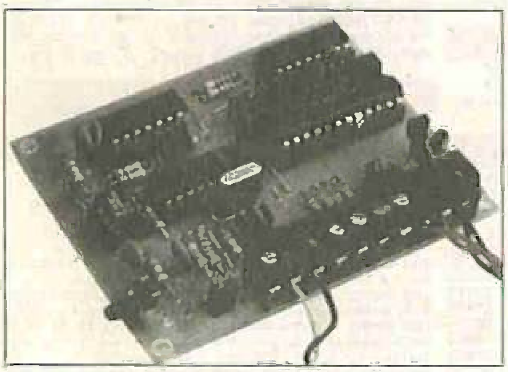
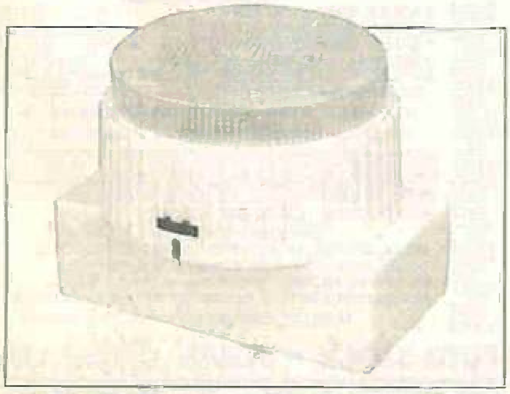
**The No. 1 Magazine for Electronics Technology and Computer Projects**







## Projects and Circuits



## Series and Features



## Regulars and Services





*Our April '99 issue will be published on Friday, 5 March 1999. See page 147 for details.*

Surplus always wanted for cash!

# THE ORIGINAL SURPLUS WONDERLAND!

**THIS MONTH'S SELECTION FROM OUR VAST EVER CHANGING STOCKS**

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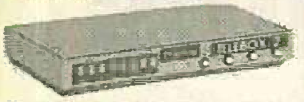
## THE AMAZING TELEBOX

**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) MK1001MAV 2.16 Gb. *New* | £199.00 |
| 2½" **TOSHI** (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**

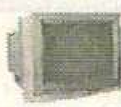
**6,000,000 Items EX STOCK**

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 <u>both</u> **RGB and standard composite 15.625 Khz video inputs via SCART** socket and separate phono jacks. Integral audio **power amp and speaker for all audio visual uses.** Will connect direct to **Amiga** and Atari BBC computers. Ideal for all **video monitoring / security** applications with direct connection **to most colour cameras.** High quality with many features such as front concealed flap controls, VCR correction button etc. Good used condition - fully tested - guaranteed
Dimensions: W14" x H12¾" x 15½" D. **Only £99** (E)

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

**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

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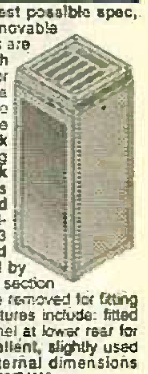

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| 1kW to 400 kW - 400 Hz 3 phase power sources - ex stock | £POA |
| IBM 8230 Type 1, Token ring base unit driver | £760 |
| Wayne Kerr RA200 Audio frequency response analyser | £2500 |
| IBM 53F5501 Token Ring ICS 20 port lobe modules | £750 |
| IBM 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 |
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| Mann Tally MT645 High speed line printer | £2200 |
| Intel SBC 486/133SE Multibus 486 system. 8Mb Ram | £945 |
| Siemens 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 16 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 |
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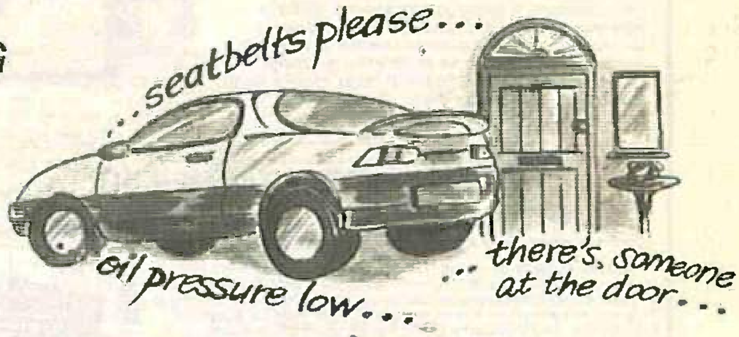
# NEXT MONTH

## FREE GUIDE TO SOLDERING AND DESOLDERING

*A free 48-page booklet written by Alan Winstanley giving in-depth information backed up by an outstanding range of photographs on all aspects of soldering. If you want to sharpen your technique, or if you are just starting out in electronic construction (or know someone who is), then this booklet will prove invaluable.*

*Alan's soldering section on the EPE Web site has been referenced the world over – it is even used by one soldering iron manufacturer to add to their own information; this booklet has been developed from that material and should be equally highly regarded.*




## VERSATILE EVENT COUNTER

*Prompted by a reader's telephone request for a unit to help him count musical beats, this constructional article first shows how a very simple BASIC program on a PC can do the job. It then takes the idea a lot further, presenting a self-contained PIC-microcontrolled design that will monitor the timing of all sorts of events. The results are displayed on an alphanumeric liquid crystal display.*

*Event signals can be input via a built-in microphone, via a jack-plugged connection to other electronic circuits, and via a panel mounted switch.*

*There are three monitoring modes:*

- *Mode 1 displays the time elapsed since monitoring began; the elapsed time at which the last event was detected; the total events counted; the average rate at which the events have been occurring, selectable for counts per second, counts per minute and counts per hour.*
- *Mode 2 is a frequency counter, principally for monitoring an external electronically generated frequency of 0V/+5V amplitude, up to about 20kHz.*
- *Mode 3 counts the elapsed time between pairs of events and is of best use with events that are longer than about one second apart.*

## VOICE RECORD/ PLAYBACK MODULE

*An easy to build unit that will digitally record up to 16 seconds of sound. Use it as a memo pad or as a voice warning instead of an l.e.d. or other indicator: "fasten seat belts", "maximum temperature exceeded", "secure area – leave within 30 seconds or the police will be called" etc. All automatic in the voice of your making.*

## MECHANICAL RADIO

*Inspired by the renowned Clockwork Radio invented by Trevor Baylis, this design shows a way in which a clockworkless power saving radio can be created using components more familiar to electronics enthusiasts than to mechanical buffs.*

*You still turn a handle, but it's not clockwork you wind up, it's a motor whose output voltage is stored in a really large capacity capacitor (one Farad, no less!). It's power from the capacitor that then keeps you tuned into the world via an easy-to-build direct conversion receiver, and the headphone-coupled output then stops you voluminously troubling the neighbours!*

*It's novel, it's simple, and it can give you lots of entertainment—not to mention the benefit of extra exercise!*

## PIC16F87x MICROCONTROLLERS REVIEW

*Thousands of you have become familiar with the PIC family of microcontrollers, especially the PIC16x84 EEPROM versions. Arizona Microchip have now introduced a new range to the family, the PIC16F87x series. In many respects, these new devices can be regarded as greatly enhanced versions of the '84s.*

*Importantly, not only do they have greater capacity than the '84s, they offer more facilities that make them ideal candidates for use in many sophisticated designs for which the '84s could not readily provide complete control solutions.*

*Of particular importance are their several on-chip analogue-to-digital converters (ADCs), and their communications options based upon internal USART (universal synchronous asynchronous receiver transmitter) protocols.*

*This review takes an overall look at the capabilities of these much-welcomed new devices.*

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| Cossor 3102 – 60MHz Dual Channel | £250 |
| Gould OS 245A/250/255/300/3000/3351/4000 | from £125 |
| Hewlett Packard 180A/160C/181A/182C | from £200 |
| Hewlett Packard 1740A, 1741A, 1744A, 100MHz dual ch | from £350 |
| Hewlett Packard 54100D – 1GHz Digitizing | £1500 |
| Hewlett Packard 54200A – 50MHz Digitizing | £500 |
| Hewlett Packard 54201A – 300MHz Digitizing | £1250 |
| Hitachi V152F/V302B/V302F/V353F/V550B/V650F | from £125 |
| Hitachi V650F – 60MHz Dual Channel | £295 |
| Hitachi V1100A – 100MHz 4 Channel | £950 |
| Intron 2020 – 20MHz Digital Storage (NEW) | £450 |
| Iwatsu SS 5710/SS 5702 – 20MHz | from £125 |
| Meguro – MSO 1270A – 20MHz Digital Storage (NEW) | £450 |
| Nicolet 310 – L.F. D.S.O. with twin Disc Drive | £400 |
| Nicolet 3091 – LF. D.S.O. | £750 |
| Lecroy 9450A – 300MHz/400 Ms/s D.S.O. 2 ch | £2250 |
| Panasonic VP5741A – 100MHz – Dual Channel D.S.O. | £1750 |
| Philips PM 3055 – 50 MHz DUAL Timebase | £450 |
| Philips PM 3211/PM 3212/PM 3214/PM 3217/PM 3234/PM 3240/PM 3243/PM 3244/PM 3251/PM 3262/PM 3263/PM 3540 | from £125 |
| Philips PM 3295A – 400MHz Dual Channel | £1750 |
| Philips PM 3335 – 50 MHz/20Ms/s D.S.O. 2 ch | £1500 |
| Tektronix 434 – 25MHz – 2 Channel Analogue Storage | £250 |
| Tektronix 454 – 150MHz – 2 Channel | £400 |
| Tektronix 455 – 50MHz Dual Channel | £0000 |
| Tektronix 464/466 – 100MHz An storage | from £0000 |
| Tektronix 465/465B – 100MHz dual ch | from £0000 |
| Tektronix 466 – 100MHz D.S.O. | £650 |
| Tektronix TAS 475 – 100 MHz – 4 Channel | £995 |
| Tektronix 475/475A – 200MHz/250MHz Dual Channel | from £0000 |
| Tektronix 485 – 350MHz – 2 channel | £750 |
| Tektronix 2213 – 60MHz Dual Channel | £375 |
| Tektronix 2215 – 60MHz Dual trace | £400 |
| Tektronix 2220 – 60MHz Dual Channel D.S.O. | £1250 |
| Tektronix 2221 – 60MHz Digital Storage 2 Channel | £1250 |
| Tektronix 2225 – 50MHz dual ch | £395 |
| Tektronix 2235 – 100MHz Dual trace | £600 |
| Tektronix 2335 – Dual trace 100MHz (portable) | £600 |
| Tektronix 2440 – 300 MHz/500 Ms/s D.S.O. 2 Ch | £2950 |
| Tektronix 2445 – 150 MHz – 4 Channel + DMM | £1200 |
| Tektronix 2445A – 100 MHz – 4 Channel | £900 |
| Tektronix 2445A – 150 MHz – 4 Channel | £1250 |
| Tektronix 5403 – 60MHz – 2 or 4 Channel | from £200 |
| Tektronix 7313, 7603, 7613, 7623, 7633, 100MHz 4 ch | from £225 |
| Tektronix 7704 – 250MHz 4 ch | from £450 |
| Tektronix 7904 – 500MHz | from £600 |
| Trio CS-1022 – 20MHz – Dual Channel | £125 |

Other scopes available too

**SPECIAL OFFER**

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|---|---|
| HITACHI V212 – 20MHZ DUAL TRACE | £160 |
| HITACHI V222 – 20 MHZ DUAL TRACE + ALTERNATE MAGNIFY | £180 |

## SPECTRUM ANALYSERS

| | |
|---|---|
| Ando AC8211 – Spectrum Analyser 1.7GHz | £2250 |
| Anritsu MS62B – 10KHz – 1700MHz | £2250 |
| Anritsu MS341A + MS3401B – (10Hz – 30MHz) | £3995 + £4500 |
| Anritsu MS610B – 10KHz – 2GHz – (Mint) | £4750 |
| Anritsu MS710F – 100KHz – 23GHz Spectrum Analyser | £5950 |
| Avcom PSA65 S – 1000MHz – portable | £850 |
| Hameg 8028/8038 – Spectrum Analyser/Tracking Gen + 100MHz Oscilloscope | £1250 |
| Hewlett Packard 182T with 8559A (10MHz – 21GHz) | £3750 |
| Hewlett Packard 182T + 8558B – 0.1 to 1500MHz | £1750 |
| Hewlett Packard 853A + 8558B – 0.1 to 1500MHz | £2500 |
| Hewlett Packard 8591A – 9KHz – 1.8GHz with Option 10 Tracking Generator | £6500 |
| Hewlett Packard 8594E – 9KHz – 2.9GHz | £7000 |
| Hewlett Packard 35601A – Spectrum Analyser Interface | £1000 |
| Hewlett Packard 3561A – Dynamic Signal Analyser | £4750 |
| Hewlett Packard 3562A Dual Channel Dynamic Sig. Analyser | £6500 |
| Hewlett Packard 3580A – 5Hz-50KHz | £995 |
| Hewlett Packard 3582A – 0.02Hz – 25.6KHz (dual ch.) | £2000 |
| Hewlett Packard 3585A – 20Hz – 40MHz | £4500 |
| Hewlett Packard 8753A – Network Analyser | £4995 |
| Hewlett Packard 8753B – Network Analyser | £6500 |
| IFR 7750 10KHz – 1GHz | £2500 |
| Marconi 2370 – 110MHz | £500 |
| Marconi 2371 – 30KHz – 2000MHz | £750 |
| Meguro MSA 4901 – 1-300GHz (AS NEW) | £850 |
| Meguro MSA 4912 – 1-1GHz (AS NEW) | £1250 |
| Rohde & Schwarz – SWOB 5 Polyskop 0.1 – 1300MHz | £1500 |
| Takeda Riken 4132 – 1.0GHz Spectrum Analyser | £2500 |
| Tektronix 7L18 with mainframe (1.5-60GHz with external mixers) | £2000 |
| Tektronix 495P – 100Hz – 1.8GHz programmable | £4950 |
| Tektronix 496P – 1KHz – 1.8GHz Spectrum Analyser | £4500 |

## MISCELLANEOUS

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|---|---|
| Adret 740A – 100KHz – 1120MHz Synthesised Signal Generator | £800 |
| Anritsu MG 360A Signal Generator 0.1-1040MHz | £1500 |
| Anritsu ME 462B DF/3 Transmission Analyser | £2500 |
| Anritsu MG 645B Signal Generator 0.05-1040MHz | £850 |
| Boonton 92C R/F Millivoltmeter | £250 |
| Boonton 93A True RMS Voltmeter | £250 |
| Dranetz 626 – AC/DC – Multifunction Analyser | £600 |
| EIP 331 – Frequency counter 18GHz | £600 |
| EIP 545 – Frequency counter 18GHz | £1250 |
| EIP 575 – Frequency counter 18GHz | £1450 |
| Eltek SMPS – Power Supply 60v-30v | £400 |
| EM 550L – Power Amplifier (1.5-400MHz) 50W | £1500 |
| Farnell TSV-70 MKII Power Supply (70V – 5A or 35V – 10A) | £250 |
| Farnell DSG-1 Synthesised Signal Generator | £125 |
| Farnell ESG-1000 Synthesised Signal Generator 1GHz (as new) | £995 |
| Farnell AP 30250A Power Supply 3v - 250A | £1750 |
| Feedback PFG 605 Power Function Generator | £200 |
| Fluke 5100A – Calibrator | £2500 |
| GN ELMI EPR31 PCM Signalling Recorder | £3000 |
| Guildline 9152 – 112 Battery Standard Cell | £550 |
| Hewlett Packard 1630D – Logic Analyser (43 Channels) | £650 |
| Hewlett Packard 16500A – Fitted with 16510A/16515A/16530A/16531A – Logic Analyser | £4000 |
| Hewlett Packard 331A – Distortion Analyser | £300 |
| Hewlett Packard 333A – Distortion Analyser | £300 |
| Hewlett Packard 334A – Distortion Analyser | £300 |
| Hewlett Packard 3325A – 21MHz Synthesiser/Function Gen | £1500 |
| Hewlett Packard 3336C – Synthesised Signal Generator (10Hz – 21MHz) | £1000 |
| Hewlett Packard 3437A System voltmeter | £250 |
| Hewlett Packard 3438A Digital multimeter | £200 |
| Hewlett Packard 3455A 6½ Digit M/Meter (Autocal) | £500 |
| Hewlett Packard 3456A Digital voltmeter | £500 |
| Hewlett Packard 3488A – HP – 1B Switch control unit (various Plug-ins available) | £550 |
| Hewlett Packard 3478A – Multimeter (5½ Digit) + HP – 1B | £550 |
| Hewlett Packard 35660A Dual Ch. Dynamic Signal Analyser | £3750 |
| Hewlett Packard 3586A – Selective Level Meter | £1000 |
| Hewlett Packard 3711A/3712A/3791B/3793B Microwave Link Analyser | £2250 |
| Hewlett Packard 3746A – Selective Measuring Set | £750 |
| Hewlett Packard 3776A – PCM Terminal Test Set | £1500 |
| Hewlett Packard 3779A/3779C – Primary Mux Analyser | from £600 |
| Hewlett Packard 3784A – Digital Transmission Analyser | £5000 |
| Hewlett Packard 3785A – Jitter Generator + Receiver | £1250 |
| Hewlett Packard 37900D – Signalling Test Set (No 7 and ISDN) | £4250 |
| Hewlett Packard P382A Variable Attenuator | £250 |
| Hewlett Packard 4192A – LF Impedance Analyser | £7000 |
| Hewlett Packard 4262A – Digital LCR Meter | £1250 |
| Hewlett Packard 4279A – 1MHz C-V Meter | £4500 |
| Hewlett Packard 4342A 'Q' Meter | £800 |
| Hewlett Packard 435A or B Power Meter (with 8481A/8484A) | from £750 |
| Hewlett Packard 4948A – (TIMS) Transmission impairment M/Set | £1500 |
| Hewlett Packard 4972A – Lan Protocol Analyser | £1750 |
| Hewlett Packard 5183 – Waveform Recorder | £1750 |
| Hewlett Packard 5238A Frequency Counter 100MHz | £250 |
| Hewlett Packard 5314A – (NEW) 100MHz Universal Counter | £250 |
| Hewlett Packard 5316A – Universal Counter (IEEE) | £500 |
| Hewlett Packard 5335A – 200MHz High Performance Systems Counter | £600 |
| Hewlett Packard 5370B – Universal Timer/Counter | £2000 |
| Hewlett Packard 5384A – 225 MHz Frequency Counter | £650 |
| Hewlett Packard 5385A Frequency Counter – 1GHz – (HP1B) with OPTS 001/003/004/005 | £995 |
| Hewlett Packard 5420A Digital Signal Analyser | £350 |
| Hewlett Packard 6033A Power Supply Autoranging (20V – 30A) | £750 |
| Hewlett Packard 6253A Power Supply 20V – 3A Twin | £200 |
| Hewlett Packard 6255A Power supply 40V – 1.5A Twin | £200 |

**HEWLETT PACKARD 6261B**
**Power Supply 20V-50A £450 *Discount for Quantities***

| | |
|---|---|
| Hewlett Packard 6264B – Power Supply (0 – 20V, 0 – 25A) | £400 |
| Hewlett Packard 6266B Power Supply 40V – 5A | £220 |
| Hewlett Packard 6271B Power supply 60V – 3A | £225 |
| Hewlett Packard 6632A – Power Supply (20V – 5A) | £800 |
| Hewlett Packard 7475A – 6 Pen Plotter | £250 |
| Hewlett Packard 7550A – 8 Pen Plotter A3/A4 | £450 |
| Hewlett Packard 8015A – 50MHz Pulse Generator | £750 |
| Hewlett Packard 8152A – Optical Average Power Meter | £1250 |
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| Hewlett Packard 8350B – Sweep Oscillator Mainframe (various plug-in options available) | £2500 |
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| Hewlett Packard 83555A – Millimeter – Wave source Module 33-50GHz | £4250 |
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| Hewlett Packard 8640B – Signal Generator (512MHz + 1024MHz) | from £850 |
| Hewlett Packard 8656A – Synthesised Signal Generator (990MHz) | £1250 |
| Hewlett Packard 8656B – Synthesised Signal Generator | £1750 |
| Hewlett Packard 8657A – Signal Generator (100KHz-1040MHz) | £2500 |
| Hewlett Packard 8660D – Synthesised Signal Generator (10KHz-2600MHz) | £3250 |
| Hewlett Packard 8750A Storage normaliser | £375 |
| Hewlett Packard 8756A – Scalar Network Analyser | £1500 |
| Hewlett Packard 8757A – Scalar Network Analyser | £2250 |
| Hewlett Packard 8901A – Modulation Analyser | £2750 |
| Hewlett Packard 8901B – Modulation Analyser | £3750 |
| Hewlett Packard 8903A – Audio Analyser (20Hz – 100KHz) | £1600 |
| Hewlett Packard 8903B – Distortion Analyser | £2500 |
| Hewlett Packard 8903E – Distortion Analyser (Mint) | £2000 |
| Hewlett Packard 8920A – R/F Comms Test Set | £4995 |
| Hewlett Packard 8922B – GSM Radio Comms Test Set | £6500 |
| Hewlett Packard 8958A – Cellular Radio Interface | £2000 |
| Keytek MZ-15/EC Minizap 15Kv Hand Held ESD Simulator | £1750 |
| Krohn-Hite 2200 Lin/Log Sweep Generator | £995 |
| Krohn-Hite 4024A Oscillator | £250 |
| Krohn-Hite 5200 Sweep, Function Generator | £350 |
| Krohn-Hite 6500 Phase Meter | £250 |
| Leader LDM-170 – Distortion Meter | £350 |
| Leader 3216 – Signal Generator (100KHz – 140KHz) AM/FM/CW with built-in FM stereo modulator (mint) | £995 |
| Marconi 2019 – 80KHz – 1040MHz Synthesised Sig. Gen. | £950 |
| Marconi 2019A – 80KHz – 1040MHz – Synthesised Signal Generator | £1250 |
| Marconi 2305 – Modulation Meter | £1995 |
| Marconi 2337A – Automatic Distortion Meter | £150 |
| Marconi 2610 – True RMS Voltmeter | £850 |
| Marconi 2871 Data Comms Analyser | £1000 |
| Marconi 2955 – Radio Comms Test Set | £2250 |
| Marconi 6960 – Power Meter & Sensor | from £950 |
| Philips PM 5167MHz function gen. | £400 |
| Philips 5190 L.F. Synthesiser (G.P.I.B) | £800 |
| Philips 5193 Synthesised Function Generator | £1500 |
| Philips 5518 Synthesised Function Generator | £1500 |
| Philips PM5519 – TV Pattern Generator | £350 |
| Philips PM5716 – 50MHz Pulse Generator | £525 |
| Prema 4000 – 6½ Digit Multimeter (NEW) | £450 |
| Quartzlock 2A – Off Air Frequency Standard | £200 |
| Racal 1992 – 1.3GHz Frequency Counter | £800 |
| Racal 6111/6151 – GSM Radio Comms Test Set | £POA |
| Racal Dana 9081/9082 Synth. sig. gen. 520MHz | from £500 |
| Racal Dana 9084 Synth. sig. gen. 104MHz | £450 |
| Racal 9301A – True RMS R/F Multivoltmeter | £300 |
| Racal Dana 9302A R/F multivoltmeter (new version) | £375 |
| Racal Dana 9303 R/F Level Meter & Head | £650 |
| Racal Dana 9917 UHF frequency meter 560MHz | £175 |
| Rohde & Schwarz LFM2 – 60MHz Group Delay Sweep Gen | £1600 |
| Rohde & Schwarz Soud Radio Code Test Set | £300 |
| Rohde & Schwarz CMTA 94 GSM Radio Comms Analyser | £7500 |
| Schaffner NSG 203A Line Voltage Variation Simulator | £950 |
| Schaffner NSG 222A Interference Simulator | £650 |
| Schaffner NSG 223 Interference Generator | £850 |
| Schlumberger 2720 1250MHz Frequency Counter | £500 |
| Schlumberger 4031 – 1GHz Radio Comms Test Set | £4995 |
| Schlumberger Stabilock 4040 Radio Comms Test Set | £2995 |
| Schlumberger 7060/7065/7075 Multimeters | from £350 |
| Solartron 1250 – Freq. Response Analyser | £2500 |
| Stanford Research DS 340 – 15MHz Synthesised Function (NEW) and arbitrary waveform generator | £1200 |
| Systron Donner 6030 – Microwave Frequency Counter (26.5GHz) | £2500 |
| Telequipment CT71 Curve Tracer | £250 |
| Tektronix AM503 + TM501 + P6302 – Current Probe Amplifier | £995 |
| Tektronix PG506 + TG501 + SG503 + TM503 – Oscilloscope Calibrator | £1995 |
| Tektronix 577 – Curve Tracer | £1150 |
| Tektronix 1240 Logic Analyser | £900 |
| Tektronix 141A PAL Test Signal Generator | £250 |
| Tektronix AA5001 & TM5006 M/F – Programmable Distortion Analyser | £1995 |
| Tektronix TM5003 + AFG 5101 Arbitrary Function Gen. | £1500 |
| Tektronix DAS9100 – Series Logic Analyser | £500 |
| Tektronix – Plug-ins – many available such as SC504, SW503, SG502, PG508, FG504, FG503, TG501, TR503 + many more | £POA |
| Time 9811 Programmable Resistance | £400 |
| Time 9814 Voltage Calibrator | £550 |
| Valhalla Scientific – 2724 Programmable Resistance Standard | £P.O.A. |
| Wandel & Goltermann PFJ-8 – Error/Jitter Test Set | £12500 |
| Wandel & Goltermann PCM4 (+ options) | £3950 |
| Wandel & Goltermann MU30 Test Point Scanner | £2000 |
| Wayne Kerr 4225 – LCR Bridge | £600 |
| Wavetek 171 – Synthesised Function Generator | £250 |
| Wavetek 172B Programmable Sig Source (0.0001Hz – 13MHz) | £P.O.A. |
| Wavetek 154 – Sweep Generator – 5MHz | £250 |
| Wavetek 3010 – 1-1GHz Signal Generator | £1250 |
| Wiltron 6409 – RF Analysers (1MHz – 2GHz) | £POA |
| Wiltron 6620S – Programmable Sweep Generator (3.6 – 6.5GHz) | £650 |
| Wiltron 6747-20 – Swept Frequency Synthesiser (10MHz-20GHz) | £4250 |
| Yokogawa 3655 – Analysing Recorder | £POA |

**MANY MORE ITEMS AVAILABLE -**
**SEND LARGE S.A.E. FOR LIST OF EQUIPMENT**
**ALL EQUIPMENT IS USED -**
**WITH 30 DAYS GUARANTEE.**
**PLEASE CHECK FOR AVAILABILITY BEFORE ORDERING – CARRIAGE & VAT TO BE ADDED TO ALL GOODS**

## £1 BARGAIN PACKS – List 1

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

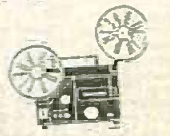
**2 LITHIUM COIN CELLS.** 3V p.c.b. mounting. Order Ref: 1078.
**2 × 5A BRIDGE RECTIFIERS** with heatsink couplers for 12V charger. Order Ref: 1070.
**1 × 12V STEPPER MOTOR.** 7·5 degrees. Order Ref: 910.
**1 × 10 PACK SCREWDRIVERS.** Order Ref: 909.
**2 × AMP PULL CORD CEILING SWITCHES**, brown. Order 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 passengers. 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.
**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: 1/21R6.
**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 March. 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.

**LIGHT 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,**
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# Transform your PC.... Into an oscilloscope, spectrum analyser and multimeter...


The ADC-200 range of PC based oscilloscopes offer performance only previously available on the most expensive `benchtop' scopes. By intergrating several instruments into one unit, the ADC-200 is both flexible and cost effective.

Connection to a PC gives the ADC-200 the edge over traditional oscilloscopes: the ability to print and save waveforms is just one example. Units are supplied with PicoScope for Windows which is powerful, yet simple to use, with comprehensive on line help.

## Applications

- Video
- Automotive
- Electronics design
- Production line tests
- Fault finding
- Education

All units are supplied with software, cables and power supply. Prices exclude VAT.

## Features

- A fraction of the cost of comparable benchtop oscilloscopes
- Up to 100 MS/s sampling
- Advanced tigger modes- capture one off events.
- Up to 50 MHz spectrum analyser
- Large buffer memory

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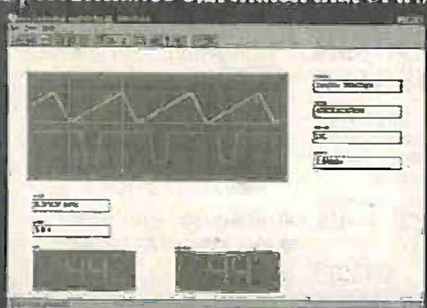
| ADC-200/100 | £499 |
| ADC-200/50 | £399 |
| ADC-200/20 | £299 |


# A scope at your fingertips....

Once oscilloscopes were heavy and clumsy to handle, but over the years they have become smaller and smaller. The latest development in this field has just arrived, a digital storage oscilloscope in a handy slim housing, scarcely longer than a pencil and about as thick as your thumb. Despite its small size, its performance can match that of a service oscilloscope.




## Applications

- On-the-spot measurements
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- Measurements in amplifiers
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The latest MAGENTA DESIGN – highly stable & sensitive – with I.C. control of all timing functions and advanced pulse separation techniques.

- New circuit design 1994
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- 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

## 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

## SUPER ACOUSTIC PROBE

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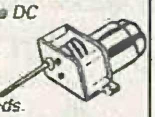
*Our Popular and Versatile DC motor/Gearbox sets. Ideal for Models, Robots, Buggies etc. 1·5 to 4·5V Multi ratio gearbox gives wide range of speeds.*



*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

## 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

## MICRO PEsT SCARER

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


- RANDOM PULSES
- HIGH POWER
- DUAL OPTION

Plug-in power supply £4.99

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

## WINDICATOR

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

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

## ★ TENS UNIT ★

### DUAL OUTPUT TENS UNIT

As featured in March '97 issue.

Set of 4 spare electrodes £6.50

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

KIT 866.... Full kit including four electrodes £32.90

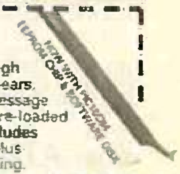
## 1000V & 500V INSULATION TESTER

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

KIT 848.................£32.95

## SPACEWRITER

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

## 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 head-phone/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

## 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.
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# VOL. 28 No. 3 MARCH '99

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## WELCOME

Welcome to the first combined issue of *EPE* and *ETI*. Over the last couple of weeks we have received a number of comments from readers about the "demise" of another electronics hobbyist magazine: one reader even sent us a copy from 1980 pointing out that it carried 128 pages and cost just 60p. I have not worked out the present equivalent of 60p when inflation is taken into account, but a quick look at the issue told an interesting story.

Back in 1980 the magazine carried over 70 pages of advertising from about 100 different companies; in this issue we carry 24 pages of advertising from around 40 different companies. Yes, the hobby in general has declined quite dramatically in those 19 years. In the '80s there were six UK magazines aimed at the electronics hobbyist – not including the amateur radio titles – now there are just three.

## MOVING ON

The 1980 copy also tells another story which is significant: Tangerine were selling the Microton 65 "the most advanced, most powerful, most expandable microcomputer available" for £69 plus VAT – it was 6502 based, had 1K of RAM plus a cassette interface; Commodore had a page listing their stockists for the PET System "£550 for a self-contained unit" – it had 8K of RAM and ran at 1MHz (our Technical Editor, John Becker, still has a 32K version and still uses it occasionally "as a giant calculator, although not all the keys work anymore!"); Science of Cambridge carried the Sinclair ZX80 for £79.95 including VAT – 1K of RAM with a 32-character by 24-line TV display; Chromasonics and Comp Shop showed the UK101 kit (a *PE* published design) for £199 + VAT – this boasted 4K of RAM and you could buy a "colour add-on card" – an extra 4K of RAM was £32 + VAT; finally Powertran had the µComp 80 "as published in *Wireless World*" – this one cost £225 + VAT in kit form, had a maths co-processor (although they did not call it that then) and 8K of "on board memory" – another 8K cost £78.50.

Yes, this was the start of personal computing in the UK and, although we did not realise it at the time, it would lead many potential electronics hobbyists away from the electronics magazines to become what are now referred to as computer nerds. Few people realised that within the next 20 years most UK homes would own a computer of some sort.

It is, of course, interesting that those computer fanatics are now getting involved in electronics, where you can now use a PC to program PIC chips to perform your specific tasks. Of course, this leads other readers to complain that too many projects are computer based. Well, they complained when we introduced i.c.s in preference to transistors – some still do – but in this hobby we feel we must move with the times, otherwise we would still be using valves. I should point out that in 99 per cent of cases it is *not essential* to have the use of a PC to build our PIC projects.

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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.

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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.*

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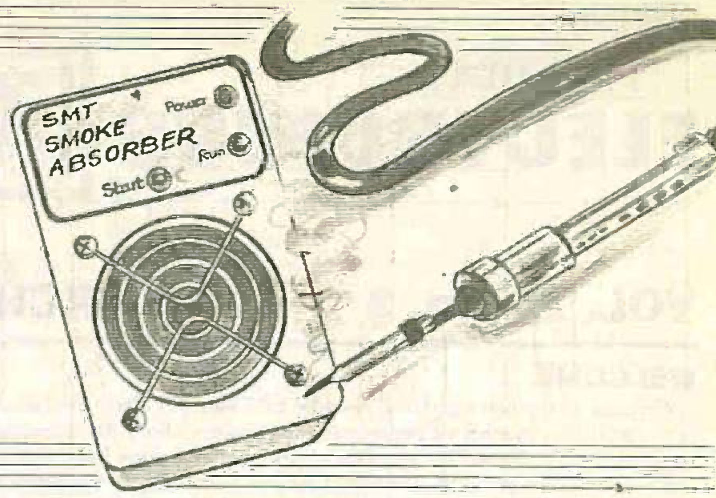
*Constructional Project*

# SMOKE ABSORBER




## BILL MOONEY

*Significantly reduce your inhalation of soldering fumes.*

**W**HEN 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. Anyone who does soldering will have noticed the unwritten law that smoke always moves towards your face, however much you try to avoid it. Close working with SMDs therefore involves a much higher risk of solder fumes being inhaled and potential bronchial problems.

Although the smoke absorber described here was designed for use with SMD soldering, it can also be used beneficially when soldering "ordinary" components. It is very compact and can be placed close to the circuit board during population. It will remove the dense solder fumes from the immediate area and a built-in charcoal filter will provide a degree of filtration and absorption.

The Smoke Absorber is powered by a standard mains adaptor and after power is applied the operation is automatic. The fan is triggered by the heat from the soldering iron and it switches off after about half a minute unless re-triggered. This is a suitable time delay as the average soldering action is usually within three seconds.

Automatic control is very convenient, as the soldering process tends to be intermittent and remembering to switch the unit on and off is quite a distraction. It is also safer since it reduces the overall current drain from the power pack and can therefore remain in stand-by mode for long periods.

### HARMFUL CHEMICALS

The harmful nature of solder fumes in production environments has been investigated in great depth by several organisations during recent years. The main component of common solder flux is a material known variously as rosin or colophony. This is derived from a few species of pine tree and is related to amber, which is a fossil material recovered from the sea or mined.

Rosin is a benign material that can usually be handled and worked without problems. It is found in a surprisingly wide range of industrial and domestic products. Common applications include paper, cosmetics and soaps, chewing gum, toothpaste, varnishes, adhesives and, of course, on violin bows.

A number of people have contact allergy to colophony, in paper for example, but it is very rare. However, our concern is the risk of inhalation. Like hardwood and coal, rosin is completely safe in normal usage. But in the form of a smoke or very fine particles, these materials can be harmful, especially if they reach our lungs.

The chemical component responsible for the adverse reaction, and indeed the main component of rosin, is abietic acid. This is a member of the terpine family of which turpentine (not the substitute) will be familiar to d.i.y. enthusiasts.

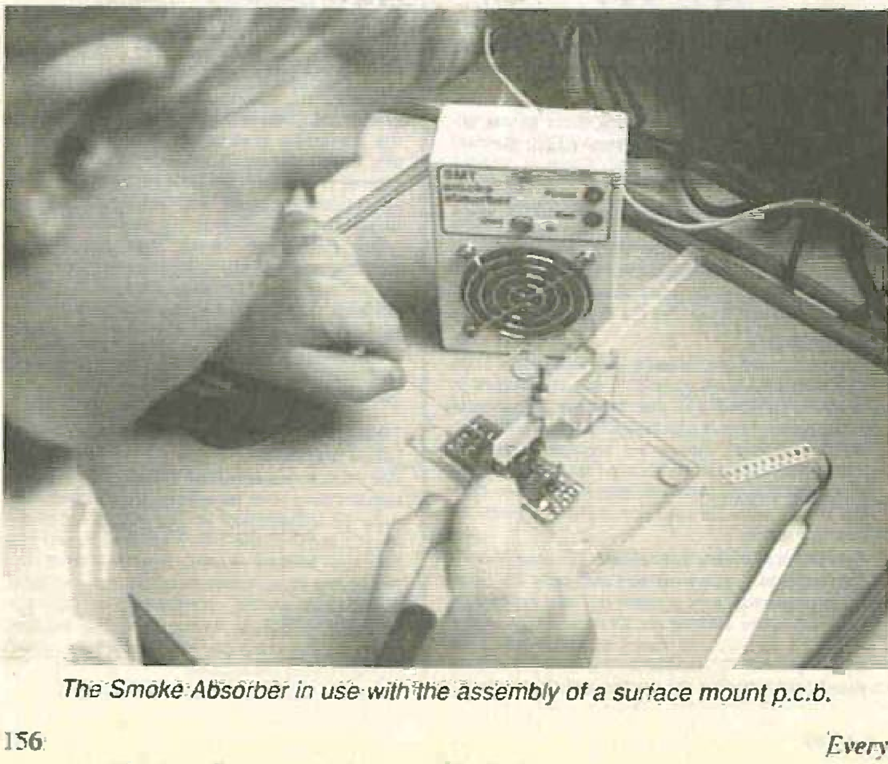
There are many other undesirable components in solder smoke, including lead derivatives and, although it is not acutely toxic, it is best to reduce its intake.

### CLOSE-UP WORK

Surface mount work increases the risk of inhalation of harmful vapours for several reasons. Close-in working means that any smoke breathed in will not have time to disperse and will therefore be more concentrated. There is a tendency to use higher levels of flux because good solderability is so much more important in surface mount work.

It is also possible to use solder paste for hand working with SMDs. Solder pastes and creams give off copious quantities of smoke and fumes when heated to the reflow temperature. Reflow takes place just below 200°C when the solder appears out of the grey paste as a bright metal. This clean liquid metal flows into the joint, wetting both the component contact and the printed circuit land to complete the soldering process. Solder paste fumes are mildly corrosive and should be avoided.

Commercial electronic production and servicing operations where full working day exposure is involved, take great care to remove fumes using costly extraction and filtration equipment. If the amateur envisages a lot of work with solder paste, more elaborate air cleaning or extraction should be considered. Similarly, if working in a very confined space for long periods a more efficient filtering system than this smoke absorber may be needed.



*The Smoke Absorber in use with the assembly of a surface mount p.c.b.*

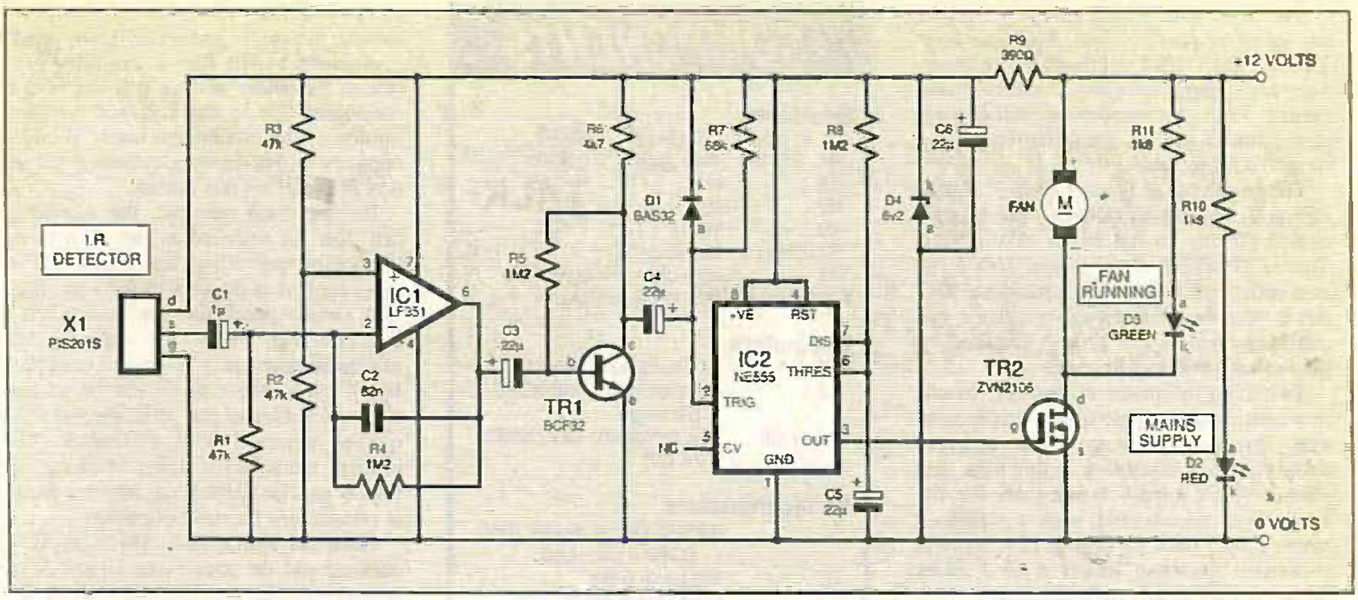



*Fig.1. Complete circuit diagram for the Smoke Absorber.*

This unit will help disperse the fumes reducing the concentration in the immediate working area and a certain portion will be absorbed. Complete removal of finely dispersed material from air is a complex and expensive science. We should not be too concerned about intermittent exposure to traces of rosin flux. It presents a very low risk and the faint therapeutic aroma of pine from the soldering process has pleasant relaxing associations within the cosy environment of the electronics workshop.

## CIRCUIT DETAILS

The full circuit diagram for the Smoke Absorber is shown in Fig.1. A 12V 500mA regulated mains adaptor is needed to power the circuit.

The circuit is required to switch on the fan for a period of about 30 seconds and then shut it down unless it is re-triggered. Since the soldering iron is to be used in close proximity to the smoke absorber, it is logical to use the infrared (i.r.) radiation from the hot iron to start the timing cycle. The elements in the circuit are therefore infrared sensor, amplifier/filter, pulse shaper, timer and motor driver.

Detection of the heat from the soldering requires a long wave infrared detector. Semiconductor i.r. diodes and transistors are very unresponsive to radiation above about one micron wavelength. The useful heat radiation from the iron covers the wavelengths longer than about five microns and, therefore, a different type of detector is required.

Fortunately, the passive infrared sensors used in security systems work in the range of five microns to about 20 microns and are ideal for the purpose of soldering iron heat detection. The device selected was the PIS201S which consists of two pyroelectric elements wired in opposition.

At a steady level of heat radiation, the output from this arrangement is zero. The field of view of the device is about 45 degrees and the elements are arranged so that the passage of the heat source across this aperture heats up one element before the other. This unbalances the system and a momentary voltage output develops. A built-in f.e.t. (field effect transistor) source follower reduces the loading on the sensor but an output of a few millivolts is all we have to work with.

The PIS201S is not the world's fastest device with a maximum response frequency of a few Hertz. The practical circuit, shown in Fig.1, is therefore required to make this low-level signal control the filter fan.

The output from the PIS201S (X1) develops across resistor R1 which is the load resistor for the internal source follower. Op.amp IC1 is configured as a low frequency amplifier with its gain rolling off above 20Hz. The values of the coupling capacitors C1, C3, C4, and the value of the feedback capacitor C2, optimises the gain in the 0·5Hz to 5Hz range.

Transistor TR1 provides the final voltage amplification to a level suitable to trigger the type 555 timer, IC2. Whilst the trigger input to IC2 pin 2 is held high by resistor R7, the timer output on pin 3 remains low. To start the timer, a negative-going signal is required to take pin 2 below one-third of the supply voltage.

Diode D1 fully discharges C4 on positive-going signals so that a well-defined trigger pulse approaching 0V reaches the timer.

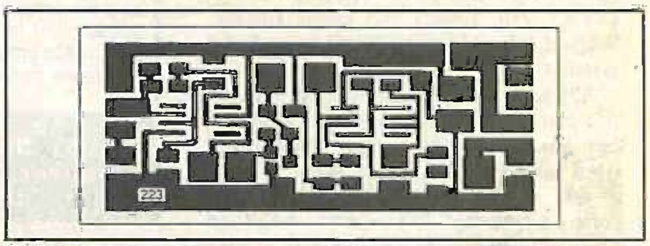



*Fig.3. Full-size topside (surface mount) copper foil master track pattern.*

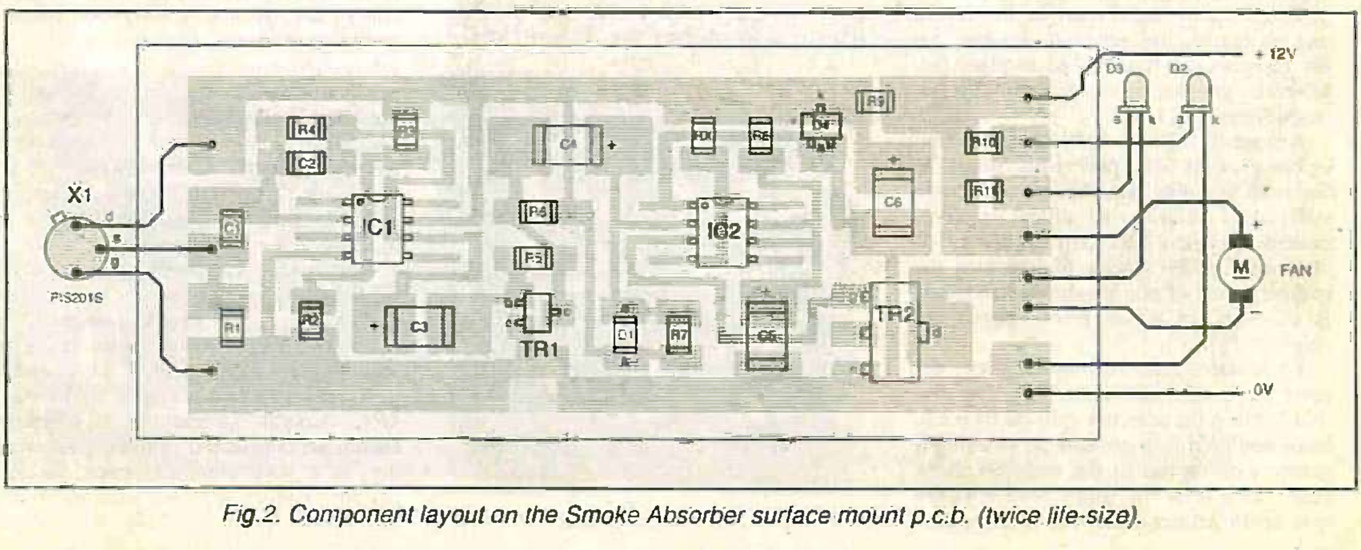



*Fig.2. Component layout on the Smoke Absorber surface mount p.c.b. (twice life-size).*

The timer will remain on for as long as the input on pin 2 is low. The time constant of the C4/R7 combination is therefore kept short to give a clear timing period. With the component values suggested for R8 and C5, the timer remains on for about 30 seconds.

The output of the timer, on pin 3, is high during the timing period and it can be connected directly to the motor driver TR2. This is MOSFET device, type ZNV2106, in a surface mount SOT223 package. TR2 has a very low channel on-resistance and can easily handle the 120mA required by the fan with minimal heating.

Switching the motor on and off results in a considerable ripple in the supply voltage. This must be removed in order to avoid feedback instability in this high gain circuit. A 6V supply is adequate for the low power circuits and, with a stabilised mains power pack supplying 12V, there is sufficient headroom to use a 6V2 Zener diode (D4) as an effective stabiliser.

The fan specified is a brushless d.c. type. These devices are very quiet and electrically clean in operation.

## CONSTRUCTION

This is a surface mount project and it is based on readily-available SMDs. The printed circuit board (p.c.b.) component layout and track pattern are shown in Fig.2 and Fig.3, respectively. This board is available from the *EPE PCB Service*, code 223.

If you choose to make your own board, by any of the techniques as used for "ordinary" through-hole circuit boards, note that a clean surface is very important for SM work. If the p.c.b. is less than bright and shiny then a few moments spent cleaning it with a little mild household abrasive will greatly improve solderability.

After polishing, rinse off the copper surface with water or p.c.b. cleaning solvent. A light coat of rework flux from an aerosol will protect the clean surface. When this has dried the board is ready for assembly.

Although the type 0805 and smaller size chip resistors are popular in commercial production, the slightly larger 1206 sized devices are best for hand working of SM circuits, at least until some experience is gained. The overall size of the p.c.b. is determined by the size of the larger devices, in this case the tantalum capacitors, plus IC1 and IC2.

There are no tight spots in the layout and no particularly sensitive devices. All the resistors can be soldered in place followed by the capacitors and finally the active devices.

A normal 12W or 15W soldering iron can be used for SMD placement. Select the finest tip available. Standard non-corrosive rosin-cored solder will suffice for component placement, but finer 26 s.w.g. silver-loaded solder wire is preferred by the author. A pair of non-magnetised tweezers is essential for initial placement of the chips.

To solder a chip resistor in place, the most basic approach is to "fix one end first". Place the selected chip on its p.c.b. lands and hold it in position by pressing it gently with the tip of the tweezers. Now touch the end of the solder wire with the iron tip to collect a small drop of solder. Apply this to one end of the component to solder it in place. Speed is important here as the protective flux is rapidly evaporating from the molten solder drop. (Purists who observe the dictum "never carry solder to the joint" can *carefully* remake the solder joint later if they wish!)

## COMPONENTS

**Resistors**

| | | |
|---|---|---|
| R1 to R3 | 47k (3 off) | |
| R4, R5, R8 | 1M2 (3 off) | |
| R6 | 4k7 | |
| R7 | 68k | |
| R9 | 390Ω | |
| R10, R11 | 1k8 (2 off) | |
| Rx | zero ohm link (see text) | |

See SHOP TALK Page

All resistors SMD 1206 package.

**Capacitors**

| | |
|---|---|
| C1 | 1μF tantalum, 16V, SMD |
| C2 | 82n ceramic, SMD 1206 package |
| C3 to C6 | 22μ tantalum, 22V, SMD (4 off) |

**Semiconductors**

| | |
|---|---|
| D1 | BAS32 signal diode, SMD SOD80 package |
| D2 | red l.e.d. 5mm |
| D3 | green l.e.d. 5mm |
| D4 | BZX84 Zener diode, 6·2V, SMD SOT23 package |
| TR1 | BCF32 *npn* transistor, SMD SOT23 package |
| TR2 | ZVN2106 MOSFET, SMD SOT223 package |
| IC1 | LF351 op.amp, SMD SO8 package |
| IC2 | NE555 timer, SMD SO8 package |
| X1 | PIS201S i.r. detector |

**Miscellaneous**

Printed circuit board, available from the *EPE PCB Service*, code 223; fan, 60mm 12V d.c., brushless; power socket, 2·5mm chassis mounting, 24mm fixing centres; l.e.d. mounting clip, 5mm, (2 off); plastic case, type PB1, 114mm × 76mm × 38mm; speaker mesh, Sentinel, galvanised, 22g, 6mm × 6mm holes, cut to 10 holes × 10 holes; filter, charcoal filled; finger guard, 60mm square, chromed steel (2 off); M3 nuts and bolts, 2cm long (rear finger guard and fan mounting) (4 off); M4 nuts and bolts, 6mm long (front finger guard) (4 off); mains power adaptor, 12V 500 mA, regulated; connecting wire; solder, etc.

**Approx Cost Guidance Only £39 excl. power supply**

As soon as the flux evaporates, oxidation of the solder surface will begin. Some residue of flux is also required for proper tinning of the component terminal and the copper pad. Pre-coating of the copper with flux is useful for this reason.

Having fixed one end, the second end can now be soldered in the normal two-handed manner where the solder and iron tip is applied to the joint at the same time.

A similar procedure can be adopted for IC1 and IC2, where two opposing leads can be soldered first to fix an i.c. in place. In all cases, the aim should be to apply minimal solder to the joint. Excess solder can be removed with solderwick. More refined methods of hand working with SMDs can be developed, but this method is satisfactory for most purposes.

Note that Zener diode D4 is an SOT23 package and the anode pins, 1 and 3, both contact the same pad. The signal diode D1 is in an SOD80 cylindrical package and therefore a little tricky to solder in place. Component Rx (Fig.2) is referred to as a "zero ohm jumper" in SM parlance and is a neat low-inductance way of jumping a p.c.b. track.

In this circuit, a 1Ω or 10Ω 1206 chip resistor would work just as well. Even a wire link could be used if necessary.

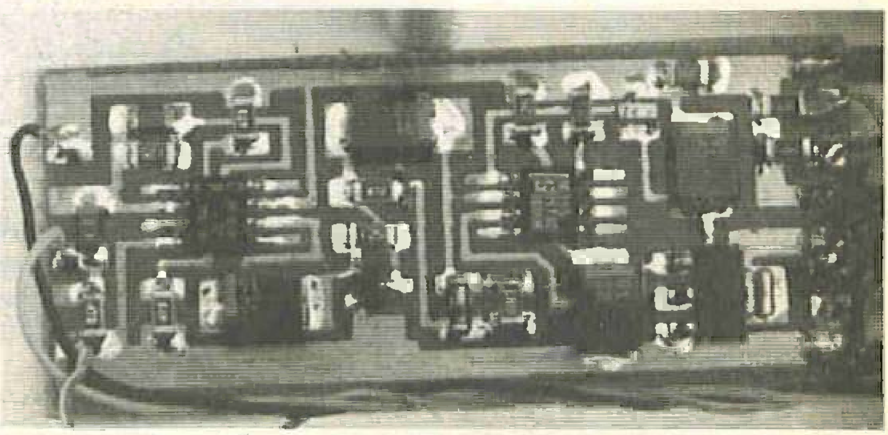
## FAN BOX

The position of the fan was determined after some experimentation. Using the smoke generated by a soldering iron and rosin-cored solder it was found that the fan needs to be close to the soldering level if it is to grab most of the smoke. A height of about 1cm off the work-surface was found to be the best compromise.

Apart from taking up less bench space, the smoke removal is more efficient if the box stands on end with the fan near the bottom and the controls at the top. The arrangement of items in the author's box is shown in Fig.4.

All holes must be drilled in the box before any units are added. The fan opening was made with a standard 5·7cm diameter hole-saw. This must be done slowly because the plastic melts easily.

Next, the four bolt holes for each of the finger guards are marked and drilled. It can be seen from Fig.5 that two guards are required. The front guard is mounted on the box lid and it holds filter material in place. The second guard is mounted on the rear of the box and it shares the four fan mounting bolts.



*Enlarged view of the assembled p.c.b.*

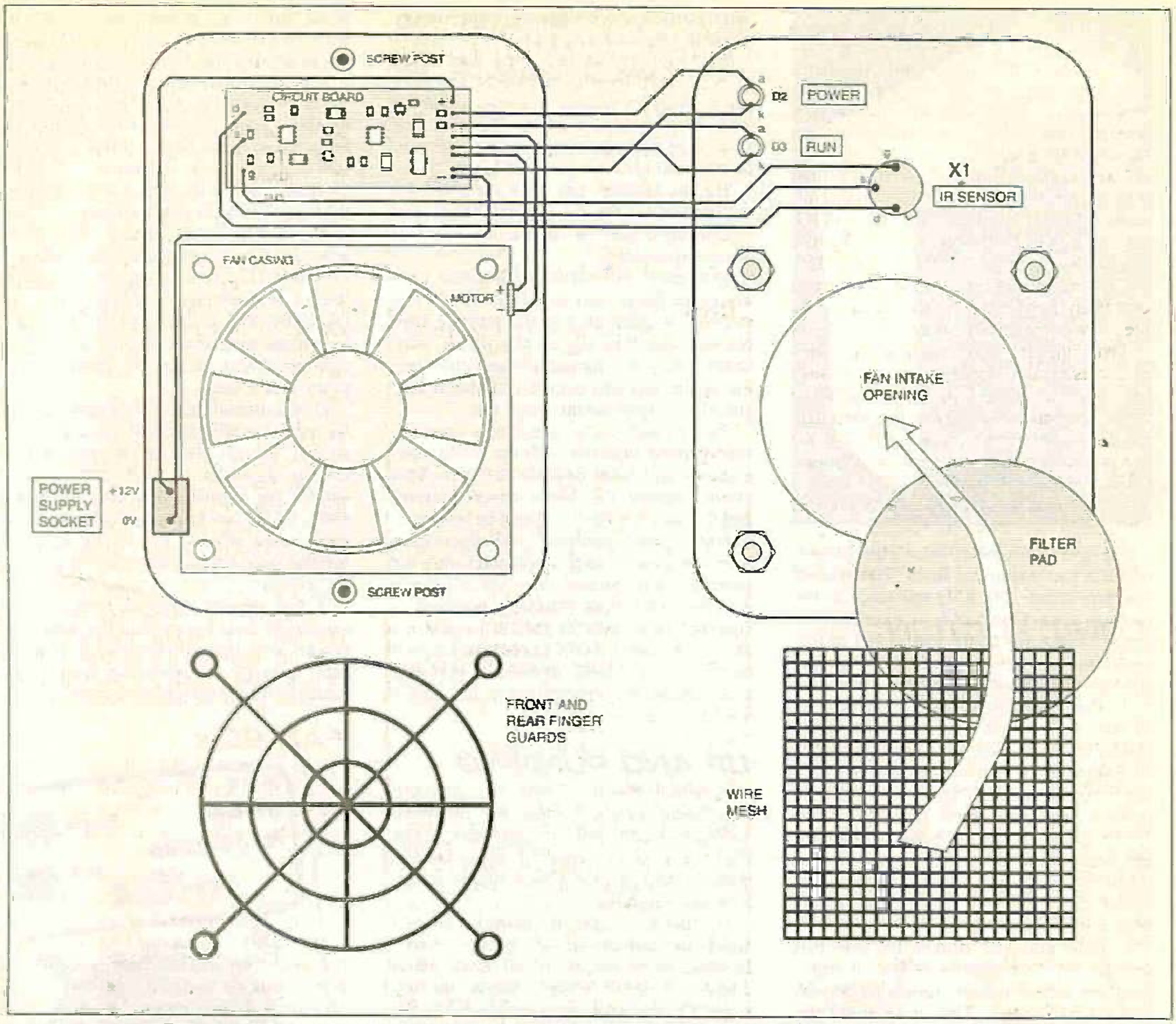



*Fig.4. Internal layout and interconnections of the Smoke Absorber components within its case.*

The filter foam is sandwiched between the front finger guard and a wire mesh. The foam is under slight compression and the wire mesh is necessary to prevent it from bulging into the fan blades. If a different size of box is used the sandwich technique may not work as well and the mesh may need to share the front guard bolts in order to hold the foam in place. Also, if the box is too deep the electronics may be exposed to the airflow.

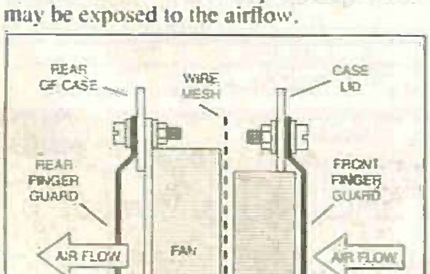
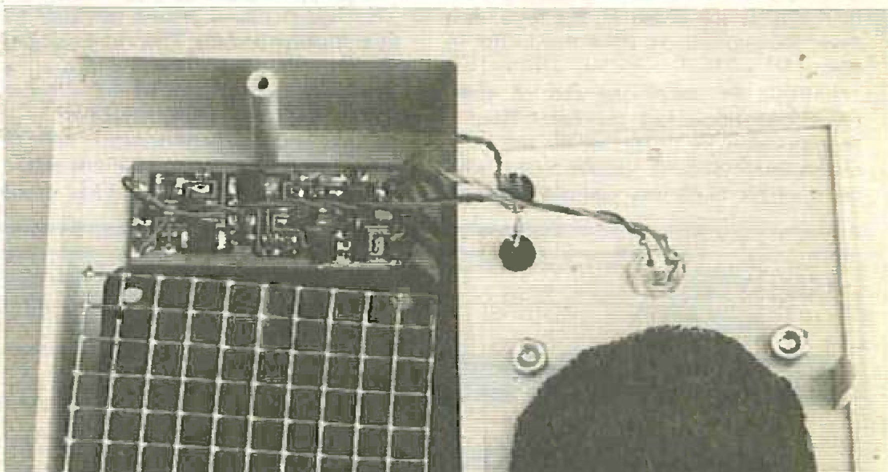
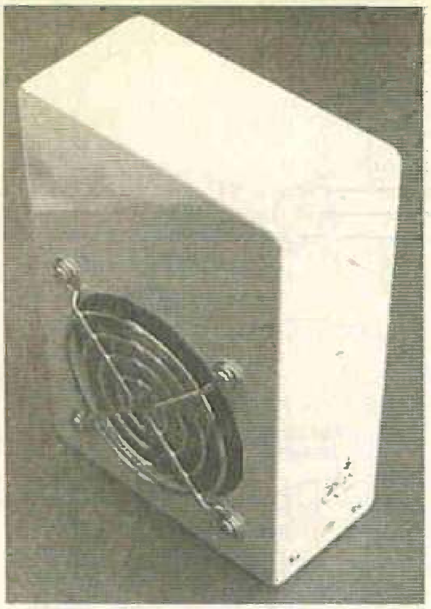



*Fig.5. Side-on view of the fan assembly.*



*Internal layout of the Smoke Absorber*



The filter consists of open-pored foam, which is partly charcoal filled. This type of structure offers very little resistance to the passage of air. Charcoal is an excellent absorber of gaseous contaminants but in this application the flow of air is very fast and absorption may not always be complete.

As the filter material is not available in the size required, it must be cut to fit the smoke absorber. The filter sheet is easily cut with scissors to a circle just larger than the fan opening, about 6cm in diameter, so that it is a tight fit.

The galvanised mesh is cut to a square just larger than the motor housing. One of the pillars of the box passes through a hole in the mesh and with the pressure of the filter it is adequately held.

A hole must be drilled for the PIR detector (X1) to make a secure fit and a small amount of adhesive from a glue gun will hold it in place. The sensor should be fixed so that the window will be horizontal relative to the work surface.

The populated p.c.b. is held in place with a little adhesive, so avoiding the need for holes in the board or the box. Two 5mm mounting clips hold the l.e.d.s in place.

Finally, the interwiring can be completed, see Fig.4. Use the finest flexible wire available for the i.r. sensor and l.e.d. connections. Suitable colour-coded wire (as used for multi-way computer cables) makes a neater job than the rather heavy hook-up wire commonly available.

The wire in the prototype was taken from a short length of 25-way screened cable. With an overall diameter of about 0·8mm, each wire contains 7/0·1mm fine strands of tinned copper making it very flexible and ideal for small SM jobs.

Slightly heavier-duty wire is needed for the fan and for the d.c. supply socket. The circuit board pads are sufficiently large for these connections.

The motor will not function unless connected to the correct supply polarity. The red wire is connected to the positive supply rail and the blue to the driver transistor. The power connector specified uses the centre pin as positive and the smoke absorber wiring should match this.

The fan pulls air in at the front opening. It should be mounted with the motor connections and label towards the rear. This motor contains electronic driver circuitry and the supply polarity cannot be reversed.

Front panel lettering and decoration were composed using a computer drawing package and printed out as a single drawing. This label was then trimmed to size and holes cut for the l.e.d.s and the sensor. A standard paper adhesive keeps it in place. An inkjet printer is perfectly adequate for this application as the unit is unlikely to get wet.

## UP AND RUNNING

A visual check of both the on-board component positions and the off-board wiring is worthwhile. In particular, check the polarity of the tantalum capacitors and make certain that the power supply socket is wired correctly.

On first switch-on, it would be wise to check the current drawn by the circuit. In stand-by mode it should draw about 20mA, rising to about 120mA in run-mode. On first application of power the fan will go into run-mode lasting for about 30 seconds and the stand-by current can be checked after this timed period.

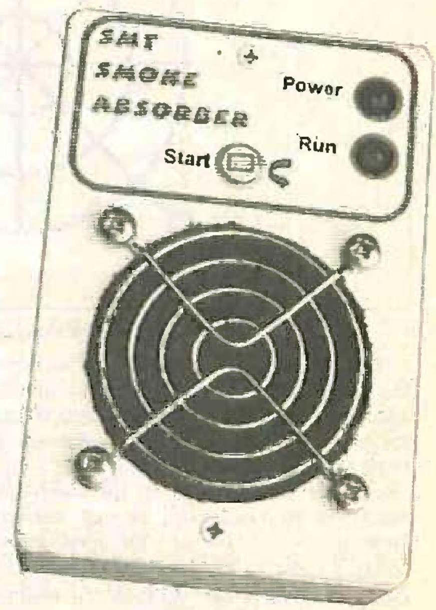
The low voltage drop across transistor TR2 means that it should run cool even after long on-periods. The stabilised power supply is rated at 500mA which is well above the requirements of the smoke absorber and only slight warming is expected. Some experimentation will help when it comes to operation of this unit.

To start with, place the filter opening about 5cm from a circuit under construction with the exit away from the face. When the fan stops after the 30 seconds timing period it is easily restarted if required by moving the hot iron tip past the sensor at a distance of about 2cm. The heat from the tip of a finger close to the sensor window will also start the run cycle. Remember it is heat *movement* across the sensor which produces the trigger pulse to start the timer.

The smoke is warm and rises rapidly aided by the rising hot air stream from the iron tip. This is a strong effect and the stream is difficult to redirect. The path taken by the smoke will be influenced by surrounding objects which will have a chimney effect causing the plume to cling to the tallest one.

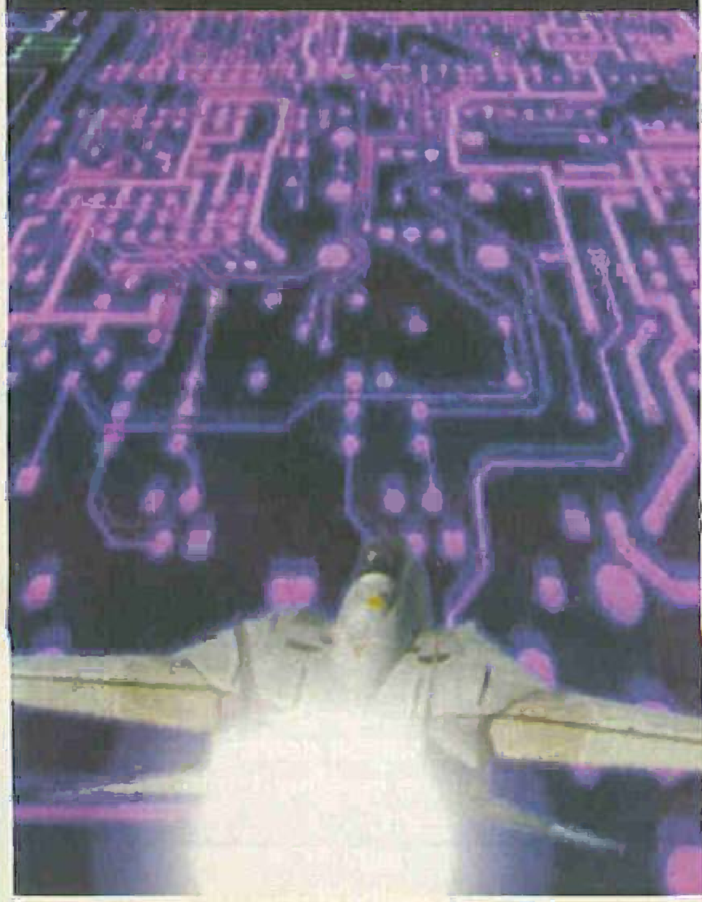
Drafts, including the body convection of the operator will also influence the plume so that, overall, its final direction is fairly chaotic. In order to catch every wisp of smoke, the absorber will need to be quiet close to the soldering operation to overcome these effects. The air stream to the fan has only a negligible cooling effect on the iron tip.

A little experimentation soon results in success in catching most of the fumes. The smoke absorber will become an indispensable part of the soldering process, particularly for the SMD constructor.



QUICKROUTE

THE QUICKROUTE



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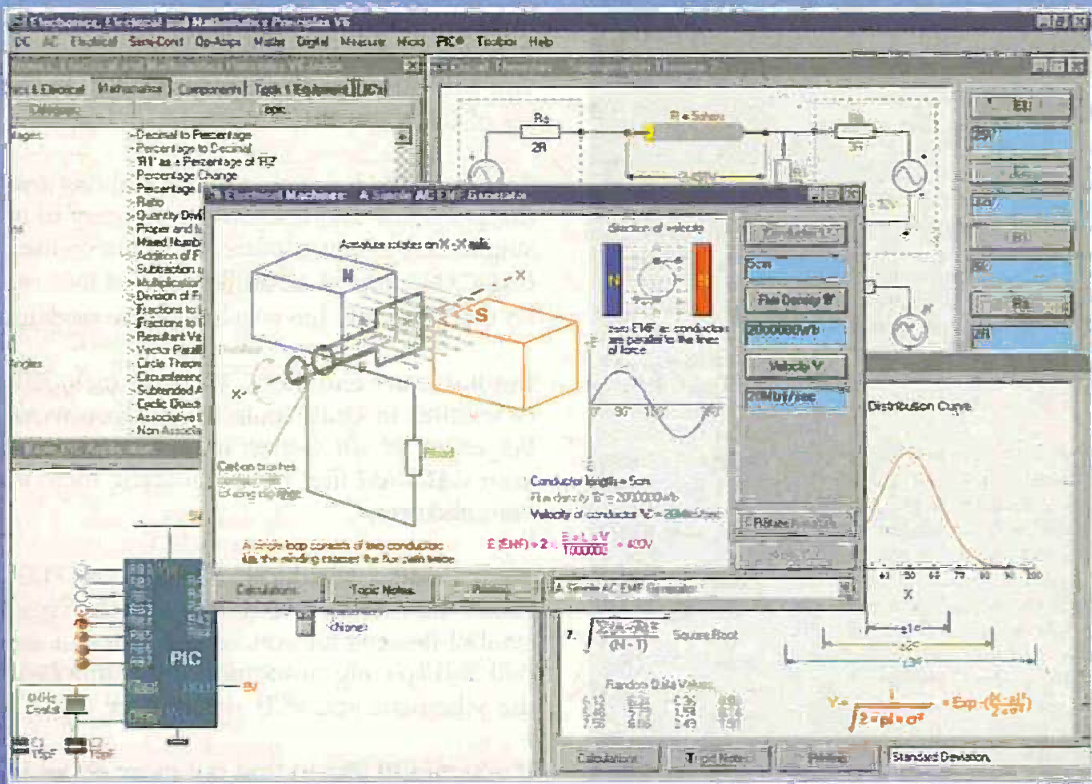

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Robert Penfold. Everyday Practical Electronics magazine. October 1998.

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# New Technology Update

*Ian Poole looks at why the "paperless" society has not happened yet and also reports on a display that uses 15 million transistors and 1·6 miles of thin film wiring.*

## Paper Chase

THE IDEA of the paperless society is a wonderful idea. Whilst the technology is available to achieve this in theory, everyone knows that in practice things are rather different. Despite all the technology that should enable less paper to be used, we actually use much more.

There are many reasons why the paperless office or society has not happened. It is often much easier to print out a document to read at leisure. Also, the fact that we have better and faster printers means it has become much easier to print documents.

Another reason is that printed sheets are much easier to read. There are a number of reasons for this. Reading a PC monitor causes more eyestrain because it is necessary to scroll the document up and down. In some cases it may be necessary to zoom in and out to catch the required detail.

Sometimes these fine details are not so easy to decipher because of the limited resolution of the screen. Whatever the reason the end result is the same. The documents on the screen are not as easy or convenient to read.

If the paperless office is to succeed then it will be necessary to make the technology more compatible with people's real requirements. Only when it is more convenient to read a document on the screen will people start to reduce the amount of paper that is produced.

In view of the green issues and cost savings of introducing a real paperless office, it is likely that there will be a significant uptake of the solution. As a result several companies are now working towards this end.

## Roentgen

In a programme that has taken place at IBM Research, an active l.c.d. display with a resolution of 200 p.p.i. (pixels per inch) has been developed. This active matrix liquid crystal display (AMLCD) has a resolution that is near the limit of the human eye.

This prototype display is named Roentgen after the famous German physicist, Wilhelm Konrad Roentgen (1845-1923), who discovered X-rays. The display is optimised to produce exceedingly sharp images that are virtually indistinguishable from the equivalent paper copies. The jagged edges that distort curved or angled lines are virtually eliminated, making viewing far more pleasant and natural.

The screen is a further development of a monitor that was known as "Monet". This was a 10·5 inch diagonal 150 p.p.i. Super XGA l.c.d. monitor. However, IBM have been researching into high quality displays for many years and started their work into active matrix displays in the mid-1980s.

The prototype "Roentgen" screen is 21·5 inches high and 16·5 inches wide, giving it a 16·3 inch diagonal viewing area. On top of this, the total depth of the whole display unit, including the base, is only 9·5 inches – a definite improvement on the standard c.r.t. screen. The whole assembly weighs less than 20lbs, making it less than a third of the weight of a comparable size c.r.t. monitor.

There are also significant power savings over the equivalent c.r.t. It consumes less than half that of an 18 inch c.r.t., and the output luminescence is high. With a 44W back-light a brightness of 130 cd/m$^2$ is achieved, making it ideal under virtually all normal lighting conditions.

## Many pixels

Crammed into the display are over five million full colour pixels, giving it a full 2560 × 2048 line up. To achieve this it has been necessary to use over 15 million transistors, and a staggering 1·6 miles of thin film wiring within the display.

The exceedingly high performance of the display carries some penalties with it. The screen has over four times the number of pixels of today's highest definition screens of the same size. This means that the amount of data that is required to drive it is increased. Consequently improvements are required in the computer that drives the display if the full benefits of the display are to be realised, and problems resulting from the increased amounts of data are not to be encountered.

Realising the possibility of these problems in advance, IBM researchers developed a scaleable graphics adaptor architecture. This is compatible with all the current operating systems and it is capable of handling these types of high image content displays.

A further advantage is that the adaptor is based on off-the-shelf components. This makes it a relatively cheap card to manufacture, unlike one using specialised components that would add significant costs to the whole system.

Whilst this should help in allowing people to view more data on screen, and thereby reducing the number of copies that are printed out, there will also be other uses. In the immediate future, while their cost is relatively high, they are more likely to be used in applications that demand very high levels of definition.

In particular, they are likely to be included in the ever-increasing number of databases of digital images. These include digital libraries, architectural and electronic blueprints, historical archives, and scanned records; including those used by hospitals and insurance companies.

It is also expected that with the exceedingly high level of definition and crispness there will be a high demand for this type of display for graphic design and electronic publishing applications.

## Future

Whilst there are many areas where these displays can be used, and it is expected that demand will be high, there are no plans to market the Roentgen (AMLCD) display at the present time. It is only a prototype used to prove the viability of the technology and the results of the work have given IBM a very good insight into the development and fabrication of highly complex displays. As such it has been a great success.

However, it will need developing for manufacture and at the moment IBM are in discussions with a number of customers around the world to investigate its production. This should mean that very high definition displays will be available in the foreseeable future.

To make the paperless office a reality, other developments will be required to ensure that people are as at home with data displayed on a screen as they are with that on paper. There are many reasons for wanting a document to be printed out. The convenience of being able to look at it when required, without requiring a computer, the way it looks, and the way many of us were brought up to look at paper at school rather than screens.

However, with more computers being installed in schools and the younger generation being more used to them, it is possible they may use less paper. The best way to cut down on paper usage would be to make printers less convenient to use, or much slower. Unfortunately, this is most unlikely to happen!

# News...

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

# CODE'S WALLOP?

## Copyright protection takes on a new twist for movie disc buffs – Barry Fox reports.

HOLLYWOOD is getting tough with the computer industry. The Motion Pictures Association of America is plugging the loopholes which let a PC play unauthorised DVD movie discs. As a result consumers risk buying PC peripherals which will not work at all.

The DVD Forum, which sets the standards for DVD, requires that all DVD movie discs are encrypted with the Content Scrambling System, to prevent digital copying. DVD discs and standalone players are also Regionally Coded, to let Hollywood stagger the release of videos to tie in with the staggered release of cinema prints.

Regional coding divides the world into six zones, with North America designated Zone 1 and Europe Zone 2. Discs of one zone should not play in another.

Manufacturers of DVD playback equipment need a CSS licence. This requires that consumer DVD players leave the factory pre-coded, so that discs can be coded for the zone in which they are sold.

Although some European firms have been modifying players so that they play discs of any zone, the UK's Federation Against Copyright Theft recently raided two British dealers and seized Region 1 discs and players which had been modified to play them. FACT can prosecute because the discs were not rated for content and certificated for sale in the UK.

### Locked-On

DVD movies will play on a PC, with display on a TV screen. A DVD-ROM drive and MPEG-2 decoder board cost under $250 (total) and many new PCs already come fitted with a DVD-ROM drive. Because PCs are international products, the Regional Protection Committee of the DVD Forum initially agreed that DVD-ROM drives need not be regionally coded. Instead the board comes with software which lets the user set and re-set its code up to five times. After that it remains locked to whatever was the fifth setting.

But hackers offer free software on the Internet which lets users over-ride the coding control. The Regional Protection Committee is now enforcing Phase 2 of its policy. From the end of 1999, all new DVD-ROM drives must be regionally coded. So a decoder board will only work when its code is set to match the drive. Some drive manufacturers are adopting RPC2 early. This is already causing confusion.

Sigma Designs (of Fremont, Ca) makes the RealMagic Hollywood decoder board, which boasts an "extraordinary feature" that converts TV standards so that North American NTSC movies play perfectly through a European PAL TV. The board conforms to RPC1 and lets the user set the regional code to taste, up to five times.

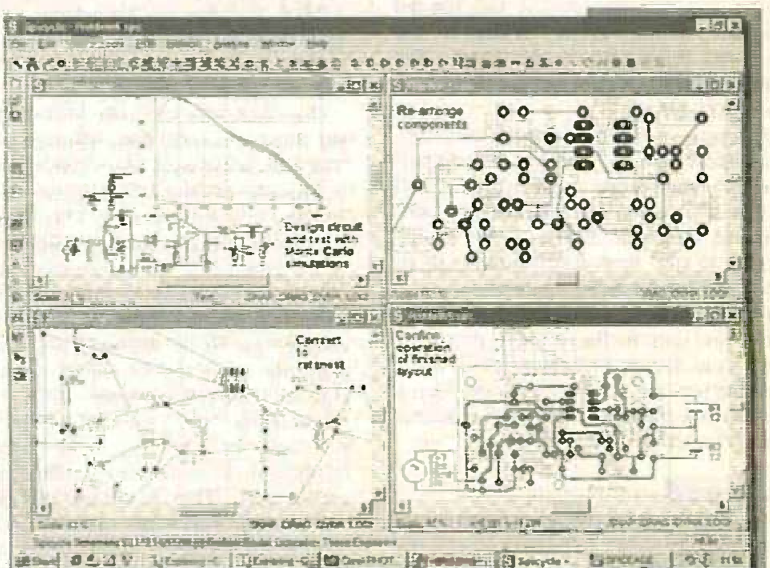
After that the setting remains locked in EEPROM memory. But if the board is used with an RPC2 ROM drive it can only play discs of the standard set by the drive. So a ROM drive bought in Europe may not work with a board set to play American discs.

Creative Labs (of Milpitas, Ca) sells the Dxr2 decoder board, and Encore DVD-ROM drive. Until October '98 the drive was not coded and the decoder zone could be reset five times by the user, and over-ridden by unauthorised software from the Internet. Now, without any formal announcement and with no warning on the packaging, Creative has started to code both the drives and boards as they leave the factory, depending on the country where they will be sold. The coding is done by chips and cannot be altered.

### Panic Calls

Creative's help line is now taking panic calls from customers who have bought drives in one country and find they will not work with boards bought in another. Movie buffs are hunting in shops for old stock.

# SPICYCLE




THOSE Engineers, the UK electronics CAD Specialists who pioneered mixed mode simulation with their SpiceAge simulator, have announced Spicycle, a new powerful schematic capture and PCB program as a front end for SpiceAge.

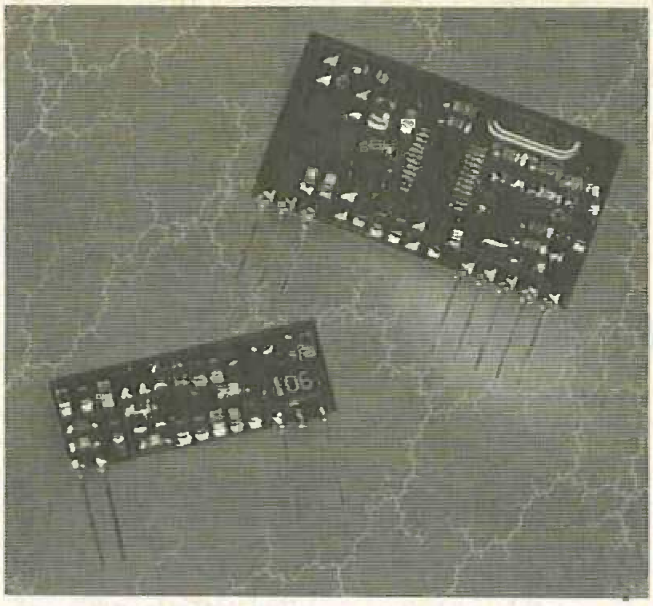
Spicycle connects to the SpiceAge simulation where you can investigate tolerances, tune component values using sweep functions, check filter suppressions, test your circuit on a range of inputs (including those grabbed from a SoundBlaster compatible card). You can even output your results to a SoundBlaster and listen to your design. Spicycle's SpiceAge simulator is independent of SPICE, though it is backwards compatible.

Amongst the many circuit and PCB design functions available, one in particular will appeal to internet-using designers. There are tens of thousands of SPICE circuits freely published on the web and Spicycle's net list import feature enables you to simulate SPICE circuits, create schematic ratsnests and to reverse-engineer these into a conventional schematic diagram. Those Engineers comment that no-one who has used the Internet for accessing SPICE data will resist this virtually limitless resource.

For more information contact Those Engineers Ltd, 31 Birkbeck Road, London NW7 4BP. Tel: 0181 906 0155. Fax: 0181 906 0969.

E-mail: Those_Engineers@compuserve.com. Web: http://www.spiceage.com.

# Low-power Radio Modules



DIP International has introduced new UHF transmitter and receiver radio devices specifically designed for use for low power radio applications. The MK KES modules are designed for use on 418MHz, 433.92MHz and the new proposed pan-European standard of 898.95MHz.

The modules have industry-standard pin-outs and have no adjustable components for tuning, resulting in a highly shock-resistant, rugged product. Voltage requirements are 6V to 9V for the transmitters, and 5V for the receivers.

For more information contact DIP International Ltd, Sheraton House, Castle Park, Cambridge CB3 0AX. Tel: 01223 462244. Fax: 01223 467316. E-mail: antonybignall@dipinternational.co.uk. Web: http://www.dipinternational.co.uk.

# YEDA '99

THE *1999 Young Electronic Designer Awards* (YEDA) programme has been announced. Staged annually since 1985 and with the enthusiastic support of HRH The Duke of York, patron since 1994, YEDA challenges young people between the ages of 12 and 25 at schools and universities, to design and build an electronic or communication device, or piece of software that answers an everyday need which they have identified.

YEDA judging is based on the same criteria as those used in industry in determining whether or not to take up a product: Is there a market need? Can it be made at the right price? Does it have unique selling features?

The purpose of the competition is to give students practical experience not only in developing their own ideas by applying modern technology, but in understanding the economics of manufacturing and marketing, so preparing them better for careers in industry. YEDA emphasises the exciting prospects offered by such careers and the important role young engineers can expect to play in the future prosperity of the country.

Prize money totalling over £10,000, together with trophies, certificates of achievement and other awards are on offer to YEDA entrants and their schools.

For further information contact The YEDA Trust, 60 Lower Street, Pulborough, West Sussex RH20 2BW. Tel: 01798 874767. Fax: 01798 873550. E-mail: postmaster@yeda.compulink.co.uk. Web: http://www.yeda.org.uk.

# VIRTUAL REALITY

INTERESTINGLY relevant to our report in this issue of the VR Exhibition *(IITEC)*, is a recently received press release from the DTI. In it is stated that VR has become much more widespread in industry since the mid-nineties when it was used by only a handful of companies.

Over 100 organisations from 10 market sectors were interviewed for the DTI's study, being asked for their perceptions and experiences of VR technology, how they use it, where they get their information from and what VR activity they were planning.

Findings from existing users of VR include:

* 63 per cent use VR for practical use rather than simply for evaluation or pilot testing

* 88 per cent describe their experience of VR as highly or moderately successful

* 25 per cent consider VR to be "essential technology", both operationally and competitively, to their company

* 79 per cent expect to make more use of VR over the next few years, spending some £30 million on over 300 projects.

The UK Virtual Reality Forum web site is at www.ukvrforum.org.uk, and the Virtual Reality Awareness programme web site is on the Information Society Initiative web site at www.isi.gov.uk.

# B.A.E.C. PLUG

NOW to give the B.A.E.C. another plug! The British Amateur Electronics Club is a worthy organisation to whom we give publicity from time to time (and who are always pleased to warmly welcome new members).

In a recent newsletter (published on a quarterly basis), we were extremely pleased to see a praising review of Andy Flind's *EPE Mood Changer* (June '98). Charles Hill, the reviewer, confesses to be in his pre-dotage years and plagued by regularly waking at four a.m. and failing to return to sleep.

To cut short an amusingly told tale, he built Andy's design and "my wife and I went to bed in some trepidation. Would it work – or wouldn't it? As usual, I fell asleep easily, and then woke a few minutes after four o'clock. After returning from the bathroom I got back into bed and that's all I can remember. Next morning my wife told me she had had a better night's sleep than usual . . . I have never looked back since".

Also of interest is that the latest newsletter gives details of new members and that in answer to the question about which mag they read, *EPE* is the most frequent answer.

To find out more about B.A.E.C., contact the Secretary, Martyn Moses, 5 Park View, Coombe Manam, Cedar View, Aberdare CF44 6PPE. Tel: 01685 877808.

E-mail: MPMOSES@compuserve.com.

# Yet More on Disk!

IT was Fujifilm technology that made Zip disks a reality, allowing around 100MB of data storage space on a single disk. Fujifilm have gone yet another step further, introducing their High Density Floppy Disk (HiFD).

Still in the 3.5inch format, it can store up to 200MB, has a lightning quick transfer rate (max 3.6MB/second) and has full backward compatibility with current 2HD and 2DD floppies. It is intended to be run on Sony's new HiFD Drive. The capacity is equivalent to 139 standard 1.44HD disks.

The suggested retail price is £10.95 for a single and £19.95 for a twin pack. For more information contact your local computer specialist, or Fuji Photo Film (UK) Ltd, 125 Finchley Road, London NW3 6HY. Tel: 0171 586 5900. Fax: 0171 722 4259. Web: www.fujifilm.co.uk.

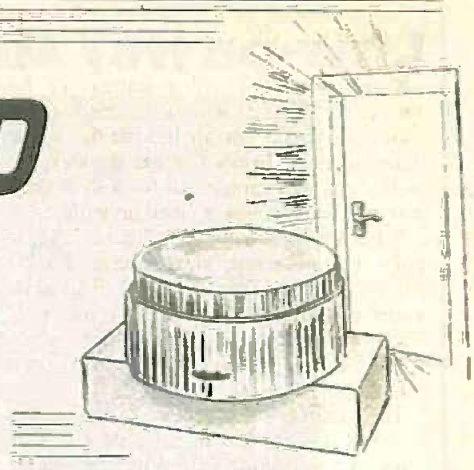
# Radio Exams

BARNSLEY & District Amateur Radio Club have asked us to publicise that their club is now a registered exam centre for the RAE and NARE. They have several courses occurring throughout the year, the first being the Novice Course which starts on 15 March, with its exam on 7 June.

For further information contact Ernie Bailey G4LUE, 8 Hild Avenue, Cudworth, Barnsley, S. Yorks S72 8RN. Tel: 01226 716339. Mobile: 0836 748958 (between 6pm and 8pm please). E-mail: badarc@cwcom.net. Web: www.badarc.mcmail.com.

Constructional Project

# AUTO CUPBOARD LIGHT




## TERRY de VAUX-BALBIRNIE


*It is almost impossible to leave it switched on!*

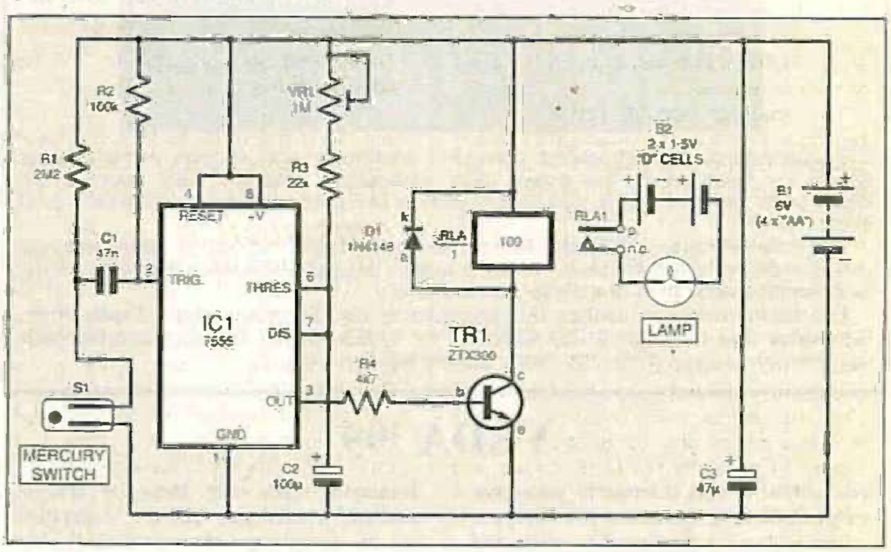



*Fig.1. Complete circuit diagram for the Auto Cupboard Light. The power supply to the circuit is independent to that of the lamp.*

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 fact that they are battery operated makes them particularly attractive for children's bedrooms because, unlike conventional mains lights, they are completely safe.

### STRINGS ATTACHED

The most common type of cupboard lamp (and the one used in the prototype unit) uses a 3V supply comprising two D-size alkaline cells. This is sufficient to provide some 20 to 30 hours of useful operation. The on-off switch is of the string-operated variety having a pull-on pull-off action

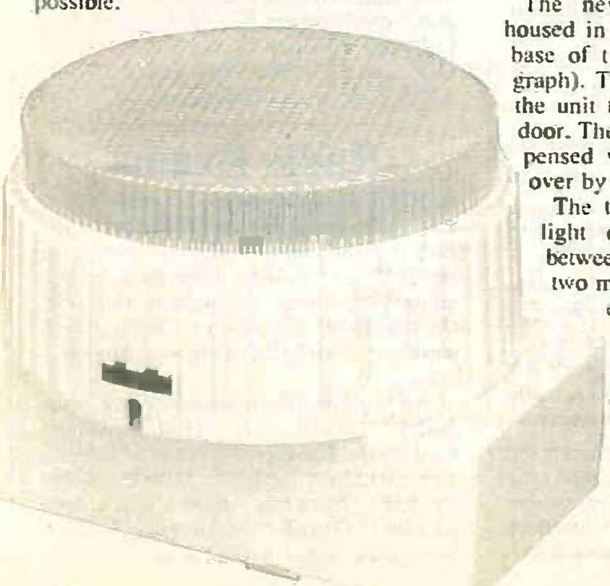
This type of lamp suffers from one major drawback – it is too easily left switched on! This is particularly true when it is used by children (due to their impatience) and the elderly (due to forgetfulness). By the time the lamp is next needed, the batteries are likely to be "flat". With a replacement cost of some £2.50 this must be avoided if possible.

### DOOR TRIGGERED

The Auto Cupboard Light is an add-on unit for a commercial cupboard lamp designed to provide it with automatic timed operation. The lamp is triggered by door movement which makes it very easy to operate and practically foolproof in use. Before proceeding, however, check that the application lends itself to the lamp being mounted on the door.

The new add-on circuit board is housed in a plastic box attached to the base of the lamp housing (see photograph). The box is also used to secure the unit to the inside of the cupboard door. The string-operated switch is dispensed with so that control is taken over by the new circuit.

The time period during which the light operates is fully adjustable between some three seconds and about two minutes. However, this could be easily extended if required.



*The lamp mounted on the circuit board box. Note that the original cord-operated switch has been removed from the lamp.*

Power to the circuit is independent from that of the lamp. This comprises four AA-size alkaline cells giving a nominal 6V output.

While the lamp is off, there is a continuous current drain of some 100µA (depending somewhat on preset VR1 setting). While on, it rises to about 60mA and, in practice, the battery pack will last for many months.

### CIRCUIT DETAILS

The full circuit diagram for the Auto Cupboard Light is shown in Fig.1. Switch S1 is a miniature tilt switch. This contains mercury or a small metal ball which bridges a pair of contacts when the orientation is right.

Various types of mercury and non-mercury switches were tested in the prototype and they were all capable of giving good results. However, you should choose one with *radial* leads – that is, both wires coming out of one end rather than the axial lead type (where the wires appear one at each end). The contacts are then at the end having the wires.

Switch S1 will be mounted perpendicular to the circuit board so that the end with the wires is slightly higher than the other one when the lamp is in position on the door. The contacts will then be *open*.

With a small forward movement of the switch, the contacts will momentarily close then open again due to the inertia of the material inside. In other words, the mercury or ball tends to remain still for a short time and the switch contacts catch up with it.

When the switch contacts "make", a low pulse is transferred, via capacitor C1, to the trigger input (pin 2) of IC1. This activates the low power CMOS timer IC1, configured as a monostable. The output (pin 3) then goes high for a certain time then reverts to low.

The time period is related to the values of fixed resistor R3, preset potentiometer VR1 and capacitor C2. With the values specified, VR1 can adjust the timing between three seconds and about two minutes, as mentioned earlier.

The lower limit (three seconds) will not be useful in practice. However, it was arranged that way because it will be handy for setting-up later.

To extend the operating period, it would be simply a matter of increasing the value of capacitor C2 in proportion. Note that IC1 pin 2 is maintained in a normally high condition by resistor R2 and this prevents possible false triggering. Resistor R1 provides a discharge path for C1 and maintains the upper contact of S1 in a normally high state.

In fact, the circuit will often trigger in whichever direction the switch is moved since the material inside it will bounce/flow around inside the casing and close the contacts on occasions. If the switch contacts end up normally-closed instead of normally-open, the circuit will probably still work because they are bound to break then make again.

The high value specified for resistor R1 ensures that, if this happens, the increased standby current (i.e. that flowing through R1 and the switch) is only a few microamps and negligible compared with the quiescent current of the circuit as a whole.

## BACK TO BASE

While IC1 pin 3 is *high*, current flows to the base (b) of transistor TR1 via resistor R4. TR1 collector (c) current then energises the coil of relay RLA, which allows the lamp to switch on using its own 3V supply and RLA1 "make" (normally-open) contacts.

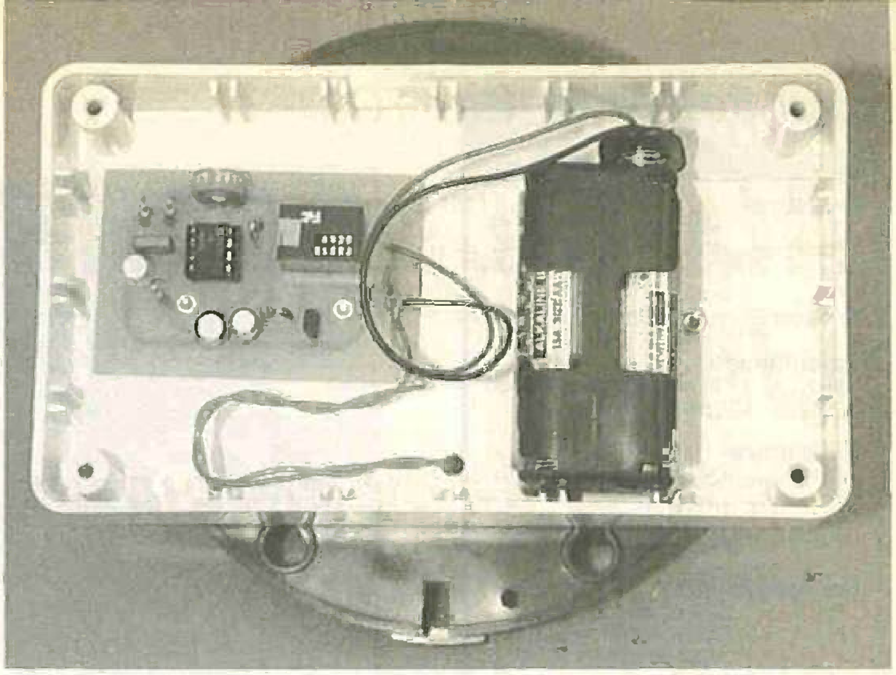
Diode D1 bypasses the reverse high-voltage pulse which appears across the relay coil when it switches off. Without it, IC1 and the transistor could be damaged.

## RELAY POINTS

The choice of relay is important. Although the bulb requires only 300mA or so, the contacts should be rated at 2A minimum. This is to take account of the current surge which occurs on switching on.

It comes about because the resistance of a cold filament is much less than when it is at operating temperature. If the contacts had a lower rating, they might stick together and cause the lamp to remain on continuously. Theory predicts that an even greater current flows instantaneously but, in practice, 2A rating is sufficient.

Use of a relay allows the full battery voltage to be developed across the bulb. Other forms of switching, such as using a transistor, would introduce a voltage drop



*The circuit battery pack and printed circuit board mounted in position on the lid section of the box.*

and, with the small battery voltage used here, any reduction would cause an unacceptable dimming of the bulb.

## CONSTRUCTION

The design for the Auto Cupboard Light is based on a single-sided p.c.b. (printed circuit board) and the topside component layout, together with a full-size copper foil master, is shown in Fig.2. This board is available from the *EPE PCB Service*, code 222.

Begin construction by drilling the two board mounting holes in the positions indicated. Solder the relay, i.c. socket (but do not insert the i.c. yet), fixed resistors, preset potentiometer and capacitor C1 in place.

Next, add capacitors C2 and C3 also the transistor observing their orientation. Finish with the "tilt" switch, mounting it so that the end having the leads is about 3mm higher than the plain one (when the p.c.b. is held vertically as shown in the photographs). This will give a reasonably correct sensitivity setting.

Solder 15cm pieces of light-duty stranded wire, together with the battery connector leads, to the lead-off copper pads as indicated in Fig.2. Adjust the preset VR1 fully anticlockwise (as viewed from the top edge of the p.c.b.). This will give the minimum three second timing, which is suitable for testing.

## SHUT THAT DOOR

To make the lamp come on as the door is opened, the p.c.b. needs to be mounted on the top section of the box (see photographs). This will give the correct direction of movement. The box used in the prototype (see *Shoptalk*) has a deep lid section making this work convenient.

A position should be chosen for the p.c.b. and battery pack. Mark and drill the p.c.b. fixing holes but do not actually attach it yet.

Remove the plastic dome of the lamp housing and take out the bulb and cells. Locate and remove the "built-in" switch to leave free ends. How this is done will depend to some extent on the lamp being

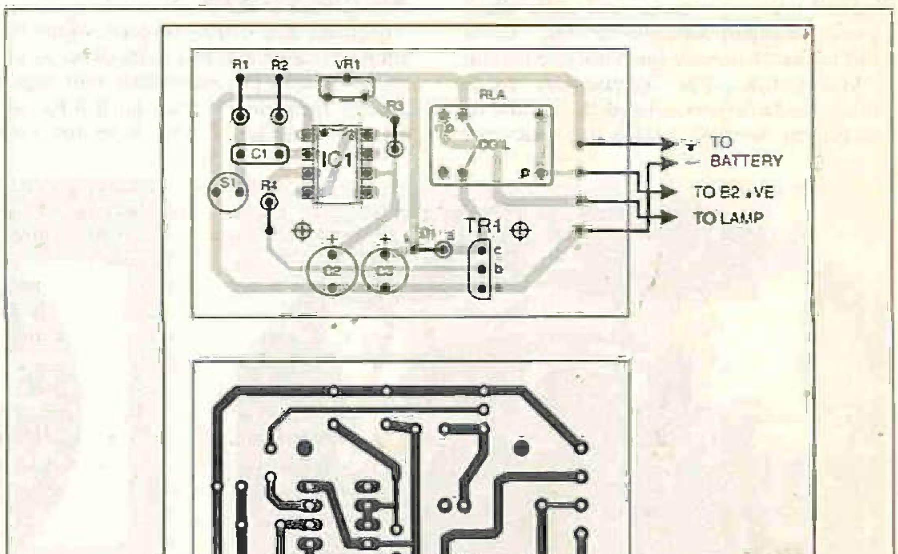



*Fig.2. Auto Cupboard Light printed circuit board component layout and full size underside copper foil master pattern.*

## COMPONENTS

**Resistors**

| | | |
|---|---|---|
| R1 | 2M2 | |
| R2 | 100k | |
| R3 | 22k | |
| R4 | 4k7 | |

All 0·25W 5% carbon film

See SHOP TALK Page

**Potentiometer**

| | |
|---|---|
| VR1 | 1M min. enclosed carbon preset, vertical |

**Capacitors**

| | |
|---|---|
| C1 | 47n polyester, 5mm pin spacing |
| C2 | 100µ radial elect. 10V |
| C3 | 47µ radial elect. 16V |

**Semiconductors**

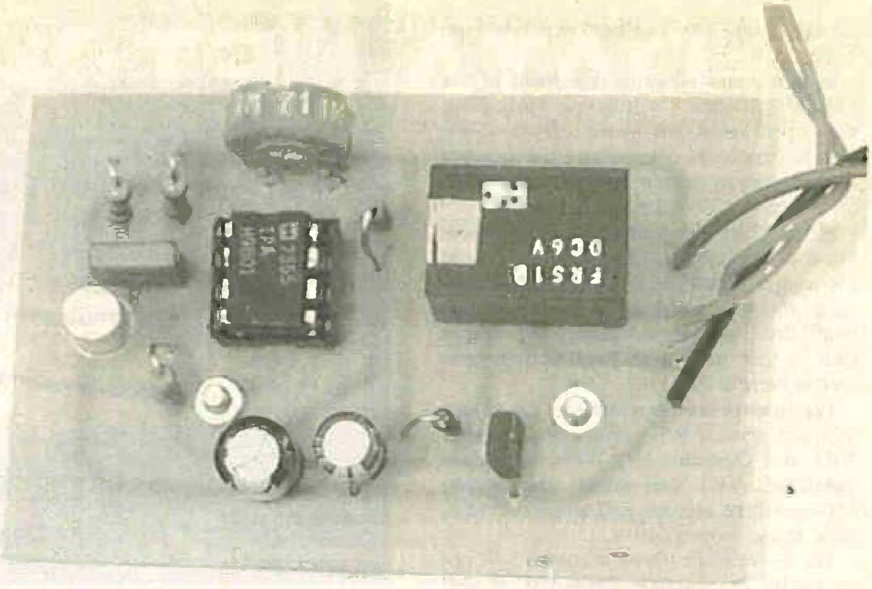
| | |
|---|---|
| TR1 | ZTX300 *npn* transistor |
| IC1 | ICM7555IPA low power CMOS timer |

**Miscellaneous**

| | |
|---|---|
| S1 | miniature tilt switch - see text |
| RLA1 | min. 6V 100 ohm coil relay, with 2A normally-open or changeover contacts |
| B1 | 6V (4xAA cell) battery pack, with holder and PP3 type connector and leads |

Printed circuit board available from *EPE PCB Service*, code 222; cupboard lamp, see *Shoptalk* page; ABS plastic case, size 143mm x 82mm x 44mm external; 8-pin d.i.l. socket, multistrand connecting wire; solder pins; solder etc.

**Approx Cost Guidance Only Excluding Batts. & Lamp £14**



*Layout of components on the completed p.c.b. Note that the metal cased tilt switch, to the left of the i.c., should be carefully bent so that the wire end is slightly higher when the unit is mounted on a door.*

used. However, in the prototype, it was a straightforward job.

By inspecting the internal details of the lamp and taking account of the p.c.b. and battery pack positions, mark and drill two holes in free positions and drill these through the lamp base and the box. "These will be used to secure the lamp in position.

Mount the p.c.b. in position using countersunk screws (so that the lamp will be flat on the top). Attach the lamp unit to the box using small nuts and bolts. Drill a small hole for the wires leading from the p.c.b. to the lamp and solder them to the contact strips where the switch used to be.

Insert the AA cells (B1) into the battery holder and attach it using adhesive Velcro fixing pads or in some other way which will make it easy to remove for battery-changing purposes. Do not connect it up yet, however. Replace the cells and bulb in the lamp.

Insert IC1 into its holder. Since this is a CMOS device, it could be damaged if there is any static charge on the body. To be safe, remove any charge by touching an earthed metal object (such as a water tap) before handling the pins. Mark the positions of the two keyhole slots for mounting the unit on the cupboard and cut these out.

### FINISHING OFF

Connect the battery holder. With the lamp held as it will be on the door, gently move the unit. The monostable will trigger and the lamp should come on if it has not already done so. If you keep the case stationary, it should then go off after a few seconds.

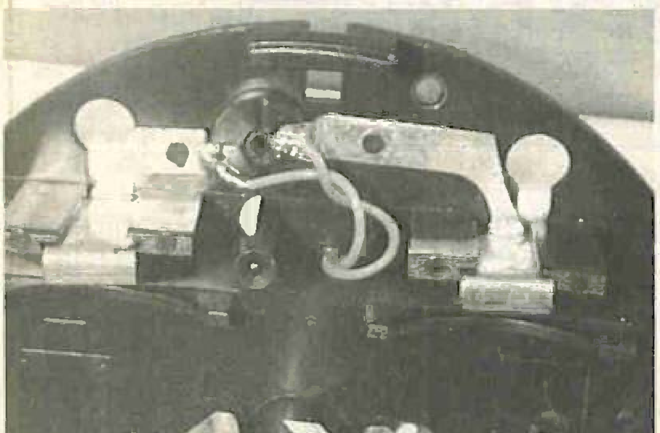
Assemble the box using only two of the screws for the moment. Fix the unit to the door and wait for the lamp to go out (it will almost certainly come on again during the movement). Open the door normally – the lamp should operate again.

If it does not do this, or if it needs a particularly harsh movement to make it work, reduce the angle of the switch and re-try. A position should be found where it is neither too sensitive nor too difficult to operate.

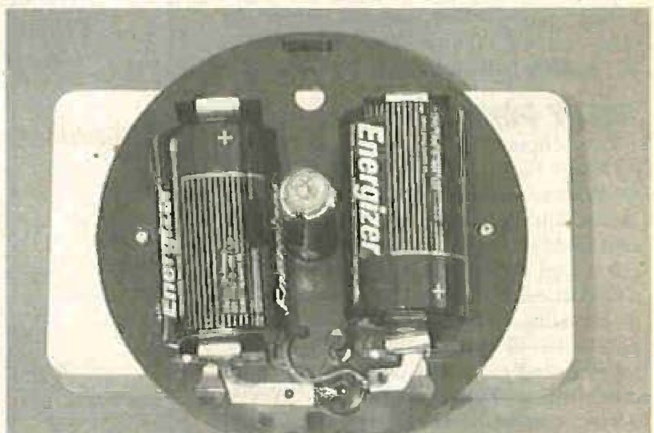
Possibly, it will need a period of "trial and error" to get this adjustment just right. Do not leave VR1 at minimum adjustment because the standby current requirement is increased. So, set it to provide a suitable timing period.

Secure the remaining screws in the box and attach the plastic dome on the lamp. Mount the unit on the door.

When the lamp is turned on, try to close the door before it goes off. If you do not, it will probably re-trigger when you close it and drain the batteries unnecessarily. □



*The original cord-operated switch has been removed from the lamp and the wires from the p.c.b. are soldered to its former position.*

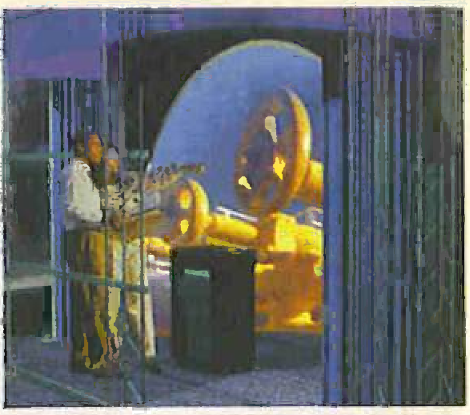




*The D-cells and bulb replaced in the finished Auto Cupboard Light unit ready for receiving the light diffuser dome.*

Special Feature

# I/ITEC SHOW REPORT



## CLIVE "MAX" MAXFIELD

*A special report from the land of virtual reality at the Interservice/Industry Training, Simulation and Education Conference in Orlando.*

IT'S rare that you see something you believe could make a significant impact on the world, but this happened to me at the beginning of December, 1998.

One of the more interesting conferences and trade shows of the year is *I/ITSEC (Interservice/Industry Training, Simulation, and Education Conference)*, which is held in Orlando, Florida, USA. This conference is unusual in that it is held immediately after Thanksgiving weekend, but it was explained to me that this gives the American Generals an excuse to bring their families to Walt Disney World, so that's OK.

The reason I/ITSEC is so interesting is that it offers a showcase for the state-of-the-art in computer-based visual simulation and virtual reality. Governments spend huge amounts of money on training, and in today's restricted economy they want to get the "biggest bang for their buck".

For example, by the time you take into account wear and tear, fuel, cost of munitions, and environmental impact, it can cost as much as $100,000 US dollars every time you start up a tank (and this doesn't take account of the danger to personnel that is inherent in live-fire exercises)! In fact, the National Training Systems Association estimates that US government investment in modeling and simulation (M&S) is currently running at about $3 billion US dollars per year, which equates to some honking big and mega-cool flight and tank simulators, let me tell you!

### MODELLING THE WORLD

The company that almost blew my socks off and takes my personal "most amazing idea" award is Geometrix Inc, San Jose, California (www.geometrixinc.com). The first product from this small (12 person) company is 3Scan, which provides a way of quickly creating models for use in 3D visualization, simulation, and animation environments. The idea is that you put the object to be scanned on a computer-controlled turntable and scan it with a single video camera (Fig.1).

The camera I saw them using was a $120 "cheap-and-cheerful" version, you could get significantly better results with a more expensive unit. Once you've instructed the computer how many images you want to use, it automatically rotates the turntable and captures the appropriate data: for example, 20 images equals 18 degrees between images.

The key points here are *standard video camera* (i.e. no lasers or anything like that), and *just one camera*, which means that you don't require multiple cameras for stereoscopic viewing to calculate depth.

Once the scanning process is finished, the 3Scan program examines the first frame to locate and identify key features in the image (the algorithm that does this is pretty sophisticated in its own right). The program then determines how far each of these features moves from frame to frame. Also some features become obscured and others become visible as the object rotates, so the program adds new features and discards old ones as it proceeds.

The program uses parallax to determine the relative positions of each of these key features (which ones are closer and which ones are further away). (In this context parallax is the apparent displacement of each of the features from one frame to another.)

The end result is that 3Scan processes the raw video data and generates a very tasty 3D model with appropriate textures

*Fig.1. The 3Scan set-up with simple turntable and single video camera.*

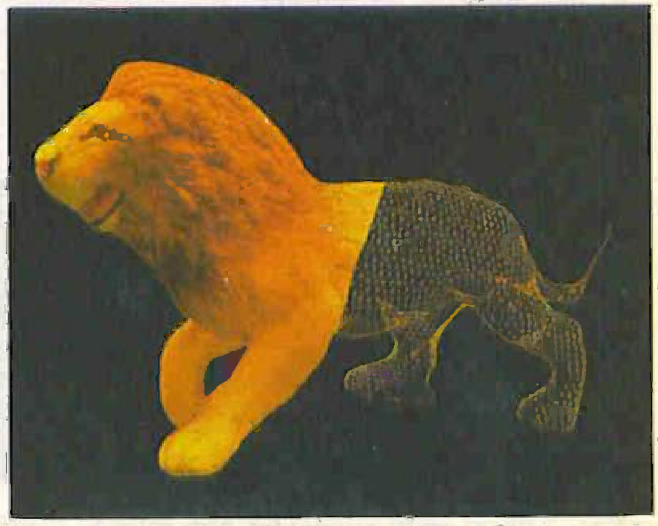


*Fig.2. The model generated by 3Scan.*

*(Figs. 1 to 7 courtesy Geometrix Inc)*

Fig.3. Original SoftScene picture with features indicated.

Fig.4. Showing the image displacement vectors.

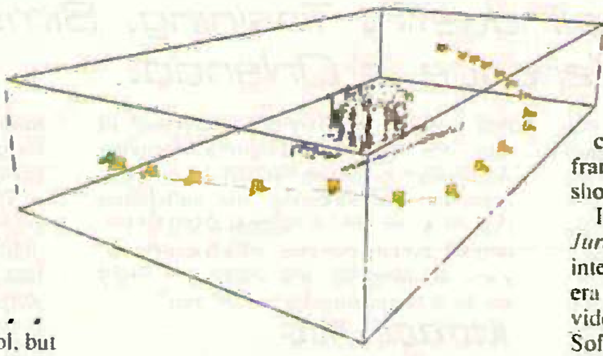


Fig.5 (right). Reconstructed camera path with "point cloud".

(surface characteristics). see Fig 2. These models are essentially a mesh of polygons (triangles) with textures applied to them. This means that the models wouldn't really be suitable for individual animation, but they would make great general-purpose models for inclusion in 3D scenes.

## BUT THEN I SAW . . .

I thought that 3Scan was pretty cool, but then the guys from Geometrix introduced me to SoftScene, which is where things start to get really amazing. With SoftScene, the clever rascals have extended the 3Scan concept to allow someone with a single hand-held camera to, say, walk around a building filming it.

As for 3Scan, SoftScene uses advanced image processing algorithms to detect and extract prominent visual features in the scene (Fig.3). In this image, green cross-hairs indicate features that have been detected in the current frame.

SoftScene tracks the prominent features from frame to frame, re-invoking the feature extraction algorithm whenever additional features are required. In Fig.4, cyan lines are used to indicate the *image displacement vectors* of the selected features (the green crosshairs indicate where the features are in the current frame). SoftScene then employs advanced *structure-from-motion* algorithms based on analyzing motion parallax to spatially locate the tracked features.

One very clever aspect of all of this is that the person holding the camera obviously isn't going to walk around the building following an exactly circular path. So one of the things the SoftScene program has to do is to calculate the path of the camera in order to compensate for the operator moving closer to and father from the building. The image in Fig.5 shows the fully reconstructed camera path along with a "point cloud" representing the final set of tracked features in 3D space. The green and red camera icons represent the first and last frames, respectively (camera icons are shown 12 frames apart in this image).

In fact some people (like the creators of *Jurassic Park*, for example) are really interested in knowing the path of the camera for the purposes of combining live video with animated characters. Using the SoftScene process, they could just give the program a video clip and it could tell them the path of their camera (this is essentially a product in its own right).

But returning to our building, to complete the process SoftScene uses advanced topology and computational geometry algorithms to construct a polygonal mesh from the data contained in the 3D point cloud (Fig.6). Textures are then automatically extracted from the video imagery and applied to the surfaces of the model, resulting in the model shown in Fig.7.

We should note that this was an early beta of the SoftScene program — Geometrix are planning on formally unveiling the full product at the *Siggraph* conference in mid-1999. Also, Geometrix

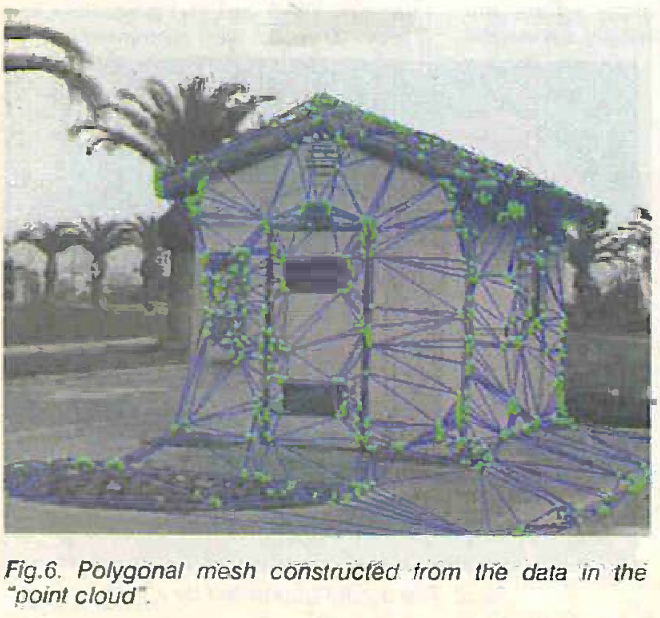


Fig.6. Polygonal mesh constructed from the data in the "point cloud".

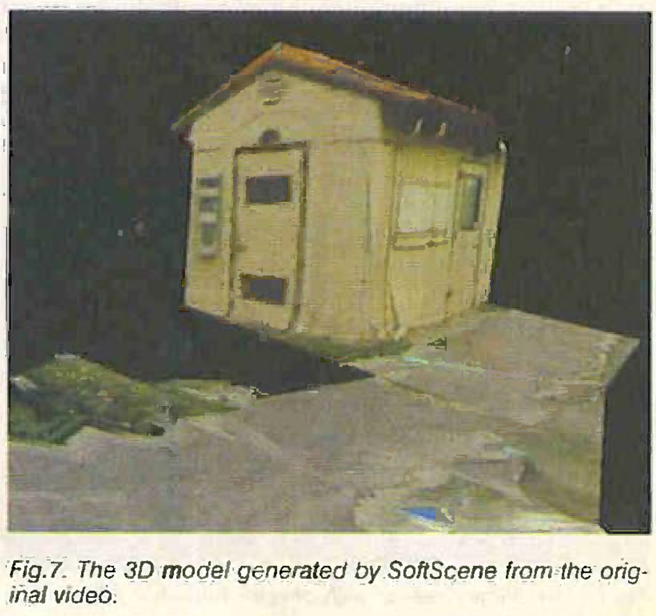


Fig.7. The 3D model generated by SoftScene from the original video.

have recently been awarded $950,000 in development funding to attach a GPS receiver to the camera and to record GPS data on the audio track of the video, which will allow them to generate extremely accurate models.

## TREMENDOUSLY EXCITING

I think that the SoftScene technology is tremendously exciting. It seems to me that there are almost limitless applications in all walks of life that would benefit from the ability to create models using this technique. For example, imagine a police officer at the scene of an accident walking round with a video camera filming everything. Later, that video could be converted into an accurate 3D model that you can "walk through". This would make it much easier to evaluate whether people could see what they said they saw from the positions they said they were in, and so forth.

Another potentially interesting market is television studios, which are increasingly making use of "virtual sets". These computer-generated sets offer many advantages, such as the fact that you don't have to set them up, take them down, or store them, and also that you can quickly and easily change things like colours and textures. The problem is that creating 3D computer models for these virtual sets can be extremely time-consuming. SoftScene technology would make creating the models for these virtual sets *much* easier.

Geometrix emphasize that their technology is not currently targeted towards the commercial (home) market, but I can also see many potential applications here. For example, imagine filming the inside of your house with your video camera and using SoftScene to create an accurate 3D model of your home. This would allow you to experiment with alternative decors in a virtual environment — the possibilities really are endless!

## EYE EYE . . .

Several companies were demonstrating eye-tracking systems, including SMI (SensoMotoric Instruments from Germany, www.smi.com) and ASL (Applied Science Laboratories, Bedford, Massachusetts). The most sophisticated version is attached to a head-mounted assembly, with sensors that track the position of each eye (and the size of your pupils and suchlike). This data can then be displayed on a computer screen superimposed on an image of what you were looking at at the time. This lets you model the path the observers' eyes took, combined with other data such as how long the eyes rested at each point.

Applications for this sort of technology range from flight simulators (for example to see what instruments the pilot looked at and in what order during a simulated emergency) to web marketing (to see how users read web pages — what they look at and what they miss or ignore).

Although the head-mount unit was a little obtrusive, it did have the advantage that it was position-sensitive, which allows the system to compensate for movements of the head. Also, this would be far less obtrusive if it were mounted directly into a fighter pilot's helmet, for example. Of course, applications of the web-marketing ilk don't require this level of sophistication, and simpler units are available that can be mounted on your desk or on top of the computer screen to track your eye motions from that perspective.

## I SEE NO SHIPS . . .

Another technology that scored high on my "cool-meter" is the concept of virtual binoculars, which were being displayed by companies such as Virtual Research Systems Inc, Santa Clara, California (www.virtualresearch.com) and n.Vision, McLean, Virginia (www.nvis.com).


*Fig.8. V8 virtual binoculars (Photo courtesy Virtual Research Systems Inc.)*

These little rascals look and feel like a standard pair of binoculars — for example, you can adjust the focus of each eye, widen or narrow the spacing between the eyes, and so forth. The difference being that the images seen by each eye are generated by a computer connected to the binoculars and displayed on small l.c.d. screens inside the binoculars (Fig.8).

One clever aspect of this is that the binoculars track their position in 3D space, so as you turn your head (and body) the scene changes appropriately. For example, when I looked through them, I could see a plane coming towards me and passing overhead, and by moving my body I could track the plane, zoom in on it, and so forth.

This sort of device can be very useful for such tasks as training forward observers to recognize planes and vehicles in a battlefield situation without the cost of actually fielding the real units.

## IF AT FIRST . . .

Whenever I hear the term "simulators" I think of flight simulators (e.g. planes and helicopters) or vehicle trainers (e.g. tanks and suchlike), so I was somewhat surprised when I meandered into the booth of Jason Associates Corporation, Draper, Utah (www.jason-sed.com) to find a smorgasbord of crane simulators.

The idea is that you sit in a seat from a real crane (well, a seat made by the same company that makes the seats for the real cranes) with real controls, facing a large screen showing the load on the end of the hoist, and then you practice, and practice, and . . . See Fig.9.

Of particular interest was a dock-side simulator that modelled the effects of the swell of the sea, the motion of the ship, the effects of the wind on the load, and so forth (in the more sophisticated units the seat has motion and the controls have tactile

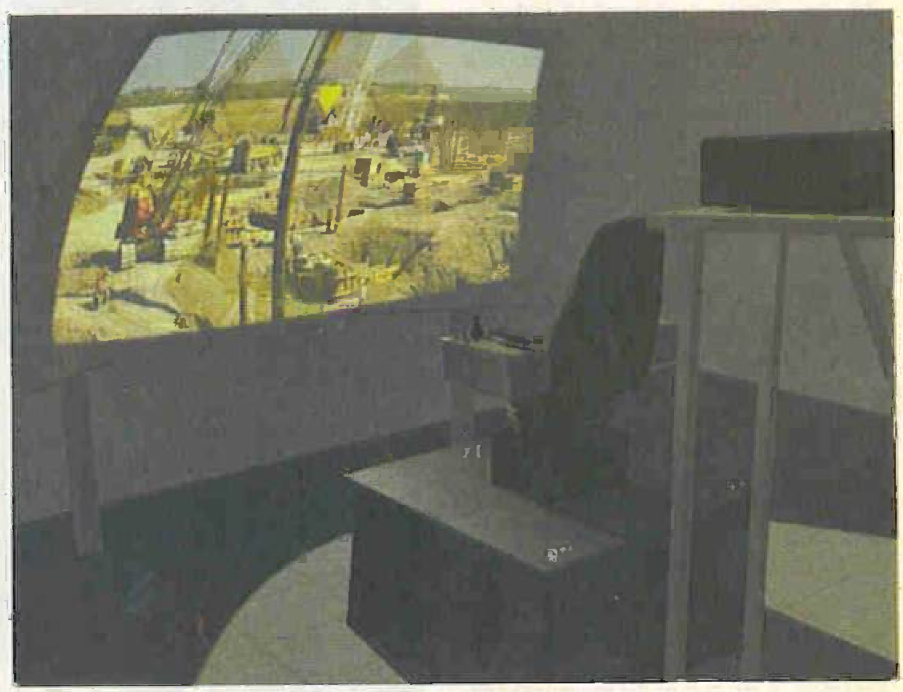


*Fig.9. The Virtual crane simulator from Jason Associates Corp.*

feedback). It obviously makes a lot of sense to practice this sort of thing in a virtual world before you are let loose on a real crane.

Jason Associates started off modeling cranes for military applications, but now they're moving into the commercial area. As the representative I was talking to said: "Have you any idea how many cranes there are in the world?" I must admit that I hadn't previously spent a lot of time pondering this poser, but it certainly makes one pause for thought.

## VISIONDOME

If you place your hands to either side of your head, and restrict yourself to about a 60 degree field of view, the resulting image is approximately the same as you see on a computer screen. Some applications, however, require a greater field of view to fully immerse you into the simulation.

One very nice solution demonstrated at I/ITSEC was the VisionDome from Alternate Realities Corporation, Durham, North Carolina (www.virtual-reality.com.), see Fig.10. These little beauties range from 5 metres wide by 3 metres high (for two to five viewers) up to models that are 8 metres in diameter and can accommodate over 45 viewers.

The nice thing about the VisionDome is that it provides a fully immersive multi-user virtual reality environment without requiring goggles, glasses, helmets, or other restrictive devices. This makes the VisionDome an ideal choice for multi-user simulations, training, design, engineering, and so forth. For example, the virtual crane simulations discussed above would be even more realistic if they were to use a VisionDome as their display device.

As I was to discover, there are three very clever portions to this system:

The dome itself
The projector/lens
The software

## THE DOME

The reason I say the dome is clever, is that the way it is constructed makes it extremely portable and easy to erect. First of all you raise an aluminum frame, then you clad the outside of the frame with a thick black covering and the inside with the white lining material.

The cunning part of all this is that if you were to try to attach the white lining to the struts of the frame, you would end up with distortions on the surface of the dome. Instead, the white lining is only attached around the edges of the frame, then a small pump is used to create a slight negative pressure by sucking out the air from between the black cladding (on the outside of the frame) and the white cladding (on the inside of the frame). This results in the inner lining being stretched taught and forming a perfect hemisphere.

## PROJECTOR AND LENS

The next interesting point is the projection system. Instead of having red, green, and blue "guns", the VisionDome employs a single-unit projector, which means that there's no problems with alignment. But the really clever part of the projection unit is the lens, which somehow manages to project a perfectly focused image across a 180 degree field of view.

Furthermore, this lens has an infinite focal length. This means that you can hold a piece of paper a few inches from the lens and see that portion of the image in focus. Then as you move the paper further and further away the image stays in focus without any correlation problems. I don't have a clue how this works, but the end result is that the image is in perfect focus at every point inside the dome.

## THE SOFTWARE

Last but not least is the software. In order to appreciate what this does, you first have to understand a few basic concepts about 3D graphics. First of all, a 3D graphics application performs a process called "tesselation", in which all of the objects in the 3D world are converted into collections of simple polygons (usually triangles). Second, the vast majority of today's high-performance 3D graphics applications use a programming interface called OpenGL©, which allows the application to pass requests to graphics accelerator boards in a well-defined format.

The problem is that OpenGL was conceived with flat-screen displays in mind. In the case of the VisionDome, if you want to display a straight line, then that line has to be curved so that it appears straight on the curved screen (if you see what I mean). In order to handle this, Alternate Realities' software takes the OpenGL calls and re-tesselates everything on the fly (for each frame) so that it can correct for the curvature of the screen.

The overall effect is one of total immersion — I now know what it feels like to fly through a 3D molecule, and that's not something you expect to hear yourself saying too often! □

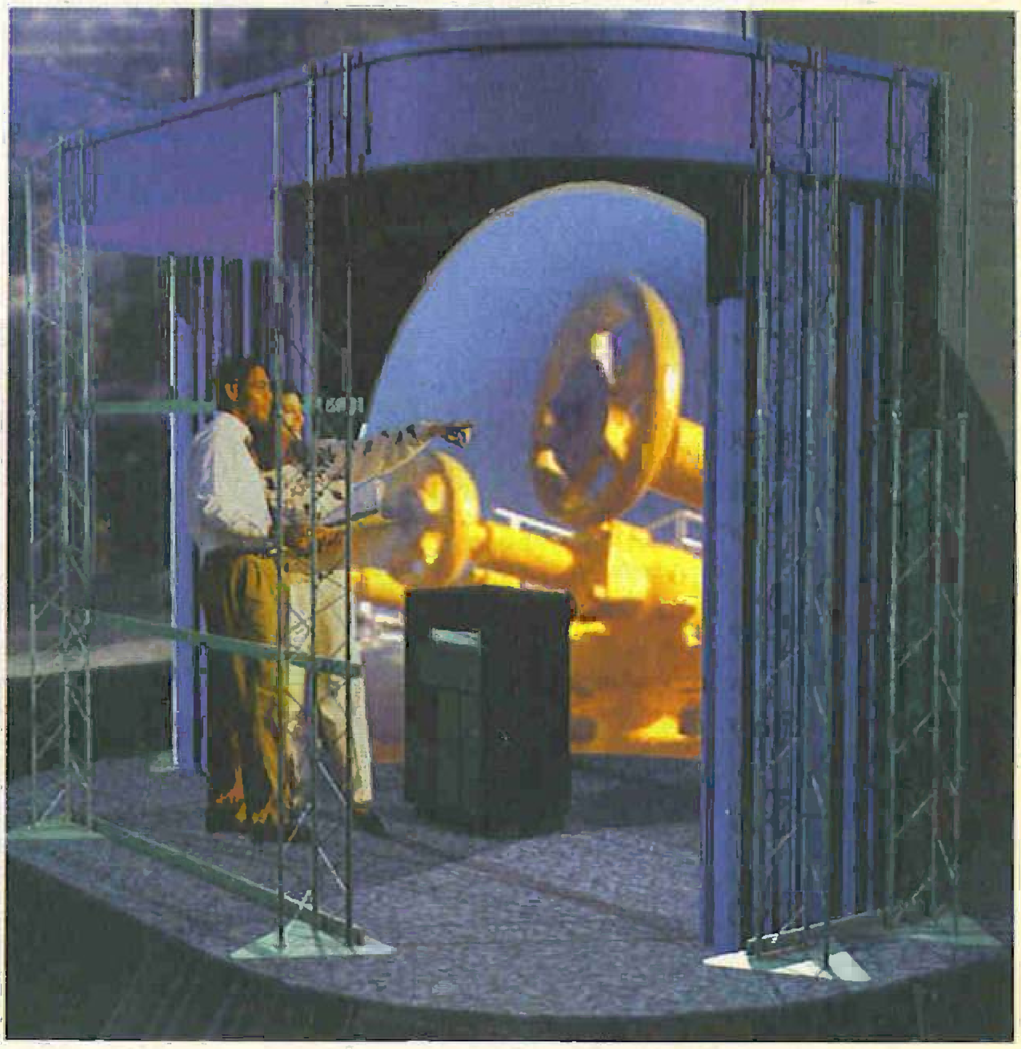
### 3D GRAPHICS

If you want to know more about 3D graphics, including the meaning behind terms like tesselation, OpenGL, textures, and suchlike, then we would recommend the easy-to-understand introductory book *Graphics Supercomputing on Windows NT*.

This book commences by introducing 2D bitmapped and vector graphics, and then moves on to discuss 3D graphics concepts. These introductions are easy to understand and set the scene for what is to come. As you will discover, the main portion of the book is occupied by an extensive colour illustrated glossary, which covers everything from the different schemes for representing colour and translucency, to lighting, shading, texturing, and rendering.

You can download a sample chapter of this book (the chapter on 3D Graphics) by visiting the *EPE Online* Web site at www.epemag.com and strolling into the *Library*. If you like what you see, you can purchase the full printed book directly from the *EPE Online Store*.

*Fig.10. The VisionDome really immerses you in the scene (Courtesy Alternative Realities Corp.)*



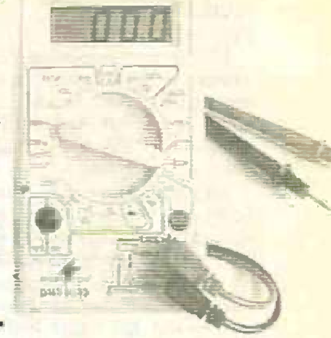
# READOUT

**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 ★

### APPLE iMAC

Dear EPE,

I was delighted to see two items in the January 1999 issue relating to the Apple iMac computer, but I think that you were very unfair with your comments in both pieces. The *Innovations* article on page 15 is very misleading on several points: it implies that suitable peripherals are difficult to find – this is simply not the case. The iMac's USB ports are standard PC connectors. A whole range of low cost devices including scanners, printers and serial adapters were available to buy in the UK when the iMac was launched in September, and many new products have come onto the market since then, including external disk drives.

The iMac does have an expansion slot, although its use is limited, but since the iMac comes with an ATI Rage Pro Turbo graphics controller and 6MB of video RAM, SRS sound, 100Mps Ethernet and 56K modem built in, it is hard to imagine what a home user would need to add. The cost of RAM for the iMac is no different to any other modern PC and the price varies greatly – at the moment (Dec '98) most iMac suppliers are including free 96MB RAM upgrades. Many people have criticised Apple for not including a floppy drive, but this does make sense if you consider that most people buy an additional zip or superdisk drive for their PC anyway, leaving the floppy redundant.

I do not understand why you have decided to quote the start-up time as your only measure of how fast the iMac is. Since when has this been a useful measure of a computer's capability? In use, the iMac is blisteringly fast – the combination of the super fast Power PC processor with its highly efficient Cache memory and accelerated video hardware mean the iMac is only marginally slower than Apple's top of the range systems costing three times as much – truly amazing for a home computer.

The *Net Work* article on page 69 does provide a far more rounded piece on the iMac, until Alan Winstanley chooses not to recommend the machine on grounds that I feel are unjustified. It is true that Apple Macs are rarely seen in the high street – but this means that there is a thriving mail order community instead. I see no reason why a "technically inexperienced" iMac owner should have difficulty buying mail order. I have yet to gain any benefit from sales staff at Dixons or PC-World when buying computer equipment. It seems far better to talk to a real expert in a mail order company over the telephone.

With regard to the issue of IBM PC software compatibility, this is no longer a serious problem for Apple users. Virtually all of the major software titles (Microsoft Word and Excel, Adobe Photoshop, etc) are available for both Mac and PC, and they use identical file formats – files saved on the Mac can be opened on the PC and vice-versa.

Easy Open file translation software, often bundled with Apple computers performs automatic translation of documents when the correct application isn't available – far more flexible than straight compatibility. I am not exaggerating by saying that in many cases, Apple computers are more compatible with PCs than PCs are. I am regularly using my Macintosh computer to unzip, translate and convert PC files for my colleagues to use on their PCs.

For software titles not available for the Mac, a number of excellent and very realistically priced software emulators are available that will run any Windows application. The astonishing speed of the iMac means it is quite capable enough to run Windows 98 at Pentium speeds. I currently use Virtual PC to run Windows 95 and the Microchip MPLAB software and program PIC microcontrollers without any problems on my Mac, a model far less well specified than the iMac.

The issue of IBM compatibility is not nearly as serious as you suggest. Apple's Macintosh computers (including the iMac) run MacOS, currently at version 8.5, which is almost universally acclaimed as the best personal computer operating system available. It is brilliantly designed from the ground up to provide fast, easy computing. The MacOS and applications that run on it really are a joy to use – a far cry from the problems of Windows 3.1, 95 and 98. Apple computer hardware is also exceedingly well built – there are many ten-year old Macintosh systems in use today.

If you want an indication of just how good Apple Computers and the Macintosh MacOS operating system is, consider this: despite the fact that Mac users are in a minority among Windows users, the fact that Mac hardware and software often isn't available on the high-street, and the fact that Apple computers have always previously been more expensive than Windows systems, Apple is still one of the largest computer companies in the world, second only to companies like Dell and Compaq in terms of numbers of computers sold, but always on top and winning awards with the fastest machines, and newest and most innovative technologies. It is fantastic that Apple is able to produce the iMac, a fully specified computer at a home computer price.

I find it sad that such a brilliant piece of engineering is knocked back largely on the basis that it isn't directly compatible with the majority of PCs. There are millions of people in the world who know that there are problems with Windows 95, millions having problems with Windows 98 – so why are people so keen to stick with something so universally known to perform so poorly? With the iMac, Apple has at last produced a very credible, affordable alternative to Windows, and this should be applauded.

PS. I am a product designer/electronic engineer who uses both Macs and IBM-PCs every day, and I don't work for Apple!

**Roger Coleman, via the Net**

*Thanks for an extremely interesting and different view point of the iMac. Editorially we try to be impartial and the views expressed by contributors are entirely their own.*

### WEBBED TRACKS

Dear EPE,

Now that the technology to publish electronically has been proven with the advent of *EPE Online*, it would be of great help for those producing p.c.b.s. at home to be able to print directly from a downloaded image of a p.c.b. track layout onto a transparency.

I also note that *EPE* does not have the hang-ups which some of the competitive electronics magazines have with respect to the protection of source code, and this is gratefully acknowledged. With the increasing number of hobby electronics projects being based on some form of microcontroller or other, protection of the code would seriously impact the constructor's ability to understand the operation of the unit.

**Martin Shipley, via the Net**

*There are a number of problems associated with downloading p.c.b. images from the Web. Although most of the p.c.b. track images have been produced by authors who use p.c.b. CAD packages, the great variety of such packages available prevents us from making direct use of authors' electronically generated images (except in vary rare cases). Generally speaking, we scan double-size paper printouts of the p.c.b. tracks into our system as Corel Draw images.*

*Whilst we have full control over the size of the images that are subsequently output as those you see on the ordinary printed pages of the magazine, we have no control over the same images when they are electronically put on the Web for downloading as part of* EPE Online. *Consequently, Web users cannot be assured that the p.c.b. images they print are the correct size, we are, however, working on this problem.*

*Regarding source codes, we have long maintained that readers have as much right to these as they have to the circuits and p.c.b. layouts. It is part of our conditions of article acceptance that the source codes are available for the use of all readers without restriction.*

### WHAT'S IN A NAME?

Dear EPE,

It is sad to see the end of *Electronics Today International* as a separate entity, but on the subject of what the combined magazine should be called (*Editorial* Feb '99): I felt the original publishers made a mistake when they chose to shorten it to *ETI* some years ago. It could stand for almost anything – English Tourist Information, maybe. If electronics magazines are trying to attract new readers, what better than to have the word *Electronics* beaming out amongst the many publications on the newsagents' shelves?

The word *Practical* should also be dropped. It was a commendable tribute to an old rival, but *Everyday Practical Electronics* never did roll off the tongue.

Then we have a possible conflict – *Everyday or Today* – perhaps not. *International* is quite relevant, as you are available worldwide.

So here is my title suggestion – *Everyday Electronics International* (NOT *EEI* please!).

**K. G. Mitchell, Loughton, Essex**

*Thanks for the observations – we'll stay silent on this subject for the moment, just letting readers have their say – Carry On Commenting!*

## COMPRESSORS

Dear EPE,

Having used limiters and compressors professionally in the 60s and 70s, as well as building many gain control circuits as a hobby, I cannot totally agree with Robert Penfold's analysis of the causes of disturbing changes in volume on TV.

Any programme (and I draw no distinction between a two hour drama production or a 30 second commercial) will be produced with consistent sound levels. Possible exceptions to this are News bulletins where material will arrive during transmission and thus cannot sometimes be checked for sound level as thoroughly as would be desirable. Although some viewers may be upset by the sound levels, it is impossible to cater for the quality delivered by all TV sets. There is a world of difference between the sound of a decent set with a forward facing loudspeaker and a small "portable" set with a sideways facing loudspeaker pointing at heavy curtains which soak up most of the frequencies that provide intelligibility.

Within a programme, the long established technique of gradually reducing the level over some 10 to 20 seconds prior to a climax will give impact without over-modulation, but it would be impossible to do this before commercial breaks without lengthy rehearsal and in today's climate it is unlikely that any broadcaster would have the resources to provide the staff to do this.

The problem is that commercial breaks as well as the trails and promos aired between programmes on BBC1 and BBC2 have been produced as standalone "programmes" and considerable time will have been spent to ensure that everything looks and sounds right. I have come across before the belief that the sound levels of programmes are reduced to make the commercials stand out. This is a very doubtful premise since advertisers are aware of their target audience and are unlikely to wish to alienate them, nor does it make sense for the broadcaster to do this since a reduction in level of say 6dB with respect to the level of the commercial is the same as having the sound transmitter on half power except for a few minutes in every twenty which will impair the signal-to-noise ratio of analogue transmissions and possibly make quantizing noise apparent on digital transmissions.

So why do some commercials sound so loud? It is because they have been compressed! There are many combinations of attack and release times, compression ratios and thresholds that can be used making it more of an art than a science. A favourite technique of mine that did not always work was to cut the bass, compress quite heavily and then boost the bass by the same amount that it had been cut: if it didn't work it sounded dreadful but there was no way of predicting this. (This was in the days before manufacturers routinely provided EQ insert points in the side chain).

Compression is not necessarily used to ensure viewers attention will be grabbed but mainly to get the message across in an impeccable style given the content and the short duration, which means there is no time to implement the techniques used in say drama productions and thus the use of compressors is the only way to achieve the desired result.

In some respects this is no different to a Top 40 single. The producer of this is not concerned what radio station it is played on: it is simply a standalone product that satisfies the producer and the artist and if they get it right it will sell. Thirty years ago, for example, broadcasters employed sound staff to ensure that sound levels were seamless. I suspect that today's solution is to simply have a peak limiter in circuit or if there is an operator in charge then that person is simply looking at a meter and not listening to the output.

That said, I'm certain that Robert Penfold's circuit will do what he says it does and better than many circuits I have seen and tried, except that I wouldn't call it a Compressor, which is generally taken to mean a device that reduces the dynamic range and thus increases the average sound level and makes things sound louder. A more accurate name, given the attack and release times, would be an Automatic Volume Control.

Where I will disagree is with the suggestion to build two boards for stereo. This will not be satisfactory. Suppose a signal in the left channel is high enough to cause gain reduction. The level in the LH channel will be reduced and a central image will be pulled to the right as no gain reduction has occurred in the RH channel.

Depending on which channel causes gain reduction, a central image will swing about the centre in a very disturbing way. What must be done to ensure stability of the central image is to ensure identical gain reduction in both channels regardless of which channel causes the reduction.

A simple way of doing this is to combine the outputs of IC3 with a virtual earth mixer and feed this into a single side chain with the output of the side chain feeding both VCAs. As there is another *n*-channel MOSFET in a 4007 and a TL072 costs the same as a TL071, a stereo version could be built for only a little more than a mono version.

**Barry Taylor, via the Net**

*Robert replies:*

*I found Barry's letter very interesting but do not think that his explanation of things is that much different to my own. I suggested that the apparent volume could be (and probably is) made greater by using a high average level, and this is something that is achieved using compression.*

*Some of the over-loud advertisements sound to me as though there has been some doctoring of the frequency response, but I obviously have no way of proving this. Whatever the cause, there are certainly large numbers of people who have problems with the sound for one reason or another. Hence this project, which was requested by readers.*

*I normally find that separate processing of stereo channels gives the best results, but in this case I think Barry is probably right, and that controlling the two channels in unison would give slightly better results, maintaining correct stereo balance.*

***Robert Penfold***

## D.I.Y. ONLY

Dear EPE,

Could you help with your *PIC Tutorial* as I now seem to be a bit stuck. I am having a problem trying to understand some of the exercises. Could you please send me the answers to all the exercises so that I can compare my answers with them.

**Roy Chaplin, via the Net**

*It's not often I refuse to help, but I am doing so on this one – sorry to disappoint you! It is not in the interests of those studying the* PIC Tutorial *that they should be given answers to the exercises. The exercises are not of the same nature as, for example, problems in mathematical text books, where often there is only one correct answer.*

*The intention of the exercises is to get readers thinking for themselves about how to deal with the programming situations presented. In many instances there are several ways in which programming solutions can be achieved. There are sufficient discussions and examples within the tutorials for readers to apply intelligence and logical thinking about how the programming commands that are available can be used to create a program routine that achieves the suggested objective. After all, there are not a lot of commands whose function you have to learn.*

*Readers who are capable of applying concentration on a logical problem should not really find the exercises difficult. For me to provide answers would not really get people thinking for themselves. In a real-life situation, you won't be able to keep on asking others how to solve programming problems that you need to overcome.*

*In your hobby activities, for example, it's you who have invented the design for which you want a PIC (or other processor) to provide control. If you keep asking others to write your programs, where's the pleasure or sense of achievement for you in having thought up the idea? It will have ceased to be your creation.*

*A more severe situation will occur if you are writing a program as part of your job requirement. If programmers cannot provide programming solutions, they will cease to be of value to their employers – need I say more?*

*As a general tip with a programming problem, if you cannot solve it immediately, take it step by step, experimenting at each step if necessary, and just keep on until you do solve it. It could be that the approach you first thought was the correct one may turn out to be based on a wrong assumption. Try alternative ways of achieving the desired end result. It's the way I learned to program – I assume it is logical to think that others involved in programming have a similar attitude.*

*But at the end of the day, it is worth recognising that not everyone is capable of seeing the world in programming terms. And there is no shame in being such a person. We all have our talents, and there are many things which some people can do successfully that others cannot, the latter having their own strong points unassailable by the former.*

*However, if you believe you are logical enough in your thinking, you probably are capable of programming – so keep at it and you'll get there!*

*Am I right in expecting to receive critical letters as a result of this reply? (Yes, I know we at* EPE *set out to educate and encourage people in electronics – but how far is hand-holding justified or desirable?) Yell at me if you wish!*

## IEE REGULATIONS

Dear EPE,

I am afraid that Bob McMillan has not consulted his IEE Regulations recently (*Readout* Jan '99). In the 16th Edition there are three earthing systems shown (TN-S, TT and TN-C-S) and it states that the classification of the system will depend upon the distribution system and not upon the customer's installation.

As a retired electrician (my career covers Contracting, Installation and Maintenance at the National Coal Board), I recommend that readers use mains testers to check their supply integrity – I have used a commercial version for many years and found them useful for quick checks, and have never found them hazardous.

**L. G. Sutton,**
**Burton-on-Trent, Staffs**

*The above is just part of a much lengthier letter from Mr Sutton, who also kindly sent illustrated extracts from the IEE Regs from which it is obvious that the situation is far more complicated than the discussion has hitherto revealed. It is a subject (as we have said on other occasions) that we shall return to in greater depth.*

## WICKETLY CHUFFED

Dear EPE,

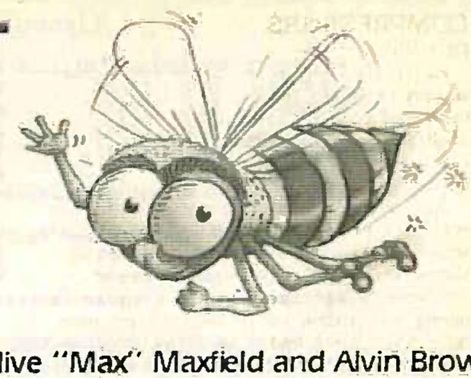
Thanks very much for making my letter *Letter of the Month* (Feb '99). I am very "chuffed" and I get a prize! Ya hoo!

And best of British luck in the one day cricket. I might be an Aussie but I still think Warne and Waugh should be tossed out ... permanently.

**Carle Wilde,**
**Acacia Ridge, Australia**

*In deference to our many overseas readers we are officially impartial to international conflicts! (Carl faxed these comments to us on 7 Jan '99 in response to us telling him of his letter's status.)*

# PhizzyB COMPUTERS



## Part 5: Introducing the PhizzyBot: The D.C. Motor Controller

Clive "Max" Maxfield and Alvin Brown

WELCOME to the fifth instalment of our really unique and exciting electronics and computing project. This series of articles, as many of you are confirming, will be of interest to anyone who wants to know how computers perform their magic, because it uses a unique mix of hardware and software to explain how computers work in a fun and interesting way.

We now 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 need to know a bit about PCs).

GOOD grief – how time flies! It seems like only yesterday we were starting this PhizzyB series, and now we're poised to hit the ground running with a simple robot called the PhizzyBot.

In his PhizzyB constructional article elsewhere in this issue, that wanton warrior of electronics, Alan Winstanley, describes how to construct a simple controller device that will allow the PhizzyB to control two d.c. motors. These motors will, in turn, provide the PhizzyB with the ability to roam around the room, thereby turning it into the PhizzyBot.

### WHAT'S IN STORE

For our part in this tutorial, we will start to consider some simple programs to first test the motors and later to control them more meaningfully. Please note that although this article concentrates on the real PhizzyB, all of the programs described herein can be run on the PhizzyB Simulator if you so desire.

Also note that this is where we start to use everything that we've done thus far (including the simple l.e.d. device from Part 2, the subroutine concepts we discussed in Part 3, the interrupt routine concepts and the interrupt-driven switch device from Part 4, and so forth).

The new programs we create here will form the basis for next month's article, in which Alan adds some collision detection capability to the PhizzyBot in the form of microswitches, while we will program the PhizzyBot to trundle around the room, taking evasive action whenever it bumps into anything. Later we'll be augmenting the PhizzyBot with some optical sensors, but all of that is in the future. For the nonce, we'll concentrate on testing and controlling the motors.

From Alan's article we know that we will be using the least-significant (LS) nibble (four bits) of one of our external output ports to drive the motor controller device (this leaves the most-significant (MS) nibble free to control more motors or other devices in the future). The bits used to control the motors are shown in Table 1.

In this context, the terms "Left" and "Right" refer to your perspective if you were to shrink yourself down to a height of six inches (15cm) and position yourself atop of the PhizzyBot looking towards its front end. If both motors are instructed to drive forwards, the entire PhizzyBot will trundle forwards (Fig.1a), and if both motors are driven in reverse, the PhizzyBot will go backwards (Fig.1b).

If the left-hand motor is driving forward while the right-hand motor is driving in reverse, then the PhizzyBot will rotate in a clockwise direction (Fig.1c). Similarly, if the right-hand motor is driving forward while the left-hand motor is driving in reverse, then the PhizzyBot will rotate in an anticlockwise direction (Fig.1d).

Almost last, if the left-hand motor drives forward and the right hand motor is turned off, the PhizzyBot will turn to the right (Fig.1e). Similarly, if the right-hand motor drives forward and the left-hand motor is turned off, the PhizzyBot will turn to the left (Fig.1f).

**Table 1. The bits used to control the motors.**

| LEFT | | | RIGHT | | |
|---|---|---|---|---|---|
| OP1 | OP0 | | OP3 | OP2 | |
| 0 | 0 | – | 0 | 0 | – |
| 0 | 1 | Reverse | 0 | 1 | Reverse |
| 1 | 0 | Forward | 1 | 0 | Forward |
| 1 | 1 | – | 1 | 1 | – |

### SKELETON PROGRAM

OK, what we're going to do is to create a skeleton (framework) program, which we'll develop as we go along. Invoke your PhizzyB Simulator, activate the assembler, and enter the program shown in Listing 1.

As we see from the Constant Declarations section at the beginning of the program, we're assuming that the interrupt-driven switch device we created in Part 4 is connected to the input port at address $F012. Similarly, we're assuming that the 8-bit l.e.d. bargraph display we created in Part 2 is connected to the output port at address $F031, while our new motor controller board will be connected to the output port at address $F032. (We'll ignore the **DELCONST** constant declaration for the moment).

The rest of this skeleton program essentially consists of comments, plus a few temporary locations and data values at the end that we'll be using in the not-so-distant future.

### EXPERIMENT 1

**Testing the motors**

Before you do anything else, save your skeleton program as **ddexp1.asm**. Now insert the following **GETCOMM** (get command) interrupt service routine between the "start and end of interrupt service routine" comments:

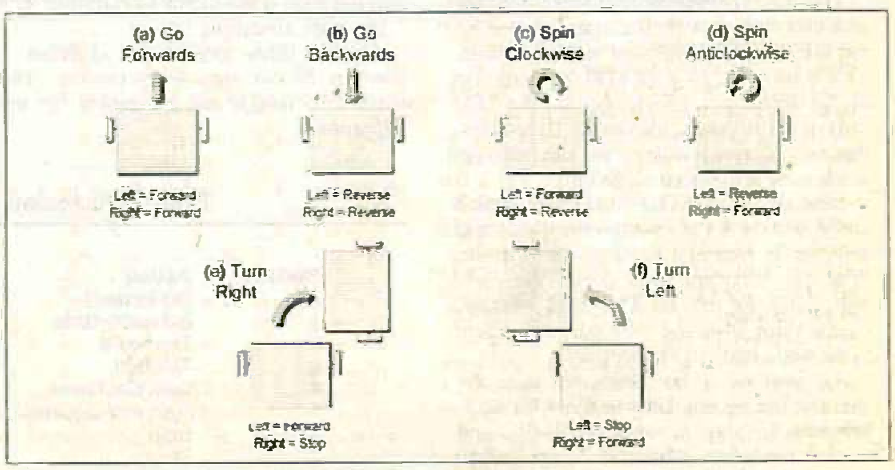



*Fig.1. Using the motors to control the PhizzyBot's direction.*

## Listing 1

```
### Start of Constant Declarations
SWITCHES:  .EQU   $F012          # Switch input device
MGRAPH:    .EQU   $F030          # Motor bargraph display
TGRAPH:    .EQU   $F031          # Timer bargraph display
MCONTROL:  .EQU   $F032          # Motor controller board
DELCONST:  .EQU    20            # Delay constant value
### End of Constant Declarations

### Start of Main Program Initialization
           .ORG   $4000          # Set program origin
           BLDSP  $4FFF          # Load stack pointer
### End of Main Program Initialization

### Start of Main Program Body
### End of Main Program Body

### Start of Interrupt Service Routines
### End of Interrupt Service Routines

### Start of Subroutines
### End of Subroutines

### Start of Temp Locations and Data Values
CNTFLAG:   .BYTE                 # Flag (0=stop count)
TVALUE:    .BYTE                 # Main timer temp value
COMMAND:   .BYTE $0A, $05, $02, $08, $06, $09, $00, $00
### End of Temp Locations and End of Program
           .END
```

```
GETCOMM:  LDA [SWITCHES]
          XOR $FF
          RTI
```

The first thing **GETCOMM** does is to read a value from the input port connected to the switches. From Part 4, we know that a closed switch (whichever one we've pressed) will present a logic 0 value to the port, while any open switches will present logic 1 values. But this is the opposite way round to the way we wish to see this data, so we next use an **XOR $FF** instruction to invert all of the 0s in the accumulator to 1s, and vice versa.

Finally, we execute an **RTI** (return from interrupt) instruction, which exits this routine and returns us to the main body of the program (with the value we read from the switches safely squirreled away in the accumulator).

Now insert the following statements between the "start and end of main program body" comments:

```
BLDIV      GETCOMM
           SETIM
MAINLOOP:  HALT
           STA [MGRAPH]
           STA [MCONTROL]
           JMP [MAINLOOP]
```

The first of these instructions loads the interrupt vector with the start address of our **GETCOMM** interrupt service routine. This is followed by a **SETIM** (set interrupt mask) instruction, which instructs the CPU to respond to future interrupts. (Interrupts, interrupt service routines, and the interrupt mask were introduced in Part 4.)

Next we use a **HALT** instruction, which will cause the CPU to stop everything and wait for an interrupt (or a reset) to occur. When an interrupt does occur, the CPU will jump to the **GETCOMM** routine, read a value from the switches, and return to the main body of the program.

As soon as we do return, we store the value in the accumulator to the 8-bit l.e.d. bargraph display at address $F030, and also to the motor controller connected to the output port at address $F032, then we jump back to the beginning of **MAINLOOP** and wait for a new interrupt to occur.

Assemble this program, download the resulting **ddexp1.ram** file to the PhizzyB, and set the program running. Now click switch S0 on the interrupt-driven switch device and observe the bit 0 l.e.d. on the $F030 bargraph display light up. Also observe that the left-hand motor starts to turn in its "reverse" direction. (Refer back to Table 1 at this time to remind yourself how the output bits relate to the motors.)

Now click switch S1 and observe bit 1 on the bargraph display light up and the left-hand motor start turning in its "forward" direction. Next click switch S2 and observe bit 2 on the bargraph light up and the right-hand motor start turning in its "reverse" direction. Now click switch S3 and observe bit 3 on the bargraph light up and the right-hand motor start turning in its "forward" direction.

Finally, click any of the switches S4 through S7 to stop both motors. Then reset the PhizzyB and proceed to the next experiment.

## *EXPERIMENT 2*

### More sophistication

The previous experiment served to prove that we can control the motors at a rudimentary level, but we really need to be a little more sophisticated. What we would like to do is to assign particular tasks to the different switches as shown in Table 2

For example, from Table 2 you will see that we want switch S4 to correspond to the command "Spin Clockwise". In order to do this, we need the left-hand motor to drive forwards (OP1 = 1 and OP0 = 0) and the right-hand motor to drive backwards (OP3 = 0 and OP2 = 1).

The hexadecimal digits associated with each of these commands are also shown in Table 2. If you now cast your attention to the data values associated with the label **COMMAND** at the end of our program, you'll see that these values correspond to those shown in Table 2 (Ah Ha! Much like my mother's custard . . . the plot thickens).

Save your modified program under the new name of ddexp2.asm, and then modify the **GETCOMM** routine so that it now looks like the one shown in Listing 2.

## Listing 2

```
#== Start of "Get Command" Routine
GETCOMM:    BLDX   $0000          # Load index register = 0
            LDA    [SWITCHES]     # Read value on switches
            XOR    $FF            # Invert 0s to 1s etc.
GCLOOP:     RORC                  # Rotate right 1 bit
            JC     [GCRETURN]     # Jump if carry flag = 1
            INCX                  # Else increment X reg
            JMP    [GCLOOP]       # Jump back and repeat
GCRETURN:   LDA    [COMMAND,X]    # Get command byte
            RTI                   # Exit routine
#== End of "Get Command" Routine
```

As you see, our new **GETCOMM** routine is a little more sophisticated than our earlier version. First we use a **BLDX** instruction to load the index register with **0**. Then we use an **LDA** to read a value from the switches and an **XOR** to invert that value into the form we prefer.

Now we enter a loop starting at **GCLOOP**, in which we rotate the accumulator one bit to the right, which causes the bit that "falls off the end" to be copied into the Carry flag. If we see a 1 in the Carry flag we jump to the **GCRETURN** label, otherwise we increment the index register and jump back to **GCLOOP**.

Thus, when we actually reach the **GCRETURN** label, the value in the index register corresponds to the number of the switch that we pressed (that is, for switch S0 the index register contains 0, for switch S1 the index register contains 1, and so forth).

The cunning part of all this occurs at **GCRETURN**, in which we use an **LDA** to load the accumulator using the indexed

**Table 2: Associating commands with the switches.**

| Switch | Action | Output Bits OP3 | OP2 | OP1 | OP0 | Hex Value |
|---|---|---|---|---|---|---|
| 0 | Go forward | 1 | 0 | 1 | 0 | A |
| 1 | Go backwards | 0 | 1 | 0 | 1 | 5 |
| 2 | Turn right | 0 | 0 | 1 | 0 | 2 |
| 3 | Turn left | 1 | 0 | 0 | 0 | 8 |
| 4 | Spin clockwise | 0 | 1 | 1 | 0 | 6 |
| 5 | Spin anti-clockwise | 1 | 0 | 0 | 1 | 9 |
| 6 | Stop | 0 | 0 | 0 | 0 | 0 |
| 7 | Stop | 0 | 0 | 0 | 0 | 0 |

## Listing 3

```
#== Start of "Main Timer" Routine
TIMER:      STA   [TVALUE]     # Store original count
            STA   [CNTFLAG]    # Set flag to non-zero
TLOOPA:     JSR   [ONETENTH]   # Call 1/10 Sec loop
            LDA   [CNTFLAG]    # Load flag
            JZ    [TRETURN]    # Jump if flag=0
            LDA   [TVALUE]     # Load count value
            DECA               # Decrement it
            STA   [TVALUE]     # Store it
            STA   [TGRAPH]     # Store it to LEDs
            JNZ   [TLOOPA]     # Loop again if !=0
TRETURN:    RTS                # Exit subroutine
#== End of "Main Timer" Routine

#== Start of "1/10 Second Sub-Timer" Routine
ONETENTH:   LDA    DELCONST    # Load count value
OTLOOPA:    DECA               # Decrement it
            JNZ   [OTLOOPA]    # Loop again if !=0
OTRETURN:   RTS                # Exit subroutine
#== End of "1/10 Second Sub-Timer" Routine
```

addressing mode. That is, the statement **LDA [COMMAND,X]** instructs the CPU to "load the accumulator with the data in the location whose address is given by adding the address of the label **COMMAND** with the contents of the index register". (Phew!)

Remember that the PhizzyB's addressing modes are discussed in Appendix A of *The Official Beboputer Microprocessor Databook* (and also that this Appendix is provided *free* with your PhizzyB Simulator – see the simulator's online help for more details).

The end result is that if you click switch S0, this instruction will load the accumulator with the data value $0A (stored at the address of **COMMAND** + index register = 0). If you click switch S1, we'll load the accumulator with the data value $05 (stored at the address of **COMMAND** + index register = 1), and so forth.

Assemble this program, download the resulting **ddexp2.ram** file to the PhizzyB, and set the program running. Now click switch S0 on the interrupt-driven switch device and observe bits 3 and 1 on the $F030 bargraph display light up. Also observe that both the left and right motors start to go in their forward direction.

Refer back to Table 2 to remind yourself how the switches relate to the different commands, then experiment by pressing switches S0 through S5 to confirm that everything works as expected.

Finally, click switch S6 or S7 to stop both motors, then reset the PhizzyB and proceed to the next experiment.

## EXPERIMENT 3

### Creating a timing routine

One thing we're going to require in the future is the ability to perform actions for specific amounts of time. For example, "go forward for 5 seconds, turn right, pause for 3.5 seconds, go forward for 2 seconds", and so forth.

Before we leap into action, it will be advantageous to our future selves if we spend a little time thinking about the "usage model" for this routine (that is, how are we going to call it from other parts of the program).

For example, it would be a pain if we created a timing loop that had to be executed some weird number of times, such as "214 cycles round the loop equals one second". In this case, whenever we wanted a specific delay, we'd have to whip out a pencil and start performing calculations (e.g. a delay of 2.5 seconds = 2.5×214 = 535 cycles . . . *arrgggh*).

A more preferable solution for our purposes would be to be able to instruct the routine to delay for a specific number of 1/10ths of a second. With this in mind, save your previous program as **ddexp3.asm** and then enter the two subroutines shown in Listing 3 between the "start and end of subroutines" comments.

First let's consider the **ONETENTH** subroutine, which is the one we're going to use to create a delay of 1/10th of a second. We commence this subroutine by loading the accumulator with the value represented by the constant label **DELCONST** (delay constant), which we originally declared in the Delay Constants section at the beginning of the program.

Next we start a loop in which we decrement the value in the accumulator and then test it with a **JNZ** (jump if not zero) instruction. This means that we keep on looping around until the accumulator contains zero, at which point we exit from the subroutine. So all we have to do is to assign an appropriate value to **DELCONST**, such that this routine does indeed take 1/10th of a second to count the accumulator down to zero.

Now turn your attention to the main **TIMER** subroutine, whose delay value (specified as an integer number of 1/10ths of a second) is already present in the accumulator when we call the routine (we'll see how this happens in a moment).

The first thing we do when we enter this routine is to save the value in the accumulator to our temporary location **TVALUE** (which we reserved at the end of the program). Next we store the same value to the **CNTFLAG** location, on the basis that we're going to use any non-zero value in this location to indicate that the count should proceed.

Now we enter a loop that commences at label **TLOOPA**, and the first thing we do is to call our **ONETENTH** subroutine (this is an example of "nested subroutines", in which one routine calls another).

As soon as we return from **ONETENTH**, we load the accumulator with the value in **CNTFLAG**. If the value of this flag has been mysteriously set to zero we will exit the **TIMER** routine, otherwise the count will continue. Next month we will investigate how we can use an interrupt to modify the **CNTFLAG** value and terminate the count. The reason we've included this test here is that adding instructions at a later date will modify (i.e. mess up) any delays generated by our routines.

Next we re-load the count value from our **TVALUE** temporary location, decrement it, store it away again, and also store it to **TGRAPH**, which is the address of the output port driving the external 8-bit l.e.d. display. Thus, this display will be updated with a new value every 1/10th of a second.

Next we test the count value to see if it is zero. If so we'll exit this routine and return to the main program, otherwise we'll jump back to the beginning of the loop at **TLOOPA** and do the whole thing again.

Now we need to create a very simple interrupt service routine. Scroll through the program to the "start of interrupt service routines" comment and insert the following statement:

```
WAITIRQ:    RTI
```

As we said, this really is a very simple routine. In fact all it does (when it's called) is to return, but that's enough for our purposes as we'll see.

Last but not least, we need to modify the instructions between the "start and end of main program body" comments such that they now read as follows:

```
BLDIV       WAITIRQ
            SETIM
MAINLOOP:   HALT
            LDA 250
            JSR [TIMER]
            JMP [MAINLOOP]
```

This is very similar to what we did before. In this case, the **BLDIV** instruction loads the interrupt vector with the start address of our new **WAITIRQ** interrupt service routine. This is followed by a **SETIM** (set interrupt mask) instruction, which instructs the CPU to respond to future interrupts.

Next we use a **HALT** instruction, which will cause the CPU to stop everything and wait for an interrupt (or a reset) to occur. When an interrupt does occur, the CPU will jump to the **WAITIRQ** routine, which, as we just discussed, does nothing except return.

As soon as we do return, we load the accumulator with a value of 250 (which we understand to mean 250 × 1/10th of a second = 25 seconds). Then we call our timer routine which we hope will count down the appropriate delay, then we jump back to the beginning of **MAINLOOP** and wait for a new interrupt to occur.

## TIMER CALIBRATING

Assemble this program to generate the corresponding **ddexp3.ram** file, download the program to the PhizzyB, and set it running.

Now place your wristwatch on the table next to your PhizzyB, wait for the second hand to reach the top, and click the PhizzyB's IRQ (interrupt request) button. Observe that the 8-bit l.e.d. bargraph display connected to the output port at address

$F031 starts to count down from binary 11111010 to 00000000 (from 250 to 0 in decimal). Note the elapsed time in seconds as soon as all of the l.e.d.s are extinguished.

Press the IRQ button again to re-time the delay. Repeat this several times and average the delay values to try to compensate for human error. This average should turn out to be approximately 38 seconds, which is a bit longer than the 25 seconds we require.

Reset the PhizzyB, return to the assembler and scroll to the **DELCONST** label at the top of the program, and modify the value assigned to this label to 5. Re-assemble the program and re-run the above tests. This time the resulting average delay should be around 15 seconds, which is somewhat shorter than the 25 seconds we're looking for.

Experiment with different **DELCONST** values until you find the one that gives you a total delay as close to 25 seconds as possible (a **DELCONST** value of 12 should be as close as makes no difference – dang, perhaps we should have mentioned that before, but then you wouldn't have had so much fun).

Once you've finished calibrating the timer, reset the PhizzyB and proceed to the final experiment.

## EXPERIMENT 4

**Honing your motor skills**

Now we're really humming along, because we've already got everything we need to proceed (no more routines to create). In fact all we've got to do is to "glue" our existing routines together in a slightly different way. So save your program as **ddexp4.asm** and then modify the main body of the program as shown in Listing 4.

**Listing 4**

```
### Start of Main Program Body
            BLDIV   GETCOMM        # Load interrupt vector
MAINLOOP:   SETIM                  # Enable interrupts
            HALT                   # Wait for an interrupt
            CLRIM                  # Disable interrupts
            STA    [MGRAPH]        # Store command to LEDS
            STA    [MCONTROL]      # Store to motor controller
            LDA     50             # Load ACC with 5 secs
            JSR    [TIMER]         # Call timer routine
            LDA    $00             # Load ACC with 0
            STA    [MGRAPH]        # Store "motors off" to LEDS
            STA    [MCONTROL]      # Store to motor controller
            JMP    [MAINLOOP]      # Wait for a new command
### End of Main Program Body
```

As we said, we've seen all of this before in one way or another, so perhaps the best thing to do is to run the program and see what happens. Assemble the new program to generate the corresponding **ddexp4.ram** file, download this program to the PhizzyB, and set it running.

Now click switch S0 and observe that the 8-bit l.e.d. at output port $F030 displays a value of 00001010 and both of the motors start up in their "forward" direction (just like they did in Experiment 2). Also observe that the 8-bit l.e.d. at output port $F031 starts to count down from 00110010 to 00000000 (from 50 to 0 in decimal), which equates to a five second delay. As soon as the timer counts down to zero, our new "main body" turns both of the motors off.

Similarly, clicking any of the switches S0 to S5 will result in the appropriate motors (as specified in Table 2) running for five seconds before stopping. Pretty cool eh? Next month we'll extend these routines to provide the PhizzyBot with some rudimentary intelligence, but feel free to experiment on your own until then.

## FURTHER EXPERIMENTS

On the off-chance that you're desperate for something to do, you could try exchanging the addresses associated with the **MGRAPH** and **TGRAPH** labels (such that the timer is now displayed on the l.e.d.s as address $F030 while the state of the motors is displayed on the l.e.d.s as address $F031).

Next, unplug the l.e.d. device from the output port at address $F031, replace it with the liquid crystal display (l.c.d.) module from Part 3, and modify the program so as to display appropriate messages on the l.c.d., along the lines of "Turning Left", "Going Forward", and suchlike. (This should keep you busy until we meet again in Part 6.)

# PhizzyB COMPETITION 1 – The Results

## AND THE QUESTION WAS ... ?

Consider the simple program shown in Listing 1. As we see, this program just loops around reading values from the 8-bit switch (connected to the input port at address $F010) and writing these values directly to the 8-bit l.e.d. (connected to the output port at address $F030).

**Listing 1**

```
INPORT:     .EQU $F010       # Constant label       =  0 bytes
OUTPORT:    .EQU $F030       # Constant label       =  0 bytes
                             #
            .ORG $4000       # Define start of prog =  0 bytes
LOOP:        LDA [INPORT]    # Load ACC             =  3 bytes
             STA [OUTPORT]   # Store ACC            =  3 bytes
             JMP [LOOP]      # Jump back and loop   =  3 bytes
                             #                        ----------
            .END             # End prog,     Total  =  9 bytes
```

Using the table provided in Appendix A of *The Official Bebopuler Microprocessor Databook*, we can determine that this program uses nine bytes of the PhizzyB's memory (note that this Appendix is provided with the PhizzyB Simulator – check the simulator's online help for more details).

Remember that a switch = down = off = logic 0, while a switch = up = on = logic 1. Also an unlit l.e.d. = off = logic 0, while a lit l.e.d. = on = logic 1. Thus, using this program, a pattern of 00110101 on the switches will, not surprisingly, result in a pattern of 00110101 on the l.e.d.s.

As you may recall, the competition described in PhizzyB Part 3 tutorial (*EPE* Jan '99) required you to perform a very similar task to that performed by the program shown in Listing 1. However, for the purposes of the competition, we requested that you "flip" the value from the switches, such that the state of the most-significant (MS) left-most switch is displayed on the least-significant (LS) right-most l.e.d., and vice versa, and so forth for the other bits. For example, a pattern of 00110101 on the switches should result in a pattern of 10101100 on the l.e.d.s.

Furthermore, the judging criterion for this competition was that your program should use the smallest possible number of bytes in the PhizzyB's memory.

## FIRST-PASS SOLUTION

Before we look at the winning entry, it will be advantageous to peruse and ponder some alternative solutions created by the authors to see how one might set about tackling a problem such as this.

In this particular case, the core strategy appeared to be relatively obvious. We know that using a **SHL** (shift left) instruction to shift the contents of the accumulator one bit to the left will cause the MS bit (the bit that "falls off the end") to be copied into the carry flag. Similarly, we

**Table 1.**

| | | Original value | | | | | | | | | | Flipped value | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | C | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| X | | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | X | | X | X | X | X | X | X | X | X | Situation after reading switches |
| 0 | <- | 0 | 1 | 1 | 0 | 1 | 0 | 1 | X | 0 | | X | X | X | X | X | X | X | X | Shift original value 1 bit left |
| 0 | | 0 | 1 | 1 | 0 | 1 | 0 | 1 | X | 0 | -> | 0 | X | X | X | X | X | X | X | Rotate new value 1 bit right |
| 0 | <- | 1 | 1 | 0 | 1 | 0 | 1 | X | X | 0 | | 0 | X | X | X | X | X | X | X | Shift original value 1 bit left |
| 0 | | 1 | 1 | 0 | 1 | 0 | 1 | X | X | 0 | -> | 0 | 0 | X | X | X | X | X | X | Rotate new value 1 bit right |
| 1 | <- | 1 | 0 | 1 | 0 | 1 | X | X | X | 1 | | 0 | 0 | X | X | X | X | X | X | Shift original value 1 bit left |
| 1 | | 1 | 0 | 1 | 0 | 1 | X | X | X | 1 | -> | 1 | 0 | 0 | X | X | X | X | X | Rotate new value 1 bit right |
| | | | | | etc. | | | | | | | | | | etc. | | | | | |

**Listing 2**

```
INPORT:   .EQU    $F010      # Constant label        =  0 bytes
OUTPORT:  .EQU    $F030      # Constant label        =  0 bytes
                             #
          .ORG    $4000      # Define start of prog  =  0 bytes
OLOOP:    BLDX    8          # Load index register   =  3 bytes
          LDA     [INPORT]   # Load ACC              =  3 bytes
          STA     [OLDVAL]   # Store ACC to temp     =  3 bytes
ILOOP:    LDA     [OLDVAL]   # Reload OLDVAL         =  3 bytes
          SHL                # Shift ACC left 1 bit  =  1 byte
          STA     [OLDVAL]   # Store ACC in OLDVAL   =  3 bytes
          LDA     [NEWVAL]   # Load ACC with NEWVAL  =  3 bytes
          RORC               # Rotate ACC right      =  1 bytes
          STA     [NEWVAL]   # Store ACC on NEWVAL   =  3 bytes
          DECX               # Decrement index reg   =  1 byte
          JNZ     [ILOOP]    # If !0 jump to ILOOP   =  3 bytes
          STA     [OUTPORT]  # Else ACC -> LEDs      =  3 bytes
          JMP     [OLOOP]    # Do it all again       =  3 bytes
                             #
OLDVAL:   .BYTE              # Temp location         =  1 byte (data)
NEWVAL:   .BYTE              # Temp location         =  1 byte (data)
                             #                         ----------
          .END               # End prog,       Total = 35 bytes
```

know that using an **RORC** (rotate right through carry) instruction to rotate the accumulator one bit to the right will copy the contents of the carry flag into the MS bit of the accumulator.

This means that if we loop around shifting the original value to the left and rotating the new value to the right, we'll end up "flipping" the old value into the new value. For example, consider the sequence shown in Table 1 (C = carry flag, X = don't know/care).

Of course there are many other ways in which we could achieve the same result, but this technique seems to offer one of the more efficient solutions, so let's consider a first-pass implementation of this approach as shown in Listing 2.

At the beginning of the program (**OLOOP** = "outer loop") we use a **BLDX** (big load index register) instruction to load the index register with the number of times we intend to go around the **ILOOP** (inner loop). Next we load a value from the switches and store it to a temporary location called **OLDVAL**.

Now we enter our inner loop, in which we shift the old value to the left and rotate the new value to the right. We do this eight times using the index register as a counter and decrementing the index register each time we go around the loop. As soon as the index register contains zero we know that we've finished, so we store the new value to the 8-bit l.e.d.s and jump back to the beginning of the program to read a new value from the switches and start all over again.

As we see, our first-pass solution requires 35 bytes. Hmmm, can we do any better than this?

## USING THE STACK

As we know, the task is to create a solution that uses the smallest number of bytes. One point to remember is that loads and stores using the absolute addressing mode each require three bytes. This can be quite expensive as a percentage of the total program, so it's worth trying to cut down on these instructions as much as possible. For example, consider the program shown in Listing 3 (the differences to our previous attempt are highlighted in bold).

In this case we've decided to make use of the stack, because we can use **PUSHA** (push accumulator onto the stack) and **POPA** (pop accumulator from the stack) instructions to store values on and retrieve values from the stack, and these instructions each only require a single byte.

Thus, we can discard our **OLDVAL** temporary location, which saves us one byte. Unfortunately, we need to add a **BLDSP** (big load stack pointer) instruction, which costs us three bytes. However, once we've done this we can replace two **STA** (store accumulator) instructions (2 × 3 = 6 bytes) with two **PUSHA** instructions (2 × 1 = 2 bytes), which saves us four bytes. Also, we can replace an **LDA** (load accumulator) instruction (three bytes) with a **POPA** instruction (one byte), which saves us a further two bytes.

So the end result is that we have to add three bytes (from the **BLDSP**), but we save seven bytes from our finagling with the other instructions, which provides us with a total saving of four bytes, resulting in a program that is only 31 bytes long. Pretty good so far, but can anyone do better?

## AND THE WINNER IS . . .

The winning solution was presented by Don McBrien who hails from Ireland. As you'll see, Don quickly spotted the "Shift-Left-Rotate-Right" strategy for solving this problem (although he used a "Rotate-Left-Rotate-Right" variation). However, Don enhanced his solution with a rather cunning technique, which involves a simple example of self-modifying code (the concept of self-modifying code is introduced in our book *Bebop BYTES Back – An Unconventional Guide to Computers*).

Before we look at Don's solution, consider what you would expect the following snippet of code to do:

```
GROK: LDA %00000000
      STA [OUTPORT]
```

You probably wouldn't be amazed to discover that running this program segment would cause a binary value of 00000000 to be written to the output port. But now consider the following:

```
      LDA %11111111
      STA [GROK + 1]
GROK: LDA %00000000
      STA [OUTPORT]
```

**Listing 3**

```
INPORT:   .EQU    $F010      # Constant label         =  0 bytes
OUTPORT:  .EQU    $F030      # Constant label         =  0 bytes
                             #
          .ORG    $4000      # Define start of prog   =  0 bytes
          BLDSP   $4FFF      # Load stack pointer     =  3 bytes
OLOOP:    BLDX    8          # Load index register    =  3 bytes
          LDA     [INPORT]   # Load ACC               =  3 bytes
          PUSHA              # Store ACC to stack     =  1 byte
ILOOP:    POPA               # Get ACC from stack     =  1 byte
          SHL                # Shift ACC left 1 bit   =  1 byte
          PUSHA              # Store ACC to stack     =  1 byte
          LDA     [NEWVAL]   # Load ACC with NEWVAL   =  3 bytes
          RORC               # Rotate ACC right       =  1 bytes
          STA     [NEWVAL]   # Store ACC on NEWVAL    =  3 bytes
          DECX               # Decrement index reg    =  1 byte
          JNZ     [ILOOP]    # If !0 jump to ILOOP    =  3 bytes
          STA     [OUTPORT]  # Else ACC -> LEDs       =  3 bytes
          JMP     [OLOOP]    # Do it all again        =  3 bytes
                             #
NEWVAL:   .BYTE              # Temp location          =  1 byte (data)
                             #                          ----------
          .END               # End prog,        Total = 31 bytes
```

### Listing 4

```
INPORT:   .EQU    $F010        # Constant label        =  0 bytes
OUTPORT:  .EQU    $F030        # Constant label        =  0 bytes
                               #
          .ORG    $4000        # Set start of prog     =  0 bytes
INIT:     BLDX    8            # Set INDEX to 8        =  3 bytes
          LDA     [INPORT]     # Get input             =  3 bytes
          STA     [LOOP+1]     # Store input           =  3 bytes
                               #
LOOP:     LDA     $00          # Load FORWARD in ACC   =  2 bytes
          ROLC                 # Shift MS bit to C     =  1 byte
          STA     [LOOP+1]     # ... and store it      =  3 bytes
          LDA     $00          # Load REVERSE to ACC   =  2 bytes
          RORC                 # Shift C to LS-bit     =  1 byte
          STA     [LOOP+7]     # ... and store it      =  3 bytes
                               #
FINISH:   DECX                 # Decrement INDEX       =  1 byte
          JNZ     [LOOP]       # Loop if not zero      =  3 bytes
          STA     [OUTPORT]    # Write REVERSE out     =  3 bytes
          JMP     [INIT]       # Jump back to start    =  3 bytes
                               #                         ----------
          .END                 # End prog,       Total = 31 bytes
```

### Table 3

| Data bytes | Even parity | Odd parity |
|---|---|---|
| 00000000 | 0 | 1 |
| 00000001 | 1 | 0 |
| 00110011 | 0 | 1 |
| 00110111 | 1 | 0 |
| 11111110 | 1 | 0 |
| 11111111 | 0 | 1 |

In this case, the value written to the output port would actually be 11111111. The reason for this is quite simple, but it does require a little "lateral thinking" to get the hang of it. Note the label **GROK**. The address the assembler associates with **GROK** is the address of the **LDA** opcode, so **GROK + 1** will be the address of the operand (data) byte associated with this opcode.

When we first assemble this program, the assembler will cause a binary value of 00000000 to be loaded into the memory location at address **GROK + 1**. However, when we actually run the program, the first **STA** instruction will overwrite the contents of location **GROK + 1** with a value of 11111111. The second **LDA** will subsequently load this 11111111 value into the accumulator, and the second **STA** will store this value to the output port.

Now consider Don's solution as shown in Listing 4 (the lines highlighted in bold are the ones in which Don uses his self-modifying code).

As we see, this program has no subroutines, no temporary data locations, and no stack. In fact this really is a rather cunning approach. First, Don saves a byte for each temporary location he doesn't use. But more importantly, the **LDA** instruction at the label **LOOP** (and the next **LDA** three instructions lower down) can now use the immediate addressing mode (two bytes) as opposed to the absolute addressing mode (three bytes).

The end result is that Don's self-modifying solution requires only 31 bytes, which equals the authors' best attempts above.

All credit – plus a year's free subscription to the printed edition of *EPE* – goes to Don for a very interesting solution.

## CLEVER DICK!

But you could flay us with wet noodles if you think that we're going to let "Clever Dick" Don beat us (or at least match us) on his first attempt!

So let's consider what happens if we apply Don's self-modifying code concept to our last solution from Listing 3. First of all we can lose our **NEWVAL** temporary location, which saves us one byte. Next we can replace our **LDA [NEWVAL]** (absolute addressing mode) instruction with an **LDA $00** (immediate addressing mode) version, which saves us a second byte. This modified program is shown in Listing 5 (the modifications are highlighted in bold).

### Listing 5

```
INPORT:   .EQU    $F010        # Constant label         =  0 bytes
OUTPORT:  .EQU    $F030        # Constant label         =  0 bytes
                               #
          .ORG    $4000        # Define start of prog   =  0 bytes
          BLDSP   $4FFF        # Load stack pointer     =  3 bytes
OLOOP:    BLDX    8            # Load index register    =  3 bytes
          LDA     [INPORT]     # Load ACC               =  3 bytes
          PUSHA                # Store ACC to stack     =  1 byte
ILOOP:    POPA                 # Get ACC from stack     =  1 byte
          SHL                  # Shift ACC left 1 bit   =  1 byte
          PUSHA                # Store ACC to stack     =  1 byte
NEWVAL:   LDA     $00          # Load ACC with NEWVAL   =  2 bytes
          RORC                 # Rotate ACC right       =  1 bytes
          STA     [NEWVAL+1]   # Store ACC in NEWVAL    =  3 bytes
          DECX                 # Decrement index reg    =  1 byte
          JNZ     [ILOOP]      # If !0 jump to ILOOP    =  3 bytes
          STA     [OUTPORT]    # Else ACC -> LEDs       =  3 bytes
          JMP     [OLOOP]      # Do it all again        =  3 bytes
                               #                          ----------
          .END                 # End program      Total = 29 bytes
```

Thus, the authors' final version of this program requires only 29 bytes. "Ha! Take that Red (Don) Baron!". And of course this is absolutely the smallest solution to this problem that anyone could ever achieve in the known universe . . . unless *you* can offer a better solution . . .

*A PIC device can do it in six bytes! Ed.*

## COMPETITION 2

When one conveys digital data from one portion of an electronic system to another or from one system to another, noise or other "glitches" may occasionally flip a bit from a 0 to a 1 or vice versa.

For example, suppose that we were to transmit a byte of information containing the value 00110111 from one computer to another, but that something occurred to flip the least-significant (LS) bit from a 1 to a 0, such that the receiving computer was presented with the value 00110110.

This could obviously cause problems, so we need some way to detect (and ideally correct) errors in our data. One of the simplest forms of error detecting codes is that of parity. For example, an extra (parity) bit can be appended to each transmitted byte of data.

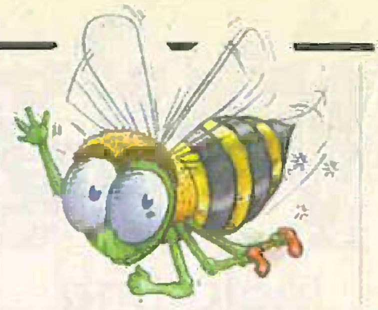
The idea is that the transmitter counts all of the 1s in the original byte, and uses this number to determine the value of the ninth bit. In the case of an "Even Parity" scheme, the ninth (parity) bit would be set so as to maintain an even number of 1s. Alternatively, when using an "Odd Parity" approach, the ninth (parity) bit would be set so as to maintain an odd number of 1s. For example, consider the data bytes and their resulting parity bits shown in Table 3.

The transmitting unit transmits each byte along with its associated parity bit. The receiving unit generates its own parity bit for each byte and compares this to the transmitted parity bit. If the two parity bits differ, the receiver knows that an error has occurred and can respond appropriately (for example, it could request that this byte be re-transmitted).

Competition 2 is to write a program that loops around reading a value from the 8-bit switch device (connected to the input port at address $F010), generating the odd-parity bit associated with this value, and displaying this parity bit using the LS bit of the 8-bit l.e.d. display (connected to the output port at address $F030).

The judgement criteria for this competition is that the program should read the value from the switches and write the resulting parity bit to the l.e.d. display using the least number of PhizzyB clock cycles (a table of PhizzyB instructions versus clock cycles is provided in the *EPE Online Library* at www.epemag.com).

E-mail submissions to editor@epemag.com. The winner will receive a year's free subscription to the printed edition of *EPE*. The closing date is whenever we decide to "close the doors" and the decision of the judges is final!



# PhizzyB COMPUTERS

## Construction – The PhizzyBot

Alan Winstanley

*Polling and interrupts set us on course for our super wheelie – the phabulous PhizzyBot!*

THIS month's practical constructional article describes the assembly and operation of a simple motorized buggy which can be guided and controlled by a suitably programmed PhizzyB. After several seconds of searching for a moniker which could be attached to Max and Alvin's latest creation, the name *PhizzyBot* was contrived, and unfortunately it appears to have stuck. So, ladies and gentlemen, start your engines, as they used to say in the golden days of grand prix motor racing.

The PhizzyBot is a two-wheel drive motor platform which can be configured to demonstrate a number of very absorbing practical assignments. In due course we will be actively investigating collision detection/obstacle avoidance as well as simple photo-sensitive applications (e.g. the PhizzyBot's inquisitive attraction to artificial light sources).

Such experiments incorporate all of the principles of computer programming which we have described in earlier parts of the PhizzyB tutorial series, as well as introducing further programming commands and techniques. Oh, and since the PhizzyBot can "feel" its way around by using a system of input detection switches, we will be able to make further use of the simple switch input devices assembled in previous months as well!

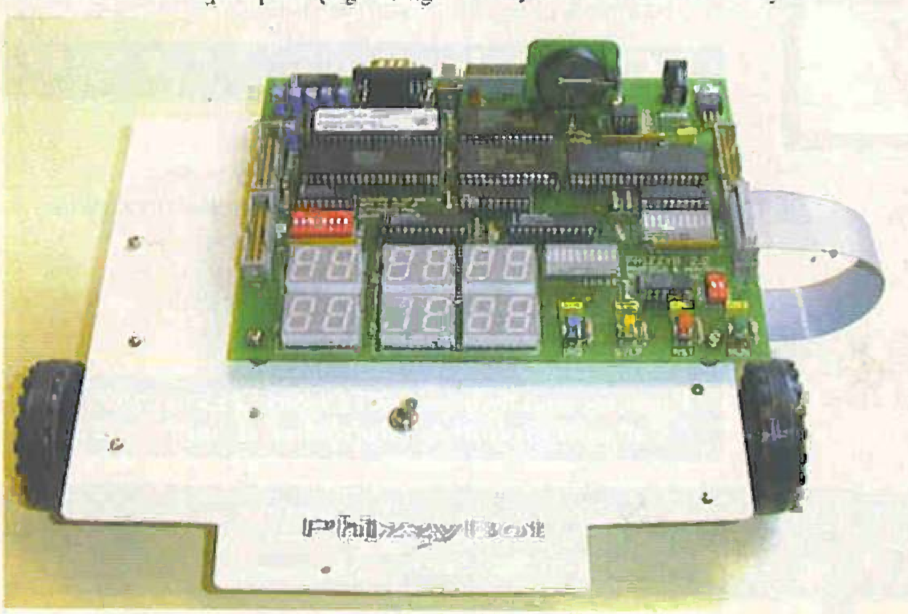
This article describes the construction of a simple motor controller which connects directly to a PhizzyB output port. A PhizzyB can then be programmed to read the state at an input port (e.g. using external microswitches that are activated in a "collision") and a control signal is then sent to the PhizzyBot motor controller board by the PhizzyB's output port.

### SIMPLE AND SAFE

The PhizzyBot platform is simple and safe to construct but is remarkably effective. It consists of two d.c. gear motors which are switched by a transistor-driven relay controller. The motors are battery powered, and later on the associated PhizzyB can be powered by a 9V rechargeable battery (for example) so that a completely independent stand-alone buggy can be produced, with a PhizzyB fitted on top of the motor platform.

The PhizzyBot can then advance, reverse or rotate in either direction under the control of a PhizzyB. By incorporating other types of input circuitry, the PhizzyBot can be made to respond to other stimuli – such as a light source (i.e. an attraction to, or repulsion from – hence the possibility of a *MothBot* and *RoachBot*), or it could be made to navigate around a maze. We'll be describing more applications and ideas for the PhizzyBot in the concluding parts of this series.

In order to assemble a PhizzyBot, readers will require a hardware PhizzyB single board computer together with the full version CD-ROM of the *PhizzyB Simulator*, which runs on a Windows 95/98/NT personal computer. The PC is used to assemble the programs which are then transmitted via the PC's serial port to the PhizzyB mounted on the PhizzyBot.



*The phabulous PhizzyBot!*

As usual, we'll give all the necessary constructional details to enable even a novice to build the PhizzyBot with every probability that it will work first time. In order to avoid disappointment, our advice is to read through all the following details and to take your time and not to rush the construction.

### PHIZZYBOT CIRCUIT

The circuit diagram for the PhizzyBot is given in Fig.1, which divides into two sections. The motor driver circuit utilises four transistor switches, TR1 to TR4, each of which controls the coil of a corresponding single-pole changeover relay (RLA to RLD respectively).

Such relays have a single contact (the "pole") which moves between two contacts labelled normally open (n.o.) and normally-closed (n.c.). Hence, when the relay coil is powered, it will connect together the pole and the *normally-open* contact. This occurs whenever the base terminal of the driver transistor is taken to +0·6V (indicating a logic "high" on its input resistor – R1 to R4 as appropriate): the transistor switches on and this completes the circuit to the relay coil.

Note that each relay coil also has a reverse-biased diode connected across its coil, in order to snub out the often substantial reverse voltage (back e.m.f.) which appears when the coil is switched off again.

### MOTOR DIRECTIONS

Two small d.c. motors, M1 and M2, are used for the left and right "engines" which are controlled by the relay contacts. The circuit diagram shows the contacts in their normal (unpowered) states. *For the purposes of our articles, the descriptions of "left" and "right" are taken from a PhizzyBot driver's point of view – as if he'd been shrunk and sat on the moving PhizzyB.*

By reversing the d.c. voltage across either motor, the direction of the PhizzyBot can be controlled. Using motor M1 as an example, we see that this is switched by the relays RLA and RLB, whose contacts RLA1 and RLB1 are connected to both terminals of motor M1.

The normally-closed contacts ensure that the motor is connected to the 0V rail when neither relay is powered. This means that the motor will not operate because no voltage is present across it. Similarly, if both relays coils are switched on, then their normally open contacts will now close. Both terminals of M1 will then be connected to the PhizzyBot's +6V supply rail – which again means that the motor will not function.

However, if one of the relay contacts is "high" at +6V and the other is at 0V, then

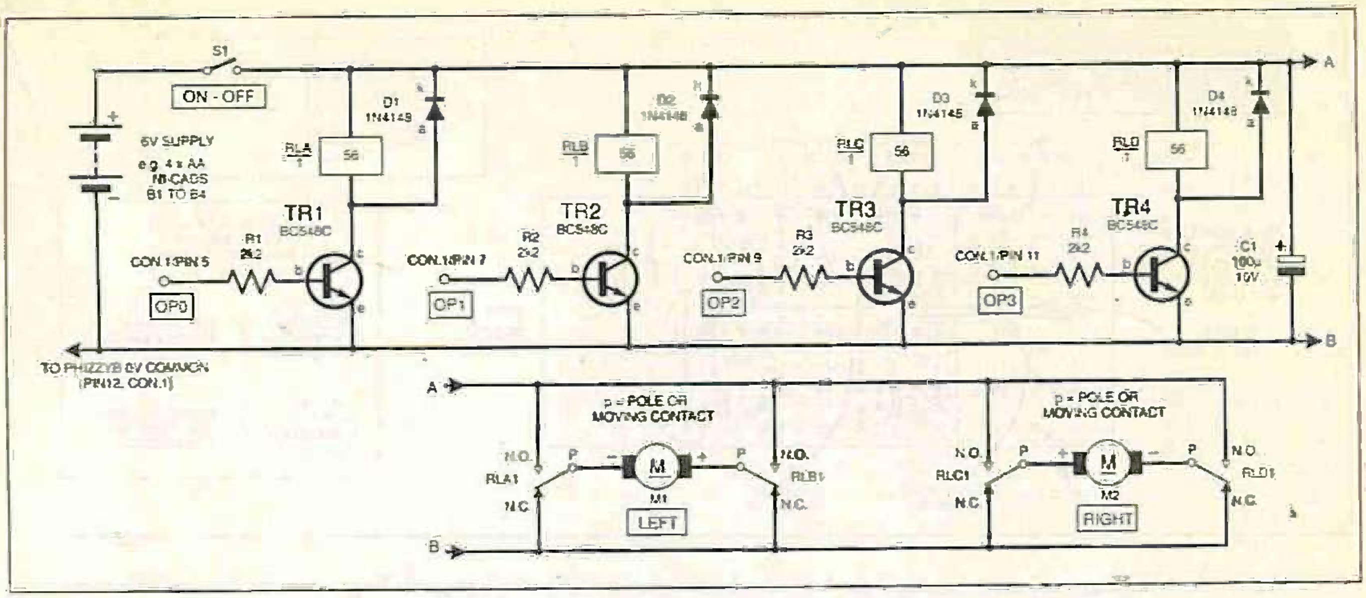



*Fig.1. Complete circuit diagram for the PhizzyBot motor control interface.*

the motor will be powered. If the contacts are in dissimilar states then the PhizzyBot will move, and the polarity of the applied voltage determines the direction of rotation of the motor's shaft.

It will be seen that the direction of both motors can be controlled very simply by using a 4-bit code. Each transistor's base terminal connects to the output pins OP0 to OP3 of a PhizzyB output port. By turning a transistor on or off, one terminal of the corresponding d.c. motor will be switched accordingly, and thus we can steer the PhizzyBot in the desired direction. This month's accompanying tutorial article describes how the PhizzyBot can be made to advance, reverse, steer or rotate in either direction.

The current consumption of each motor is quite substantial – approximately 500mA each as measured. Thus the PhizzyBot's motor circuit is powered by an independent 6V d.c. power supply which, on the prototype, was derived from four AA-size nickel cadmium (NiCad) cells (B1 to B4), switched by S1.

Note that the 0V rail of the motor driver circuit is also connected to the 0V bus of the PhizzyB (via pin 12 of the PhizzyB output port CON1). This is to provide a common 0V rail between the PhizzyB and the PhizzyBot. Let's now consider the assembly of the PhizzyBot.

## CONSTRUCTION

The constructional method falls into three sections: the transistor driver circuit, the relay board and lastly the motorised platform which will carry the rest of the electronics, including a fully-assembled PhizzyB board! Assembly can commence with the transistor board, see Fig.2.

This circuit is built onto a type "A" I/O board which is cut from one quarter of a full I/O board. Drill two 3mm clearance holes for the board mounting hardware (e.g. insulated stand-offs). A good tip: use the empty board to then mark out a simple template for the drilling centres which will be needed later when the board is fitted to the platform. The circuit board stand-offs will then align perfectly!

Commence assembly by inserting the transistors which must be orientated as shown (the pinout diagram gives the base view, looking "down" the pins); being semiconductors, they might be damaged by

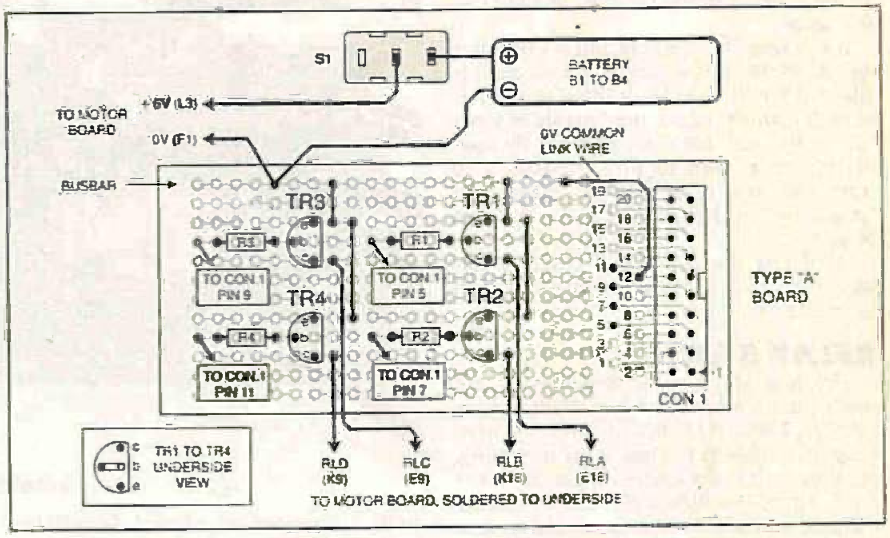
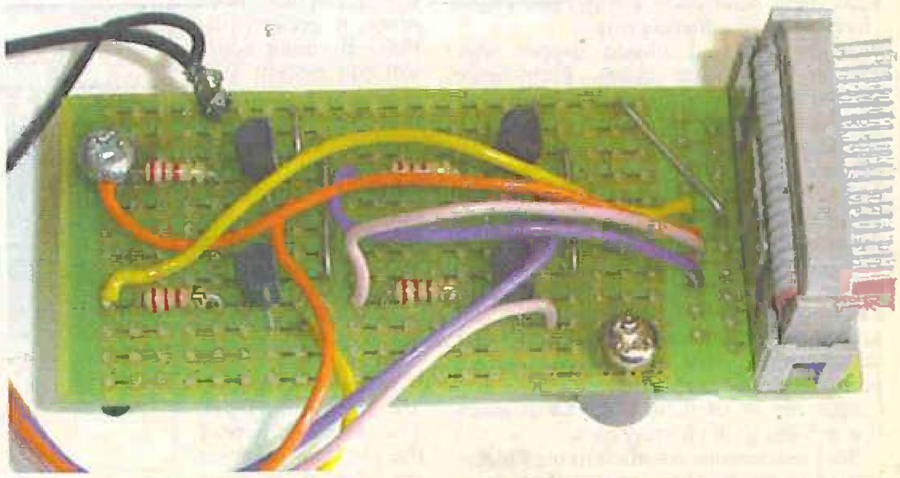



*Fig.2. The transistors are mounted on their own board.*

excessive heat but, provided that the solder joints are each completed in roughly a second or so, there will not be any problem.

Continue with the resistors and tinned copper wire jumpers. A 20-way box header is used for CON1, which is orientated as shown (look for the central slot along one side, and the arrowhead for pin 1 as usual). A solitary pin header can be inserted for the connection to the 0V terminal of the battery pack B1 to B4. It will be seen that a +6V connection is not needed for this board.

At this point, four 6in (152mm) long flying leads made from general purpose hook-up wire can also be soldered, the other ends of which will eventually connect to the separate relay board. Four 2in (50cm) link wires are also needed to connect the resistors to their corresponding



*Fully assembled transistor board, complete with connector.*

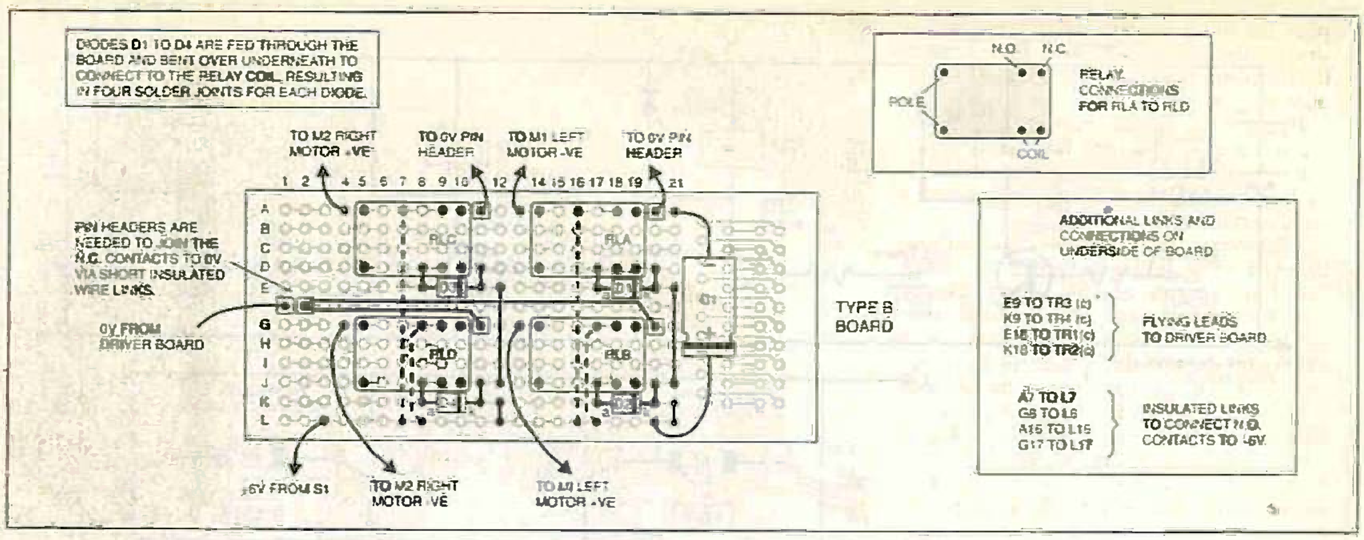



*Fig.3. The four relays are also mounted on their own board and linked to the transistor board and motors as indicated.*

OP solder pads next to CON1– however, **do not connect to the OP pins of CON1 at this stage.**

It will simplify checking and testing later on considerably if a simple colour code is adopted for all eight leads fitted (two leads of each colour). Leave the four short leads "up in the air" for now, because by connecting any of them to +6V, the associated transistor and relay can be turned on "manually" so that motors and relays can be tested.

We'll test the completed circuitry this way at the end, so put the transistor board to one side for now.

## RELAY STATION

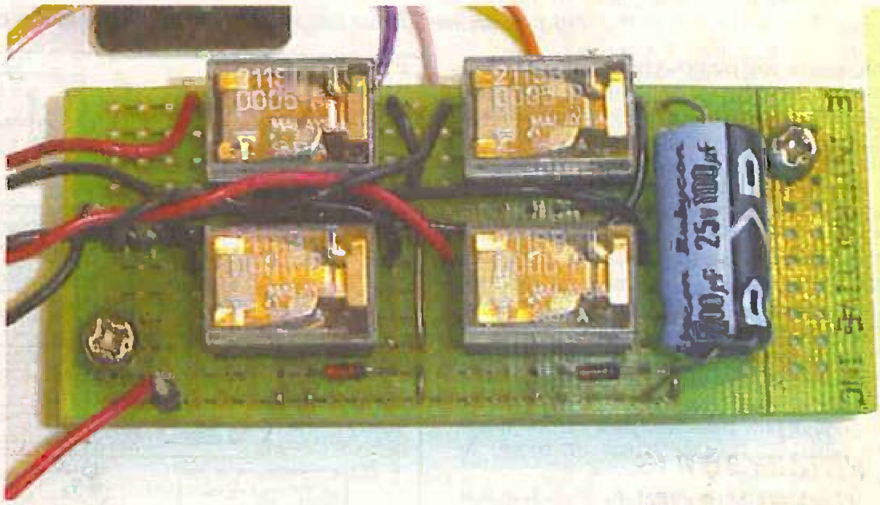
The next stage is the assembly of the small relay board which was built onto a type "B" PhizzyB I/O board. Drill two 3mm clearance holes in the board for mounting, then proceed to the interwiring as shown in Fig.3. Space is a little tight but the recommended relays will all fit comfortably onto one board, so commence by soldering the four relays into place, observing their orientation (see inset diagram).

The four diodes (D1 to D4) can follow next, and **correct polarity is essential or they will be damaged when the circuit is powered. Check for a stripe which denotes the cathode terminal.** The diodes are fed through the board from above and their leads should then be cut to length and "doubled over" on the underside to connect to the relay coils. There are thus *four* solder joints per diode. Take care not to heat these semiconductor devices excessively with the soldering iron.

Insert the four tinned copper wire jumper leads from above. Four more jumper wires are suggested on the underside of the board to connect each relay's n.o. terminals to the +6V bus. Use insulated wire or PVC sleeving for these links.

The n.c. contacts have to be wired to 0V, and the prototype made use of a pair of pin headers soldered into place as shown. Four insulated wires were soldered to the n.c. solder pad for each relay, then all four wires were soldered together on the pin headers. The electrolytic capacitor C1 can be soldered on the top side and **correct polarity is very important.** A single pin header can be used for the +6V connection needed to the battery pack.

We next turn our attention to the PhizzyBot platform in order to install the two motors, after which they can be interwired



*Fully assembled relay board.*

to the completed relay board. We will then be ready to test the motor driver circuitry, and at the same time the connections to OP0-OP3 will be finalised to ensure that both PhizzyBot motors respond correctly to some simple control commands (see "Final testing" later).

## PHIZZYBOT CHASSIS

The PhizzyBot chassis was constructed from 1/16in (1·6mm) Plasticard which is available from model shops. It is somewhat flexible but this is not a problem because the PhizzyB circuit board will add rigidity. It is considered feasible that thin gauge aluminium sheet could perhaps be used as a stronger alternative, but the plasticard was cheap and lightweight and was very easy to work with and forms a good basis for prototyping.

Approximate dimensions of the prototype are shown in Fig.4. The underside view of the platform is shown (so that it is clear which motor is "left" and "right"). An area approximately 5in × 1in (127mm × 25mm) protrudes from the front to allow leading-edge sensors to be fitted later, e.g. for use as a white line follower. Dimensions are not too critical.

Since the top of the PhizzyBot platform carries a hardware PhizzyB single board computer, the underside of the platform is used to mount the two motors, the battery

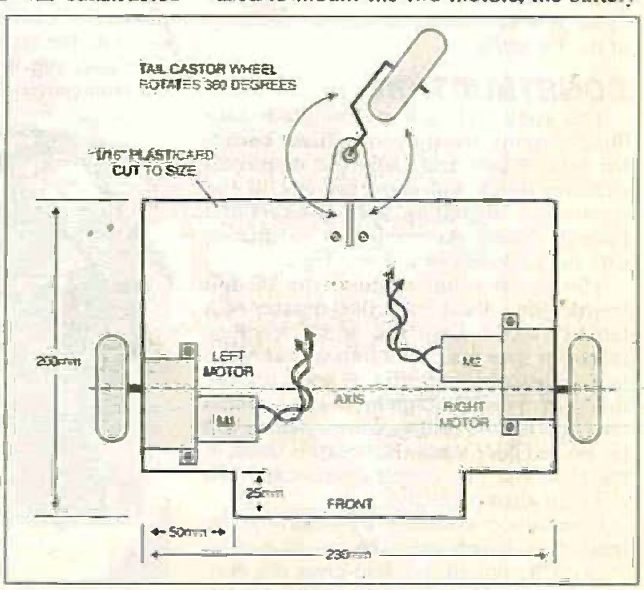



*Fig.4. Dimensions of the PhizzyBot platform.*

pack and the transistor and relay boards. A short ribbon cable will then interconnect the transistor board and the PhizzyB – see photos.

Recommended gear motors are stated in the components list, but alternative types could be utilised. The suggested ones are multi-ratio 1·5V to 4·5V d.c. motors with self-assembly gears.

They should be assembled as per the instructions included, selecting an initial speed of 74 r.p.m. at 4·5V supply. Therefore, four black gears are used, and three or four spacer washers (supplied) are used to take up the remaining free space on the drive axle. The gearmotors are bolted into position – *remembering that the two axles must align along a common axis*, see Fig.4. Astute readers will soon realise that if the PhizzyBot is to move forward, the two motors must therefore rotate in opposite directions – but let's worry about that later!

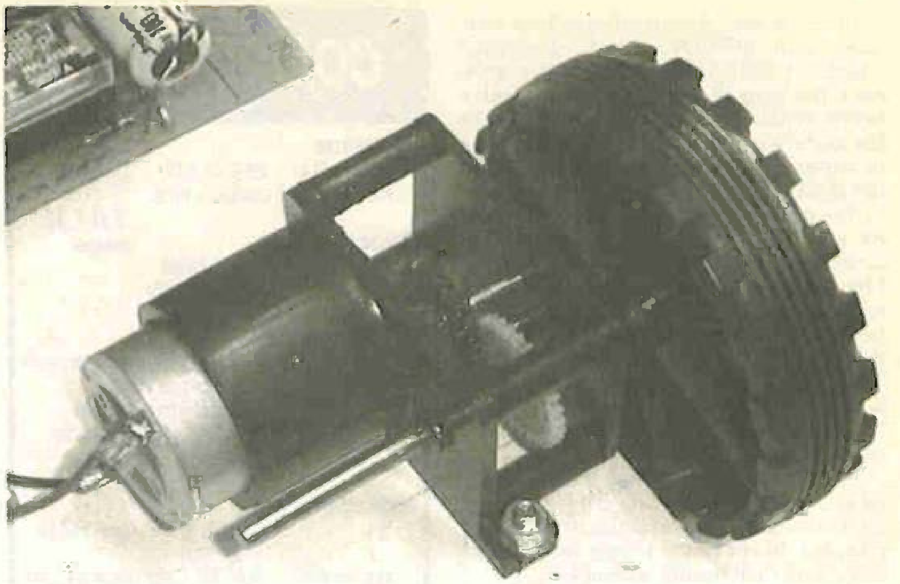
Unfortunately, during assembly the author found it impossible to close the plastic gearboxes together fully because the length of the two internal shafts prevented everything seating reliably. Some care was needed not to force everything together or the plastic gearbox housing could be easily damaged.

In the end, a solution was achieved by carefully grinding a fraction of a millimetre from the two shorter shafts using a Dremel sanding disk. This completely cured the problem and allowed the gear housings to be snapped together successfully. Readers will soon be able to determine if similar remedial action is needed.

Several drops of light oil are essential on the gears. (Apart from that, your PhizzyBot does not need a 12,000 mile service interval!)

## PHIZZYBOT IS WHEELY COOL!

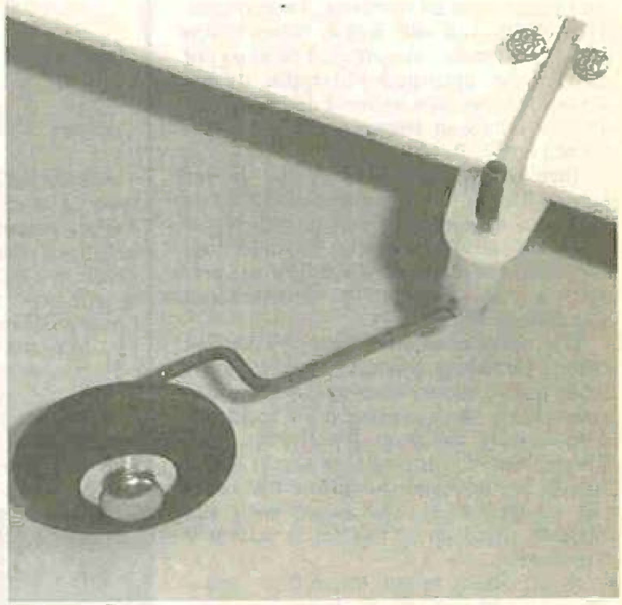
The gearmotors are surprisingly powerful and propel the complete PhizzyBot with ease but the efficiency of the completed PhizzyBot depends entirely on the type of wheels used. After some interesting trials the author eventually settled for 56mm diameter push-on rubber tyres which are very "grippy" and easily transport the PhizzyB along any carpeted or smooth surface.



*Close-up detail of a motor and its wheel.*

The tyres must be of sufficient diameter to enable the motors and circuit boards to clear the ground. Only cut the motor drive shafts to length when suitable tyres have been tested, and the recommended tyres simply push on with a tight fit and are perfect for the job. Each completed gearmotor can be tested using a d.c. battery up to 4·5V or so.

The rear wheel is just a stabilising "jockey" wheel, and a model aircraft freewheel with rubber tyre. This can be fitted centrally along the rear edge. Happily, this performs perfectly in that when the PhizzyBot reverses, the wheel swings round underneath the platform to become the "leading" wheel. It swings back out and trails the platform when the PhizzyBot moves forward again.

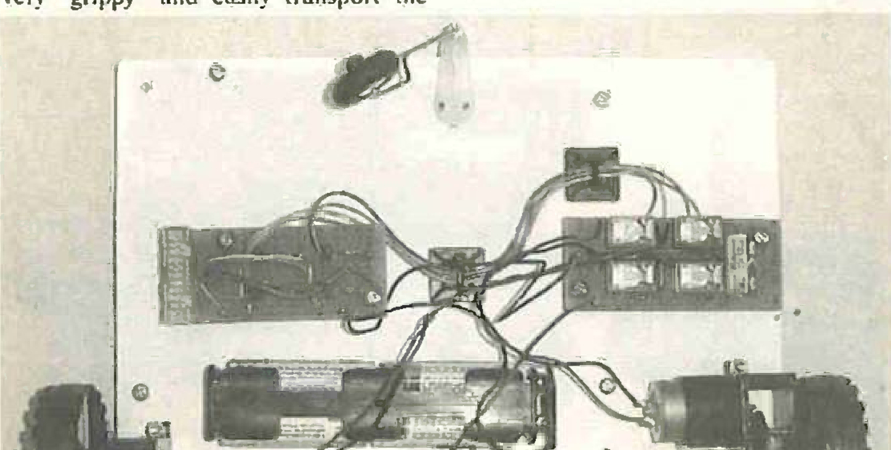


*The "jockey" wheel mounted in position.*

Simply cut a slot in the chassis and screw the mounting bracket into place, then bend the wheel's wire arm to ensure that the PhizzyBot is roughly level. A short piece of PVC sleeving can be fitted tightly over the wire end to prevent the arm falling through. All of the parts fitted to the underside should then be clear of the ground.

Continue construction by completing the interwiring between the relay and transistor board, plus the two motors themselves. Keep the motor wires as short as possible, and they can be soldered directly to the relay board. The motors should have a polarity marking and there will probably be a "+" sign moulded next to that terminal.

In order to allow for the fact that one motor must rotate in the opposite direction to the other for them to both transport the PhizzyBot in the same direction, note the polarity markings of the motor interwiring as shown in Fig.3. A simple test (see later) will soon confirm that the set-up is correct.



*The underside view of the motor platform showing the complete PhizzyBot hardware in position.*

At this stage, do not solder those four short wires OP0-OP3 on the transistor board to CON1 just yet, but you can hook over the long flying leads to the relay board. Nylon tie wraps and stick-on bases are useful for tidying up the wiring, or dabs of hot-melt glue can be used to tack down the wiring.

You can now plan for fitting the transistor and relay boards underneath the platform. The author recommends using M3 (3mm thread) standoffs, 10mm high. Some care is needed when positioning the circuit boards (see photos). *The main consideration is that CON1 on the transistor board must align approximately with the output port SF032 on the PhizzyB above it.* A short 20-way IDC ribbon cable then connects the two neatly.

It will then be seen that there is sufficient clearance underneath the platform to accommodate CON1 and the ribbon cable plug, but do not fit the ribbon cable at this stage until final testing is complete.

The PhizzyB can then be carefully fitted on the top, using M3 standoffs once again. The motor driver boards can be screwed into place when all soldering is completed. Henceforth, you will find it easier if you use, for example, an upturned bowl or pot to rest the upturned PhizzyBot during assembly (take care to avoid damaging the PhizzyB's back-up battery when the unit is turned upside down).

Turning our attention to the power source needed for the completed PhizzyBot, at a later stage it will be feasible to power a PhizzyB from an on-board 9V battery. This will allow the PhizzyBot to operate as a completely independent stand-alone buggy.

The author used an ordinary 9V Ni-Cad battery for testing: a simple power lead was made from a battery snap-on clip and a d.c. power plug, which enabled a 9V rechargeable battery to plug directly into the PhizzyB board in lieu of an external power supply. For now you should use the external mains adaptor as usual, with the PhizzyB raised up on the bench so that it freewheels.

As previously noted, the author used a set of four "AA" Ni-Cad cells to power the motor circuit. Expect 30 to 40 minutes before recharging is necessary. A low-profile battery holder was stuck down under the platform using double-sided sticky pads. A single toggle switch was used for S1, fitted onto the platform centrally.

## FINAL TESTING

The final aspect is to test the transistor and relay board, in order to ensure that the motors operate in accordance with the following truth table:

| LEFT | | | RIGHT | | |
|---|---|---|---|---|---|
| OP1 | OP0 | | OP3 | OP2 | |
| 0 | 0 | – | 0 | 0 | – |
| 0 | 1 | Reverse | 0 | 1 | Reverse |
| 1 | 0 | Forward | 1 | 0 | Forward |
| 1 | 1 | – | 1 | 1 | – |

A "1" in the table indicates a logic high, which means that when a particular OP line is high, the corresponding relay will switch on and the relevant motor will operate. By applying a little reverse engineering, we can make life easy for ourselves and force the PhizzyBot to behave as required simply by testing the four inputs OP0-OP3 on the constructed platform, see what happens and then solder the four OP flying leads to the appropriate connections at CON1.

## COMPONENTS

**Resistors**
R1 to R4 2k2 (4 off)
All 1/4W 5% carbon film

See SHOP TALK page

**Capacitor**
C1 100µ axial elect. 16V

**Semiconductors**
TR1 to TR4 BC548C or any general purpose *npn* transistor (4 off)
D1 to D4 1N4148 signal diode (4 off)

**Miscellaneous**
S1 s.p.s.t. miniature toggle switch
B1 to B4 "AA" Ni-Cad cells (4 off)
RLA to RLD s.p.c.o. min. relay, 5V 56Ω 1A, p.c.b. mounting, Fujitsu FBR211 series (4 off)
M1, M2 1·5V to 4·5V d.c. gearmotor (Como 430G) (2 off)
CON1 20-way IDC box header

PhizzyB I/O board, "A" type and "B" type (1 each); 56mm × 16mm solid rubber wheels (2 off); model aircraft tailwheel; Plasticard, 9in × 8in × 1/16in (228mm × 203mm x 1.6mm) gauge or to suit (see text); low profile 4 × AA battery holder; battery snap connector; M3 × 10mm mounting pillars (8 off); connecting wire; solder, etc.

The 20-way IDC lead and interrupt board required for this part have been constructed previously. (Fluffy dice and go-faster stripes are optional!)

**Approx. Cost Guidance Only £29** excluding batteries

Do this as follows: raise the PhizzyBot off the bench. Ensure CON1 is disconnected from the PhizzyB, then snap on the battery pack and switch on the +6V supply to the driver boards. None of the motors should turn, and none of the relays should be heard to click. Temporarily hook the flying leads from the four resistors R1 to R4 in turn to +6V (this equals a logic 1). This should switch on the associated relay and the corresponding motor should then operate.

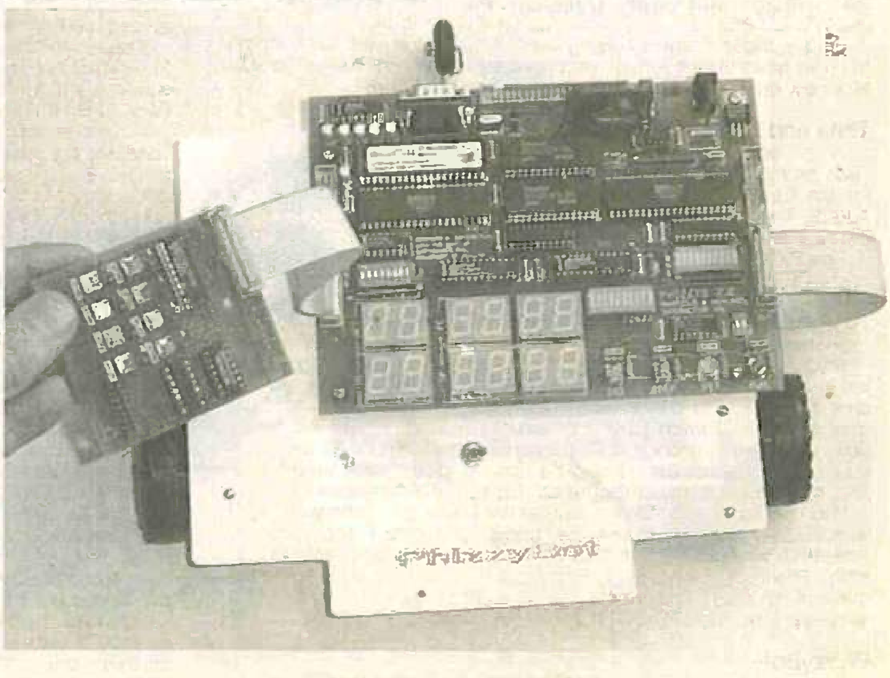
Try all four leads and see what happens. Prove that each relay powers up, and check that both motors operate in both directions properly. It can require some mental gymnastics to work out what is left, right, forwards and backwards! Remember that we take the PhizzyBot "driver's eye" view in this respect.

From the simple tests you can confirm which OP signal wire performs which function. If all is well and you have followed the diagrams then you will be able to prove the truth table given above, so go ahead and complete the interwiring to CON1 on the transistor board, guided by Fig.2 which gives the wiring details. All that remains is to fit the boards to their mounting pillars and tidy up the interwiring, then your PhizzyBot is ready for action!

## DRIVING TEST

We are pretty sure you can't wait to road test your PhizzyBot, so here is a simple test routine which will confirm for sure that your PhizzyBot is behaving itself. Hook up the motor driver board to output port SF032 using a ribbon cable, and use the 8-bit interrupt switch device constructed in Part 4, connected to the SF012 input port with a second ribbon cable. Enter and save the routine in Listing 1 as motortest.asm then download it to your PhizzyB mounted atop the PhizzyBot platform. This is based on the original interrupt program from Part 4. If you then click and release:

Switch S0 – motor 1 (left) backwards
Switch S1 – motor 1 forwards
Switch S2 – motor 2 (right) backwards
Switch S3 – motor 2 forwards



*The PhizzyBot platform with the PhizzyB computer board mounted in position, plus the temporary connection of the switched control board.*

```
Listing 1
              .ORG     $4000
              BLDSP    $4FFF
              BLDIV    IRRUPT
              SETIM
              LDA      $00
              STA      [$F032]
LOOP:         JMP      [LOOP]
IRRUPT:       LDA      [$F012]
              XOR      $FF
              STA      [$F032]
              RTI
              .END
#This is the end of the file
```

Clicking switches S4 to S7 (see Fig.4 of last month's constructional article) will stop both motors. Thus the PhizzyBot can be made to zig-zag around the floor! Further tests can be made using a full 10 feet (3 metres) length (no less!) of ribbon cable on the interrupt latch board and happily the prototype should respond to every command, trundling around the floor and sounding like a food blender on steroids.

A variation of the above routine is used in the main tutorial article, in which Max and Alvin describe how to program some fundamental control commands for the PhizzyBot. You will probably find it best simply to raise the motor platform off the bench top for the purposes of this month's tutorial, and it will be adequate, therefore, to use the mains adaptor for the PhizzyB's power source at this time.

## HELP IS AT HAND

If you have any problems related to the constructional aspects of the series, you can contact the author by E-mail at alan@epemag.demon.co.uk or by writing to the Editorial address. Don't forget that Max and Alvin love to hear from you too, by E-mail to max@maxmon.com.

And if you're new to the PhizzyB (where have you been that you missed parts 1 to 4? – if you are an ETI reader we extend a very warm welcome to you!) we can supply back issues of the previous parts – see this month's Back Issues page).

## NEXT MONTH

Next month, we'll be adding sensory switches to the PhizzyBot and will introduce more computer programming techniques, using the principles of collision detection as a further example of the PhizzyB's versatility as a computer teaching aid and control system.

### PhizzyB "LITE"

Undoubtedly some of you reading about our phabulous PhizzyBot will be longing to build it but have not built the PhizzyB itself – well, you don't have to build the whole shebang in order to run our wheely, you can omit a number of PhizzyB parts. Here's a list of what you can omit (you can always add them at a later date if you wish)

* IC5 (32K RAM) and its d.i.l. socket
* IC7 (memory battery back-up controller
* IC10 and IC102 (two display drivers) and their d.i.l. sockets
* BAR101 (status register 10-bit l.e.d. bargraph)
* DUAL1 to DUAL6 (7-segment displays)
* CON1 (50-way boxed header connector)

In this case we believe that a PhizzyB "Lite" would cost not much more than half that of a fully-populated PhizzyB.

Please refer to the full components list on page 812, November 1998 issue for more details.

## SHOP TALK

with David Barrington

### Smoke Absorber

Extracting a source for the components for the *Smoke Absorber* project should not prove too difficult. The main problems could be the infra-red detector, low voltage fan, filter and finger guard.

Regarding the surface mount devices (SMDs), these are now widely stocked by advertisers but you will probably have to buy in minimum quantities. You could try ***Electromail*** (☎ ***01536 204555***) or Maplin (limited range).

The PIS201S passive infra-red detector, with an internal f.e.t. amp, was purchased from a Maplin store, code AJ77J. The 12V brushless d.c. fan also came from them (code YZ38R, 60mm version), together with the charcoal filled filter pad (code BN91Y) and the 60mm square finger guard (code JU23A; two required). The filter pad will cost around £10 and comes in a much larger size than needed and will have to be cut to size.

The Sentinel galvanised wire mesh should be stocked by garden centres. Once gain, like the filter pads, it will be necessary to purchase a piece larger than required and cut it down to size.

The plastic project box came from Maplin, code LF01B, and the surface mount ZVN2106G MOSFET from Electromail, code 274-992. The small surface mount printed circuit board is available from the *EPE/ETI PCB Service*, code 223 (see page 220).

Finally, those readers having access to the Internet and wishing to know more about surface mount may like to "visit" the author, Bill Mooney, on the web at: ***www.billssmd.mcmail.com***.

### Time and Date Generator

A few points need to be raised regarding components for the *Time and Date Generator* project. The only listing we have spotted for the EL4581 video sync separator i.c. has been Maplin, code AJ62S. The rest of the "semiconductor" devices should be generally available.

The PIC16C84-10/P should be the 10 meg version. If you do not wish to program your own PIC chip, a ready-programmed PIC16C84-10 microcontroller is available from Magenta Electronics (☎ ***01283 565435*** or ***http://www.magenta2000.co.uk***) for the inclusive price of £5.90 each. Overseas readers add £1 for postage.

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/ETI PCB Service* page 220. 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/timedate.

You can replace the 2-way jumper links with straightforward bare wire links. If you wish to use the "bridging" jumpers, these can be ordered from Maplin, codes UL70M (pin jumpers) and JW59P (pin strip). The interlocking 2-way 5mm, p.c.b. mounting, right-angle terminal block should be widely available. The printed circuit board is available from the *EPE/ETI PCB Service*, code 221.

### PhizzyBot

Casting a quizzical eye over the parts needed to produce *PhizzyBot*, our motorised buggy, some of the major items appear, at first sight, as though they could give some readers headaches locating a supplier. The relay and motors are likely to be the main culprits.

The low voltage, 1·5V to 4·5V d.c., Como 430G gearmotor is currently being advertised by Magenta Electronics (☎ ***01283 565435*** or ***http://www.magenta2000.co.uk)*** and is listed as MGS (small); there is a postal charge. Model shops may stock similar types.

Turning to the relay. This is from the Fujitsu FBR211 series and is currently held by Farnell (☎ ***0113 263 6311*** or ***http://www.farnell.com***), code 103-063.

If you cannot find suitable solid model rubber wheels or an aircraft tailwheel at your local model craftshop, we have found that Maplin (***http://www.maplin.co.uk***) can supply them. When ordering quote code WC94C (4 pack) for the wheels and code LJ61R for the tailwheel assembly.

You will also need the 4-section PhizzyB I/O printed circuit board. This is obtainable from the *EPE/ETI PCB Service*, code 216.

### Auto Cupboard Light

If you are unable to find a suitable cord-operated type cupboard lamp for the *Auto Cupboard Light* at your local electrical store, then we suggest you use the one listed by Maplin, code KR34M.

The choice of miniature 6V d.c. relay for this project is important, as apart from it being physically identical, if it is to fit on the small printed circuit board, it must also have contacts rated at 2A minimum to handle any switch-on current surge. The one in the model also came from the above mentioned source, code FM91Y.

The author calls-up a mercury filled tilt switch from Maplin, code FE11M. However, due to the highly toxic nature of mercury, we would suggest readers go for the *non-mercury* version, code DP50E. Both types are obtainable from Maplin.

A deep-seated lid section is required for the circuit board control case and the recommended one used in the model is the ABS plastic BM12 type listed by the above, code CC82D. No doubt some of our excellent components advertisers will be able to come up with something similar. The printed circuit board is available from the *EPE/ETI PCB Service*, code 222 (see page 220).

### Wireless Monitoring System–2

Having investigated any possible buying bugs for the *Wireless Monitoring System* in last month's *Shoptalk*, we only have some good news to pass on this month. The f.m. versions of the transmitter and receiver modules are also stocked by the companies mentioned last month.

We understand that Radio-Tech (☎ ***01992 576107*** or ***htpp://www.radio-tech.co.uk)*** are presently running a special offer on Radiometrix modules. They are offering a free *additional* transmitter module with every order placed for a *pair* of f.m. modules. We suggest you contact them to see if it applies to this month's f.m. adaptor circuits, quote reference EPE-RM1.

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.

The f.m. adaptor p.c.b.s come with the main a.m. printed circuit boards. See the *EPE/ETI PCB Service* page 220 for prices.

# PRACTICALLY SPEAKING

## *Robert Penfold looks at the Techniques of Actually Doing it!*

MOST panel mounting components are very easy to fix in position, and in the majority of cases a single fixing hole of modest diameter is all that is required. Inevitably there are a few components that are more difficult, and this is usually due to their large size and the large mounting holes that they consequently require.

In this month's article we will consider some of the numerous ways of dealing with large panel cutouts. There is a wide range of tools available for carving large pieces out of metal and plastic panels, but provided you are in no great hurry, some simple and inexpensive tools will suffice.

Moving coil panel meters remain quite popular for use in home constructor projects, and they are a good example of a component that has unusual mounting requirements. The standard mounting arrangement for a normal moving coil panel meter having a front plate of about 60mm by 45mm is shown in Fig. 1.

The four small mounting holes are for the threaded rods built into the meter itself. The meter should be supplied with matching washers and fixing nuts. There is no difficulty in marking the positions of these as they are simply at the corners of a square having 32mm sides.

### Getting the Needle

The large (38mm dia.) cutout accommodates the body of the meter, and its centre is at the middle of the square. This cutout has to be made quite accurately, since the meter will not fit if it is fractionally undersize, and it will tend to engulf the four smaller holes if it is made slightly too large.

There is an obvious problem in making a hole of this size, which is larger than normal methods of drilling can accommodate. The cheap way of attacking any large cutout, whether regular or irregular in shape, is to use a miniature round file. For obvious reasons, these are also known as "needle" files.

One or two of these files or even a complete set of assorted shapes and sizes is something that you should buy sooner rather than later. While files do not represent a quick way of making large cut-outs, they do at least provide you with a means of making virtually any required hole no matter how large or irregular in shape.

The best needle files for making cutouts are "Abrafiles". These can sometimes be a bit difficult to track down, but they will probably be available from at least one of your local DIY superstores.

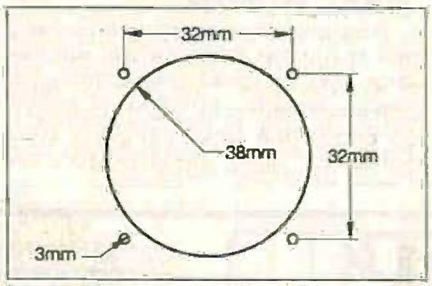



*Fig.1. Mounting holes for a panel meter look easy enough, but a 38mm dia. hole can be awkward to produce.*

Their main claim to fame is (literally) their flexibility, and these files can be bent to reach inaccessible places. This ability is probably of no great importance in the current context, and the bigger asset is their coarseness, which enables them to cut relatively quickly. You can obtain an Abrafile that fits into a special frame that looks rather like a coping saw.

Cutting quickly and accurately with one of these is very easy, and the ability of the blade to cut in any direction makes life much easier than using a fretsaw or coping saw. On the other hand, the frame prevents the tool from making holes towards the middle of large panels, whereas simple needle files can make cuts just about anywhere in any panel.

### Don't Fret

If you have a fretsaw or a coping saw it is worth giving it a try when making large cutouts. There are blades specifically for cutting metal and plastic, but virtually any coping/fretsaw blade seems to cope with aluminium and plastic panels quite well.

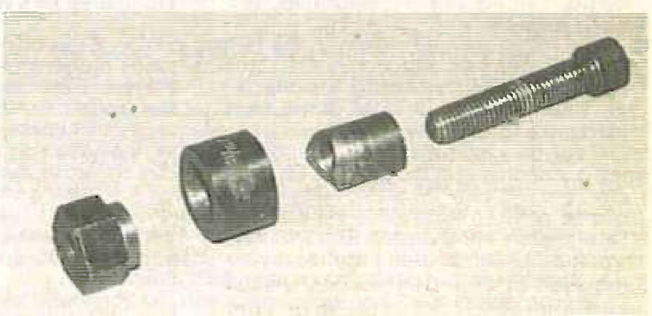
With any of these filing and sawing methods it is necessary to drill a hole of about three millimetres in diameter first, and then work outwards from this starting point.

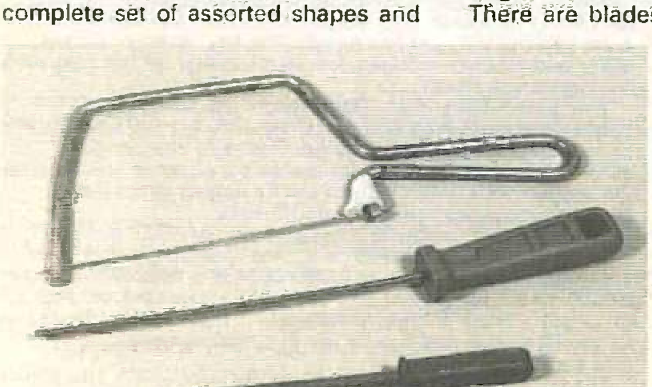
Patience is important with any creative hobby, but is especially important when cutting anything. Go at things like the proverbial "bull in the china shop" and you will at best make a mess of the job, and at worst you will injure yourself.

Even if you are very skilful at using saws and files, it is still advisable to cut just inside the line marking the required cutout. A file can then be used to carefully enlarge the cutout to precisely the required size and shape. Provided suitable time and care is taken over the exercise, even those who are "practically-challenged" should find that this method enables them to produce some quite neat and accurate results.

The importance of good accuracy is something that varies from job to job. In the case of something like a panel meter there should be no major problem provided the main mounting hole is not made so large that it does not leave anywhere for the four smaller ones. If necessary, the meter will cover a multitude of sins when it is fixed in place.

With some components, such as push-fit rocker switches, there is practically no margin for error. Make the cutout fractionally too small and the switch will not snap into place. Make the hole slightly too large and the switch will be a very obvious loose fit, and may refuse to stay in position. With any push-fit components it is a good idea to make the mounting hole slightly too small initially, and to then gradually enlarge





*The four main parts of a chassis punch (above). The cutting blade (second right) is forced through the panel and into the die (second left). This produces very neat and accurate results.*

*(Left) The frame version of the Abrafile (top) and the standard version (middle) provide an inexpensive means of handling practically any cutout. The miniature round file (bottom) is equally versatile, but can be quite slow.*

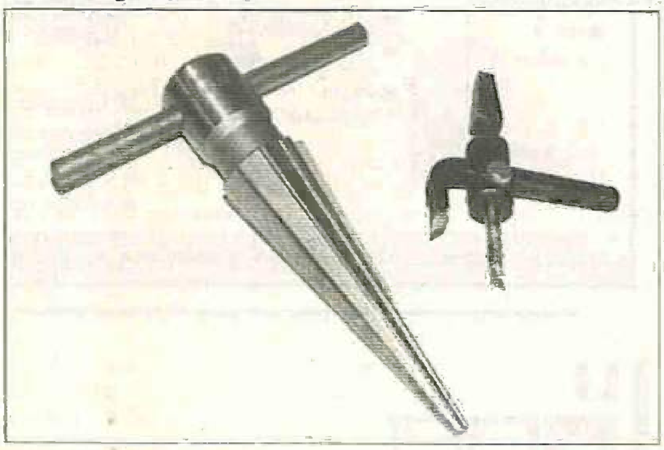
it until the component fits into place properly.

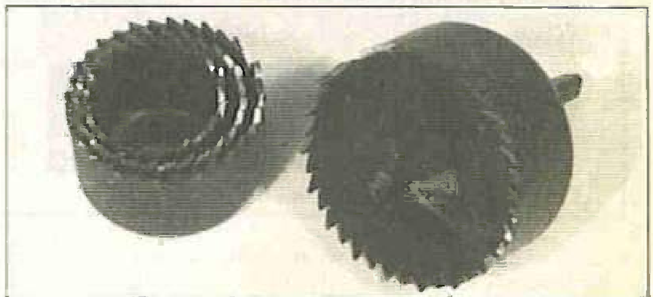
## Ring Around

When using needle files that have fine blades it can take a very long time to make large cutouts. There is a simple but effective way of speeding things up, and this is to drill a ring of 3mm to 3·5mm diameter holes just inside the perimeter of the required cutout.

The holes should be about 4mm or 5mm apart so that there is a small gap between them, but the gap should be kept quite small. The needle file is then used to join up the holes and complete the cutout.

Most of the material is removed by the drilling, which does not take long despite the large number of holes involved. This leaves relatively little to do with the needle file and greatly speeds things up. The resultant cutout will probably have some rough edges, but it will not take long to file it out to a hole of the correct size having a neat finish.





*(Above) Hole-saws produce neat results and are quite fast. They work best in a power drill set to a slow speed. (Left) A reamer can turn a small hole into a larger one, up to about 30mm. The tank cutter (right) can handle holes having diameters from around 25mm to 120mm.*

## Quick Cuts

Where a large round mounting hole is required, such as for a panel meter or a loudspeaker, there are quick ways of making the hole. A chassis punch is a tool that makes the "cleanest" holes, and it is also very quick. It consists of four main pieces, see photograph.

A small guide hole is drilled in the panel, and a bolt with the circular cutting blade attached is fitted into this. A nut and a short metal tube are then fitted onto the bolt on the other side of the panel. The bolt is tightened with the aid of an Allen key, forcing the cutting blade through the panel and into the tube. In doing so it punches a round hole in the panel.

In fact there are chassis punches that produce rectangular holes, including some that are designed to produce accurate holes for push-fit switches. Unfortunately, the relatively high cost of chassis punches makes them impractical for one-off or very occasional use, and you will probably only use the round variety.

## In The Hole

A chassis punch is fine for holes of up to about 30mm in diameter, but larger sizes are difficult to obtain and it can be difficult to use them with anything more than thin aluminium panels. For larger holes a "hole-saw" is a better option.

This is basically just a saw blade in the form of a ring, plus a mandrel that enables it to be mounted in a hand drill or power drill. The mandrel includes a drill bit that produces a guide hole of a few millimetres in diameter. The blade then comes into action and produces the main hole.

The blades are quite thick, which means that quite a lot of material is removed when cutting the hole. However, with a power drill on a slow setting it does not take long to produce holes having diameters of around 30mm to 60mm. Provided the saw is not seriously worn, the holes should be quite "clean" and neat.

There is an obvious limitation with hole-saws and chassis punches in that each one can only produce one size of hole. Buying several tools of either type individually can be quite expensive, and it is worth considering one of the sets of popular sizes that are available. Although the tools in these sets are not usually of the highest quality, they seem to be adequate for dealing with the aluminium and plastic panels encountered in project construction.

Unless you have proper workshop facilities and high quality tools it is advisable not to try making large cutouts in steel panels. Tools that cut through softer materials with no difficulty will usually need a lot of lubrication in order to cut through steel, and may break under the strain.

There is an inexpensive alternative to chassis punches and hole-saws in the form of hole cutters, or "tank" cutters, as they are also known. Tools of this type are available from most DIY superstores.

A hole cutter is a bit like a hole-saw, but with only one tooth on the end of an adjustable arm. By adjusting the effective length of the arm it is possible to produce holes from typically about 25mm up to around 120mm in diameter.

These tools are very quick and effective, but a few points need to be borne in mind when using them. First and foremost, they are *only* intended for use in a *hand brace*, and should *not* be used in power drills. They are designed to operate at very low speeds, and do not even work properly using most hand drills.

They are just about usable with a heavy-duty hand drill set to its slower speed, but only when used to make holes of up to about 40mm in diameter. A brace gives the best results and enables large holes to be handled with ease.

A hole cutter is surprisingly fast even when cutting very large holes, but it does not produce neat results. A substantial amount of filing is usually required in order to "clean" the hole, and the hole therefore tends to grow. Consequently, it is necessary to cut a hole one or two millimetres smaller than the required size to allow for this "inflation".

## Cheating

Where possible, you may prefer to avoid large cutouts. In most cases this is not possible, but with miniature loudspeakers there is an alternative to the "text book" approach.

Normally the panel is drilled with a hole that is slightly smaller than the overall diameter of the loudspeaker, and some speaker cloth or fret is then glued in place behind the cutout. It is very unusual for miniature loudspeakers to have any provision for screw mounting, and they invariably have to be glued in place on the speaker material.

Any good quality general-purpose adhesive should do this well enough, but glue-guns are now remarkably cheap and offer the quickest means of handling jobs of this type. Avoid smearing adhesive onto the diaphragm of a speaker as this could seriously impair its performance.

The alternative to the conventional approach is to drill a matrix of small holes in the panel to form a simple speaker grille. The loudspeaker is then glued in place onto the panel, behind the matrix of holes.

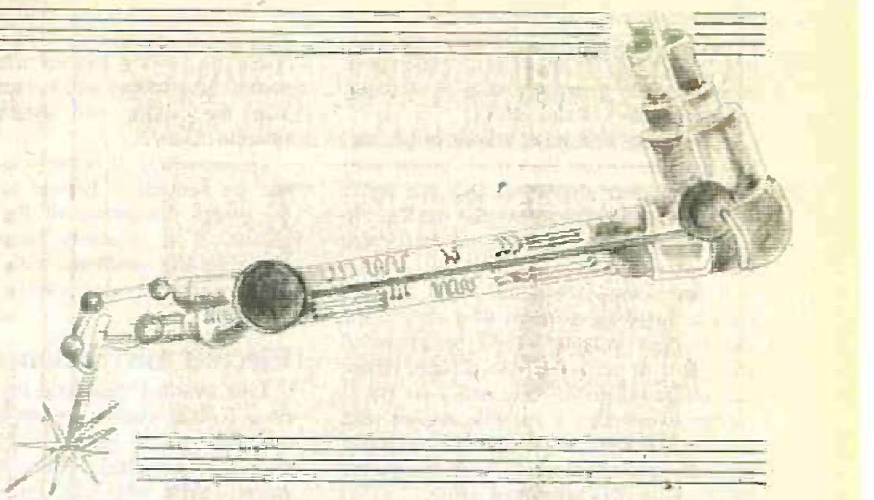
Making a neat job of this is trickier than you might think, and it is a job that needs to be given due care and attention. It is best to drill small guide holes first and then enlarge these to the required size. An advantage of this approach is that it should leave the panel quite stiff and strong.

Making large cutouts in small panels can cause serious weaknesses and is best avoided.

# Regular Clinic

# CIRCUIT SURGERY


## ALAN WINSTANLEY

***This month's roundup of readers' queries and comments follows up with more information on electret microphones, a quick capacitor check with ohmmeters and some pointers for using variable regulators.***

THE QUESTION of using variable voltage regulators to produce simple power supplies crops up from time to time. Here's a query from *G. A. Wilsher* of Teddington, Middlesex.

### Regulators sum it up

*I have been waiting patiently for a "decent" Bench Power Supply unit to appear when I came across the variable regulator LM338 which will produce an output from 1·2V to 32V at 5A, and this would give me exactly what I'm looking for. Although I could manage such a design on stripboard I would appreciate some guidance.*

*I happen to have a transformer with bridge rectifiers and smoothing capacitors which produces 50V d.c. The LM338 specification states that the difference between input and output voltages should not exceed 35V. What are the implications of this? Second, I can see that two resistors are required to set the voltage. How does one calculate their values?*

Three-terminal regulators are simple and convenient to use "on paper" but there are one or two drawbacks to consider, especially at the higher voltages/currents you are hoping to provide.

I'm not sure that stripboard would be a suitable medium on which to construct a reliable high current design. You might consider assembling with old-fashioned tag strips or "turret board", using heavy gauge solid core wires for interwiring, which should be kept as short as possible. A simple point-to-point design will cope admirably with higher currents as well as having a higher mechanical strength than anything you could make with stripboard.

The output ratings of your transformer are not quite clear, so here are a few points to bear in mind. Transformer manufacturers normally rate secondary voltages and currents assuming only a simple *resistive* load is used at the maximum permissible current of the transformer. This has two implications: first, due to its regulation the secondary voltage will rise at *lower* currents, so allowances must be made for this (when specifying the rectifier and smoothing capacitor voltage ratings).

Second, although makers specify ratings assuming a *resistive* load, in a full-wave rectified power supply the load is more complex than that – we are placing rectifiers and a very large smoothing capacitor across the secondary winding. The effect is that we find currents flowing in the secondary circuit higher than those found in an ordinary resistive circuit.

As a good rule of thumb, the transformer secondary current figure should be derated by about 40 per cent in such cases. A 5A transformer (for example) should only be expected to safely supply about 3A total load current in a full-wave power supply, see Fig. 1.

Furthermore, that 5A secondary current is only valid when a simple resistive load is used as shown. Ideally your own transformer must be capable of providing 8·3A on full load, but to be realistic you are limited by what you can buy off the shelf or happen to have available anyway.

### Regulations

Looking at the regulator itself, a guaranteed way of destroying such a device is to exceed the input-output voltage, so well done for highlighting this parameter! Incidentally my National Semiconductor data book specifies 40V as the maximum input-output differential.

This input-output voltage rating is the maximum difference in voltage which is

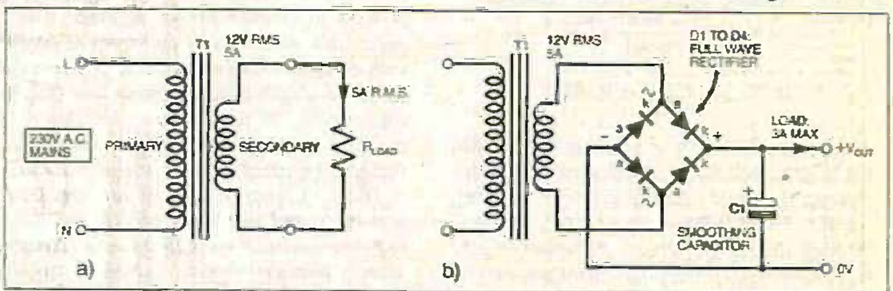



*Fig.1. Transformers must be derated when full-wave bridge rectifiers and smoothing capacitors are used. Makers' ratings usually assume a* resistive *load.*

The term *root-mean-square* (r.m.s.) is applied to alternating voltage and current values, including the ratings of transformers. Root-mean-square values are useful as a way of comparing a.c. voltages and currents against d.c. equivalents.

An alternating voltage of say 12V r.m.s. placed across a fixed resistor will produce the same heating effect (power dissipation) as would a voltage of 12V d.c. (Multiplying the r.m.s. value by 1·414, the square root of 2, tells us the *peak* value of the alternating voltage.)

In the example of Fig. 1, the transformer shown will have a manufacturer's secondary voltage rating of 12V r.m.s. at 5A output. The voltage will tend to increase when the load curent is reduced, and a value of nearer 16V or so off-load would not be surprising.

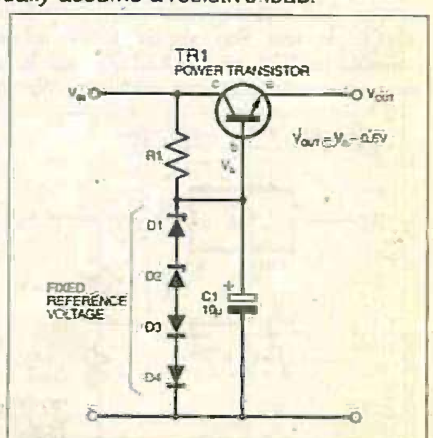



*Fig.2. A simple pre-regulator may help avoid excessive input-output voltage appearing across variable regulators. D1 and D2 are the Zener diodes.*

permitted between the input and the output pins of the regulator. A bench power supply is likely to be subjected to some rough treatment, and it is quite easy to overlook the implications of this rating.

If the input voltage is known to be, say, 30V d.c. maximum then if the power supply output was shorted to 0V, the entire voltage will appear across the device. No harm will be done at 30V and the device will current limit.

If for some reason the input voltage rises to say 50V or more then clearly the input-output voltage would be exceeded and you risk destroying the device. Hence you ought not to directly use your transformer to produce a variable design with the LM338. One work-around is to use a form of "pre-regulator" which clamps the input voltage to a safe fixed value.

A simple Zener diode with an external pass transistor might be suitable (see Fig. 2) provided the tolerances are not too wide. You can combine Zener diodes and also "jack up" the voltage with ordinary forward-biased rectifiers using some trial and error if necessary. The output voltage seen at the transistor emitter (e) is one diode drop lower than that appearing at the base (b). Remember to select a transistor with a high enough collector current rating.

## Doing your Sums

Your second question relates to the calculation of the resistor values. The formula is just a derivation of that for a potential divider. A typical three terminal variable regulator is shown in Fig.3.

A reference voltage $V_{ref}$ is developed across the resistor R1 and by applying ordinary potential divider theory we can say:

$$V_{ref} = \frac{R1}{(R1 + R2)} \times V_{out}$$

$$\text{so } V_{out} = \frac{V_{ref}(R1 + R2)}{R1}$$

$$\text{or } V_{out} = V_{ref}(1 + R2/R1)$$

A value of 1·25V is a nominal value for the reference voltage. A value of 240 ohms is typically used (220 ohms will be fine) for R1, which allows about 5mA to flow through the resistor chain. A further 50µA ($I_{adj}$) flows out of the adjustment pin to 0V, but for most purposes it is not often necessary to consider this any further.

One final aspect of your proposed power supply is that you should allow for a suitable heatsink on the LM338, and it is here where the plan may fall down. Whilst the device is protected from thermal overload, it does mean that if you are to enjoy maximum current outputs then some substantial heatsinking will be required, otherwise the device will thermally-limit in extreme cases.

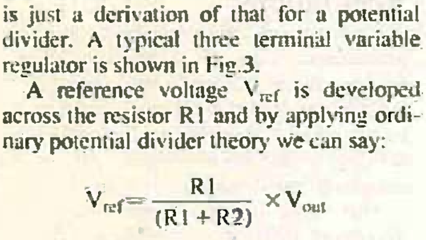



*Fig.3. Calculating the output voltage from a variable voltage regulator. A typical value for $V_{ref}$ is 1·25V.*

Unfortunately, it is not possible to calculate the heatsink's thermal resistance until the power dissipation of the regulator is known. It is precisely because of thermal efficiency problems with such designs that switched-mode power supplies are preferred.

## Electret microphones

Last month I described the composition of a typical electret microphone capsule, and went off in search of the mysterious transistor contained within. My thanks to *Barry Taylor* who adds further interesting comments and describes the electret effect in more detail:

*I would guess that the transistor labelled K596 is probably a 2SK596 as I have frequently come across devices from the Far East that omit the first two characters (esp. on TO92 packages). K indicates an n-channel f.e.t. or MOSFET. You say that Motorola suggest a 2N5484 but according to my sources this is not a MOSFET but an n-channel j.f.e.t. I regret that I can't find any listing of a 2SK596 though.*

*You make no mention of the meaning of the word "electret", which could imply that the variation in capacitance directly produces the a.f. output. This is not strictly true even though it is easily demonstrated that tapping a length of screened cable connected to a high input impedance amplifier will produce a noise on the output. Electret material, which is a fluorocarbon polymer, can be given an electrostatic charge which lasts almost for ever.*

*If an electret material is used as the diaphragm (with one side metallised of course) in a microphone together with a rigid back plate then a capacitor is formed with constant charge Q. Sound pressure will cause the diaphragm to vibrate and thus the capacitance to vary. Since the charge is constant and as V = Q/C the result is a voltage proportional to the sound pressure.*

*The f.e.t. simply acts as an impedance converter and this must be (as you found only one resistor) configured as a common-source amplifier which, given a suitable j.f.e.t., doesn't need a source resistor if the input signal is small. So, I would guess that the resistor you destroyed was a gate to source resistor with a value of possibly tens of megohms. I'd be interested if anyone can confirm this surmise of mine about the f.e.t.*

*Professional condenser microphones generally do not use electret materials. The diaphragm is a metallized polymer film polarised by 48V d.c. via a 1G ohm resistor which results in a virtually constant charge. The polarising voltage is fed to the microphone via a "phantom" power supply from the mixer which also powers the built-in impedance converter.*

It is true that the "2N" or "2S" is commonly omitted from the nomenclature printed on the device. My first thought was also that the mysterious transistor was a 2N or 2SK type but further research drew a blank (as you found yourself). A device type KSK596 is listed by Motorola but there was no data available. I rechecked the National Semiconductor web sites as described last month, and this bounced over to the Fairchild web site.

I finally obtained the data sheet which states "N-Channel RF amplifier" so I'm none the wiser. In retrospect I would concur that it's probably a junction f.e.t. but hopefully I can be forgiven my near miss!

Back to my groaning bookshelves and my *Dictionary of Electronics* defines "electret" as the electrical analogue of a permanent magnet. It is a dielectric body with separate electric poles and a stable existence. The metallic disk I alluded to is a synthetic dielectric film, metallised on one face.

I agree that there is a dearth of information about electrets, which is what prompted the article to start with, but a quick look at several microphone manufacturers' web sites did reveal interesting information including more on "phantom" power supplies. Try www.sennheiser.com and www.shure.com. I also found an enthusiastic web page on www.mpage.demon.co.uk/electret.htm. Thank you for filling us in with the extra information!

## Quick cap check

*I would like to know how to check a capacitor both out of board and in-board, to determine whether the capacitor is leaking or otherwise faulty.*

So asks *Siva Pathmanathan* (by E-mail). It is straightforward to check larger capacitors just by using an ordinary multimeter set to a high resistance range. A moving coil meter is possibly better for this experiment.

By clipping the test leads to an electrolytic capacitor, the resistance reading will briefly be seen to fall as the capacitor will charge up through the meter's internal battery. The meter's *black* lead is in fact positive (the reverse is true on digital multimeters, which have a much higher impedance), so by touching this to the capacitor's positive lead, the needle "blip" will be seen.

With lower value capacitors, probably the best you can hope for is to check for a shorted capacitor, which will show as a low resistance.

Checking a capacitor in-situ isn't reliable because other components in the same circuit may affect the readings. In any case, definitely do *not* check while power is applied to the circuit, and remember to *discharge the capacitor to start with, using a low-value* resistor for larger electrolytic capacitors if necessary.

### 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.

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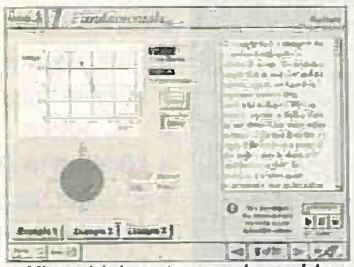

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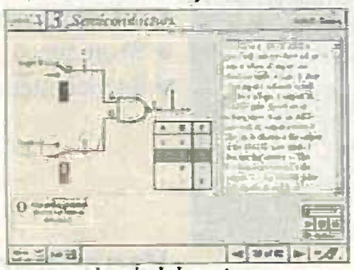

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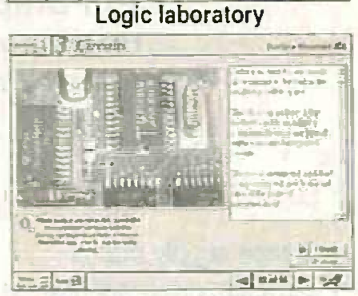

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### *by Mike Tooley*

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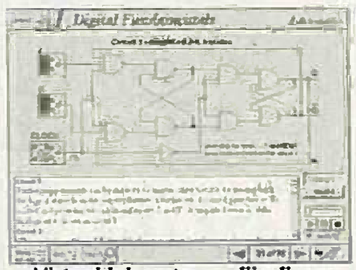

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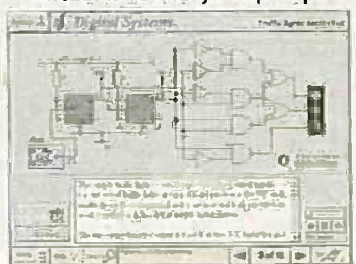

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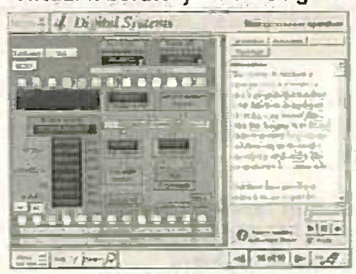

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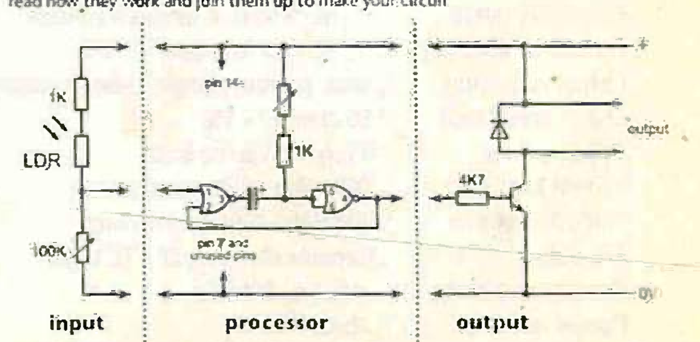


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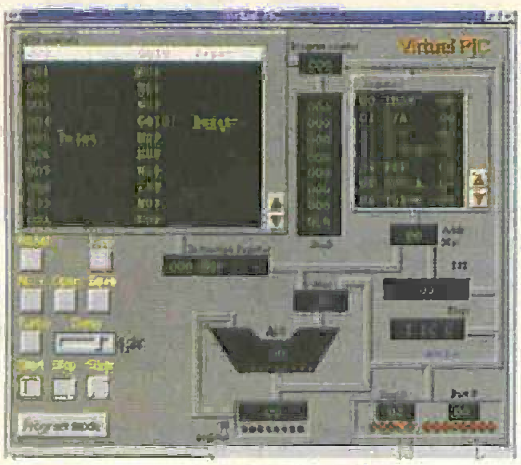
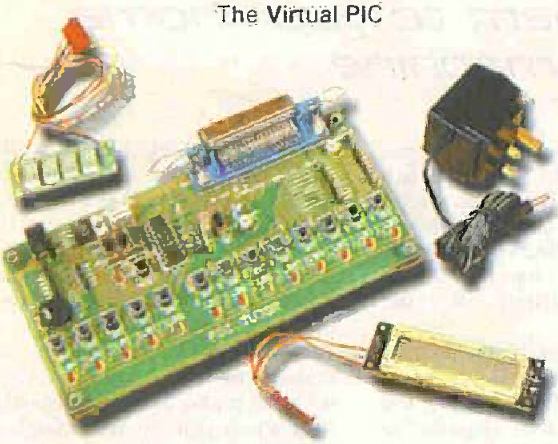


The Virtual PIC


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.

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| | |
|---|---|
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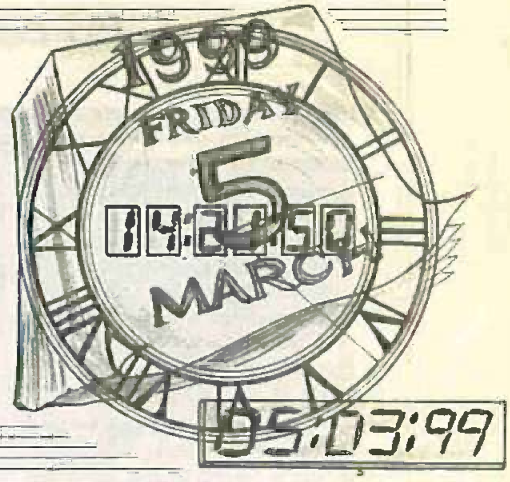
Constructional Project




# TIME AND DATE GENERATOR


TONY HART


*Capture real time events on your security monitor screen or add them to your home videos with this PIC time machine.*

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 occur.

Designed for home use, this project adds time and date information to a multicamera home video security system. The Time and Date Generator inserts a steady and easily readable time and/or date caption onto any composite video signal. The time and date information being displayed at the bottom of the screen.

It also has the optional facility to display a camera number (1 to 8) provided from an external camera selector by inputting a 3-bit camera address. This will allow the user to know which one of eight cameras is currently active.

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.

## CIRCUIT OVERVIEW

A system block diagram of the Time and Date Generator is shown in Fig.1. The full circuit diagram is given in Fig.3.

The circuit is based around the PIC16C84 microcontroller IC3 (from here-on referred to as the PIC). The PIC has three main functions, namely to maintain the real time clock, to generate all the character pixel data that is necessary to display up to 32 characters at the bottom of the screen and finally to control when the character pixels are displayed.

Each character is composed of an eight pixel by seven screen line matrix. For this number of characters the PIC is not fast enough to directly superimpose the required display data onto the composite video signal coming from the video source. Instead, the PIC loads the character display data on a line-by-line basis into an external RAM chip IC5 in the period of time immediately after the frame sync.

One line is written per frame, so that every seven frames the RAM is fully updated. At the end of this period the RAM contains all the data required to produce a 32-character by 7-line display on a TV/monitor screen.

Between line 256 and 291 the PIC releases control of the RAM chip (IC5) to a fast gated oscillator, IC2a, which clocks the previously stored lines out of the RAM, each bit modulating the input composite video signal on the fly. The gated oscillator is repeatedly synchronised to start a few microseconds after each line sync, therefore enabling the output display to appear steady on the monitor screen.

## REAL TIME CLOCK (RTC)

The PIC software implements a real time clock (RTC) function. The real time clock data is stored in registers SEC, MIN, HRS, DAY, MTH, YRS and YRSH. The DAY register is incremented to the value determined by the MTH and YRS registers according to the verse:

*"30 days hath September, April, June and November. All the rest have 31 except February alone which has 28, except 29 during a leap year."*

A leap year is normally any year divisible by four except if the year ends in 00 when it also has to be divisible by 400 to be a leap year. So, for example, the year 1900 was not a leap year, but the year 2000 will be.

The RTC only operates when the PIC is powered, either from the main 12V source or from a battery back-up.

## RTC ACCURACY

The RTC relies on the PIC's crystal controlled clock for timing. For this application the PIC's 8-bit timer TMR0 is set to operate in conjunction with the 8-bit prescaler to form a 16-bit counter which is incremented each instruction cycle. This is every 0·4µs with the 10MHz crystal specified (X1).

The PIC maintains the real time clock by counting the TMR0 overflows. When incremented every instruction cycle TMR0

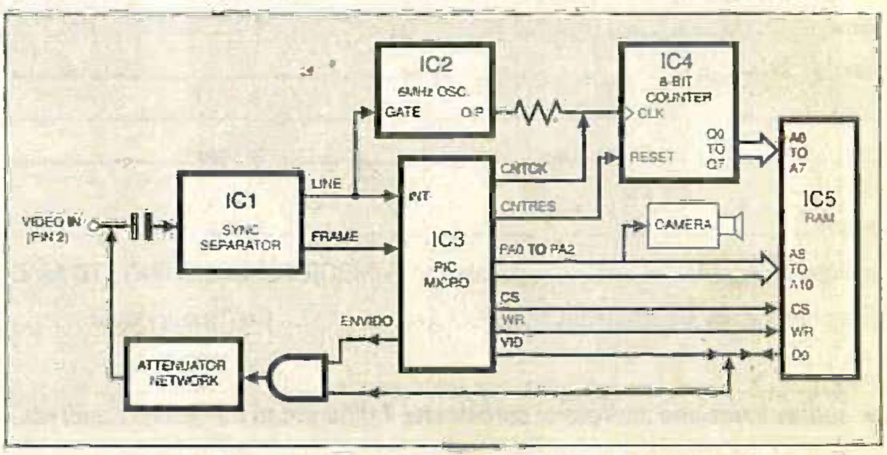



*Fig.1. System block diagram for the Time and Date Generator.*

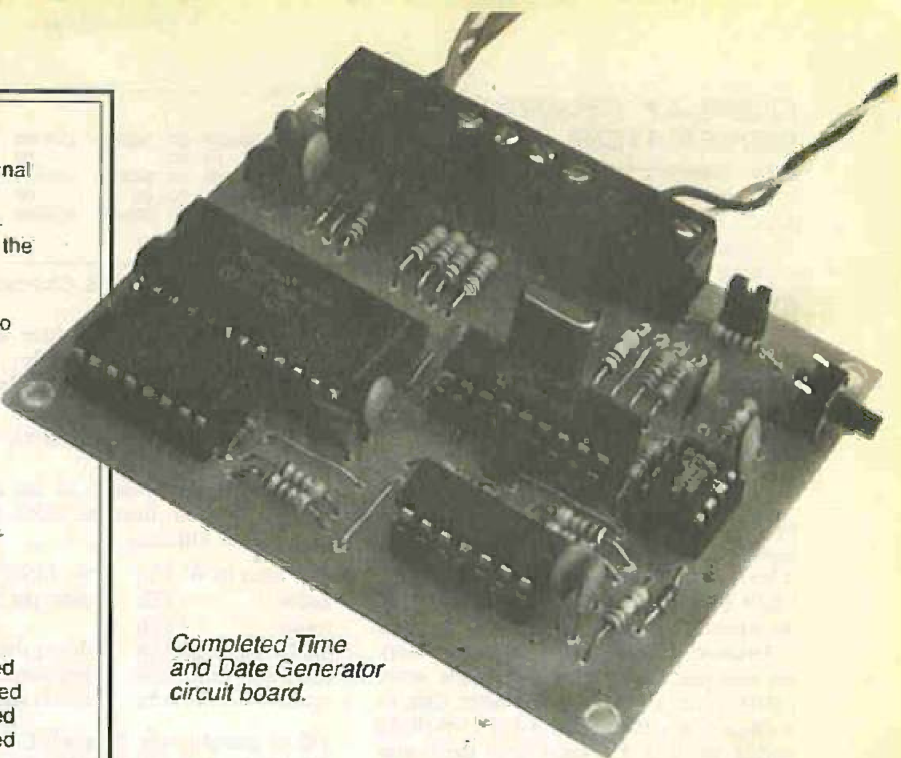
## SPECIFICATION

- 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.
- Selectable line display from line 256 to line 291 at the bottom of the screen.
- Inverse or normal video display.
- Day and month display are swapable for those who prefer the American standard.
- Display external camera number from 1 to 8 via external 3-bit input.
- Display symbol with camera number via external 1-bit input.
- Leap year correction.
- Battery back-up if required.
- Accurate Real Time Clock with a software trimmer.
- Year 2000 compliant.

### DISPLAY EXAMPLES

***Examples of the display are as follows :-***

| | | | |
|---|---|---|---|
| 23:59:33 | 23/02/1998 | | time/date displayed |
| 23:59:33 | 02/23/1998 | | day/month swapped |
| 23:59:33 | 23/02/1998 | C-5 | camera 5 displayed |
| 23:59:33 | 23/02/1998 | C/5 | camera 5 displayed symbol change |
| 23:59:33 | | | time only |
| | 23/02/2001 | | date only |



*Completed Time and Date Generator circuit board.*

will overflow every 0·4×256×256ms or 26·2144ms. At each overflow, a counter called CLOCK1 is incremented and every 38 CLOCK1s the clock's second counter (SEC) is incremented.

However, one second is not exactly 38 CLOCK1 periods, it is actually equal to 1 sec/26·2144ms or 38·147 overflows. So incrementing SEC every 38 CLOCK1 periods will produce a fairly inaccurate real time clock as the inaccuracy will be 0·147×CLOCK1 or 3·8ms error every second, which translates to 332 seconds per day error – not very good.

## IMPROVED ACCURACY

Luckily, the computing power of the PIC allows some easy manipulation to improve the accuracy. Consequently every seven seconds an extra CLOCK1 is added so that 39 overflows are counted. So every seventh SEC count there are 38×7+1 or 267 overflows. This translates to 267 × 26·2144ms = 6·9992448 sec. This reduces the inaccuracy from 332 sec/day to about 9·3 sec/day, which is a big improvement.

To improve the accuracy even more, every 35 of the seven second periods another CLOCK1 is added. So every 7×35 or every 245 seconds the PIC actually counts 35×6·9992448+0·0262144 seconds=244·99978secs. This reduces the inaccuracy from 9·3 sec/day to about 0·1 sec day.

These numbers assume that the 10·000MHz crystal oscillator providing all the timing is running at exactly zero parts per million (ppm) error. This is highly unlikely and with tolerance, temperature and ageing effects the crystal frequency will be more likely to be within ±100ppm unless a trimmer is incorporated.

An error of 100 ppm translates to an error of about 8·6 seconds per day. So unadjusted, the real time clock is going to keep time to better than 10 seconds per day or say five minutes per month, providing the crystal oscillator is running at 10MHz ±100ppm. A method of trimming has been included in the software to trim the real time clock by up to plus or minus nine seconds per day.

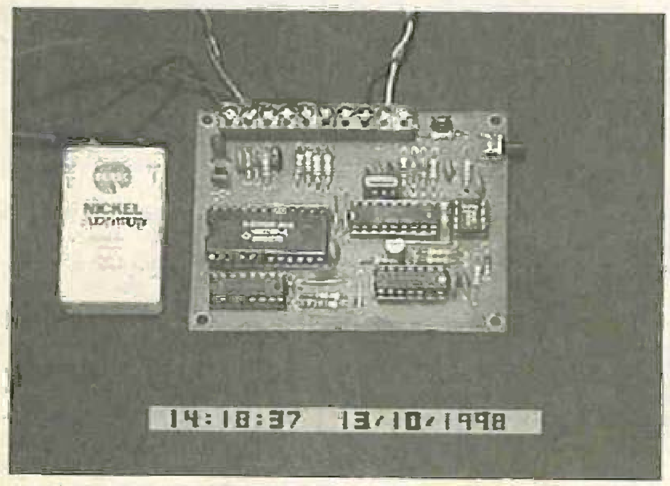
## TIME STORE

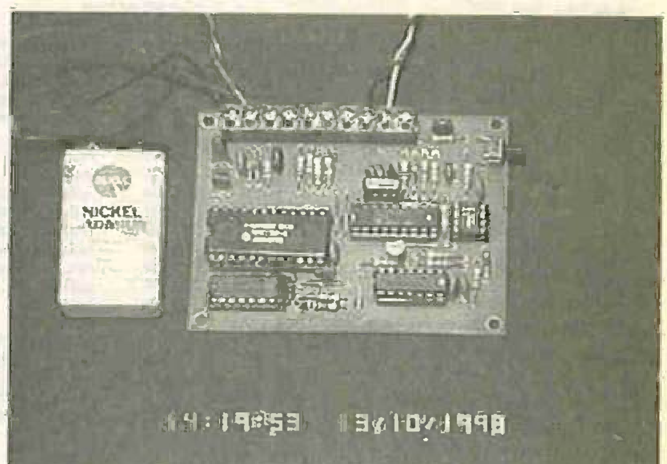
Every time any of the clock counters, e.g minutes, hours, day, month or year changes, its value is stored in the EEPROM of the PIC, so that should the power supply fail the time will be reset to what it was before the power failure, except that the seconds count will be reset to zero. There is a slight problem here, in that the data EEPROM of the PIC has a limited lifetime of typically one million write cycles.

For the hours counter, one million writes relates to 114 years of use. But for the minutes counter it relates to only 1·9 years of use which means that the minutes memory location in EEPROM will become unreliable in just under two years time.

To overcome this the minutes value is stored in the EEPROM address calculated from the year ANDed with 1F hex and is therefore distributed over 32 EEPROM locations, which increases the EEPROM lifetime from 1·9 years to about 60 years. (Let me know in 60 years if my calculation is correct.)

In practice it is recommended that a rechargeable back-up battery is used so that the power never fails.




*Monitor screen shots of the Time and Date Generator module showing two forms of displaying the time and date readout. Note the rechargeable back-up battery.*

## DISPLAY CHARACTER GENERATOR

The character format for the numbers 0 to 9 is shown in Fig.2. Characters are composed of a simple 8-dot by 7-line matrix (lines L0 to L6 ). Each numeral is six dots or pixels wide with a blank dot either side, producing two spaces between characters.

In normal video the top line (L0) and a bottom line (L6) are always blank so this effectively produces an 8-dot wide by 5-line high matrix which is quite readable. If the inverse video option is enabled the top and bottom lines appear white, so producing the effect of an 8-dot × 7-line matrix.

The software allows each line of dots to be output once, twice, three or four times providing actual character height of 5,10,15 or 20 lines. The user can therefore select the most easily readable format for their particular screen.

Because the PIC is too slow to insert the time/date pixels directly onto the composite video signal, the character data is written by the PIC to the RAM chip (IC5) during the first 256 lines after the frame sync at a rate of one line per frame. The RAM chip used is actually a 2048 × 8-bit device, but only one bit of each 8-bit byte is used here. Each of the five lines of the display plus the spacing lines at the top and bottom of the display (seven lines in total) are therefore clocked into the RAM during a seven frame period.

The bottom 8-bits of the RAM address A0-A7 come from a 4040 binary counter (IC4) and the top 3-bits (A8,A9,A10) are driven directly from PORTA of the PIC (IC3). The PIC can control the RAM address by initially clearing and then clocking the counter via PORTB pins RB5 and RB3 respectively.

The PIC can therefore write up to 256-bits of data or pixels to up to eight blocks of RAM, where each block contains one line of bits to display. This allows up to 32 characters to be displayed across the screen, although the normal maximum used here is 28 characters.

However, during configuration up to six extra characters are required to be displayed and to allow this each character is displayed with only one space between characters. This bunching up allows up to 36 characters to be displayed, but with slightly less legibility.

## PIXEL LOOK-UP TABLE

The PIC is responsible for compiling and generating the character pixels to store in the RAM. The following is an example that shows how each pixel of the character "2" is formed and Table 1 shows an extract from the actual software.

On entry to the **wrramblk** routine the value to be displayed, in this case "2", is in the high nibble of the W register. This is the same as the value to be displayed multiplied by16 (2 × 16 = 32 decimal = 20 hex). The low nibble is cleared with the **andlw 0F0h** instruction and then the pixels are obtained from the look up table in **segment**.

The W register is stored in memory location **OFFSET** which is then divided by 2 by the **rrf OFFSET** instruction. This is now the equivalent of the value to be displayed multiplied by 8 and gives the offset to any number in the look up table.

```
L0
L1 000000  00  000000  000000   00   00  000000   000000   000000   000000   000000
L2 00   00 00      00      00   00   00  00       00           00   00  00   00  00
L3 00   00 00  000000  000000   000000   000000   000000       00   000000   000000
L4 00   00 00  00          00        00      00   00  00      00    00  00       00
L5 000000  00  000000  000000        00  000000   000000     00     000000       00
L6
```

*Fig.2. Character format for the numbers 0 to 9.*

To this is added the number stored in **POINTER** and copied to the program counter PC. The value is then returned in W and copied to the memory location **SHIFT**. **POINTER** is effectively the current line of the character.

For example, if line 5 of the character "2" is required, then the value added to the PC is as follows:

| | | |
|---|---|---|
| Character in W | 25h | the MSB "2" is to be displayed |
| andlw | F0h | clear the low nibble |
| result | 20h | |
| div by 2 | 10h | this is the character offset |
| add POINTER | 05h | line number |
| result | 15h | this is added to the PC |

15h is added to the Program Counter and the PC is changed to address + 15h and executes the following instruction

retlw h'01111110'

therefore returning with the value 01111110 in the W register

In summary

| | | | |
|---|---|---|---|
| If pointer = 00 then | retlw b'00000000' | is executed |
| If pointer = 01 then | retlw b'01111110' | is executed |
| If pointer = 02 then | retlw b'00000110' | is executed |
| If pointer = 03 then | retlw b'01111110' | is executed |
| If pointer = 04 then | retlw b'01100000' | is executed |
| If pointer = 05 then | retlw b'01111110' | is executed |
| If pointer = 06 then | retlw b'00000000' | is executed |

**Table 1: Example of the use of a Look-up table for character generation**

```
wrramblk
          andlw   0f0h                    ;select top nibble
          call    segment
          movwf   SHIFT
          etc

          ORG     0300h
segment                                   ;w = 16 x value
          movwf   OFFSET                  ;save in OFFSET
seg1
          movlw   03h
          movwf   PCLATH                  ;select 3rd page for computed goto
          rrf     OFFSET,w                ;w = CHAR x 8
          andlw   b'01111000'             ;mask in good data
          addwf   POINTER,w
          addwf   PCL                     ;jump to OFFSET and return value

PC address
00        retlw   0
01        retlw   b'01111110'     ;0
02        retlw   b'01100110'
03        retlw   b'01100110'
04        retlw   b'01100110'
05        retlw   b'01111110'
06        retlw   0
07        retlw   0
08        retlw   0
09        retlw   b'00001100'     ;1
0A        retlw   b'00001100'
0B        retlw   b'00001100'
0C        retlw   b'00001100'
0D        retlw   b'00001100'
0E        retlw   0
0F        retlw   0
10        retlw   0
11        retlw   b'01111110'     ;2
12        retlw   b'00000110'
13        retlw   b'01111110'
14        retlw   b'01100000'
15        retlw   b'01111110'     ** This is the value returned
16        retlw   0                  in the example above
17        retlw   0

etc
```

On returning from the segment routine the value in W is placed in register **SHIFT**. The software then shifts the eight bits (01111110) of this data, MSB first, into the main RAM chip IC5 by outputting each-bit in turn and generating a WE and CS pulse for the RAM. If inverse video is selected then all-bits are simply inverted before shifting into the RAM.

After each-bit is shifted to the RAM, the RAM address counter IC4 is incremented by the PIC (IC3) generating a clock pulse on pin RB3.

At the beginning of each line the PIC resets the RAM address counter to zero and increments the RAM address A8,A9,A10 by incrementing PORTA. In this way all the pixels are loaded into the RAM for each line of all characters to be displayed.

## DISPLAY CIRCUIT

Some relevent waveforms to help understand the display circuit operation are shown in Fig.4. The PIC is interrupted every line sync and counts the number of lines following the frame sync. At the appropriate display line (lines 256–291 under software control) the PIC releases control of the RAM clock to a fast clock synchronised to the line sync.

Initially at the start of each display line the PIC resets the counter IC4 by raising and lowering PORTB pin RB5 (**CNTRES**). Then it allows the gated oscillator (IC2a) to clock the counter IC4 by simply setting PORTB pin RB3 tristate, allowing the gated oscillator IC2a to clock the counter IC4 via resistor R8. The counter increments the RAM address and the RAM outputs the previously stored data for the line of the display controlled by the upper three address lines set by PORTA pins RA0, RA1 and RA2.

The counter IC4 increments 256 times until counter output Q9 goes high which pulls the clock input high via diode D2. This inhibits any more of the gated oscillator clocks until the counter is reset at the beginning of the next line. Without this mechanism the counter would overflow and the line could be partly displayed again.

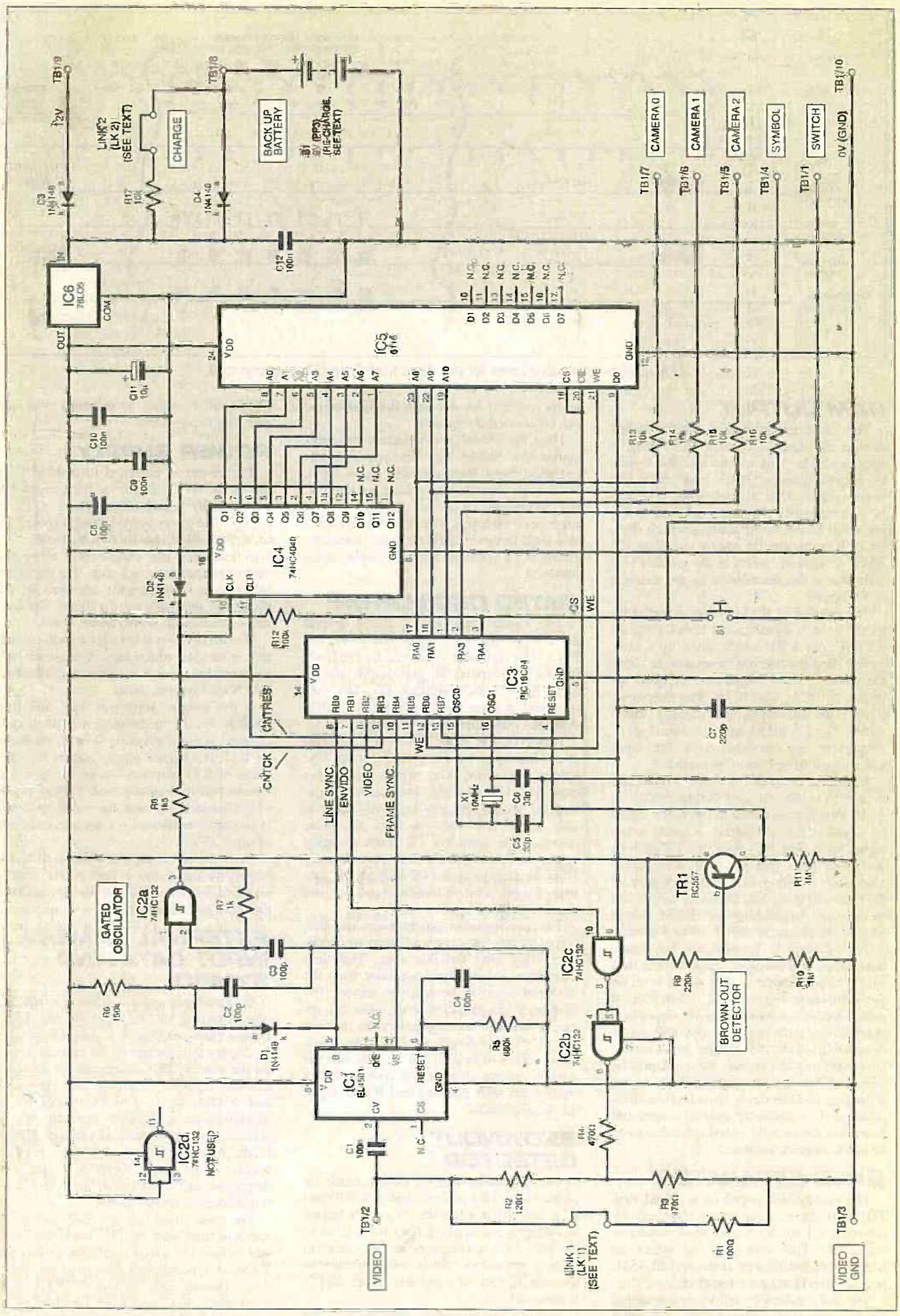



*Fig.3. Complete circuit diagram, including back-up battery, for the Time and Date Generator.*

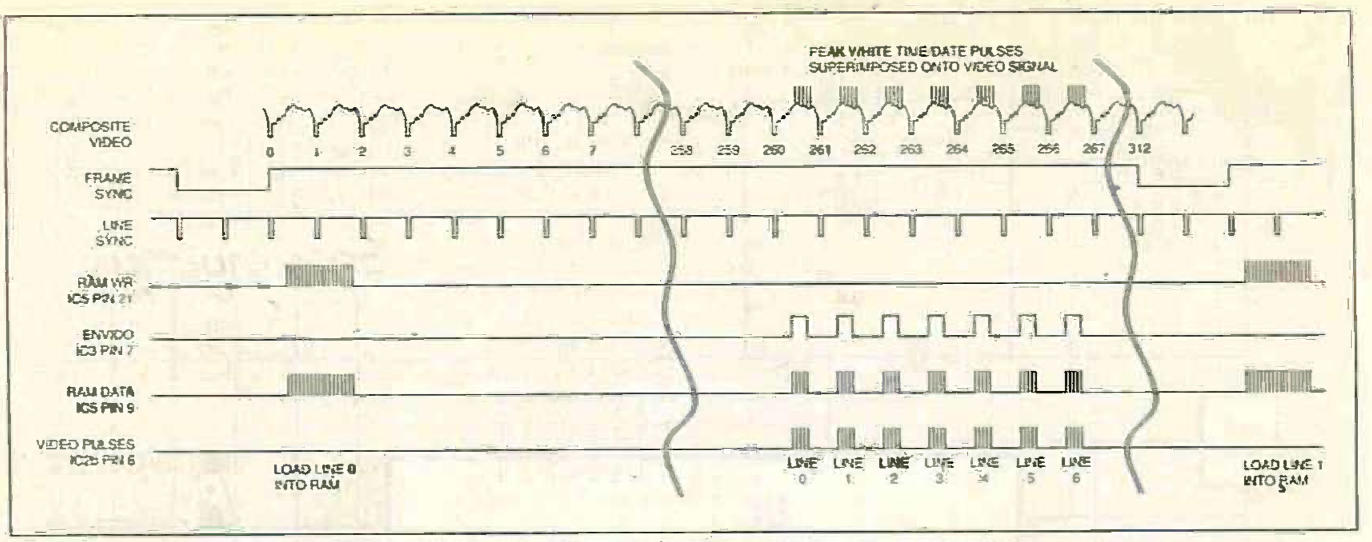



*Fig.4. Example waveforms for the Time and Date Generator circuit.*

## RAM OUTPUT

The RAM output contains a few glitches due to the address counter IC4 being a ripple counter. This means that the higher Q outputs change state later than the lower outputs after a clock input resulting in a temporarily incorrect address being presented to the RAM address inputs. This effect is overcome by adding capacitor C7 which reduces the width of the glitches to a level that is not discernible on the monitor or TV screen.

The deglitched RAM output is gated by an active high signal called ENVIDO from the PIC pin RB1 which goes high only during the lines that are to be used to show the display. These signals are ANDed together by IC2c and IC2b. The output of IC2b then overwrites the existing video signal. The ENVIDO signal is timed so as to prevent any modulation of the input video signal during the sync period.

Resistors R3 and R4 form a potential divider to reduce the gate output voltage to 2·5V. This is then added to the video signal by resistor R2, producing a peak white signal level. The PIC does this for each of the seven lines that make up the display characters resulting in a steady display of the time and date. The character height can be selected by making the RAM output each of the character lines 1,2,3 or 4 times.

This design is simple but has some drawbacks. For example, the time/date data simply superimposes a peak white level on the composite video signal. Therefore, if peak white is currently being displayed it is possible that parts of the display will not be discernible from the picture information. However, this can usually be overcome by adjusting the line display position during setting-up and has rarely been found to be a problem. To enclose the graphic output and insert the data would require the design to be much more complicated.

## SYNC SEPARATOR

The video signal input (at terminal strip TB1 pin 2) is capacitively coupled by capacitor C1 to the Video Sync Separator chip IC1. This chip can be either an LM1881 or the slightly improved EL4581, both devices being pin compatible.

The only external components required for the video sync separator chip to function are resistor R5 and capacitor C4. C4 is not really required for use with the EL4581 so can be omitted if required.

Here the video sync separator produces active-low frame and line sync signals extracted from the composite video input. Both these signals are passed to the PIC microcontroller (IC3) and the line sync is used as an interrupt. The line sync signal is also used to synchronise the gated oscillator circuit IC1a to enable a steady display to be obtained.

## GATED OSCILLATOR

The Gated Oscillator is based around the 2-input Schmitt NAND gate IC2a, see Fig.3. The oscillator is formed by feedback resistor R7 between the gate output (pin 3), input (pin 2) and capacitor C3. The gate oscillates at approximately 6MHz to 7MHz when the other input (pin 1) is high.

However, this input (pin 1) is pulled low every line sync by the sync separator line output via diode D1, which discharges capacitor C2 causing oscillation to be stopped. The active-low line sync pulse is only about 1µs wide, so after the pulse returns high, capacitor C2 starts charging again, via resistor R6. After approximately 10µs the voltage across C2 exceeds the gate logic 1 input positive threshold and the gate starts to oscillate again.

This arrangement synchronises the gate output to the line sync and starts the oscillator 10µs after the line sync. This time determines the display start point from the left-hand edge of the monitor screen. The frequency of oscillation determines the apparent width of the display on the monitor screen. If it is found necessary to adjust these values to best fit the display into the monitor screen then adjust resistor R6 to control the start position and R7 to adjust the display width.

## BROWNOUT DETECTOR

The brownout detector circuit, made up of transistor TR1 and resistors R9, R10 and R11, will detect when the 5V supply begins to collapse and apply a hard reset level to the PIC. This is necessary in this circuit to prevent erroneous values being written to the data EEPROM when the power supply is removed.

Without the brownout detector it is not uncommon to get rubbish written into the EEPROM, resulting in incorrect time and date data being stored.

## POWER SUPPLY

The circuit is designed to operate from the same +12V supply as the camera but will actually operate from about +7V to +30V. The lower limit depends on the type of +5V voltage regulator (IC6) used.

A low drop out version will allow the supply to approach +5volts. The upper input voltage is really only imposed by the maximum regulator input voltage. The current consumption is only about 10mA.

The design also allows for a back-up battery to be used which may, if required, be a rechargeable type. It is recommended that a PP3 NiCad type be used.

If the normal supply is 12V and link LK2 is fitted, the battery will be trickle charged at approximately 0·3mA via resistor R17. If a higher supply is used then the value of R17 may need to be increased to ensure that the rechargeable battery is not over charged, although the value specified is probably sufficient for an input voltage of up to 20V.

Note that if a supply of less than the battery voltage is used, then power will be supplied from the back-up battery and not the main power source!

## EXTERNAL CAMERA INPUT DATA AND SYMBOL

In a multiple camera system, where the image shown on the monitor can come from a video selector, it is useful to be able to display the number of the camera in use on the screen. This design allows a binary number input to terminals TB1 pins 7, 6 and 5 (bits 0, 1, 2 respectively) to be displayed as a decimal number on the screen. The actual decimal value displayed is the inputted binary plus one, in other words, if the binary input is 0 then 1 is displayed, and if the binary input is 7, then 8 is displayed on the screen.

The three input bits are read during the space of time after the PIC loads the RAM and before the gated oscillator causes the RAM to superimpose data onto the video data. During this period PORTA pins RA0, RA1, RA2 and RA3 are changed to inputs and all the bits are read via input resistors R13 to R16.

Additionally, the input to TB1/4 alters the symbol between the "C" and the camera number. This can be used to indicate an external event or simply be set for preference.

| Terminal (TB1) | | | | Display |
|---|---|---|---|---|
| 4 | 5 | 6 | 7 | |
| 0 | 0 | 0 | 0 | C – 1 |
| 0 | 0 | 0 | 1 | C – 2 |
| 0 | 0 | 1 | 0 | C – 3 |
| 0 | 0 | 1 | 1 | C – 4 |
| 0 | 1 | 0 | 0 | C – 5 |
| 0 | 1 | 0 | 1 | C – 6 |
| 0 | 1 | 1 | 0 | C – 7 |
| 0 | 1 | 1 | 1 | C – 8 |
| 1 | 0 | 0 | 0 | C / 1 |
| 1 | 0 | 0 | 1 | C / 2 |
| 1 | 0 | 1 | 0 | C / 3 |
| 1 | 0 | 1 | 1 | C / 4 |
| 1 | 1 | 0 | 0 | C / 5 |
| 1 | 1 | 0 | 1 | C / 6 |
| 1 | 1 | 1 | 0 | C / 7 |
| 1 | 1 | 1 | 1 | C / 8 |

A logic 0 is any voltage less than 2·5V
A logic 1 is any voltage greater than about 2·5V up to 12V

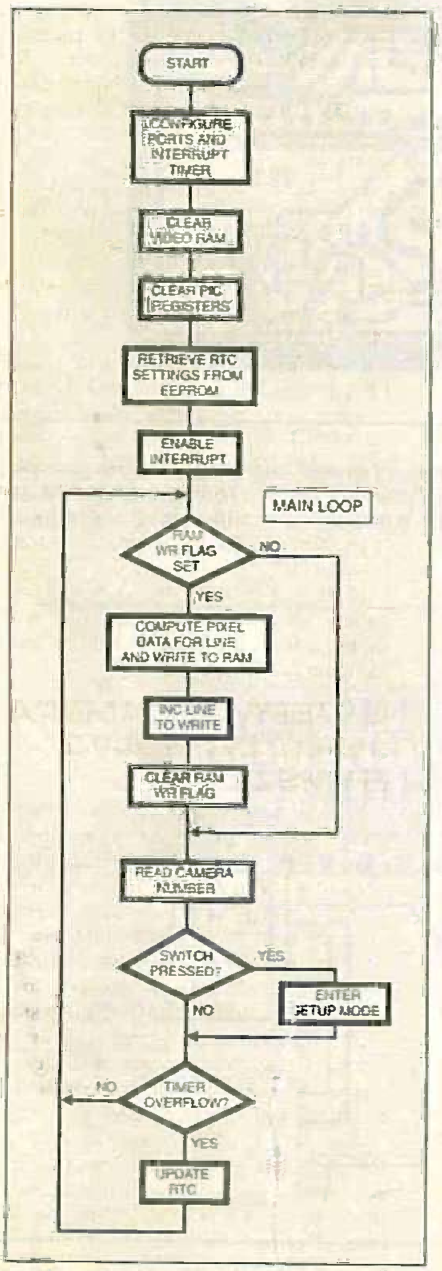



Fig.5. Setup and main loop initialisation flowchart.

The camera number display can be disabled if not required during setting up with the F6 setting.

## SOFTWARE

The PIC program for the PIC16C84 has been written using MPASM, but may easily be converted to TASM assembler format.

Software for the Time and Date Generator is available on a 3·5in. PC-compatible disk from the *EPE PCB Service*. The software is *free* but there is a nominal postage and handling charge. If you have access to the Internet, it can be downloaded free from our web site: **ftp://ftp.epemag.wimborne.co.uk/pub/PICS/timedate.**

See *Shoptalk* page for details of how to obtain a ready-programmed PIC16C84-10 microcontroller.

When programming the PIC the fuses should be set as follows:

WD on, OSC HS, CP off, PU on.

All of the PIC's memory is used except for just a few locations. The software is really too complex to discuss in any detail here, but two flowcharts are included to indicate the main functions.

The initialisation and MAIN loop of the software where a line of data is written to the RAM every frame is shown in Fig.5, the switch is checked and the real time clock (RTC) is maintained. This process is repeated continuously. Fig.6 shows what happens after each line sync interrupt and how control of the RAM is released to the gated oscillator when the display line is reached.

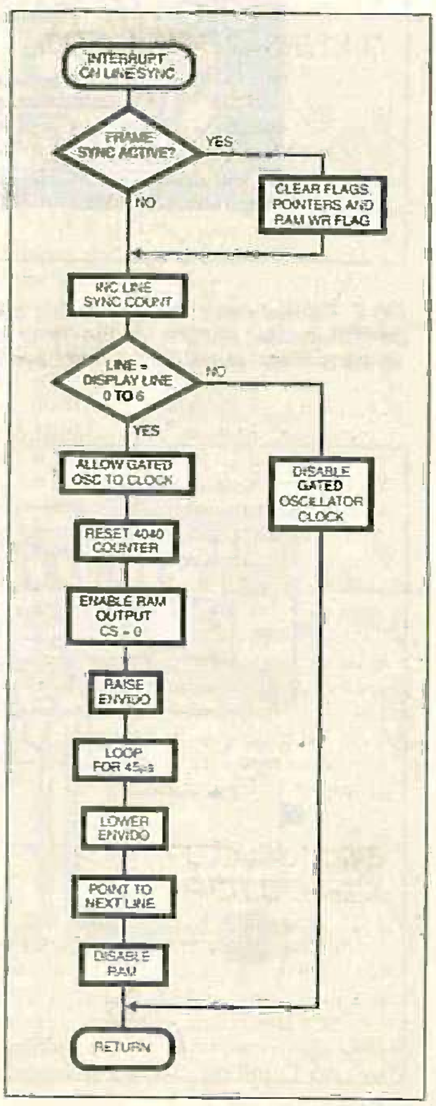



Fig.6. Simplified flowchart for the interrupt routine.

Other aspects of the software such as the character pixel generation have already been discussed in detail.

## CONSTRUCTION

Details of the printed circuit board topside component layout and underside copper tracking are shown in Fig.7. This board is available from the *EPE PCB Service*, code 221.

## COMPONENTS

See SHOP TALK Page

**Resistors**

| | |
|---|---|
| R1 | 100Ω |
| R2 | 120Ω |
| R3, R4 | 470Ω (2 off) |
| R5 | 680k |
| R6 | 150k |
| R7 | 1k |
| R8 | 1k5 |
| R9 | 220k |
| R10, R11 | 1M (2 off) |
| R12 | 100k |
| R13 to R17 | 10k (5 off) |

All 0·25W 5% carbon film or better

**Capacitors**

| | |
|---|---|
| C1, C4, C8 to C10, C12 | 100n ceramic disc (6 off) |
| C2, C3 | 100p ceramic disc (2 off) |
| C5, C6 | 33p ceramic disc (2 off |
| C7 | 220p ceramic disc |
| C11 | 10µ tantalum bead, 16V |

**Semiconductors**

| | |
|---|---|
| D1 to D4 | 1N4148 signal diodes (4 off) |
| TR1 | BC557 *pnp* transistor |
| IC1 | EL4581 or LM1881 video sync separator |
| IC2 | 74HC132 quad Schmitt NAND gate |
| IC3 | PIC16C84-10 pre-programmed microcontroller, see *Shoptalk* |
| IC4 | 74HC4040 12-stage binary counter |
| IC5 | 6116 2K × 8 static RAM |
| IC6 | 78L05 +5V 100mA voltage regulator |

**Miscellaneous**

| | |
|---|---|
| S1 | min. pushbutton, right-angle, p.c.b. mounting switch (press-to-make, release-to-break) |
| X1 | 10MHz crystal |
| TB1 | 10-way screw terminal strip, made up from linkable 2-way 5mm p.c.b. mounting terminal block (5 off) |

Printed circuit board available from the *EPE PCB Service*, code 221; 2-way pin jumper and strip (2 off); 8-pin d.i.l. socket; 14-pin d.i.l. socket; 16-pin d.i.l. socket; 18-pin d.i.l. socket; 24-pin d.i.l. socket; coaxial cable; optional 4-way 2-pole rotary switch; multistrand connecting wire; 9V rechargeable battery (PP3); solder etc.

**Approx Cost Guidance Only £28 excluding batt.**

There are six bare wire links on the p.c.b. and construction should commence by soldering these in position first. These may be made from lengths of tinned copper wire or zero ohm resistors if you have any.

Solder all the other components on the board, working from the smallest up to the largest. The PIC microcontroller and the other i.c.s should all be mounted in d.i.l. sockets. Pay particular attention over the orientation of the i.c.s and diodes.

The p.c.b. terminal block may have to be slotted together to form the correct number of "ways", depending on the type purchased. Do not forget the two "jumper" links LK1 and LK2 if required, see later.

If the generator is to be mounted away from an accessible case edge, then an external switch may be included. This is effectively wired in parallel to the on-board switch S1, which may be omitted if not required.

No details have been provided for fitting the Time and Date Generator into a case, because the unit was intended to be included within the enclosure of an existing video switcher. However, if it is required to case the generator there are many suitable plastic or metal cases available and there are no special precautions that need to be taken.

Holes have been provided at each corner of the p.c.b. to facilitate fixing if required. Alternatively the p.c.b. could be fixed to another board by replacing the terminal strip with stiff wire links and soldering these down directly.

Finally, double-check for solder shorts or integrated circuits the wrong way round. When confident, wire up the generator, as shown in Fig.8 and switch on the 12V power supply. Hopefully some form of display will be shown on the monitor screen. Initially there may be a lot of dashes, indicating silly values, but after following the setting up procedure a clean display should soon result.

## SETTING UP

How to connect the Time and Date Generator up to the video camera and power supply is shown in Fig.8 A typical four-camera system set-up, that allows the camera number to be displayed, is shown in Fig.9.

If video termination is required then use shorting link LK1, otherwise leave the link open. With LK1 open the input impedance is approximately 355 ohms, which will not affect the picture quality much. With LK1 fitted the input impedance is 78 ohms.

The terminal block TB1 pin functions are as follows:

| Pin | Function |
|---|---|
| 1 | Switch |
| 2 | Composite video in/out |
| 3 | Video ground |
| 4 | Symbol input 5V = /; 0V = -. CMOS voltage levels |
| 5 | CAM bit 2 0 to 5V CMOS logic levels (max 12V) |
| 6 | CAM bit 1 |
| 7 | CAM bit 0 |
| 8 | Back-up battery +9V |
| 9 | +12V supply (9V to 20V) |
| 10 | Power and switch ground |

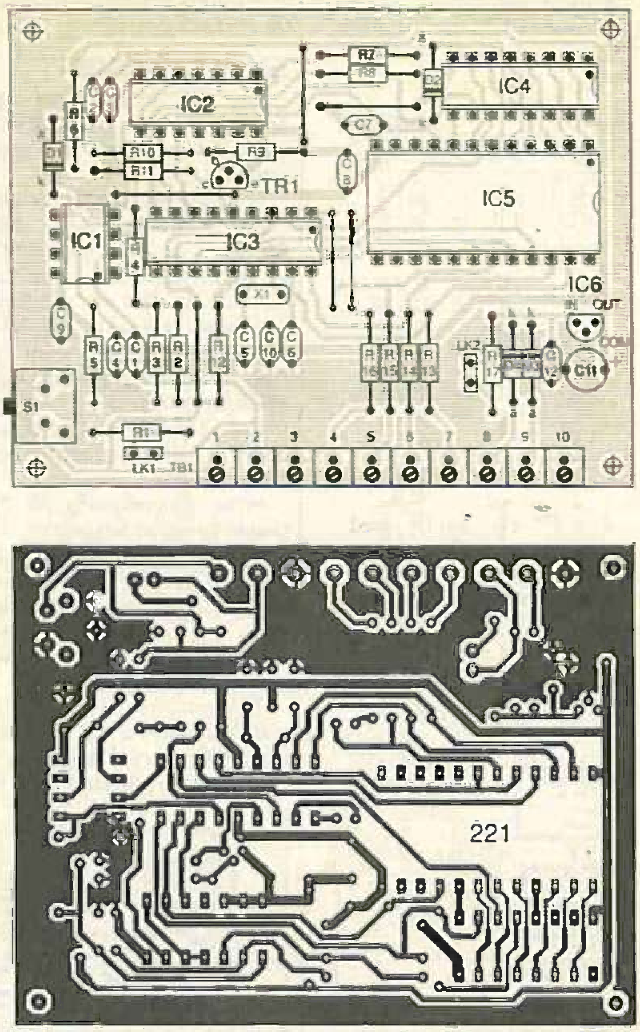



*Fig.7. Printed circuit board topside component layout and full size underside copper foil master pattern for the Time and Date Generator. The right-angle 10-way screw terminal block (TB1) may have to be made up from "linkable" 2-way types.*

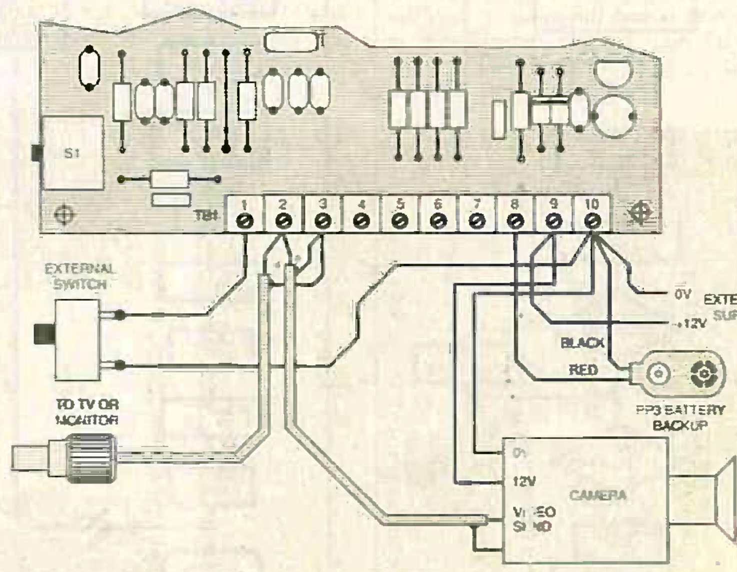



*Fig.8. Typical interwiring and power supply arrangement for a single video camera setup. The external switch is optional and replaces S1 on the p.c.b.*

**Table 2: Function Settings**

| | |
|---|---|
| F1 | Select character height of 5, 10,15 or 20 lines. |
| F2 | Select line display from line 256 to line 291. |
| F3 | Inverse or normal video display. |
| F4 | Select time or date or both. |
| F5 | Swap day and month display. |
| F6 | Display camera number (1 to 8) and symbol |
| F7 | Trim accuracy by up to ±9 seconds per day. |
| HOURS | adjust |
| MINUTES | adjust |
| SECONDS | adjust |
| DAY | adjust |
| MONTH | adjust |
| YEAR | adjust |

The display time, date and switchable functions are all controlled by a single pushbutton switch, S1. The switch used may be S1 on the p.c.b. or it may be an external one wired between terminals TB1/1 and TB1/10 (Gnd).

When the pushbutton switch S1 is pressed for more than five seconds the display enters the set-up mode and shows "F1". A typical display being as shown below:

F1 23:59:33 23/02/1998 C-5 (function 1 selected)

Quick presses of the pushbutton then allow the required selection to be changed and displayed for that function. In the case of F1 the display height will be changed every quick press. The display is cyclic, in that after the maximum height, the next press will select the smallest height.

To get to the next function hold the push button on for five more seconds. In total there are seven function settings (F1 to F7 – see Table 2) before the time adjustment is reached. After F7 the real time clock adjustment can take place and the timer being controlled will flash. The year value increments from 1997 to 2096 before returning to 1997.

All settings and times except seconds are stored in the PIC's EEPROM such that if all power is lost then only a few settings will require changing when power is restored. A description of each of the function settings obtained by keeping the pushbutton switch S1 pressed for more than a few seconds is shown in Table 2.

If the pushbutton is inactive for approximately ten seconds the set mode is aborted and the display returns to normal.

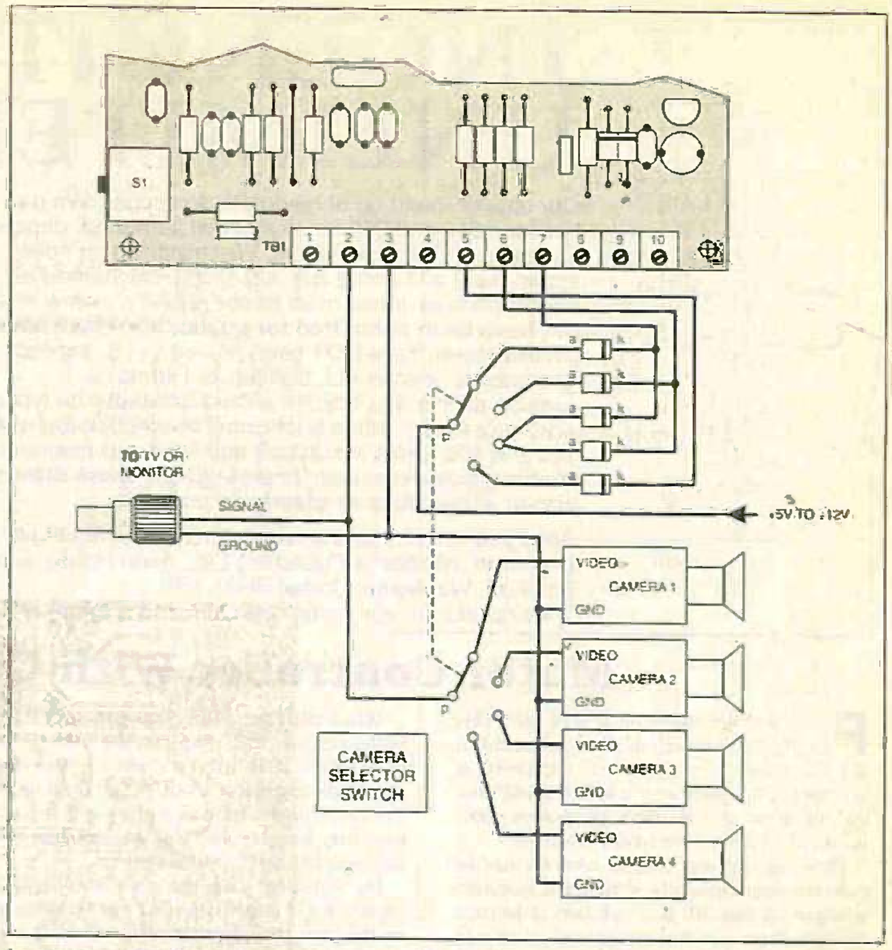


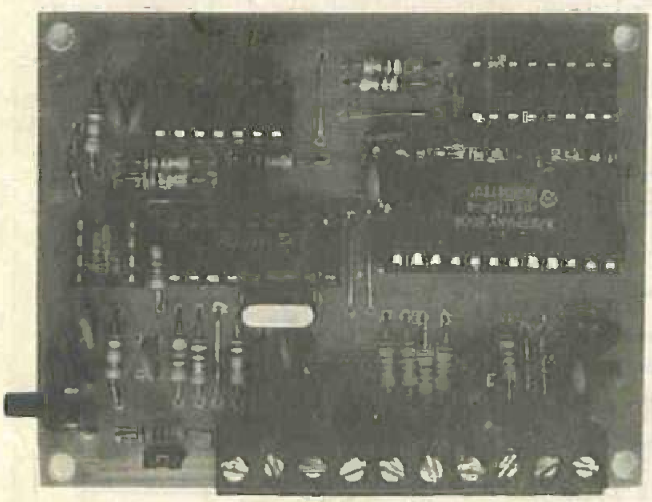

*Fig.9. A typical four camera system using a 4-way 2-pole rotary switch for camera selection. The power supply connections are not shown in this diagram – see Fig.8.*

## TRIMMING

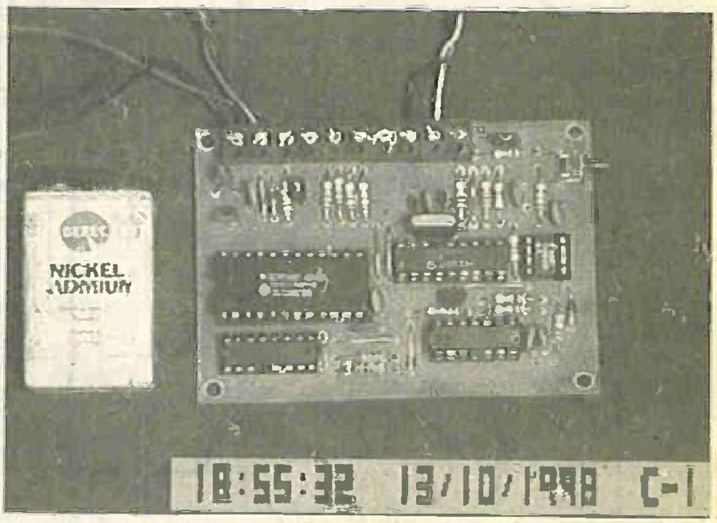
The best way to trim the real time clock is to set the trim value in the function F7 setting to zero. Adjust the clock display to read the same as a known accurate clock (e.g teletext) and leave for 24 hours. After 24 hours the clock will probably have lost or gained a few seconds. Adjust the trim value (F7) to match the number of seconds as in the following examples:

If the display is five seconds fast, set F7 to 5. If the display is nine seconds slow, set F7 to −9 (the '−' indicates minus here). This will apply the appropriate trim value to compensate for the error. Up to plus or minus nine seconds can be accommodated with this method.

If the real time clock runs faster or slower than this the crystal oscillator X1 must be oscillating more than 100ppm fast or slow. If fast increase (try doubling) the value of capacitors C5 and C6. If slow decrease (try halving) the value of these capacitors.



*Layout of components on the finished p.c.b. The pushbutton function setting switch is on the bottom-left corner.*




*Monitor screen shot capturing the time and date together with the "camera-on" indication (C-1).*

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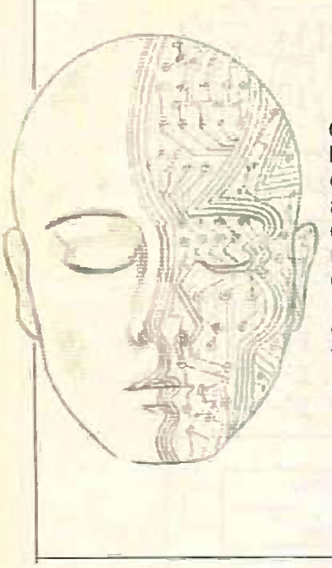

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## Motor Controller With Centre Off

Pulse width modulation (PWM) provides an efficient and reliable way of controlling the speed of d.c. motors, especially at low speed. In addition to a rotary speed control, these pulse controllers often have some means of switching the motor direction.

However, the use of two controls can be cumbersome, especially if frequent direction changes are needed. One solution is to have a single rotary control configured so that in its mid-way position, the motor is stationary. Turning the control clockwise, will result in forward motion, and anti-clockwise, reverse. The speed increasing when it is advanced.

The circuit diagram presented in Fig. 1 is a PWM Motor Controller, with a centre-off facility. The first section of the circuit generates two pulse-width modulated signals, one for forward, the other reverse. The second section combines these signals to determine which direction is required and also to provide the output drive for the motor.

The pulse signals are formed by two retriggerable monostables, contained in IC2, a 4538B dual precision monostable. Both monostables (IC2a and IC2b) are triggered simultaneously by a common clock pulse provided by IC1, which is a 4047B used in astable mode. Timing components resistor R1 and capacitor C2 produce a frequency of approximately 390Hz.

When the Speed/Direction control VR1 is in the central "off" position, the time period of IC2a and IC2b will be slightly longer than that of the triggering clock pulse. Both of the inverted outputs (pins 7 and 9) will be continuously low, because both monostables will retrigger before their time elapses.

By adjusting VR1, the resistance between capacitor C3 and resistor R2 can be reduced, so the time period associated with IC2a will decrease. Since the monostable will now complete its timing before being retriggered, a square wave will appear on IC2a pin 7.

The mark-to-space ratio will be determined by how far the control VR1 is advanced. When fully advanced, only R2 (4k7) will be used to charge C3 and the time period will be about 120μs, which is approximately 4·7 per cent of the width of the clock pulse. This gives an output with a 95 per cent duty cycle.

When VR1 is turned the other way the same thing happens to the other monostable IC2b which provides the second pulse signal. Note that 4·7 kilohms is the minimum recommended value of timing resistor.

By performing a logic OR operation on the monostable outputs, a signal is produced whose duty cycle is dependent on the position of VR1. It will have a high mark-to-space ratio at either end of VR1's travel, reducing towards the middle, and completely off when centrally positioned. IC3c and IC3d (4001B quad NOR gates) are connected to provide the OR function, which is used to drive the emitter follower output stage of Darlington transistor TR2.

### In Reverse

The relay RLA reverses the motor direction and is driven, via transistor TR1, by an RS flip-flop, comprising the NOR gates IC3a and IC3b. The two monostable outputs are connected to the flip-flop R and S inputs.

Since the monostables' outputs will not both be high at the same time, the output of the flip-flop will go high when the output of IC2b goes high. The flip-flop remains in this state until reset by the output of IC2a going high, which indicates a direction change, the relay then reverses the motor's rotation.

In practice it may be necessary to adjust the frequency at which IC1 oscillates, by varying the value of resistor R1. The supply voltage is not critical, and can be chosen to suit the motor used.

However, the supply must stay within the limits of the 4000B series, that is 5V to 15V, and also comply with that of the relay coil. Capacitor C1 was included to decouple the supply.

*Steve Teal, Witney, Oxon.*

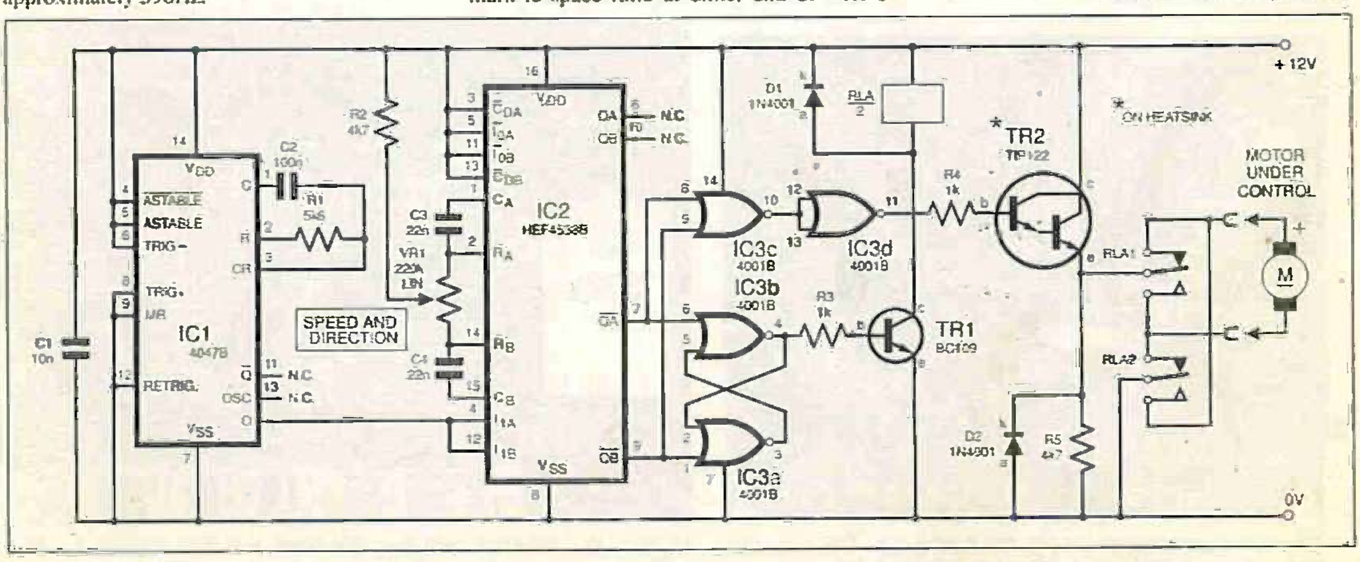


*Fig. 1. Circuit diagram for a PWM Motor Controller, with centre off.*

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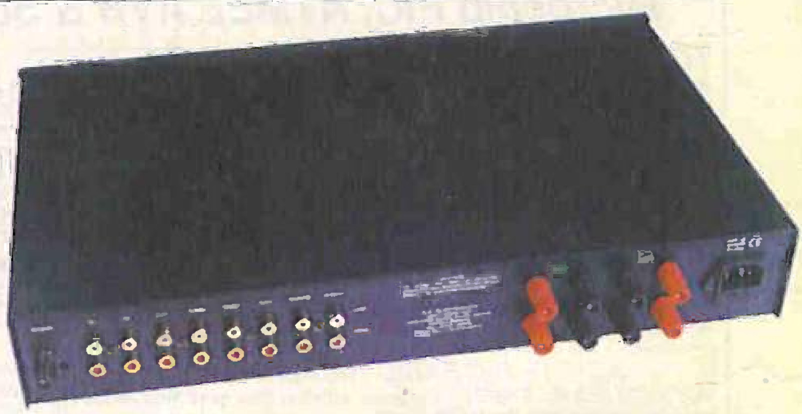

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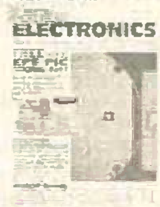


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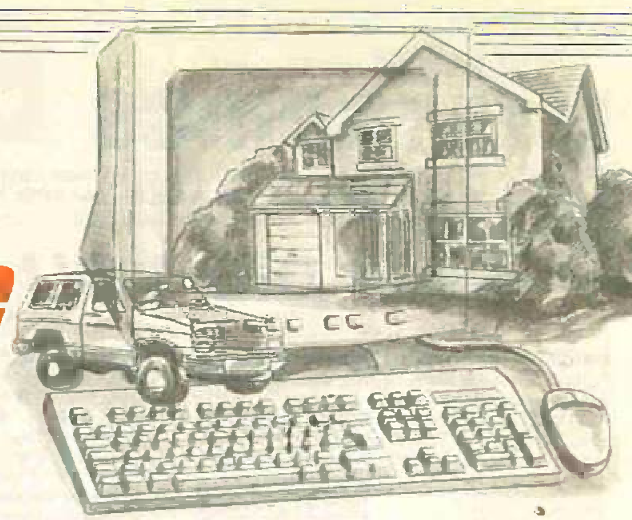
M3/99

Constructional Project

# WIRELESS MONITORING SYSTEM



JAMES HUMPHRIS

Part Two

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

LAST month we gave the circuits and constructional details for building an a.m. Transmitter and Receiver. This month we set about testing the system modules, consider the software and also offer the option of going f.m.

## RECEIVER TESTING

It is essential to get the Receiver unit to operate correctly before the transmitter units as the latter do not have any physical indicators as to whether or not they are functioning properly.

Without a PIC inserted into the Receiver, plug in and switch on the power supply. If the voltage regulator IC1 is working correctly and there are no power supply shorts on the board, l.e.d. D3 should light.

If this is the case, then test the power connections on all the i.c.s to ensure a clean 5V supply of the correct polarity. In this state, the board should consume around 16·3mA. If it is a little higher or lower than this level then don't worry, as long as it is not excessive.

Check the COMM connection on the board near IC4, it should be at +8·7V. Also check that the case is well grounded with a continuity tester or multimeter.

Switch off the unit, carefully insert the programmed PIC and connect the serial lead between the receiver and the computer, connecting to the port that is in use at 9600 baud with 8 data bits, 1 stop bit and no parity.

Load either HyperTerminal in Windows '95 or Terminal in Windows 3.1 (or any other terminal package that is available). Check the flow control is either set to Hardware or None and the emulation is set to ANSI.

When the receiver is first switched on, l.e.d. D1 should flash briefly and the PC screen should display the message "Hello". This indicates that the unit has booted up correctly and is ready to receive r.f. signals.

If this is not the case, use an oscilloscope to check that a 3·6864MHz square wave is present on pins 15 and 16 of IC2. If this is OK, then check that IC2 pin 4 has a good 5V connection and look for a brief pulse train on pin 11 of IC2 as power is applied. If this is present, test IC4 pin 14 in the same way for a brief pulse chain of +8·4V to −8·4V.

Note that the duration of this pulse train is only five bytes at 9600 baud (5·2ms) and can easily be missed. The receiver unit must be operational before the tuning of the transmitter units as, otherwise, you could end up in a very difficult situation where nothing appears to work!

## TRANSMITTER TUNING

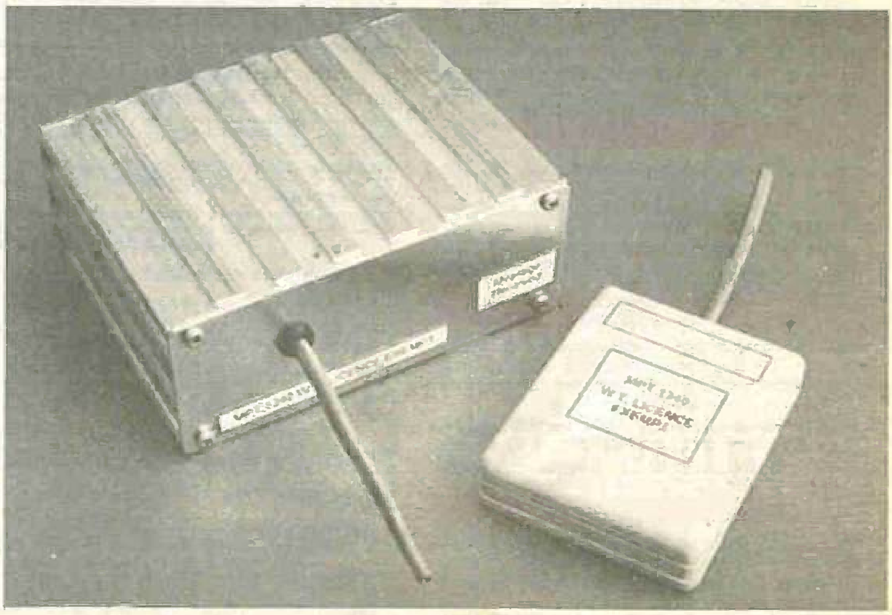
Remove the PIC from the Transmitter module and short pins 13 and 14 of its socket together using a small wire link. This supplies the transmitter module with a permanent high level so that a continuous 418MHz carrier wave is transmitted.

Switch on the receiver module and connect a multimeter measuring d.c. volts on a suitable range between ground and test point TP1. With the transmitter module switched off, a reading of around 2·6V should be obtained.

Separate the transmitter and receiver modules by a couple of metres and apply power to the transmitter. The meter reading should increase to between 2·85V and 3·15V.

Slowly adjust variable capacitor C4 on the transmitter using a non-ferrous tuning tool until the reading is maximised at around 3·15V. This may take some time and requires the separation between the units to be adjusted so that this maximum can be achieved. Remove the tuning tool and move away from the transmitter so that the best reading can be observed.

Note that best results will be achieved by using a clear line of sight between the two units. Once this has been done, switch off the transmitter, remove the temporary link and replace the PIC.




*Completed Receiver module and Transmitter, with licence exempt label.*

This process needs to be completed for each individual transmitter unit and once done, no further adjustments are necessary.

### RADIO LINK

Although all the modulation and demodulation is completed by the r.f. modules and no particular r.f. knowledge is required, the radio link is not analogous to a length of wire linking the two units together!

Sometimes what is received is very different from what is transmitted. This is due to interference that occurs either when two transmitters attempt to transmit simultaneously, or due to other electrical appliances that generate radio frequency interference (r.f.i.) at the same frequency as the system.

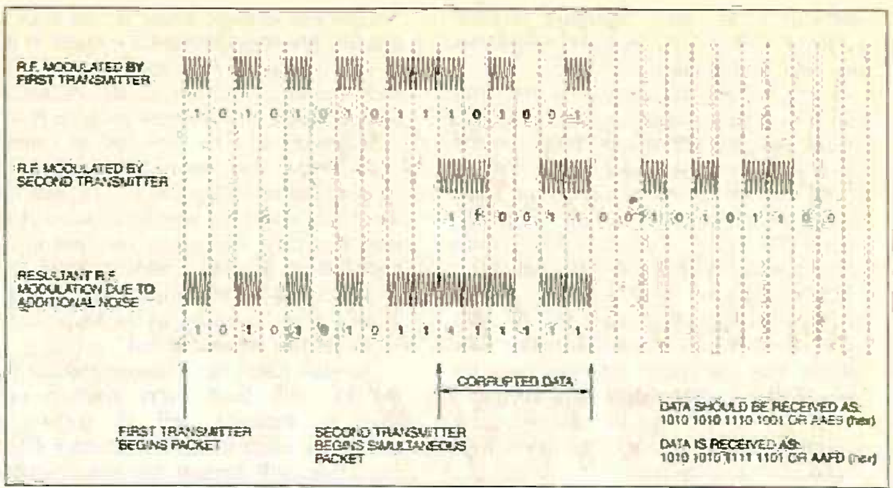



*Fig.10. Example of data corruption in r.f. channel.*

All the transmitter units operate on the same r.f. channel. Therefore, if several events occur simultaneously then the channel will contain a mixture of information. An example of this is illustrated Fig.10.

If possible, the events that are being monitored should be time independent, i.e. not always occurring at the same instant in time. This is sometimes unavoidable and some transmissions will either occur together or overlap one another. The result of this is that all of the transmissions will be corrupted.

Each transmission takes only 330ms and events are usually separated by a longer period, i.e. a few seconds or minutes. Therefore, the chance of two independent events occurring at once is remote.

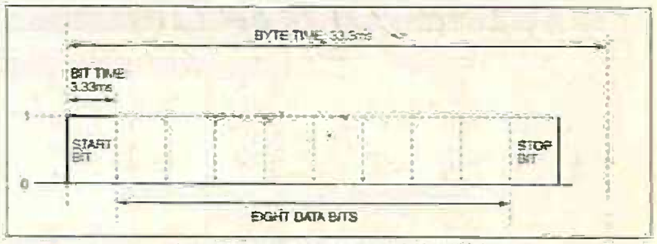



*Fig.11. R.F. data byte details.*

### VALIDITY CHECKS

In order to detect if the information is corrupted, some method of checking the validity of the received data is required to be included in the data that is transmitted. It is important to realise that almost any method of data checking is not perfect and sometimes a corrupted message is interpreted as being correct. It is the software designer's responsibility to ensure that the chance of accepting an incorrect message is minimised.

The software algorithm in the transmitter modules encodes the digitised sensor information into discrete data packets that are sent across the r.f. link. Each data byte consists of ten data bits, as illustrated in Fig.11.

The high level Start Bit serves to let the receiver know that a data byte is on its way, and to prepare to receive the following eight bits that constitute the actual byte. A low level Stop Bit ensures that a short time exists between sequential data bytes and follows the eight data bits to complete each byte.

Each packet consists of nine data bytes as can be seen in Fig.12. Full descriptions of each byte are given in Table 1.

The Transmit Sync Code is used to stabilise the receiver module and allows it to lock to the correct frequency. It also serves to indicate to the receiver software that a valid transmitter module is producing the signal and not another device using the 418MHz frequency.

The Identification byte enables the PC to identify which transmitter has produced the data. The Transmit Number allows the analysis of the number of any missed data packets by the PC. The Data bytes represent the actual digitised data received by the transmitter PIC. The software only uses the first data byte but, if required, the remaining four bytes can easily be implemented by changing the PIC software. The cyclic redundancy check (CRC) nibble is mainly the method used to determine the validity of the data.

**Table 1. Data Packet Description**

| Byte Number | Typical Value (Hex) | Description |
|---|---|---|
| 1 | 55 | **Synchronisation Byte** – Tells the receiver that a transmitter has started a packet and that it should wait for the rest of the packet |
| 2 | Any | **Identification Byte** – Allows the PC to identify which unit has made the transmission |
| 3 | 00 to FF | **TX Number** – The number of transmissions that the unit has made (00 follows FF). This allows the PC to determine if any transmissions have been missed due to interference |
| 4 | Any | **Data 1** – Sensor level data byte 1 |
| 5 | Any | **Data 2** – Sensor level data byte 2. (Not used) |
| 6 | Any | **Data 3** – Sensor level data byte 3. (Not used) |
| 7 | Any | **Data 4** – Sensor level data byte 4. (Not used) |
| 8 | Any | **Data 5** – Sensor level data byte 5. (Not used) |
| 9 | 00 to 0F | **Cyclic Redundancy nibble** – Used to detect if any errors have occurred in the radio link due to interference |

### CYCLIC REDUNDANCY CHECK

The CRC nibble (half byte) is reasonably unique to each data packet and is found by performing a complex polynomial computation upon the whole data packet (excluding itself) as it is transmitted. It is essentially the remainder of a long division of the data stream by a binary polynomial.

The receiver performs exactly the same calculation on the received data stream excluding the CRC nibble and produces its own second CRC nibble. If any corruption has occurred, the second CRC will be

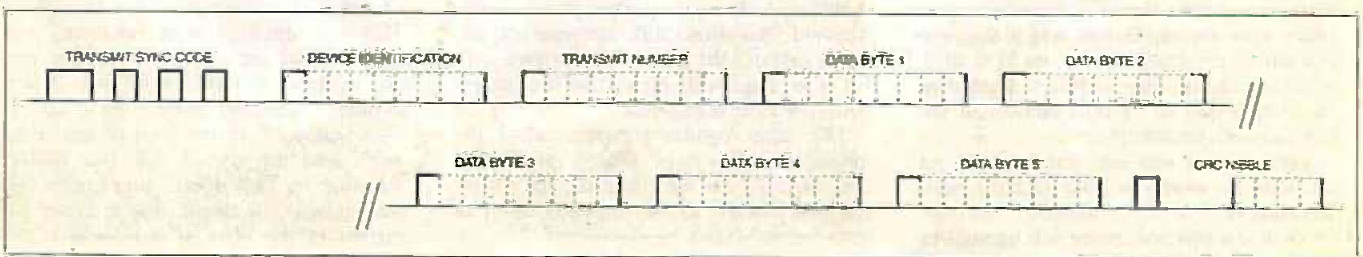



*Fig.12. Breakdown information of the r.f. data packet transmission.*

different to the first. Therefore, a comparison of these two nibbles determines the validity of the received data.

The CRC nibble consists of four bits and has sixteen possible values. The rest of the data packet is essentially an 80-bit binary word that has a staggering $2^{80}$ ($1{\cdot}208 \times 10^{24}$) values. Each of these values will correspond to one of the sixteen CRC values, i.e. each CRC value corresponds to $7{\cdot}55 \times 10^{22}$ data values.

Distribution of these values is almost completely random amongst the $2^{80}$ possible combinations and, therefore, the chance that corrupted data produces the same CRC as the correct data stream is very slim! In fact, with the author's units, a corrupted data message has never been interpreted as correct!

You will next be asked if you want to load the previous calibration settings. If this is the first time that you are using the software, then there are not any calibration settings stored and you must click on No.

Following this, the View options window is displayed. This allows you to select the type of time recording that you require. Full Time means that the time is recorded as the time that each message is received in 24-hour format. Similarly, Seconds Since Start or Minutes Since Start allow different types of recording depending on the frequency of messages that are anticipated.

Audible Alerts for Messages means that the PC will beep every time a message is received and is useful for testing the range of the transmitters. Clicking Done will present the main window where the messages are displayed. A typical screen shot is shown in Fig.13.

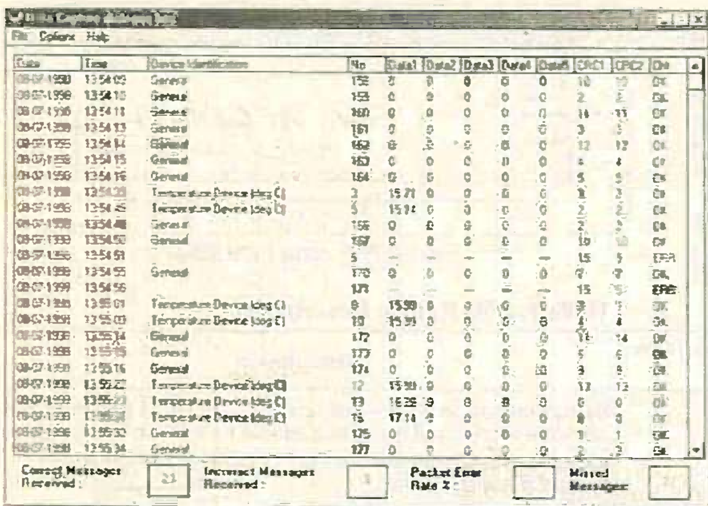


Fig.13 (left). Data capture application screen shot.

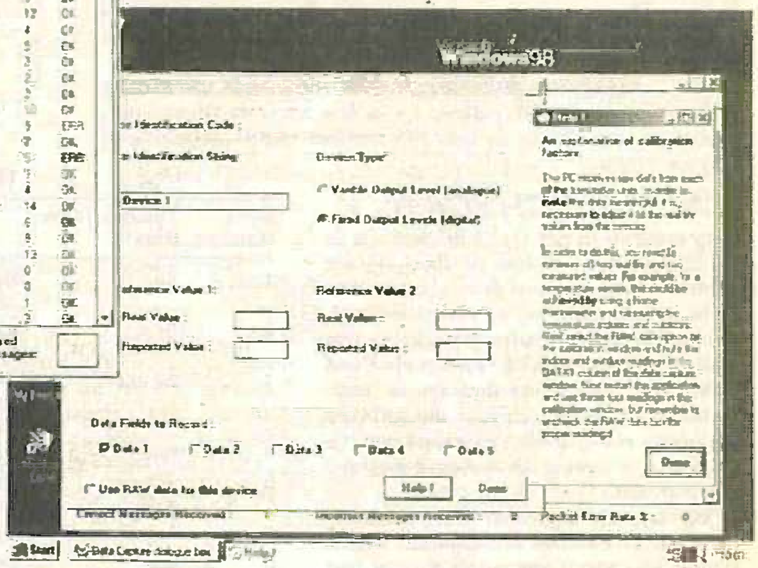


Fig.14 (right). Screen shot for sensor calibration.

The receiver does not compare the two CRC values, but simply appends the second CRC nibble to the received data. This forms a ten-byte packet that is transmitted across the RS232 serial link. The raw RS232 information can be observed by using a terminal package with a hexadecimal display capability. Such a window is included in the system's software for diagnostic purposes.

## SOFTWARE

When the hardware has been built and tested, the information that is received can be analysed.

The software written for this purpose is available free as detailed later. It provides a simple interface between the received data and the user's preferred spreadsheet or database application. If the spreadsheet or database that is used has the ability to collect data directly from a serial port, then this is an alternative route that can also be used for analysis.

Running the software is simple: install the package onto the PC's hard-drive (see later), start the application and a dialogue box will be displayed asking you to identify which serial port the receiver is connected to. Type in the COM port number in the box and click the mouse on Test.

The program will then test the port and ask you to switch on the receiver unit. Once the receiver's boot message has been checked, the Proceed button will be enabled and once clicked on, the main window will be displayed.

Switch on the transmitters one at a time and force a message to be transmitted by changing the condition that the sensor is used to monitor, e.g. manually induce a change in the temperature of the temperature sensor.

When a message is received from a new transmitter, the calibration window is displayed. A Help window is available from here that will help you enter the correct calibration settings for each transmitter and ensure that the data is logged in the correct manner. See Fig.14.

The Export Options window from the Options menu allows you to set-up the method that is used to export the data to a file that is subsequently used by your spreadsheet or database. This allows fully automatic exporting of data to a file every time a certain number of messages are received, or manual exporting whenever required.

The other menus available allow the message window to be cleared, the calibration settings to be deleted, the View Options window to be displayed again or hexadecimal data to be shown.

In Fig.13, the calibrated information can be seen alongside the date, time and message status. If a packet is received correctly, the last column of the table shows OK. If it is not received correctly the column shows ERR.

Statistics are calculated for the number of messages received correctly and incorrectly and a calculated current Packet Error Rate is determined. Messages that have been missed are counted and a current total is shown. The packet error rate total does not take into account any missed packets.

These statistics give an indication as to the performance of the system at any point in time and allow adjustments of the transmitters for better reception.

When you exit from the program using the File Exit menu, you will be asked if you want to save your calibration settings. This means that you can re-start the program again without having to enter in all the settings for the sensors each time. If the settings are not wanted, then click No to exit.

The graph in Fig.15 shows some sample results that have been collected from a temperature sensor transmitter unit. They correspond to the temperature of fruit juice placed in the fridge to cool down, then removed and ice added. The dots on the graph indicate the times that messages were received, i.e. when the temperature changed and a transmission occurred.

The tilt switch transmitter unit is probably most useful in testing the range of operation of the units. The advantage of the switch is that it can easily be moved and its orientation changed such that the environment within which the system is used can be explored for range and suitability.

A typical application is shown in the graph of Fig.16, where the tilt switch is used within a vehicle to monitor the opening and closing of the boot hatch. This is combined with information recorded from another sensor that is being used to monitor pulses from the odometer in order to measure distance travelled.

A laptop PC in the boot of the vehicle was used to record all the received information. This information can be used, for example, to ensure that a secure load carried in the boot of a vehicle is only accessed at particular points along a specific journey.

## OPERATING RANGE

If the range of operation of the transmitter units is not acceptable for the particular application required, several methods could be implemented to increase the physical separation between the transmitter and receiver units. Two possible methods exist: replacing the radio modules with more sophisticated f.m. types and, secondly, increasing the power that is supplied to the existing a.m. transmitter module.

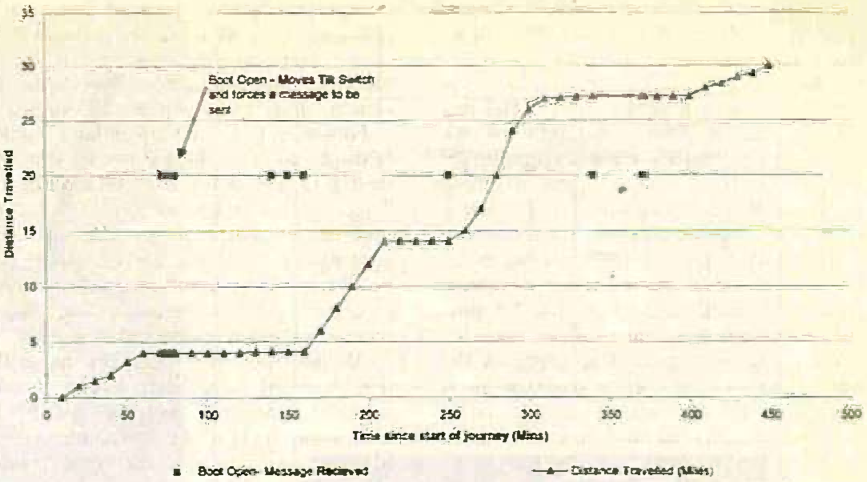



Fig.16. Graph details from a boot sensor and a distance travelled sensor.

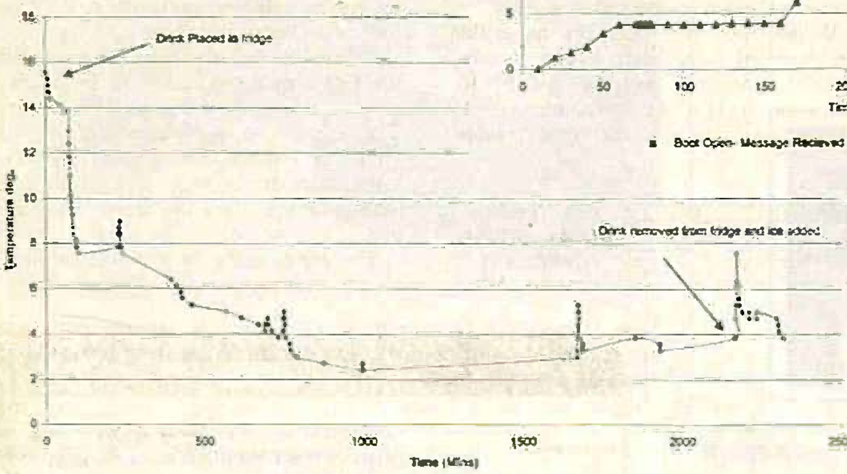



Fig.15. Sample graph of temperatures obtained from a fruit juice drink placed in a fridge.

## BOOSTING A.M. POWER

An easy method of increasing the range of operation with a.m. is simply to provide the transmitter with a higher operating voltage and hence allow more current to be consumed by it. The PIC has a maximum operating voltage of 6V and, therefore, without any extra interfacing between the PIC and transmitter, this provides an upper limit on the voltage allowed. In order to limit the current that is consumed by the transmitter when running from 6V, the value of resistor R5 needs to be adjusted according to Table 2.

**Table 2: Resistor R5 values according to $V_{CC}$ voltage.**

| $V_{cc}$ Min | $V_{cc}$ Max | R5 Value (Ohms) |
|---|---|---|
| 2·5 | 3·5 | 100 |
| 2·8 | 4·0 | 220 |
| 3·2 | 4·5 | 330 |
| 3·6 | 5·2 | 470 |
| 4·2 | 6·1 | 680 |
| 5·2 | 7·6 | 1k |

Performance can be further improved by the use of a mains adaptor power supply that can provide a regulated and smoothed 5V d.c. output. This provides the transmitter with a good ground connection that cannot be achieved with the use of a floating power supply such as a battery.

## SWITCHING TO F.M.

Frequency Modulation (f.m.) is considerably more reliable than the older technology, Amplitude Modulation (a.m.). This can be easily observed by listening to an a.m. radio station in a car and travelling around an urban area or under a bridge. The signal strength received is subject to variation due to buildings, hills, etc.

With f.m., however, these effects are reduced and a strong signal is either received or not received, and is reasonably independent of direction. This is true in the case suggested here also. An f.m. system, although *not* tested, would provide a significant improvement in performance and range of operation, but at an increased cost.

Switching to f.m. involves significantly more effort than increasing the power of the a.m. modules. It also consumes more power than a.m. and is not as well suited to battery operation. Consequently, f.m. is recommended only for use where greater ranges are required. Manufacturers' data sheets for f.m. modules suggest that a range of up to 200 metres free space and 30 metres worst case are possible.

## F.M. RECEIVER

A modified schematic for the f.m. receiver unit is shown in Fig.17, a suitable adaptor p.c.b. is shown in Fig.18. This board is available from the *EPE PCB*

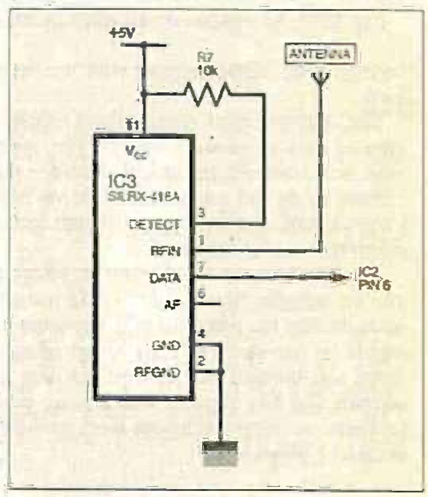
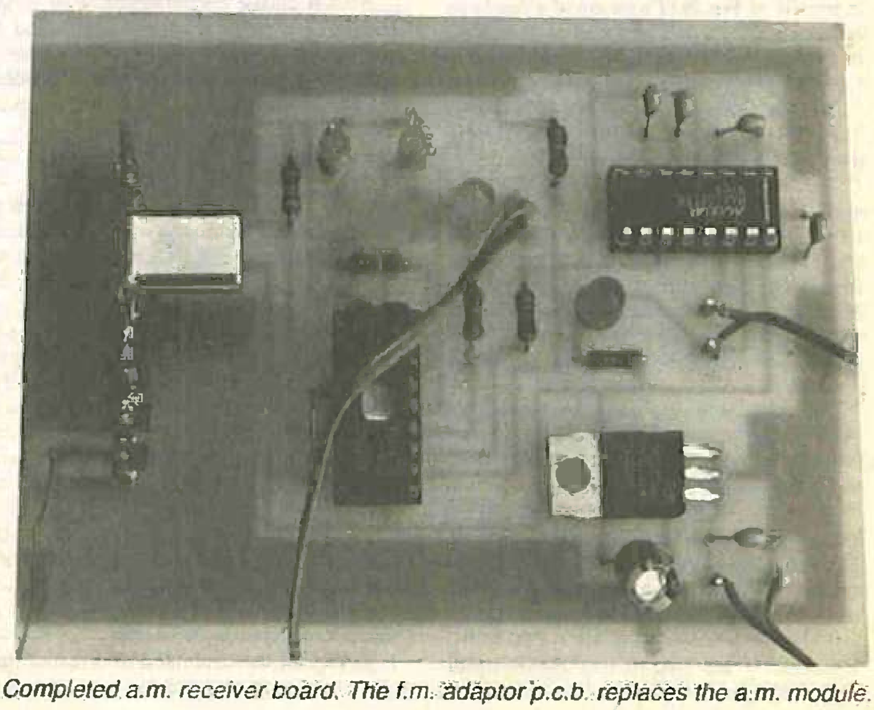
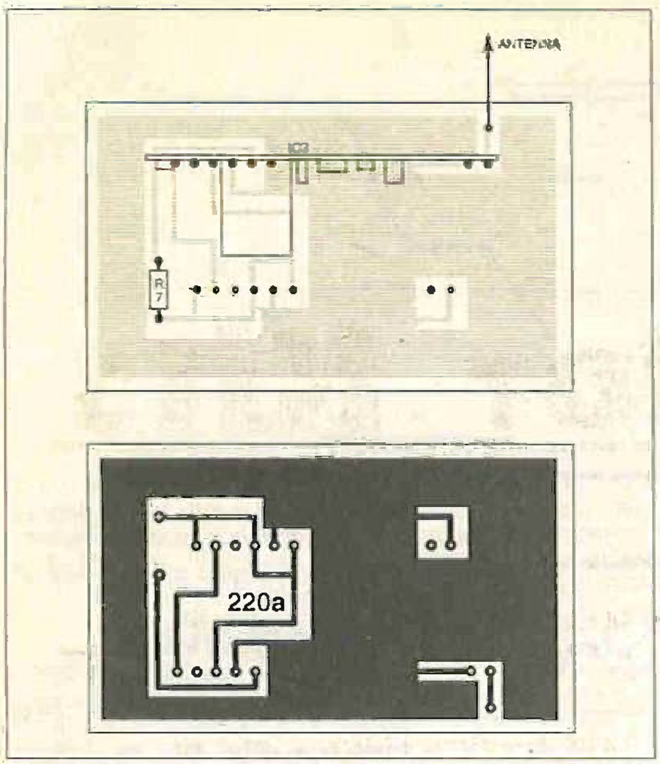
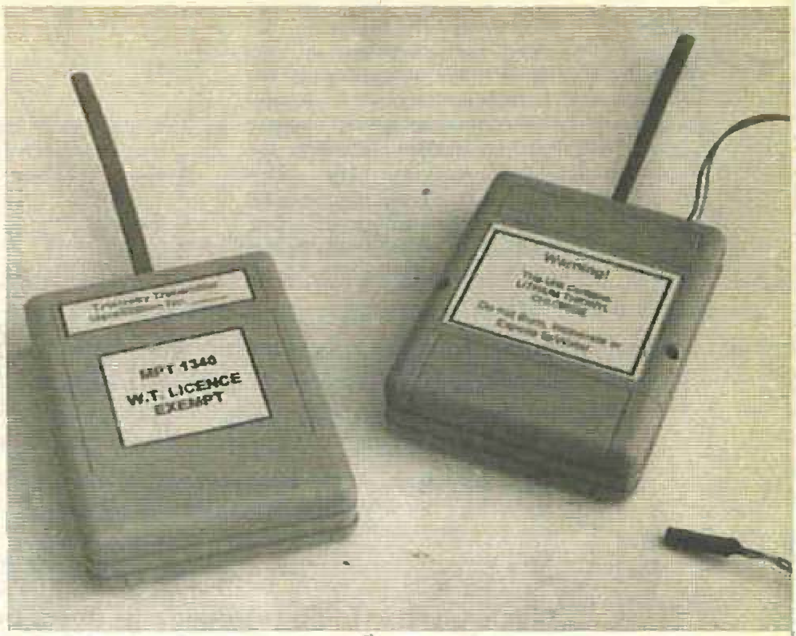



Fig.17. Receiver modification details for f.m. operation.



Completed a.m. receiver board. The f.m. adaptor p.c.b. replaces the a.m. module.




*Two completed Transmitters. One with a remote thermistor sensor (right-hand corner), and the other showing the required "licence exempt" label.*

*Fig.18. F.M. Receiver adaptor printed circuit board details.*

*Service*, code 220a, together with the main p.c.b.

The adaptor board allows direct replacement of the a.m. module with the f.m. type. This board should be mounted above the existing p.c.b. and connection made via pins from the a.m. receiver holes through to the matching holes in the adaptor.

The f.m. receiver should then be soldered into the adaptor board and a 10kΩ resistor soldered into the holes for R7. The antenna should be connected directly to the adaptor board and brought out through the case as normal. The f.m. module uses a more conventional quarter-wavelength short whip antenna of 170mm length.

## F.M. TRANSMITTER

The modified f.m. transmitter schematic is shown in Fig.19. Capacitor C3 needs to be removed and R5 replaced with a wire link or zero ohm resistor. Components C4, L1 and IC2 also need to be removed.

The transmission adaptor p.c.b. is shown in Fig.20. This board is also available from the *EPE PCB Service*, code 119a.

The board should be connected to the main p.c.b. via short flying leads. DATA IN and GND connections are taken from the existing holes for IC2. The power should be taken directly from the battery or other convenient location on the transmitter p.c.b. The antenna must be 170mm long rather than the 90mm type described previously.

The adaptor board must be located as close to the transmitter board as possible, in order to reduce conducted interference along the ground connection.

The 3·6V supply should be replaced by a 6V type in order for the unit to operate correctly. This *must* not be exceeded or reduced, as it is the upper limit for the PIC and lower limit for the transmitter module.

It should be noted that MPT1340 is independent of the type of modulation used. That is to say, all the antenna constraints detailed previously for the a.m. system still apply and must be conformed with.

More details of the f.m. radio modules used are available from the

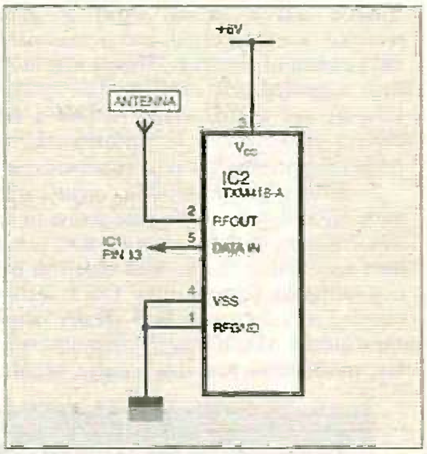



*Fig.19. Transmitter modification details for f.m. operation.*

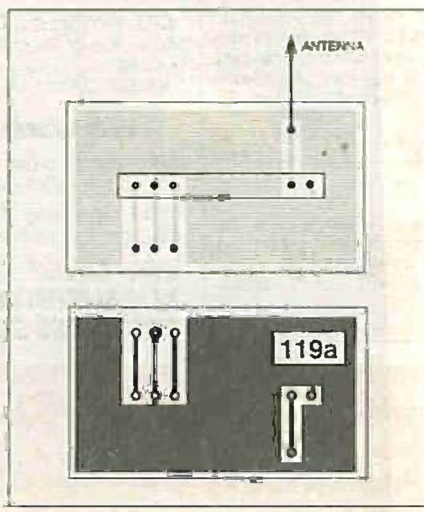



*Fig.20. Full size F.M. Transmitter adaptor board details.*

manufacturing company's web site at: **http://www.radiometrix.co.uk/products/product1.htm**.

## SOFTWARE INSTALLATION

Installation of the application software is the same as for any other Windows based application. Before installation, please ensure that all applications are closed, this includes the Microsoft Office toolbar that is easily forgotten! Then, simply double click on the file named **SETUP.EXE** and follow the on-screen instructions.

The default installation directory is **C:\EPE**. This can be changed to install the software on any other drive or directory. Once this is completed, a Program Manager icon called Data Capture is created. The application is executed by double clicking on this icon either from the Program Manager in Windows 3.1 or the Start menu in Windows 95 or later.

If any problems are experienced during installation such as "Version Conflict" or "File in use, cannot replace" then this generally means that a later version of the same file is already installed and does not need to be replaced. If this is the case, select the Ignore or Skip buttons.

## 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 *Shoptalk* page. Information on obtaining other "special" components for this design are also given on this same page.

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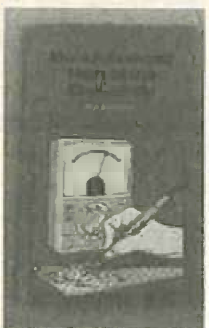

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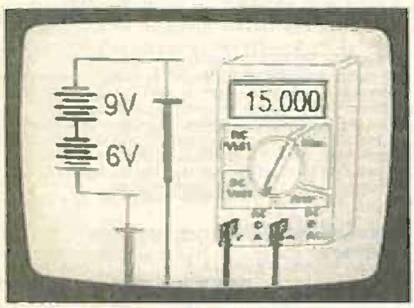


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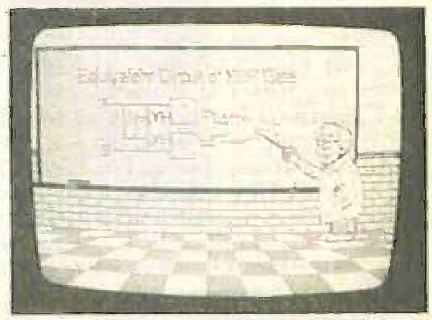

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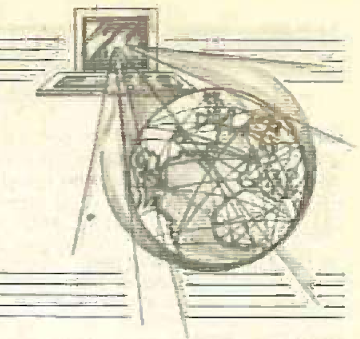
E22

# SURFING THE INTERNET

# NET WORK

## ALAN WINSTANLEY



NET WORK is the monthly column specially written for readers who access the Internet either at home or work. Our web site http://www.epemag.wimborne.co.uk provides details of the contents of current and previous issues, with photographs and brief descriptions of many past projects, and the web site is as popular as ever amongst readers all around the world.

Also available on the *EPE* web site is the *EPE Chat Zone* (/wwwboard) which is a message board where readers and other electronics enthusiasts can air their views or ask for help from other readers. By using the fill-in form on the *Chat Zone* page, a message can be posted in virtually real time for others to follow up. It should be noted that we cannot guarantee a personal reply to any queries raised addressed to *EPE* Editorial staff by *Chat Zone* users, although we do visit at regular intervals: queries requiring a reply should be mailed to the appropriate E-mail address – see the separate panel elsewhere in this issue concerning *EPE* Net Addresses.

Messages are retained in the *Chat Zone* for approximately fourteen days subject to our discretion but follow-ups cannot be archived on our web site after they expire, so it's advisable to check back at reasonable intervals to check for any replies. The Acceptable Use Policy (AUP) is also published online and is accessible from the *Chat Zone*. It contains common sense rules which are designed to ensure that everyone enjoys their visit and may hopefully contribute to the running of the *Chat Zone*. Please follow the spirit of the AUP and help us to maintain the *EPE Chat Zone*. You benefit!

### EPEMAG DOT COM

It can be taken for granted that the Internet has swiftly become an integral part of your computer system. The next generation of Microsoft's Office software suite – Microsoft Office 2000 – will include closer Internet and Intranet support than ever before. Windows NT users may be aware of the forthcoming release of Windows 2000 Professional version (see www.microsoft.com/windows/professional/) which also offers tighter integration with online and offline browsing. Even with the current URL-obsessed version of Microsoft Word 97, any URLs can be detected and made "clickable", so that the computer will make an Internet connection and go straight to that address.

Really, having an Internet connection is the same as having a giant external hard drive connected to your system. All you have to do is find the data, and learn to discriminate between what looks reliable and what is complete garbage: you soon learn how to dismiss the latter. The Internet has become almost as indispensable as a multimeter, and many local libraries or Internet cafes will be happy to help inexperienced users get to grips with it.

As far as our own Internet presence goes, *EPE* was the first hobby electronics magazine to offer an E-mail contact address all those years ago, and regular readers will know how my personal Demon Internet "*epemag*" moniker is now also applied to our American Internet-only version *EPE Online*, which features a downloadable version of your favourite magazine available from www.epemag.com. This is again a world-first and the initial reaction has been highly encouraging. The first issue published online (November '98) is permanently free for download, and each issue is contained in a series of .PDF files stored on your hard disk.

### ADOBE ACROBAT

To view each issue of *EPE Online* you require the free Adobe Acrobat Reader which will be found on the free *EPE CD-ROM No.1* given away with the November 98 issue. Both 16-bit (Windows 3.x) and 32-bit versions for Windows 95 + are provided. Both versions are located in the EPE/ Proteus folder on the CD. Alternatively, you can simply bounce over to www.adobe.com and fetch the free reader from there. There are several .PDF files on the free CD-ROM as well – to find them, insert your CD-ROM then use Windows Explorer to right-click on your CD drive letter. Click Find... and enter (Files) Named : *.PDF to produce a list of them. Please ensure you are using Version 3 or higher of the Acrobat Reader.

Although Adobe Acrobat is now widely accepted as the electronic document standard, many newcomers are not familiar with such terms, and I have had several E-mails from readers who have struggled with this file format (or more specifically, how to read it properly and without facing lengthy wasted downloads).

Some examples of Adobe Acrobat files will be found on the new "Resources" page which has been added to the *EPE* web site (/resources.htm). This web page provides a list of our free FAQs and data: there you will find lead-ins to the *Basic Soldering Guide*, TENS User Page and a copy of Julyan Ilett's excellent article *How to use Intelligent L.C.D.s*. The L.C.D. article is in Adobe Acrobat format.

There are two options available to web users who are confronted by .PDF files such as these: having installed the free reader software (a simple task), you can click on the file name on the web page and your browser will then immediately launch the reader within the browser window. However, there can follow a lengthy delay depending on the file size, during which time the files are downloaded onto your PC, after which the document can be viewed on-screen.

A much better alternative is to fetch the file via the Internet and save it to your hard disk for viewing and printing later when offline. You can easily do this by pointing the mouse at the file name on the web page, then right-mouse click and choose (in MS Internet Explorer) Save Target As . . . or (Navigator) Save Link As... From there, navigate to a desired local directory to save the file on your hard disk. The transfer will then take place.

You can then re-open the file when offline, simply by double-clicking its filename in Windows Explorer, which should launch Adobe Acrobat Reader. Note that you may not necessarily be able to print some .PDF files locally – it depends whether the option to print was disabled when the file was originated by its owner. Usually, though, you can produce a hard copy for retention.

### WHICH EPE MAG?

The other query which is arising is whether readers should choose between buying *EPE Online* or continue to take the printed version. There are some important differences between the two editions: one is that the projects published in *EPE Online* may not quite be the same as those in the corresponding printed issue. There may sometimes be some rescheduling of projects to fit within *EPE Online's* format.

A second difference is that the online edition is tailored to an international audience rather than being UK-centric. Hence there is little advertising within *EPE Online*, although the inclusion of advertisements has not been ruled out for the future. None-the-less, the subscription price for *EPE Online* is highly competitive – less than US $2 per issue. Whichever option you choose, we hope you'll agree that with the advent of the Internet, this is now a very exciting time to be involved in electronics.

In coming months, I will be discussing more Internet services and applications which may help *EPE* readers to get more out of the Internet. For example, I'll be examining what is probably the world's most popular software download at the moment – ICQ. I will also try to offer more advice and pointers for novice Internet users.

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.

# PCBs FROM PAST ISSUES OF ETI

(prior to the merger of EPE and ETI in March 99). See below for ordering details.

| Name and issue of project | Unit code | Price |
|---|---|---|
| ***ETI PCB Service Issue 1 1999*** | | |
| Stress and Skin Temperature Meter | E/0199/1 | £14.55 |
| 'Short Cut' Continuity Tester | E/0199/2 | £5.09 |
| R.F. Probe | E/0199/3 | £5.09 |
| Switch Volt PSU | E/0199/4 | £5.09 |
| ***ETI PCB Service Issue 13 1998*** | | |
| Programmable Logic Microcontroller Board | E/1398/1 | £7.32 |
| Programmable Logic Simulator Board | E/1398/2 | £5.09 |
| Regulated Battery PSU | E/1398/3 | £5.09 |
| Audio Power Meter | E/1398/4 | £7.32 |
| Car Vigilante | E/1398/5 | £5.64 |
| Millivolt Meter | E/1398/6 | £6.77 |
| Wobbulator | E/1398/7 | £6.22 |
| ***ETI PCB Service Issue 12 1998*** | | |
| Beerstat | E/1298/1 | £5.09 |
| Fishbiter | E/1298/2 | £5.09 |
| Smooth Fuzz | E/1298/3 | £5.09 |
| ***ETI PCB Service Issue 11 1998*** | | |
| Loop Alarm | E/1198/1 | £5.09 |
| Ricky Sound (Music Lovers) | E/1198/2 | £5.09 |
| ***ETI PCB Service Issue 10 1998*** | | |
| Ionisation Chamber | E/1098/1 | £5.09 |
| Ionisation Chamber (SMD) | E/1098/2 | £5.09 |
| PIC Development Board: see also issue 6 below | E/698/1 | £5.50 |
| ***ETI PCB Service Issue 9 1998*** | | |
| Q Meter | E/998/2 | £5.09 |
| Bath Duck | E/998/3 | £5.09 |
| ***ETI PCB Service Issue 8 1998*** | | |
| PIC Electronics Security Switch | E/898/1 | £5.09 |
| PIC Multiplexed LED Display | E/898/2 | £5.09 |
| PIC Non-multiplexed LED Display | E/898/3 | £5.09 |
| Easy Parker | E/898/4 | £6.77 |
| Tiny Traffic Lights | E/898/5 | £5.09 |
| Q Meter | E/898/6 | £5.09 |
| Bath Duck | E/898/7 | £5.50 |
| ***ETI PCB Service Issue 7 1998*** | | |
| PIC 16C74 Development Board | E/798/1 | £5.09 |
| Surface Mount Diagnostic Interface | E/798/2 | £5.09 |
| Surface Mount Logic probe | E/798/3 | £5.09 |
| Mains Monitor | E/798/4 | £12.33 |
| Aquaprobe | E/798/5 | £5.50 |
| ***ETI PCB Service Issue 6 1998*** | | |
| PIC Development Board | E/698/1 | £5.50 |
| Signal Generator | E/698/2 | £8.99 |
| Headlight Delay Unit | E/698/3 | £5.50 |
| 6-Interval Games Timer | E/698/4 | £5.09 |
| ***ETI PCB Service Issue 5 1998*** | | |
| UHF Transmitter (DS) | E/598/1 | £5.07 |
| UHF Transmitter Encoder | E/598/2 | £5.09 |
| UHF Receiver Front End (DS) | E/598/3 | £5.07 |
| UHF Receiver I.F. stage (DS) | E/598/4 | £5.07 |
| Fridge Thermometer | E/598/5 | £5.50 |
| AVR Controller | E/598/6 | £5.50 |
| 27C16 Eprom Programmer | E/598/7 | £7.87 |
| Guardian Light | E/598/9 | £6.22 |
| ***ETI PCB Service Issue 4 1998*** | | |
| LED Voltmeter | E/498/1 | £5.64 |
| BB Ranger Control Board | E/498/2 | £6.22 |
| BB Ranger Score Board | E/498/3 | £22.89 |
| Line-Up Oscillator with Glitch | E/498/4 | £8.99 |
| Tic-Tac-Toe | E/498/5 | £8.44 |
| ***ETI PCB Service Issue 3 1998*** | | |
| Medium Wave Loop | E/398/1 | £5.64 |
| AA Cell Eliminator | E/398/2 | £7.32 |
| PIC Based Double Bass Tuner | E/398/3 | £5.64 |
| 5-range Capacitor Meter | E/398/4 | £6.77 |
| MIDI Drum Pads | E/398/5 | £5.64 |
| ***ETI PCB Service Issue 2 1998*** | | |
| Smartcam main board | E/298/1 | £5.09 |
| Smartcam opto-sensor board | E/298/2 | £5.09 |
| Both smartcam boards | E/298/1&2 | £7.00 |
| Switched Mode Internal Power Supply | E/298/5 | £7.87 |
| Auto Cupboard light | E/298/3 | £5.64 |
| ***ETI PCB Service Issue 1 1998*** | | |
| Control Centre Desk-Top unit | E/198/1 | £8.99 |
| Control Centre Main Section | E/198/2 | £7.87 |

# 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 |
|---|---|---|
| Low-Range Ohmmeter Adaptor — SEPT'95 | 926 | £5.55 |
| Simple Theremin | 952 | £6.68 |
| Vandata – Boot Control Unit | 953 | £10.52 |
| Display Unit | 954 | £6.61 |
| Sound Switch — OCT'95 | 915 | £6.55 |
| Multiple Project PCB | 932 | £3.00 |
| Audio Sinewave Generator | | |
| Treble Booster | | |
| Infra-Red Controller/Alarm (2 boards required) | | |
| Capacitor Check | 955 | £5.76 |
| Ginormous VU Meter | 956 | £9.31 |
| Multiple Project PCB — NOV'95 | 932 | £3.00 |
| Video Enhancer – Current Tracer – Distortion Effects Unit | | |
| Digital Delay Line | 958 | £8.04 |
| 50Hz Field Meter | 959 | £8.32 |
| Temperature Warning Alarm (Teach-In '96) | 960 | £6.15 |
| Stereo "Cordless" Headphones — DEC'95 | | |
| Transmitter | 961 | £8.04 |
| Receiver | 962 | £7.66 |
| ★EPE Met Office – Sensor/Rainfall/Vane | 963/965 | £11.33 |
| Spiral transparency free with above p.c.b. | | |
| Light-Operated Switch | 966 | £6.37 |
| Modular Alarm System (Teach-In '96) | 967a/b | £7.12 |
| ★EPE Met Office – — JAN'96 | | |
| Computer Interface (double-sided) | 964 | £7.69 |
| Audio Signal Generator | 969 | £6.58 |
| Mains Signalling Unit, Transmitter and Receiver | 970/971 (pr) | £9.09 |
| Automatic Camera Panning (Teach-In '96) | 972 | £6.63 |
| Printer Sharer | 973 | £9.93 |
| Vari-Speed Dice (Teach-In '96) — FEB'96 | 974 | £5.69 |
| Mains Signalling Unit – 2 12V Capacitive PSU | 975 | £6.07 |
| Multi-Purpose Mini Amplifier — MAR'96 | 976 | £6.12 |
| High Current Stabilised Power Supply | 979 | £6.62 |
| Mind Machine Mk III – Sound and Lights | 980 | £7.39 |
| Infra-Zapper Transmitter/Receiver (Teach-In '96) | 981/982 (pr) | £8.01 |
| Bat Band Converter/B.F.O. — APR'96 | 984a/b | £5.80 |
| Hearing Tester | 985 | £6.87 |
| Event Counter (Teach-In '96) | 986 | £8.39 |
| B.F.O. and Bat Band Converter — MAY'96 | 984a/b | £5.80 |
| Versatile PIR Detector Alarm | 988 | £6.76 |
| Mind machine Mk III – Tape Controller | 989 | £6.70 |
| Midi Analyser | 992 | £6.74 |
| Countdown Timer (Teach-In '96) | 993 | £9.44 |
| Sarah's Light — JUNE'96 | 996 | £7.17 |
| Home Telephone Link | 997 (pr) | £10.72 |
| ★PulStar | 998 | £6.60 |
| VU Display and Alarm | 999 | £7.02 |

## Special KNOCK DOWN SALE of PCBs.

We have a few p.c.b.s left from past projects these are being offered at the knock down price of **£2.00** each – *no matter what size they are* (some of these boards are worth over £15.00 each) while stocks last. This price includes VAT and UK post – overseas orders please add 50p postage (or £1 per board for airmail postage).

**£2.00 EACH inc. VAT and p&p**

1W Stereo Amplifier, 851; Visual Doorbell, 863; EPE SounDAC PC Sound Board, 868; Microprocessor Smartswitch, 881; Print Timer, 874; Stereo HiFi Controller – Power Supply, 886 – Main Board, 887 – Expansion/Display Boards, (pair) 888; Power Controller, 905; 1000V/500V Insulation Tester, 906; Active Guitar Tone Control, 907; TV Off-er (pair), 908/909; Video Modules – 1 Simple Fader, 910; Video Enhancer, 912; Rodent Repeller, 913; Spacewriter Wand, 921; Video Modules – 3 Dynamic Noise Limiter, 919 – System Mains Power Supply, 920; The Ultimate Screen Saver, 927; 12V 35W PA Amplifier, 930; ★National Lottery Predictor, 935; MIDI Pedal, 938; Club Vote Totaliser, 939; EPE HiFi Valve Amplifier – Phase splitter, 941; PIC-DATS 4-channel Light Chaser, 942; HV Capacitor Reformer, 943; Ramp Generator – Logic Board (double-sided p.t.h.), 944 – Analogue board, 945; Microcontrolled 3-Digit Timer, 933.

**Any of the above for just £2 each inc. VAT and p&p.**

Back numbers or photostats of articles are available see the *Back Issues* page for details.

| PROJECT TITLE | | Order Code | Cost |
|---|---|---|---|
| Ultra-Fast Frequency Generator | JULY'96 | | |
| and Counter – Oscillator/L.C.D. Driver | | 994/995 (pr) | £12.72 |
| Timed NiCad Charger | | 100 | £6.99 |
| Single-Station Radio 4 Tuner | | 101 | £7.02 |
| Twin-Beam Infra-Red Alarm – Transmitter/Receiver | | 102/103 (pr) | £10.50 |
| ★Games Compendium | | 104 | £6.09 |
| Mono "Cordless" Headphones | AUG'96 | | |
| – Transmitter/Receiver | | 990/991 (pr) | £10.16 |
| Component Analyser (double-sided p.t.h.) | | 105 | £12.18 |
| Garden Mole-Ester | | 106 | £6.07 |
| Mobile Miser | | 107 | £6.36 |
| Bike Speedo | | 108 | £6.61 |
| ★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 | [illegible] | 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 |
| Kissometer | | 181 | £7.67 |
| ★EPE PIC Tutorial | MAR'98 | 182 | £7.99 |
| 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 |
| 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 |

| PROJECT TITLE | | Order Code | Cost |
|---|---|---|---|
| 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 |
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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**
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