FREE SPECIAL SUPPLEMENT

THE No.1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

EVERYDAY

PRACTICAL ELECTRONICS

APRIL 2001

INCORPORATING ELECTRONICS TODAY INTERNATIONAL

£2.75

Special Supplement

THE END TO ALL DISEASE

Can disease be cured electronically?

INTRUDER ALARM

A sophisticated, easy to build system

WAVE SOUND EFFECT

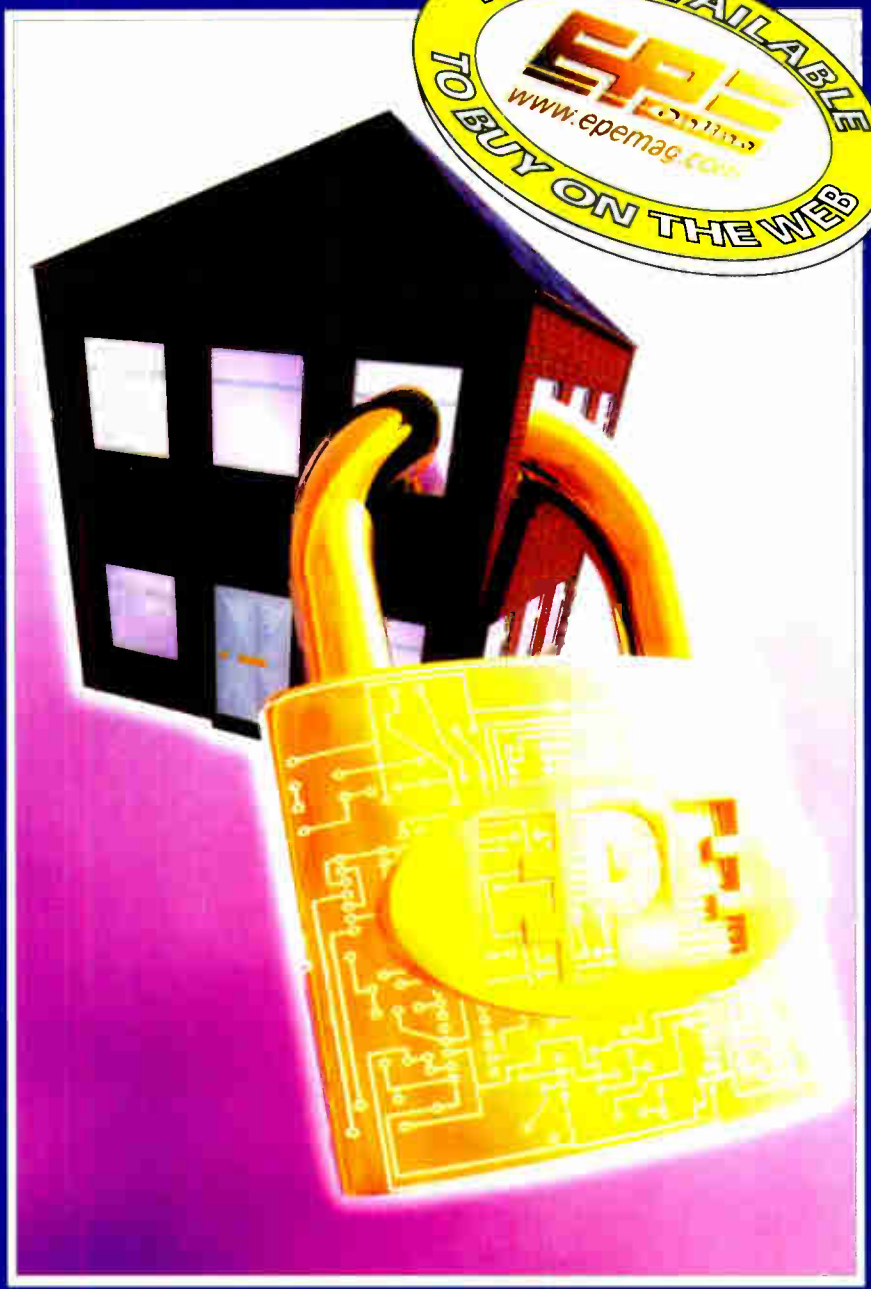
Relaxing & noise suppressing

SNUG BUG

Tropical pet heat pad controller

PLUS

All the regular features



9 770262 361096 04

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

World Radio History

PIR OPERATED WATER VALVES. These brand new units consist of a control box with integral PIR and a water valve fitted with 15mm compression fittings. The valve is 6V d.c. operation and latches, e.g. 6V pulse will open it, 6V negative pulse will release it. Originally made to control urinals (flush when someone comes in) they have many other uses in cat scarers, automatic watering systems etc. They have built-in adjustable time delays and settings and run quite happily for months on just a 9V battery. The valve alone could have many uses in garden features, solar systems, etc. Current retail price for the complete unit is £120, we can offer them at just £19.95 while stocks last! Ref PIRVAL2.

PIR SECURITY SWITCHES. These brand new swivel mounting PIR units will switch up to 2 kilowatts. Adjustable sensitivity, light level and time delay (9 seconds to 10 minutes). 15m detection range, mains operated, waterproof. £5.95. Ref PIR1PACK or a pack of 5 for £22 Ref PIR5PACK or 10 for £39.95 Ref PIR10PACK.

12V 18Ah SEALED LEAD ACID BATTERIES, new and boxed, unused, pack of 4 £44.95, Ref CYC7 or £15.95 each, Ref CYC6.

12V 6·5Ah SEALED LEAD ACID BATTERIES, new and boxed, pack of 5 £34.95, Ref CYC65A, or individually at £8.99, Ref CYC65B.

A new range of 12V to 240V INVERTERS

IV400S (400 watt) £89

IV800S (800 watt) £159

IV1200S (1200 watt) £219

SODIUM LAMP SYSTEMS, £75.70. Complete system with 250W or 400W SON-T Agro bulb, reflector with bulb holder and remote ballast and starter (uncased), all you need is wire. 250W system Ref SLS1, 400W system SLS2.

HYDROPONICS – DO YOU GROW YOUR OWN? Check our web site at **www.bullnet.co.uk**.

PC COMBINED UPS AND PSU. The unit has a total power of 292 watts, standard motherboard connectors and 12 peripheral power leads for drives etc. Inside are three 12V 7·2aH sealed lead acid batteries. Backup time is 8 mins at full load or 30 mins at half load. Made in the UK by Magnum, 110V or 240V a.c. input, +5V at 35A, –5V at 0·5A, +12V at 9A, –12V at 0·5A outputs. 170mm x 260mm x 220mm, new and boxed. £29.95. Ref PCUPS2.

ALTERNATIVE ENERGY CD, PACKED WITH HUNDREDS OF ALTERNATIVE ENERGY RELATED ARTICLES, PLANS AND INFORMATION ETC. £14.50. Ref CD56.

AERIAL PHOTOGRAPHY KIT. This rocket comes with a built-in camera, it flies up to 500 feet (150m), turns over, and takes an aerial photograph of the ground below. The rocket then returns, with its film, via its parachute. Takes 110 film. Supplied complete with everything, including a launch pad and three motors (no film). £29.98. Ref ASTRO.

3HP MAINS MOTORS. Single-phase 240V, brand new, 2-pole. 340mm x 180mm, 2,850 rpm, built-in automatic reset overload protector, keyed shaft (40mm x 16mm). Made by Leeson. £99 each. Ref LEE1.

BUILD YOUR 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 scrapyard could make you self-sufficient in electricity! £12. Ref LOT81.

MAGNETIC CREDIT CARD READERS AND ENCODING MANUAL, £9.95. Cased with flyleads, designed to read standard credit cards! Complete with control electronics p.c.b. and manual covering everything you could want to know about what's hidden in that magnetic strip on your card! Just £9.95. Ref BAR31.

SOLAR POWER LAB SPECIAL. 2in. x 6in. x 6in., 6V 130mA cells, 4 l.e.d.s, wire, buzzer, switch plus 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.

LOCKPICKS. We sell a full range of lockpicks and lockpicking books on our website: **www.lockpicks.co.uk.**

SHUT THE BOX. Check out **www.bullybeef.co.uk** for a range of pub games and magic tricks.

AIR RIFLES FROM LESS THAN £40, CROSSBOWS, WIDE RANGE OF BB GUNS, AMMO, TARGETS, PISTOLS, REPLICA GUNS, UZI MACHINE GUN REPLICAS (BB), REPEATERS, LASER SIGHTS, ELECTRIC BB, GAS BB

www.airpistol.co.uk

INKJECT CARTRIDGES FROM JUST £3 AT www.pinkjets.co.uk

ONE MILLION HITS A MONTH WWW.BULLNET.CO.UK

Hydrogen fuel cells. Our new Hydrogen fuel cells are 1V at up to 1A output, Hydrogen input, easily driven from a small electrolosis assembly or from a hydrogen source, our demo model uses a solar panel with the output leads in a glass of salt water to produce the hydrogen! Each cell is designed to be completely taken apart, put back together and expanded to whatever capacity you like (up to 10 watts and 12V per assembly). Cells cost £49. Ref HFC11.

PHILIPS VP406 LASER DISC PLAYERS, SALE PRICE JUST £9.95. SCART OUTPUT, JUST PUT YOUR VIDEO DISK IN AND PRESS PLAY. STANDARD AUDIO AND VIDEO OUTPUTS. £9.95. REF VP406.

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.

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

CCTV CAMERAS FROM £22. Check out our web site at **www.cctvstuff.co.uk**.

MAMOD STEAM ENGINES AND A FULL RANGE OF SPARE PARTS.
CHECK OUT **www.mamodspares.co.uk**.

14 WATT SOLAR PANEL. Amorphous silicon panel fitted in an anodised aluminium frame. Panel measures 3ft. by 1ft. with screw terminals for easy connection. 3ft. x 1ft. solar panel £69. Ref MAG45. **Unframed** 4 pack (3ft. x 1ft.) £69. Ref SOLX.

12V SOLAR POWERED WATER PUMP. Perfect for many 12V d.c. uses, from solar fountains to hydroponics! Small and compact, yet powerful, works direct from our 10 watt solar panel in bright sun. Max hd: 17ft., max flow = 8l.p.m., 1·5A. Ref AC8. £18.99

SOLAR MOTORS. Tiny motors which run quite happily on voltages from 3V-12V d.c. Works on our 6V amorphous 6in. 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 DISPLAY. Bargain prices, 40-character 1-line 154mm x 16mm, £6.00. Ref SMC4011A.

YOUR HOME COULD BE SELF-SUFFICIENT IN ELECTRICITY. comprehensive plans with loads of info on designing systems, panels, control electronics, etc. £7. Ref PV1.

SOLAR POWER LAB SPECIAL. 2in. x 6in. x 6in., 6V 130mA cells, 4 l.e.d.s, wire, buzzer, switch plus 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.

MINIATURE TOGGLE SWITCHES. These top quality Japanese panel mounting toggle switches measure 35mm x 13mm x 12mm, are 2-pole changeover and will switch 1A at 250V a.c., or 3A at 125V a.c. Complete with mounting washers and nuts. Supplied as a box of 100.

BRAND NEW NATO ISSUE RADIATION DETECTORS, SALE PRICE JUST £39.95. Current NATO issue standard emergency services unit used by most of the world's military personnel. New and boxed. Normal retail price £400, BULL'S bargain price just £99. The PDRM 82M is a portable, lightweight, water resistant gamma radiation survey meter to measure radiological dose rate in the range 0·1 to 300 centigrays per hour in air. The Geiger muller (G.M.) tube detecting unit is energy and polar response corrected. The radiation level is displayed on a Liquid Crystal Display. The microcomputer corrects for the non-linearity of the G.M. tube response. The instrument is powered by three international C-size batteries giving typically 400 hours operation in normal conditions. The dose rate meter PDRM 82M, designed and selected for the United Kingdom Government, has been fully evaluated to satisfy a wide range of environmental conditions and is nuclear hard. The construction enables the instrument to be easily decontaminated. The instrument is designed for radiation surveys for post incident monitoring. Used in a mobile role, either carried by troops or in military vehicles for rapid deployment enabling radiation hot spots to be quickly located. Range 0-300 cGy/h in 0·1 cGylh increments. Over-range to 1500 cGh/h – indicates flashing 300. Accuracy ±20% of the true dose rate +1 cGylh, 0-100 cGy/h. ±30% of true dose rate, 100-300 cGy/h. Energy Response 0·3 MeV to 3 MeV – within ±20% (Ra 226). 80 KeV to 300 KeV – within ±40% (Ra 226). Detector Energy compensated Halogen quenched Geiger Muller Tube. Controls combined battery access and ON/OFF switch. Batteries 3 international standard C cells. Weight 560 grams. Operating temperature range 30 deg. C to +60 deg. C. Indications high contrast 4 digit l.c.d. £39. Ref PDRM.

BASIC GUIDE TO BIO DIESEL. HOW TO MAKE DIESEL FUEL FROM USED KITCHEN OIL, £6. REF BIOF.

BULL ELECTRICAL
250 PORTLAND ROAD, HOVE, SUSSEX BN3 5QT (ESTABLISHED 50 YEARS)
MAIL ORDER TERMS: CASH, PO OR CHEQUE WITH ORDER PLUS £5.00 P&P PLUS VAT
24 HOUR SERVICE £7.50 PUS VAT
OVERSEAS ORDERS AT COST PLUS £3.50
(ACCESS, VISA, SWITCH, AMERICAN EXPRESS)
'phone orders: 0871 871 1300
FAX 0871 871 1301
Sales@bull-electrical.com

BASIC GUIDE TO LOCKPICKING. New publication gives you an insight! £6. Ref LPK.

30 WATTS OF SOLAR POWER for just £69, 4 panels, each one 3ft. x 1ft. and producing 8W, 13V, Pack of four £69. Ref SOLX.

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. Ref TF3.

INFRA-RED FILM. 6in. 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. £15. Ref IRF2.

33 KILO LIFT MAGNET. Neodynium, 32mm diameter with a fixing bolt on the back for easy mounting. Each magnet will lift 33 kilos, 4 magnets bolted to a plate will lift an incredible 132 kilos! £15. Ref MAG33. Pack of 4 just £39. Ref MAG33AA.

77 KILO LIFT MAGNET. These Samarium magnets measure 57mm x 20mm and have a threaded hole (5/16th UNF) in the centre and a magnetic strength of 2·2 gauss. We have tested these on a steel beam running through the offices and found that they will take more than 170lb (77kg) in weight before being pulled off. Supplied with keeper. £19.95 each. Ref MAG77.

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

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

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

12V OPERATED SMOKE BOMBS. Type 3 is a 12V trigger and three 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 mock equipment fires etc.) and one 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 p.c.b. fitted with hi power strobe tube and control electronics and speed control potentiometer. Perfect for interesting projects etc. 70mm x 55mm 12V d.c. operation. £6 each. Ref FLS1. Pack of 10 £49. Ref FLS2.

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 3 days use from a PP3 battery this is our top selling bug! Less than 1in. square and a 10m voice pick-up 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 POWER BEAM. Handheld battery powered lamp, 4 inch reflector, gives out powerful pure infra-red light! Perfect for CCTV use, nightsights etc. £29. Ref PB1.

SUPER WIDEBAND RADAR DETECTOR. Whistler 1630. Detects both radar and laser, XK and KA bands, speed cameras, and all known speed detection systems. 360 degree coverage, front and rear waveguides. 1·1in. x 2·7in. x 4·6in., fits on visor or dash. New low price £99. Ref WH1630.
Other models available at **www.radargun.co.uk.**

LOPTX. Made by Samsung for colour TV. £3 each. Ref SS52.

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.

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

INFRA-RED REMOTE CONTROLS. Made for TVs but may have other uses. Pack of 100 £39. Ref IREM.

RCB UNITS. In-line IEC lead with fitted RC breaker. Installed in seconds. Pack of 3 £9.98. Ref LOT5A.

STEPPER MOTORS. Brand new stepper motors, 4mm fixing holes with 47·14mm fixing centres, 20mm shaft, 6·35mm diameter, 5V/phase, 0·7A/phase, 1·8 deg. step (200 step), body 56mm x 36mm. £14.99 each. Ref STEP6. Pack of 4 for £49.95.

On our web sites you can:

1. **Order online.**
2. **Check your premium bonds.**
3. **Enter our auction or build your own.**
4. **Add E-commerce to your own site.**
5. **Discover our software site, optical site, hydroponics site, holiday home exchange site, inkjet site, radar detectors, hotels site.**

http://www.bullnet.co.uk

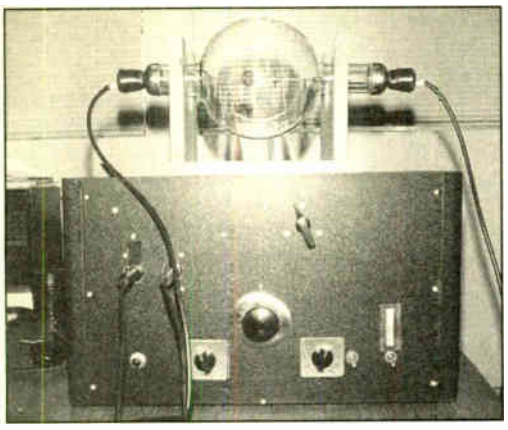
World Radio History

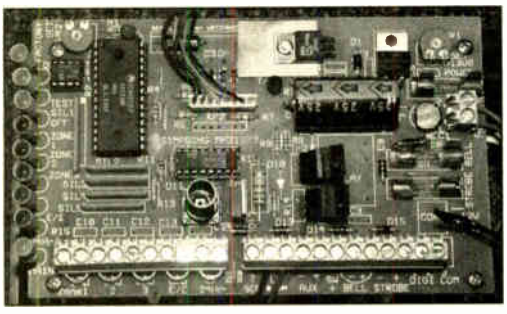
ISSN 0262 3617
PROJECTS . . . THEORY . . . NEWS . . .
COMMENTS . . . POPULAR FEATURES . . .

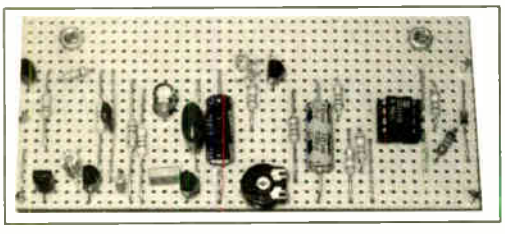
VOL. 30. No. 4 APRIL 2001
Cover illustration by Jonathan Robertson

EVERYDAY
PRACTICAL
ELECTRONICS
INCORPORATING ELECTRONICS TODAY INTERNATIONAL

www.epemag.wimborne.co.uk
EPE Online: www.epemag.com







© Wimborne Publishing Ltd 2001. Copyright in all drawings, photographs and articles published in EVERYDAY PRACTICAL ELECTRONICS is fully protected, and reproduction or imitations in whole or in part are expressly forbidden.

Projects and Circuits

WAVE SOUND EFFECT by Robert Penfold **244**
Let the susurration of the waves soothe intrusions on your senses

INTRUDER ALARM CONTROL PANEL by John Griffiths **254**
5-zone microcontrolled security system designed to meet British Standards specifiction BS4737

SOUND TRIGGER by Owen Bishop **266**
How to soundly lighten your darkness – another Top-Tenner project

***EPE* SNUG-BUG** by Mike Delaney **271**
Treat your tropical pets to a personalised 4-channel central heating system

INGENUITY UNLIMITED hosted by Alan Winstanley **290**
12V Sealed Lead/Acid Charger; Audio Preamplifier; Model Police Car L.E.D.s

Series and Features

NEW TECHNOLOGY UPDATE by Ian Poole **248**
3-D liquid crystal displays become reality

PRACTICALLY SPEAKING by Robert Penfold **263**
A novice's guide to trouble-shooting project assembly

CIRCUIT SURGERY by Alan Winstanley and Ian Bell **269**
More on phase-locked loops

NET WORK – THE INTERNET PAGE surfed by Alan Winstanley **286**
EPE Online Shop

THE SCHMITT TRIGGER – 6. Further Digital Applications
by Anthony H. Smith **293**
A designers' guide to investigating and using Schmitt triggers

Regulars and Services

EDITORIAL **243**

NEWS – Barry Fox highlights technology's leading edge **251**
Plus everyday news from the world of electronics

READOUT John Becker addresses general points arising **259**

SHOPTALK with David Barrington **281**
The *essential* guide to component buying for *EPE* projects

PLEASE TAKE NOTE Doorbell Extender; Body Detector **281**

ELECTRONICS MANUALS **282**
Essential reference works for hobbyists, students and service engineers

BACK ISSUES Did you miss these? Some now on CD-ROM! **284**

CD-ROMS FOR ELECTRONICS **288**
Teach-In 2000; Electronic Projects; Filters; Digital Works 3.0; Parts Gallery + Electronic Circuits and Components; Digital Electronics; Analogue Electronics; PICtutor; Modular Circuit Design; Electronic Components Photos; C for PIC Micros; CAD Pack

DIRECT BOOK SERVICE **302**
A wide range of technical books available by mail order

PRINTED CIRCUIT BOARD AND SOFTWARE SERVICE **305**
PCBs for *EPE* projects. Plus *EPE* software

ADVERTISERS INDEX ***308***

Free Supplement

AN END TO ALL DISEASE by Aubrey Scoon **between 270 and 271**
Can disease be cured electronically? A story involving electronics, blackmail, intimidation, government conspiracies, arson, vandalism, theft, bribery and murder!

Our May 2001 issue will be published on Thursday, 12 April 2001. See page 235 for details

Readers Services • Editorial and Advertisement Departments 243

World Radio History

Visit our website
www.distel.co.uk

THE *ORIGINAL* SURPLUS WONDERLAND!

THIS MONTH'S SELECTION FROM OUR VAST EVER CHANGING STOCKS

Surplus always wanted for cash!

THE AMAZING TELEBOX

Converts your colour monitor into a QUALITY COLOUR TV!!

TV SOUND & VIDEO TUNER
CABLE COMPATIBLE*

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

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

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

NEW State of the art PAL (UK spec) UHF TV tuner module with composite 1V pp video & NICAM hi fi stereo sound outputs. Micro electronics all on one small PCB only 73 x 160 x 52 mm enable full tuning control via a simple 3 wire link to an IBM pc type computer. Supplied complete with simple working program and documentation. Requires +12V & + 5V DC to operate.
BRAND NEW - Order as MY00. Only £49.95 code (B)
See www.distel.co.uk/data_my00.htm for picture + full details

FLOPPY DISK DRIVES 2½" - 8"

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 or see our web site *www.distel.co.uk* for over 2000 unlisted drives for spares or repair.

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" Floppy / 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" - 14"

2½" TOSHIBA MK1002MAV 1.1Gb laptop(12.5 mm H) *New*	£79.95
2½" TOSHIBA MK2101MAN 2.16 Gb laptop (19 mm H) *New*	£89.50
2½" TOSHIBA MK4309MAT 4.3Gb laptop (8.2 mm H) *New*	£105.00
2½" TOSHIBAMK6409MAV 6.1Gb laptop (12.7 mm H) *New*	£190.00
2½" to 3½" conversion kit for Pc's, complete with connectors	£14.95
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 40 mb IDE I/F (or equiv.) RFE	£69.00
3½" QUANTUM 40S Prodrive 42mb SCSI I/F, New RFE	£49.00
5¼" MINISCRIBE 3425 20mb MFM I/F (or equiv.) RFE	£49.95
5¼" SEAGATE ST-238R 30 mb RLL I/F Refurb	£69.95
5¼" CDC 94205-51 40mb HH MFM I/F RFE tested	£69.95
5¼" HP 97548 850 Mb SCSI RFE tested	£99.00
5¼" HP C3010 2 Gbyte SCSI *differential* RFE tested	£195.00
8" NEC D2246 85 Mb SMD interface. *New*	£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 (C1)

IC's -TRANSISTORS - DIODES

OBSOLETE - SHORT SUPPLY - BULK
10,000,000 items EX STOCK
For *MAJOR SAVINGS*
CALL OR SEE OUR WEB SITE www.distel.co.uk

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, 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 available - CALL

Ex demo 17" 0.28 SVGA Mitsubishi Diamond Pro monitors, Full multisync etc. Full 90 day guarantee. Only £199.00 (E)

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

PHILIPS HCS35 (same style as CM8833) attractively styled 14" colour monitor with both RGB and standard composite 15.625 Khz video inputs via SCART socket and separate phono jacks. Integral audio power amp and speaker for all audio visual uses. Will connect direct to Amiga and Atari BBC computers. Ideal for all video monitoring / security applications with direct connection to most colour cameras. High quality with many features such as front concealed flap controls, VCR correction button etc. Good used condition - fully tested - guaranteed Dimensions: W14" x H13¾" x 15½" D. **Only £99.00** (E)

PHILIPS HCS31 Ultra compact 9" colour video monitor with standerd 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

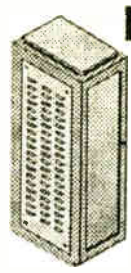
Superbly made UK manufacture. PIL all solid state colour monitors, complete with composite video & *optional* sound input. Attractive teak style case. Perfect for Schools, Shops, Disco, Clubs, etc.In EXCELLENT little used condition with full 90 day guarantee.

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

We probably have the largest range of video monitors in Europe. All sizes and types from 4" to 42" call for info.

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.



19" RACK CABINETS

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

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

OPT Rack 1 Complete with removable side panels. £345.00 (G)
OPT Rack 2 Rack Less side panels £245.00 (G)

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

32U - High Quality - All steel RakCab

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

Sold at LESS than a third of makers price !!

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

12V BATTERY SCOOP - 60% off !!

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

RELAYS - 200,000 FROM STOCK

Save £££'s by choosing your next relay from our Massive Stocks covering types such as Military, Octal, Cradle, Hermetically Sealed, Continental, Contactors, Time Delay, Reed, Mercury Wetted, Solid State, Printed Circuit Mounting etc. , CALL or see our web site www.distel.co.uk for more information. Many obsolete types from stock. Save ££££'s

COLOUR CCD CAMERAS

BIG £ SAVER

Undoubtedly a miracle of modern technology & our special buying power ! A quality product featuring a fully cased COLOUR CCD camera at a give away price ! Unit features full autolight sensing for use in low light & high light applications. A 10 mm fixed focus wide angle lens gives excellent focus and resolution from close up to long range. The composite video output will connect to any composite monitor or TV (via SCART socket) and most video recorders. Unit runs from 12V DC so ideal for security & portable applications where mains power not available. Overall dimensions 66 mm wide x 117 deep x 43 high. Supplied BRAND NEW & fully guaranteed with user data, 100's of applications including Security, Home Video, Web TV, Web Cams etc. etc.

Web ref = LK33 *ONLY £99.00 or 2 for £180.00 (B)*

SOFTWARE SPECIALS

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

ENCARTA 95 - CDROM, Not the latest - But at this price !	£7.95
DOS 5.0 on 3½" disks with concise books c/w QBasic	£14.95
Windows for Workgroups 3.11+ Dos 6.22 on 3.5" disks	£55.00
Wordperfect 6 for DOS supplied on 3½" disks with manual	£24.95

shipping charges for software is code B

TEST EQUIPMENT & SPECIAL INTEREST ITEMS

MITS. FA3445ETKL 14" Industrial spec SVGA monitors	£245
FARNELL 0-60V DC @ 50 Amps, bench Power Supplies	£995
FARNELL AP3080 0-30V DC @ 80 Amps, bench Suppy	£1850
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	£4995
HP1650B Logic Analyser	£3750
HP3781A Pattern generator & HP3782A Error Detector	£POA
HP6621A Dual Programmable GPIB PSU 0-7 V 160 watts	£1800
HP6264 Rack mount variable 0-20V @ 20A metered PSU	£675
HP54121A DC to 22 GHz four channel test set	£POA
HP8130A opt 020 300 MHz pulse generator, GPIB etc	£7900
HP A1, A0 8 pen HPGL high speed drum plotters from	£550
HP DRAFTMASTER 1 8 pen high speed plotter	£750
EG+G Brookdeal 95035C Precision lock in amp	£1800
View Eng. Mod 1200 computerised inspection system	£POA
Sony DXC-3000A High quality CCD colour TV camera	£995
Keithley 590 CV capacitor / voltage analyser	£POA
Racal ICR40 dual 40 channel voice recorder system	£3750
Fiskers 45KVA 3 ph On Line UPS - Now batteries	£9500
Emerson AP130 2 5KVA industrial spec.UPS	£2100
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
HP6030A 0-200V DC @ 17 Amps bench power supply	£1950
Intel SBC 486/125C08 Enhanced Multibus (MSA) New	£1150
Nikon HFX-11 (Ephiphot) exposure control unit	£1450
PHILIPS PM5518 pro. TV signal generator	£1250
Motorola VME Bus Boards & Components List. SAE / CALL	£POA
Trio 0-18 vdc linear, metered 30 amp bench PSU. New	£550
Fujitsu M3041R 600 LPM high speed band printer	£1950
Fujitsu M3041D 600 LPM printer with network interface	£1250
Perkin Elmer 299B Infrared spectrophotometer	£500
Perkin Elmer 597 Infrared spectrophotometer	£3500
VG Electronics 1035 TELETEXT Decoding Margin Meter	£3250
LightBand 60 output high spec 2u rack mount Video VDA's	£495
Sekonic SD 150H 18 channel digital Hybrid chart recorder	£1995
B&K 2633 Microphune pre amp	£300
Taylor Hobson Tallysurf amplifier / recorder	£750
ADC SS200 Carbon dioxide gas detector / monitor	£1450
BBC AM20/3 PPM Meter (Ernest Turner) + drive electronics	£75
ANRITSU 9654A Optical DC-2.5G/b waveform monitor	£5650
ANRITSU MS9001B1 0.6-1 7 uM optical spectrum analyser	£POA
ANRITSU ML93A optical power meter	£990
ANRITSU Fibre optic characteristic test set	£POA
R&S FTDZ Dual sound unit	£650
R&S SBUF-E1 Vision modulator	£775
WILTRON 6630B 12.4 / 20GHz RF sweep generator	£5750
TEK 2445 150 MHz 4 trace oscilloscope	£1250
TEK 2465 300 Mhz 300 MHz oscilloscope rack mount	£1955
TEK TDS380 400Mhz digital realtime + disk drive, FFT etc	£2900
TEK TDS524A 500Mhz digital realtime + colour display etc	£5100
HP3585A Opt 907 20Hz to 40 Mhz spectrum analyser	£3950
PHILIPS PW1730/10 60KV XRAY generator & accessories	£POA
CLAUDE LYONS 12A 240V single phase auto volt. regs	£325
CLAUDE LYONS 100A 240/415V 3 phase auto. volt. regs	£2900

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

DISPLAY ELECTRONICS

ALL MAIL TO
Dept PE, 29/35 Osborne Rd
Thornton Heath
Surrey CR7 8PD
Open Mon - Fri 9.00 - 5:30

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

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

ALL ☎ ENQUIRIES
0208 653 3333
FAX 0208 653 8888

All prices for UK Mainland. UK customers add 17.5% VAT to TOTAL order amount. Minimum order £10. Bona Fide account orders accepted from Government, Schools, Universities and Local Authorities - minimum account order £50. Cheques over £100 are subject to 10 working days clearance. Carriage charges (A)=£3.00, (A1)=£4.00, (B)=£5.50, (C)=£8.50, (C1) £12.50, (D)=£15.00, (E)=£18.00, (F)=£20.00, (G)=CALL. Allow approx 6 days for shipping - faster CALL. All goods supplied to our Standard Conditions of Sale and unless stated guaranteed for 90 days. All guarantees on a return to base basis. All rights reserved to change prices / specifications without prior notice. Orders subject to stock. Discounts for volume. Top CASH prices paid for surplus goods. All trademarks, tradenames etc acknowledged. © Display Electronics 1999. E & O.E. 07/99.

SWITCH · MasterCard · VISA · EST. 26 YEARS

World Radio History

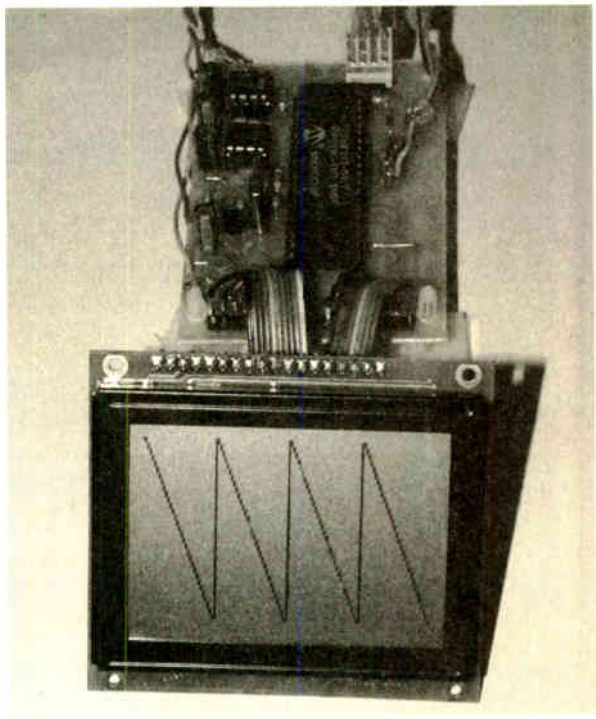
NEXT MONTH

PIC GRAPHICS L.C.D. SCOPE

EPE *Feb '01 contained a supplement in which the author's researches into* Using Graphics L.C.D.s *were published. The* PIC Graphics L.C.D. Scope (G-Scope) *is* EPE*'s first example of putting such displays to practical use. It is another addition to the widening family of simple oscilloscope-type constructional projects published in* EPE *over the last few years.*

G-Scope is a self-contained single-channel unit, catering nominally for waveforms in the audio range and uses a graphics l.c.d. screen having a pixel density of 64 x 128. It also displays frequency and signal amplitude factors as alphanumeric text lines. The signal source can be a.c. or d.c. and waveforms up to 5V peak-to-peak can be input without external attenuation. A simple pre-amp stage can be switched to provide x1 or x10 amplification.

The control facilities include sync (waveform synchronisation stability) on/off selection, frequency/voltage monitoring on/off and a choice of three sampling rates. The lowest sampling rate allows sub-Hertz signals to be slowly traced on screen while they occur.



CAMCORDER MIXER

Modern camcorders, especially the digital variety, produce pictures of a very high quality. However, the amateur often spoils the finished result with inferior sound. It could be said that most camcorder operators concentrate more on the visual aspect than the sound, yet only if both are treated with equal care will the video have a "professional" feel.

This circuit is a mixer which will combine the outputs of up to two stereo microphones (or four mono ones) plus a stereo line source and feed them into the camcorder. It may also be used in conjunction with a domestic hi-fi system or power amplifier for other purposes, such as karaoke. By using a well placed microphone or microphones instead of the built-in camcorder mic the sound on videos can be greatly improved.

D.C. MOTOR CONTROLLER

Inexpensive d.c. motors are often used by model-makers, not only for model locomotives and racing cars but in robots of all kinds. They may also be used for driving non-mobile models made from anything from cardboard to Meccano. This project controls a small 6V d.c. motor, but can be used for 12V or high-voltage d.c. motors as well. The circuit controls both the speed and the direction of the motor. This Top Tenner project is simple, easy to build and inexpensive.

PLUS ALL THE REGULAR FEATURES

NO ONE DOES IT BETTER

EVERYDAY PRACTICAL ELECTRONICS

INCORPORATING ELECTRONICS TODAY INTERNATIONAL

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

Demand is bound to be high

MAY 2001 ISSUE ON SALE THURSDAY, APRIL 12

World Radio History

QUASAR ELECTRONICS LIMITED

Unit 14 Sunningdale, BISHOPS STORTFORD, Herts. CM23 2PA

TEL: 01279 306504 FAX: 07092 203496

ADD £2.00 P&P to all orders (or 1st Class Recorded £4. Next day (Insured £250) £7. Europe £4.00. Rest of World £6.00). We accept all major credit cards. Make cheques/PO's payable to Quasar Electronics. Prices include 17.5% VAT. MAIL ORDER ONLY.
FREE CATALOGUE with order or send 2 x 1st class stamps (refundable) for details of over 150 kits & publications.

VISA

PROJECT KITS

Our electronic kits are supplied complete with all components, high quality PCBs (NOT cheap Tripad strip board!) and detailed assembly/operating instructions

● **2 x 25W CAR BOOSTER AMPLIFIER** Connects to the output of an existing car stereo cassette player, CD player or radio. Heatsinks provided. PCB 76x75mm. **1046KT. £24.95**

● **3-CHANNEL WIRELESS LIGHT MODULATOR** No electrical connection with amplifier. Light modulation achieved via a sensitive electret microphone. Separate sensitivity control per channel. Power handling 400W/channel. PCB 54x112mm. Mains powered. Box provided. **6014KT £24.95**

● **12 RUNNING LIGHT EFFECT** Exciting 12 LED light effect ideal for parties, discos, shop-windows & eye-catching signs. PCB design allows replacement of LEDs with 220V bulbs by inserting 3 TRIACs. Adjustable rotation speed & direction. PCB 54x112mm. **1026KT £15.95; BOX (for mains operation) 2026BX £9.00**

● **OISCO STROBE LIGHT** Probably the most exciting of all light effects. Very bright strobe tube. Adjustable strobe frequency: 1-60Hz. Mains powered. PCB: 60x68mm. Box provided. **6037KT £28.95**

● **ANIMAL SOUNDS** Cat, dog, chicken & cow. Ideal for kids farmyard toys & schools. **SG10M £5.95**

● **3 1/2 DIGIT LED PANEL METER** Use for basic voltage/current displays or customise to measure temperature, light, weight, movement, sound levels, etc. with appropriate sensors (not supplied). Various input circuit designs provided. **3061KT £13.95**

● **IR REMOTE TOGGLE SWITCH** Use any TV/VCR remote control unit to switch onboard 12V/1A relay on/off. **3058KT £10.95**

SPEED CONTROLLER for any common DC motor up to 100V/5A. Pulse width modulation gives maximum torque at all speeds. 5-15VDC. Box provided. **3067KT £12.95**

● **3 x 8 CHANNEL IR RELAY BOARD** Control eight 12V/1A relays by Infra Red (IR) remote control over a 20m range in sunlight. 6 relays turn on only, the other 2 toggle on/off. 3 operation ranges determined by jumpers. Transmitter case & all components provided. Receiver PCB 76x89mm. **3072KT £52.95**

PRODUCT FEATURE

4 WATT FM TRANSMITTER

Small but powerful 4 Watt 88-108MHz FM transmitter with an audio preamplifier stage and 3 RF stages. Accepts a wide variety of input sources – the electret microphone supplied, a tape player or for more professional results, a separate audio mixer (like our 3-Input Mono Mixer kit *1052*). Can be used with an open dipole or ground plane antenna. Supply: 12-15V DC/0.5A. PCB: 45 x 145mm.

ORDERING INFO: Kit 1028KT **£22.95.**
OPTIONAL EXTRAS: 3-Input Mono Mixer Kit 1052KT **£17.95.** AS1028 **£39.95.**

● **SOUND EFFECTS GENERATOR** Easy to build. Create an almost infinite variety of interesting/unusual sound effects from birds chirping to sirens. 9VDC. PCB 54x85mm. **1045KT £8.95**

● **ROBOT VOICE EFFECT** Make your voice sound similar to a robot or Darlek. Great fun for discos, school plays, theatre productions, radio stations & playing jokes on your friends when answering the phone! PCB 42x71mm. **1131KT £8.95**

● **AUDIO TO LIGHT MODULATOR** Controls intensity of one or more lights in response to an audio input. Safe, modern opto-coupler design. Mains voltage experience required **3012KT £8.95**

● **MUSIC BOX** Activated by light. Plays 8 Chrstmas songs and 5 other tunes. **3104KT £7.95**

● **20 SECOND VOICE RECORDER** Uses non-volatile memory - no battery backup needed. Record/replay messages over & over. Playback as required to greet customers etc. Volume control & built-in mic. 6VDC. PCB 50x73mm. **3131KT £12.95**

● **TRAIN SOUNDS** 4 selectable sounds : whistle blowing, level crossing bell, 'clickety-clack' & 4 in sequence. **SG01M £6.95**

● **PC CONTROLLED RELAY BOARD** Convert any 286 upward PC into a dedicated automatic controller to independently turn on/off up to eight lights, motors & other devices around the home, office, laboratory or factory using 8 240VAC/12A onboard relays. DOS utilities, sample test program, full-featured Windows utility & all components (except cable) provided. 12VDC. PCB 70x200mm. **3074KT £31.95**

● **2 CHANNEL UHF RELAY SWITCH** Contains the same transmitter/receiver pair as 30A15 below plus the components and PCB to control two 240VAC/10A relays (also supplied). Ultra bright LEDs used to indicate relay status. **3082KT £27.95**

● **TRANSMITTER RECEIVER PAIR** 2-button keyfob style 300-375MHz Tx with 30m range. Receiver encoder module with matched decoder IC. Components must be built into a circuit like kit 3082 above. **30A15 £14.95**

● **PC DATA ACQUISITION/CONTROL UNIT** Use your PC to monitor physical variables (e.g. pressure, temperature, light, weight, switch state, movement, relays, etc.), process the information & use results to control physical devices like motors, sirens, relays, servo & stepper motors. Inputs: 16 digital & 11 analogue. Outputs: 8 digital & 1 analogue. Plastic case with printed front/rear panels, software utilities, programming examples & all components (except sensors & cable) provided. 12VDC. **3093KT £99.95**

● **PIC 16C71 FDUR SERVO MOTDR DRIVER** Simultaneously control up to 4 servo motors. Software & all components (except servos/ccntrol pots) supplied. 5VDC PCB 50x70mm **3102KT £15.95**

● **PC SERIAL PORT ISOLATED I/O BOARD** Provides eight 240VAC/10A relay outputs & 4 optically isolated inputs. Designed for use in various control & sensing applications e.g. lead switching, external switch input sensing, contact closure & external voltage sensing. Controlled via serial port & a terminal emulator program (built into Windows). Can be used with ANY computer/operating system. Plastic case with printed front/rear panels & all components (except cable) provided. **3108KT £54.95**

● **UNIPOLAR STEPPER MOTOR DRIVER** for any 5/6/8 lead motor. Fast/slow & single step rates. Direction control & on/off switch. Wave, 2-phase & half-wave step modes. 4 LED indicators. PCB 50x65mm **3109KT £14.95**

● **PC CONTROLLED STEPPER MOTOR DRIVER** Control two unipolar stepper motors (3A max. each) via PC printer port. Wave, 2-phase & half-wave step modes. Software accepts 4 digital inputs from external switches & will single step motors. PCB fits in D-shell case provided. **3113KT £17.95**

● **12-BIT PC DATA ACQUISITION/CONTROL UNIT** Similar to kit 3093 above but uses a 12 bit Analogue-to-Digital Converter (ADC) with internal analogue multiplexor. Reads 8 single ended channels or 4 differential inputs or a mixture of both. Analogue inputs read 0-4V. Four TTL/CMOS compatible digital input/outputs. ADC conversion time <10uS. Software (C, QB & Win), extended D shell case & all components (except sensors & cable) provided. **3118KT £52.95**

● **LIQUID LEVEL SENSOR/RAIN ALARM** Will indicate fluid levels or simply the presence of fluid. Relay output to control a pump to add/remove water when it reaches a certain level. **1080KT £5.95**

● **STEREO VU METER** shows peak music power using 2 rows of 10 LED's (mixed green & red) moving bar display. 0-30db. **3089KT £11.95**

● **AM RADIO KIT 1** Tuned Radio Frequency front-end, single chip AM radio IC & 2 stages of audio amplification. All components inc. speaker provided. PCB 32x102mm. **3063KT £10.95**

● **DRILL SPEED CONTROLLER** Adjust the speed of your electric drill according to the job at hand. Suitable for 240V AC mains powered drills up to 700W power. PCB: 48mm x 65mm. Box provided. **6074KT £17.95**

● **3 INPUT MONO MIXER** Independent level control for each input and separate bass/treble controls. Input sensitivity: 240mV. 18V DC. PCB: 60mm x 185mm **1052KT £16.95**

● **NEGATIVE\POSITIVE ION GENERATOR** Standard Cockcroft-Walton multiplier circuit. Mains voltage experience required. **3057KT £10.95**

● **LED DICE** Classic intro to electronics & circuit analysis 7 LED's simulate dice roll, slow down & land on a number at random. 555 IC circuit. **3003KT £9.95**

● **STAIRWAY TO HEAVEN** Tests hand-eye co-ordination. Press switch when green segment of LED lights to climb the stairway - miss & start again! Good intro to several basic circuits. **3005KT £9.95**

● **ROULETTE LED** 'Ball' spins round the wheel, slows down & drops into a slot. 10 LED's. Good intro to CMOS decade counters & Op-Amps. **3006KT £10.95**

● **9V XENON TUBE FLASHER** Transformer circuit steps up 9V battery to flash a 25mm Xenon tube. Adjustable flash rate (0-25-2 Sec's). **3022KT £11.95**

● **LED FLASHER 1** 5 ultra bright red LED's flash in 7 selectable patterns. **3037MKT £5.95**

● **LED FLASHER 2** Similar to above but flash in sequence or randomly. Ideal for model railways. **3052MKT £5.95**

● **INTRODUCTION TO PIC PROGRAMMING.** Learn programming from scratch. Programming hardware, a P16F84 chip and a two-part, practical, hands-on tutorial series are provided. **3081KT £22.95**

● **SERIAL PIC PROGRAMMER** for all 8/18/28/40 pin DIP serial programmed PICs. Shareware software supplied limited to programming 256 bytes (registration costs £14.95). **3096KT £13.95**

● **'PICALL' SERIAL & PARALLEL PIC PROGRAMMER** for all 8/18/28/40 pin DIP parallel AND serial PICs. Includes fully functional & registered software (DOS, W3.1, W95/8). **3117KT £59.95**

● **ATMEL 89Cx051 PROGRAMMER** Simple-to-use yet powerful programmer for the Atmel 89C1051, 89C2051 & 89C4051 uC's. Programmer does NOT require special software other than a terminal emulator program (built into Windows). Can be used with ANY computer/operating system. **3121KT £24.95**

● **3V/1.5V TO 9V BATTERY CONVERTER** Replace expensive 9V batteries with economic 1.5V batteries. IC based circuit steps up 1 or 2 'AA' batteries to give 9V/18mA. **3035KT £5.95**

● **STABILISED POWER SUPPLY 3-30V/2.5A** Ideal for hobbyist & professional laboratory. Very reliable & versatile design at an extremely reasonable price. Short circuit protection. Variable DC voltages (3-30V). Rated output 2.5 Amps. Large heatsink supplied. You just supply a 24VAC/3A transformer. PCB 55x112mm. Mains operation. **1007KT £16.95.**

● **STABILISED POWER SUPPLY 2-30V/5A** As kit 1007 above but rated at 5Amp. Requires a 24VAC/5A transformer. **1096KT £27.95.**

● **MOTORBIKE ALARM** Uses a reliable vibration sensor (adjustable sensitivity) to detect movement of the bike to trigger the alarm & switch the output relay to which a siren, bikes horn, indicators or other warning device can be attached. Auto-reset. 6-12VDC. PCB 57x64mm. **1011KT £11.95** Box **2011BX £7.00**

● **CAR ALARM SYSTEM** Protect your car from theft. Features vibration sensor, courtesy/boot light voltage drop sensor and bonnet/boot earth switch sensor. Entry/exit delays, auto-reset and adjustable alarm duration. 6-12V DC. PCB: 47mm x 55mm **1019KT £11.95** Box **2019BX £8.00**

● **PIEZO SCREAMER** 110dB of ear piercing noise. Fits in box with 2 x 35mm piezo elements built into their own resonant cavity. Use as an alarm siren or just for fun! 6-9VDC. **3015KT £10.95**

● **COMBINATION LOCK** Versatile electronic lock comprising main circuit & separate keypad for remote opening of lock. Relay supplied. **3029KT £10.95**

● **ULTRASONIC MOVEMENT DETECTOR** Crystal locked detector frequency for stability & reliability. PCB 75x40mm houses all components. 4-7m range. Adjustable sensitivity. Output will drive external relay/circuits. 9VDC. **3049KT £13.95**

PIR DETECTOR MODULE 3-lead assembled unit just 25x35mm as used in commercial burglar alarm systems **3076KT £8.95**

● **INFRARED SECURITY BEAM** When the invisible IR beam is broken a relay is tripped that can be used to sound a bell or alarm. 25 metre range. Mains rated relays provided. 12VDC operation. **3130KT £12.95**

● **SQUARE WAVE OSCILLATOR** Generates square waves at 6 preset frequencies in factors of 10 from 1Hz-100KHz. Visual output indicator. 5-18VDC. Box provided. **3111KT £8.95**

● **PC DRIVEN POCKET SAMPLER/DATA LOGGER** Analogue voltage sampler records voltages up to 2V or 20V over periods from milli-seconds to months. Can also be used as a simple digital scope to examine audio & other signals up to about 5KHz. Software & D-shell case provided. **3112KT £18.95**

● **20 MHz FUNCTION GENERATOR** Square, triangular and sine waveform up to 20MHz over 3 ranges using 'coarse' and 'fine' frequency adjustment controls. Adjustable output from 0-2V p-p. A TTL output is also provided for connection to a frequency meter. Uses MAX038 IC. Plastic case with printed front/rear panels & all components provided. 7-12VAC. **3101KT £69.95**

SURVEILLANCE

High performance surveillance bugs. Room transmitters supplied with sensitive electret microphone & battery holder/clip. All transmitters can be received on an ordinary VHF/FM radio between 88-108MHz. Available in Kit Form (KT) or Assembled & Tested (AS).

ROOM SURVEILLANCE

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

MRTX **- MINIATURE 9V TRANSMITTER** Our best selling bug. Super sensitive, high power - 500m range @ 9V (over 1km with 18V supply and better aerial). 45x19mm. **3018KT £7.95 AS3018 £12.95**

HPTX **- HIGH POWER TRANSMITTER** High performance, 2 stage transmitter gives greater stability & higher quality reception. 1000m range 6-12V DC operation. Size 70x15mm. **3032KT £9.95 AS3032 £18.95**

● ***MMTX*** **- MICRO-MINIATURE 9V TRANSMITTER** The ultimate bug for its size, performance and price. Just 15x25mm. 500m range @ 9V. Good stability 6-18V operation. **3051KT £8.95 AS3051 £14.95**

● ***VTX*** **- VOICE ACTIVATED TRANSMITTER** Operates only when sounds detected. Low standby current. Variable trigger sensitivity. 500m range. Peaking circuit supplied for maximum RF output. On/off switch. 6V operation. Only 63x38mm. **3028KT £12.95 AS3028 £21.95**

HARD-WIRED BUG/TWO STATION INTERCOM Each station has its own amplifier, speaker and mic. Can be set up as either a hard-wired bug or two-station intercom. 10m x 2-core cable supplied. 9V operation. **3021KT £15.95 (kit form only)**

● ***TRVS*** **- TAPE RECORDER VOX SWITCH** Used to automatically operate a tape recorder (not supplied) via its REMOTE socket when sounds are detected. All conversations recorded. Adjustable sensitivity & turn-off delay. 115x19mm **3013KT £9.95 AS3013 £21.95**

TELEPHONE SURVEILLANCE

● ***MTTX*** **- MINIATURE TELEPHONE TRANSMITTER** Attaches anywhere to phone line. Transmits only when phone is used! Tune-in your radio and hear both parties. 300m range. Uses line as aerial & power source. 20x45mm. **3016KT £8.95 AS3016 £14.95**

● ***TRI*** **- TELEPHONE RECORDING INTERFACE** Automatically record all conversations. Connects between phone line & tape recorder (not supplied). Operates recorders with 1.5-12V battery systems. Powered from line. 50x33mm. **3033KT £9.95 AS3033 £18.95**

● ***TPA*** **- TELEPHONE PICK-UP AMPLIFIER/WIRELESS PHONE BUG** Place pick-up coil on the phone line or near phone earpiece and hear both sides of the conversation. **3055KT £11.95 AS3055 £20.95**

● **1 WATT FM TRANSMITTER** Easy to construct. Delivers a crisp, clear signal. Two-stage circuit. Kit includes microphone and requires a simple open dipole aerial. 8-30VDC. PCB 42x45mm. **1009KT £14.95**

● **4 WATT FM TRANSMITTER** Comprises three RF stages and an audio preamplifier stage. Piezoelectric microphone supplied or you can use a separate preamplifier circuit. Antenna can be an open dipole or Ground Plane. Ideal project for those who wish to get started in the fascinating world of FM broadcasting and want a good basic circuit to experiment with. 12-18VDC. PCB 44x146mm. **1028KT, £24.95 AS1028 £39.95**

● **15 WATT FM TRANSMITTER (PRE-ASSEMBLED & TESTED)** Four transistor based stages with Philips BLY 88 in final stage. 15 Watts RF power on the air. 88-108MHz. Accepts open dipole, Ground Plane, 5/8, J, or YAGI configuration antennas. 12-18VDC. PCB 70x220mm. SWS meter needed for alignment. **1021KT £74.95**

● **SIMILAR TO ABOVE BUT 25W Output. 1031KT £84.95**

BARGAIN BUY!!

30-In-ONE
Electronic Projects Lab

Great introduction to electronics. Ideal for the budding electronics expert! Build a radio, burglar alarm, water detector, morse code practice circuit, simple computer circuits, and much more! NO soldering, tools or previous electronics knowledge required. Circuits can be built and unassembled repeatedly. Comprehensive 68-page manual with explanations, schematics and assembly diagrams. Suitable for age 10+. Excellent for schools. Requires 2 x AA batteries. **ONLY £14.95** (phone for bulk discounts).

X FACTOR PUBLICATIONS

THE EXPERTS IN RARE & UNUSUAL INFORMATION!

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

● **SUPER-EAR LISTENING DEVICE** Complete plans to build your own parabolic dish microphone. Listen to distant voices and sounds through open windows and even walls! Made from readily available parts. **R002 £3.50**

● **TELEPHONE BUG PLANS** Build you own micro-beetle telephone bug. Suitable for any phone. Transmits over 250 metres - more with good receiver. Made from easy to obtain, cheap components. **R006 £2.50**

● **LOCKS** - How they work and how to pick them. This fact filled report will teach you more about locks and the art of lock picking than many books we have seen at 4 times the price. Packed with information and illustrations. **R008 £3.50**

● **RADIO & TV JOKER PLANS** We show you how to build three different circuits for disrupting TV picture and sound plus FM radio! May upset your neighbours & the authorities!! DISCRETION REQUIRED. **R017 £3.50**

● **INFINITY TRANSMITTER PLANS** Complete plans for building the famous Infinity Transmitter. Once installed on the target phone, device acts like a room bug. Just call the target phone & activate the unit to hear all room sounds. Great for home-office security! **R019 £3.50**

● **THE ETHER BOX CALL INTERCEPTOR PLANS** Grabs telephone calls out of thin air! No need to wire-in a phone bug. Simply place this device near the phone lines to hear the conversations taking place! **R025 £3.00**

● **CASH CREATOR BUSINESS REPORTS** Need ideas for making some cash? Well this could be just what you need! You get 40 reports (approx. 800 pages) on floppy disk that give you information on setting up different businesses. You also get valuable reproduction and duplication rights so that you can sell the manuals as you like. **R030 £7.50**

WEB: http://www.QuasarElectronics.com
email: epesales@QuasarElectronics.com

Secure Online Ordering Facilities
Full Kit Listing, Descriptions & Photos
Kit Documentation & Software Downloads

Credit Card Sales: 01279 306504

www.QuasarElectronics.com

World Radio History

QUASAR ELECTRONICS

Number 1 For Kits

www.QuasarElectronics.com

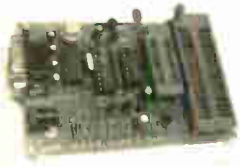
Credit Card Sales: 01279 306504

'PICALL' PIC Programmer

Kit will program **ALL** 8, 18, 28 and 40 pin serial AND parallel programmed PIC micro controllers. Connects to the parallel port of a PC. Supplied with fully functional pre-registered PICALL DOS and WINDOWS AVR software packages, all components and high quality DSPTH PCB. Also programs certain ATMEL AVR, serial EPROM and SCENIX SX devices. New PIC's can be added to the software as they are released. Software shows you where to place your PIC chip on the board for programming. Now has new-chip auto sensing feature for super-fast bulk programming.

3117KT	'PICALL' PIC Programmer Kit	£59.95
AS3117	Assembled 'PICALL' PIC Programmer	£69.95
AS3117ZIF	Assembled 'PICALL' PIC Programmer c/w ZIF socket	£84.95

ATMEL 89xxxx Programmer



Powerful programmer for Atmel 8051 micro controller family. All fuse and lock bits are programmable. Connects to serial port. Can be used with ANY computer & operating system. 4 LEDs to indicate programming status. Supports 89C1051, 89C2051, 89C4051, 89C51, 89LV51, 89C52, 89LV52, 89C55, 89LV55, 89S8252, 89LS8252, 89S53 & 89LS53 devices. NO special software required – uses any terminal emulator program (built into Windows). **NB ZIF sockets not included.**

3123KT	ATMEL 89xxx Programmer	£32.95
AS3123	Assembled 3123	£47.95

Atmel 89Cx051 and AVR programmers also available.

PC Data Acquisition & Control Unit

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

FEATURES:

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

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

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

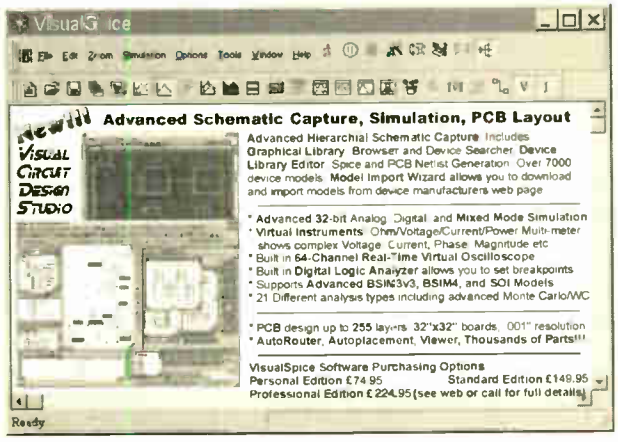
See opposite page for ordering information on these kits

ABC Mini 'Hotchip' Board

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

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

Advanced Schematic Capture and Simulation Software



Serial Port Isolated I/O Controller

Kit provides eight 240VAC/12A (110VAC/15A) rated relay outputs and four optically isolated inputs. Can be used in a variety of control and sensing applications including load switching, external switch input sensing, contact closure and external voltage sensing. Programmed via a computer serial port, it is compatible with ANY computer & operating system. After programming, PC can be disconnected. Serial cable can be up to 35m long, allowing 'remote' control. User can easily write batch file programs to control the kit using simple text commands. NO special software required – uses any terminal emulator program (built into Windows). All components provided including a plastic case with pre-punched and silk screened front/rear panels to give a professional and attractive finish (see photo).

3108KT	Serial Port Isolated I/O Controller Kit	£54.95
AS3108	Assembled Serial Port Isolated I/O Controller	£69.95

World Radio History

SURVEILLANCE

Electronic Surveillance Equipment Kits from the UK's No.1 Supplier

SUMA DESIGNS has been supplying professional quality electronic surveillance equipment kits for over 20 years. Whether your requirement is hobbyist, amateur or professional you can be sure that you are buying from a company that knows the business. We ONLY sell surveillance products, no alarms, disco lights or computer bits. All of our kits are designed for self assembly and are well tried, tested and proven. All kits are supplied complete with top grade components, fibreglass PCB, full instructions, circuit diagrams and assembly details. Unless otherwise stated all transmitter kits are tuneable and can be received using an ordinary VHF FM radio.

UTX Ultra-miniature Room Transmitter
At less than 1/2 the size of a postage stamp the UTX is the smallest room transmitter kit in the world! Incredible 10mm x 20mm including microphone, 3-12V operation. Range up to 500m **£13.95**

MTX Micro-miniature Room Transmitter
Our best selling room transmitter kit. Just 17mm x 17mm including mic. Extremely sensitive. 3-12V operation. Range up to 1000m. . . **£14.95**

STX High-performance Room Transmitter
High performance transmitter with buffered output for greater stability and range. Measures just 22mm x 22mm including mic. 6-12V operation. Range up to 1500m. **£16.95**

VT500 High-power Room Transmitter
Our most powerful room transmitter with around 250mW of output power. Excellent range and penetration. Size 20mm x 40mm, 6-12V operation. Range up to 3000m. **£17.95**

VXT Voice-activated Room Transmitter
Triggers only when sounds are detected by on-board mic. Variable trigger sensitivity and on-time with LED trigger indicator. Very low standby current. Size 20mm x 67mm, 9V operation, range up to 1000m. **£21.95**

HVX400 Mains Powered Room Transmitter
Connects directly to 240V AC supply. Ideal for long-term monitoring. Size 30mm x 35mm, range up to 500m. **£21.95**

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

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

UTLX Ultra-miniature Telephone Transmitter
Smallest kit available. Connects onto telephone line, switches on and off automatically as phone is used. All conversations transmitted. Size 10mm x 20mm, powered from line, up to 500m range. **£13.95**

TLX700 Micro-miniature Telephone Transmitter
Best selling kit. Performance as UTLX but easier to assemble as PCB is 20mm x 20mm. **£14.95**

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

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

CD400 Pocket Size Bug Detector/Locator
LED and piezo bleeper pulse slowly. Pulse rate and tone pitch increase as signal source is approached. Variable sensitivity allows pinpointing of signal source. 9V operation, size 45mm x 54mm. **£34.95**

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

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

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

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

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

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

MBX-1 Hi-Fi Micro Broadcaster
Connects to headphone socket of CD player, Walkman or Hi-Fi and broadcasts your favourite music around house and garden up to 250m. Size 27mm x 60mm, 9V operation. **£22.95**

DLTX/RX Radio Remote Switch System
Two kits, transmitter sends a coded signal (256 selectable codes) when button pressed. Receiver detects signal, checks code and activates relay. Can be set to be momentary or toggle (on/off) operation. Range up to 100m, 9V operation on both units. TX 45mm x 45mm, RX 35mm x 90mm. **£44.95**

TO ORDER:
Post, fax or telephone your order direct to our sales office. Payment can be Credit card (Visa or Mastercard), Postal Order, cash (please send registered) or cheques. Kits despatched same day (cheques need clearing). All orders sent by recorded or registered post. Please add postage as follows:
ORDER UP TO £30.00: To UK £2.50 To EUROPE £5.50 All other £7.50
ORDERS OVER £30.00: To UK £3.80 To EUROPE £7.50 All others call
Overseas customers please use credit cards or send sterling cheque or bank draft.

SEND 2 x 1st CLASS STAMPS FOR OUR 2000 KIT CATALOGUE CONTAINING FULL DETAILS OF THESE AND OTHER KITS.
A BUILD-UP SERVICE IS AVAILABLE ON ALL OF OUR KITS, DETAILS IN CATALOGUE. VISIT OUR WEBSITE: www.suma-designs.co.uk
Please note: Some of our part numbers are being unscrupulously used by other companies selling kits eg. MTX, VXT. DO NOT BE MISLEAD! These are NOT GENUINE SUMA KITS which are only available direct from us or our appointed distributors.
If you wish to collect kits direct from our office PLEASE TELEPHONE

SUMA DESIGNS
Dept. EE, The Workshops, 95 Main Road, Baxterley, Warwickshire, CV9 2LE, U.K.
Website: www.suma-designs.co.uk
TEL/FAX: 01827 714476 (24 HOUR ORDERLINE)
email: sales@suma-designs.co.uk

World Radio History

£1 BARGAIN PACKS
Selected Items

CROCODILE CLIPS. Small size. 10 each red and black. Order Ref: 116.

PLASTIC HEADED CABLE CLIPS. Nail in type, several sizes. Pack of 50. Order Ref: 123.

30A PANEL MOUNTING TOGGLE SWITCH. Double pole. Order Ref: 166.

SUB MIN TOGGLE SWITCHES. Pack of 3. Order Ref: 214.

HIGH POWER 3in. SPEAKER (11W 8ohm). Order Ref: 246.

MEDIUM WAVE PERMEABILITY TUNER. It's almost a complete radio with circuit. Order Ref: 247.

PANEL METER. 0-1mA, scaled 0-100, face size approximately 2¾in. square. Order Ref: 756.

MAINS MOTOR with gearbox giving 1 rev per 24 hours. Order Ref: 89.

ROUND POINTER KNOBS for flatted ¼in. spindles. Pack of 10. Order Ref: 295.

CERAMIC WAVE CHANGE SWITCH. 12-pole, 3-way with ¼in. spindle. Order Ref: 303.

REVERSING SWITCH. 20A double pole or 40A single pole. Order Ref: 343.

LUMINOUS PUSH-ON PUSH-OFF SWITCHES. Pack of 3. Order Ref: 373.

SLIDE SWITCHES. Single pole changeover. Pack of 10. Order Ref: 1053.

PAXOLIN PANEL. Approximately 12in. x 12in. Order Ref: 1033.

CLOCKWORK MOTOR. Suitable for up to 6 hours. Order Ref: 1038.

TRANSISTOR DRIVER TRANSFORMER. Maker's ref. no. LT44, impedance ratio 20k ohm to 1k ohm, centre tapped, 50p. Order Ref: 1/23R4.

HIGH CURRENT RELAY. 12V D.C. or 24V A.C., operates changeover contacts. Order Ref: 1026.

2-CORE CURLY LEAD. 5A, 2m. Order Ref: 846.

3 CHANGEOVER RELAY. 6V A.C., 3V D.C. Order Ref: 859.

3 CONTACT MICRO SWITCHES, operated with slightest touch. Pack of 2. Order Ref: 861.

HIVAC NUMICATOR TUBE. Hivac ref XN3. Order Ref: 865.

2IN. ROUND LOUDSPEAKERS. 50Ω coil. Pack of 2. Order Ref: 908.

2IN. ROUND LOUDSPEAKERS. 8Ω. Pack of 2. Order Ref: 908/8.

5K POT, standard size with DP switch, good length ¼in. spindle, pack of 2. Order Ref: 11R24.

13A PLUG, fully legal with insulated legs, pack of 3. Order Ref: GR19.

OPTO SWITCH on p.c.b., size 2in. x 1in., pack of 2. Order Ref: GR21.

1000W FIRE SPIRALS. In addition to repairing fires, these are useful for making high current resistors. Price 4 for £1. Order Ref: 223.

BRASS ENCASED ELEMENT. Mains working, 80W standard replacement in some fridges but very useful for other heating purposes. Price £1 each. Order Ref: 8.

PEA LAMPS, only 4mm but 14V at 0·04A, wire ended, pack of 4. Order Ref: 7RC28.

HIGH AMP THYRISTOR, normal 2 contacts from top, heavy threaded fixing underneath, think amperage to be at least 25A, pack of 2. Order Ref: 7FC43.

BRIDGE RECTIFIER, ideal for 12V to 24V charger at 5A, pack of 2. Order Ref: 1070.

TEST PRODS FOR MULTIMETER with 4mm sockets. Good length very flexible lead. Order Ref: D86.

LUMINOUS ROCKER SWITCH, approximately 30mm square, pack of 2. Order Ref: D64.

MES LAMP HOLDERS, slide onto ¼in. tag, pack of 10. Order Ref: 1054.

HALL EFFECT DEVICES, mounted on small heatsink, pack of 2. Order Ref: 1022.

12V POLARISED RELAY, 2 changeover contacts. Order Ref: 1032.

PROJECT CASE, 95mm x 66mm x 23mm with removable lid held by 4 screws, pack of 2. Order Ref: 876.

LARGE MICRO SWITCHES, 20mm x 6mm x 10mm, changeover contacts, pack of 2. Order Ref: 826.

PIEZO ELECTRIC SOUNDER, also operates efficiently as a microphone. Approximately 30mm diameter, easily mountable, 2 for £1. Order Ref: 1084.

LIQUID CRYSTAL DISPLAY on p.c.b. with ICs etc. to drive it to give 2 rows of 8 characters. price £1. Order Ref: 1085.

THIS MONTH'S SPECIAL

IT IS A DIGITAL MULTITESTER, complete with backrest to stand it and hands-free test prod holder. This tester measures d.c. volts up to 1,000 and a.c. volts up to 750; d.c. current up to 10A and resistance up to 2 megs. Also tests transistors and diodes and has an internal buzzer for continuity tests. Comes complete with test prods, battery and instructions. Price £6.99. Order Ref: 7P29.

12V DC POWER SUPPLY. 650mA regulated with 13A plug-in pins, £2.50. Order Ref: 2.5P26.

VERY THIN DRILLS. 12 assorted sizes vary between 0·6mm and 1·6mm. Price £1. Order Ref: 128.

EVEN THINNER DRILLS. 12 that vary between 0·1mm and 0·5mm. Price £1. Order Ref:129.

BT PLUG WITH TWIN SOCKET. Enables you to plug 2 telephones into the one socket for all normal BT plugs. Price £1.50. Order Ref: 1.5P50.

D.C. MOTOR WITH GEARBOX. Size 60mm long, 30mm diameter. Very powerful, operates off any voltage between 6V and 24V D.C. Speed at 6V is 200 rpm, speed controller available. Special price £3 each. Order Ref: 3P108.

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.

MOST USEFUL POWER SUPPLY. Rated at 9V 1A, this plugs into a 13A socket, is really nicely boxed. £2. Order Ref: 2P733.

MOTOR SPEED CONTROLLER. These are suitable for D.C. motors for voltages up to 12V and any power up to 1/6h.p. They reduce the speed by intermittent full voltage pulses so there should be no loss of power. In kit form these are £12. Order Ref: 12P34. Or made up and tested, £20. Order Ref: 20P39.

BT TELEPHONE EXTENSION WIRE. This is proper heavy duty cable for running around the skirting board when you want to make a permanent extension. 4 cores properly colour coded, 25m length. Only £1. Order Ref:1067.

FOR QUICK HOOK-UPS. You can't beat leads with a croc clip each end. You can have a set of 10 leads, 2 each of 5 assorted colours with insulated crocodile clips on each end. Lead length 36cm, £2 per set. Order Ref: 2P459.

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: 2P44.

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.

DOORBELL PSU. This has AC 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.

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. These instruments are ex-British Telecom but in very good condition, tested and guaranteed OK, 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 slightly faulty, not working on all ranges, should be repairable, we supply diagram, £3. Order Ref: 3P176.

TWO MORE POST OFFICE INSTRUMENTS

Both instruments contain lots of useful parts, including sub-min toggle switch sold by many at £1 each. They are both in extremely nice cases, with battery compartment and flexible carrying handles, so if you don't need the intruments themselves, the case may be just right for a project you have in mind.

The first is **Oscillator 87F.** This has an output, continuous or interrupted, of 1kHz. It is in a plastic box size 115mm wide, 145mm high and 50mm deep. Price only £1. Order Ref: 7R1.

The other is **Amplifier Ref. No. 109G.** This is in a case size 80mm wide, 130mm high and 35mm deep. Price £1. Order Ref: 7R2.

HEAVY DUTY POT

Rated at 25W, this is 20 ohm resistance so it could be just right for speed controlling a d.c. motor or device or to control the output of a high current amplifier. Price £1. Order Ref: 1/33L1.

STEPPER MOTOR

Made by Philips as specified for the wind-up torch in the Oct '00 Practical Electronics is still available, price £2. Order Ref: 2P457.

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.

RELAYS

We have thousands of relays of various sorts in stock, so if you need anything special give us a ring. A few new ones that have just arrived are special in that they are plug-in and come complete with a special base which enables you to check voltages of connections of it without having to go underneath. We have 6 different types with varying coil voltages and contact arrangements. All contacts are rated at 10A 250V AC.

Coil Voltage	Contacts	Price	Order Ref:
12V DC	4-pole changeover	£2.00	FR10
24V DC	2-pole changeover	£1.50	FR12
24V DC	4-pole changeover	£2.00	FR13
240V AC	1-pole changeover	£1.50	FR14
240V AC	4-pole changeover	£2.00	FR15

Prices include base

NOT MUCH BIGGER THAN AN OXO CUBE. Another relay just arrived is extra small with a 12V coil and 6A changeover contacts. It is sealed so it can be mounted in any position or on a p.c.b. Price 75p each, 10 for £6 or 100 for £50. Order Ref: FR16.

RECHARGEABLE NICAD BATTERIES. AA size, 25p each, which is a real bargain considering many firms charge as much as £2 each. These are in packs of 10, coupled together with an output lead so are a 12V unit but easily divideable into 2 x 6V or 10 x 1·2V. £2.50 per pack, 10 packs for £25 including carriage. Order Ref: 2.5P34.

SMART HIGH QUALITY ELECTRONIC KITS

CAT.NO.	DESCRIPTION	PRICE £
1005	Touch Switch	2.87
1010	5-input stereo mixer with monitor output	19.31
1016	Loudspeaker protection unit	3.22
1023	Dynamic head preamp	2.50
1024	Microphone preamplifier	2.07
1025	7 watt hi-fi power amplifier	2.53
1026	Running lights	4.60
1027	NiC.cad battery charger	3.91
1030	Light dimmer	2.53
1039	Stereo VU meter	4.60
1042	AF generator 250Hz-16kHz	1.70
1043	Loudness stereo unit	3.22
1047	Sound switch	5.29
1048	Electronic thermostat	3.68
1050	3-input hi-fi stereo preamplifier	12.42
1052	3-input mono mixer	6.21
1054	4-input instrument mixer	2.76
1059	Telephone amplifier	4.60
1062	5V 0·5A stabilised supply for TTL	2.30
1064	12V 0·5A stabilised supply	3.22
1067	Stereo VU meter with leads	9.20
1068	18V 0·5A stabilised power supply	2.53
1071	4-input selector	6.90
1080	Liquid level sensor, rain alarm	2.30
1082	Car voltmeter with l.e.d.s	7.36
1083	Video signal amplifier	2.76
1085	DC converter 12V to 6V or 7.5V or 9V	2.53
1093	Windscreen wiper controller	3.68
1094	Home alarm system	12.42
1098	Digital thermometer with l.c.d. display	11.50
1101	Dollar tester	4.60
1102	Stereo VU meter with 14 l.e.d.s	6.67
1106	Thermometer with l.e.d.s	6.90
1107	Electronics to help win the pools	3.68
1112	Loudspeaker protection with delay	4.60
1115	Courtesy light delay	2.07
1118	Time switch with triac 0-10 mins	4.14
1122	Telephone call relay	3.68
1123	Morse code generator	1.84
1126	Microphone preamplifier	4.60
1127	Microphone tone control	4.60
1128a	Power flasher 12V d.c.	2.53
1133	Stereo sound to light	5.26

TERMS

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

J & N FACTORS
Pilgrim Works (Dept.E.E.)
Stairbridge Lane, Bolney
Sussex RH17 5PA
Telephone: 01444 881965
E-mail: jnfactors@aol.com

World Radio History

MAGENTA ELECTRONICS LTD

EE224 135 Hunter Street, Burton-on-Trent, Staffs. DE14 2ST
Tel 01283 565435 Fax 546932
http://www.magenta2000.co.uk
E-mail: sales@magenta2000.co.uk
All Prices include V.A.T. ADD £3.00 PER ORDER P&P. £6.99 next day

VISA EUROCARD MasterCard SWITCH

MAIL ORDER ONLY • CALLERS BY APPOINTMENT

EPE MICROCONTROLLER P.I. TREASURE HUNTER

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

- High stability drift cancelling
- Easy to build & use
- No ground effect, works in seawater

- Detects gold, silver, ferrous & non-ferrous metals
- Efficient quartz controlled microcontroller pulse generation.
- Full kit with headphones & all hardware

KIT 847 .....£63.95

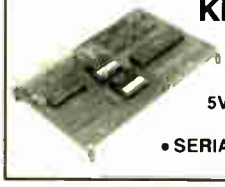
PORTABLE ULTRASONIC PEsT SCARER

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

68000 DEVELOPMENT TRAINING KIT

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



KIT 621 £99.95

- ON BOARD 5V REGULATOR
- PSU £6.99
- SERIAL LEAD £3.99

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
- HIGH POWER OUTPUT
- SWEPT FREQUENCY
- AUDIO & VISUAL MONITORING

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

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

MICRO PEsT SCARER

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

- RANDOM PULSES
- HIGH POWER
- DUAL OPTION

Plug-in power supply £4.99

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

WINDICATOR

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

KIT 856.....£28.00

★ TENS UNIT ★

DUAL OUTPUT TENS UNIT

As featured in March '97 issue.

Set of 4 spare electrodes £6.50

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

KIT 866. . Full kit including four electrodes £32.90

1000V & 500V INSULATION TESTER

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

KIT 848.....£32.95

EPE TEACH-IN 2000

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

***TEACH-IN 2000* -**

KIT 879 £44.95
MULTIMETER £14.45

SPACEWRITER

NOW WITH PIC16C84 EEPROM CHIP & SOFTWARE DISK

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

KIT 849 .....£16.99

12V EPROM ERASER

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

KIT 790 .....£29.90

SUPER BAT DETECTOR

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

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

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

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

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

Kit No. 845 .....£64.95

EPE PROJECT PICS

Programmed PICs for all* EPE Projects
16C84/18F84/16C71
All **£5.90** each
PIC16F877 now in stock
£10 Inc. VAT & postage
(*some projects are copyright)

ULTRASONIC PEsT SCARER

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

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

KIT 812.....£15.00

World Radio History

SIMPLE PIC PROGRAMMER

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

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

Power Supply £3.99

EXTRA CHIPS:
PIC 16F84 £4.84

Based on February '96 EPE. Magenta designed PCB and kit. PCB with 'Reset' switch, Program switch, 5V regulator and test L.E.D.s, and connection points for access to all A and B port pins.

PIC 16C84 DISPLAY DRIVER

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

Kit 860 £19.99

Power Supply £3.99

FULL PROGRAM SOURCE CODE SUPPLIED – DEVELOP YOUR OWN APPLICATION!

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

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

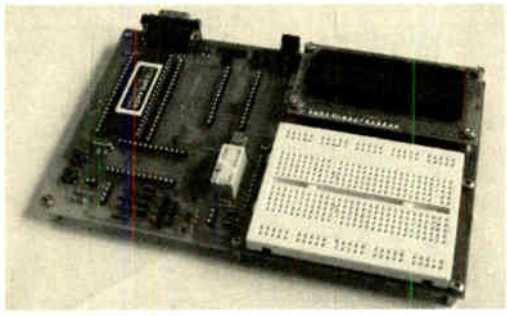
- WITH PROGRAMMED 16F84 AND DISK WITH SOURCE CODE IN MPASM
- ZERO VOLT SWITCHING MULTIPLE CHASE PATTERNS
- OPTO ISOLATED 5 AMP OUTPUTS
- 12 KEYPAD CONTROL
- SPEED/DIMMING POT.
- HARD-FIRED TRIACS

Kit 855 £39.95

Now features full 4-channel chaser software on DISK and pre-programmed PIC16F84 chip. Easily re-programmed for your own applications. Software source code is fully 'commented' so that it can be followed easily

LOTS OF OTHER APPLICATIONS

ICEBREAKER



PIC Real Time In-Circuit Emulator

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

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

KIT 900 . . . £34.99

POWER SUPPLY **£3.99** STEPPING MOTOR **£5.99**

EPE PIC Tutorial

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

- **Learn Programming from scrach using PIC16F84**
- **Start by lighting l.e.d.s and do 30 tutorials to Sound Generation, Data Display, and a Security System.**
- **PIC TUTOR Board with Switches, l.e.d.s, and on board programmer**

PIC TUTOR BOARD KIT

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

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

Optional: **Power Supply – £3.99, ZIF Socket – £9.99**
LCD Display ..... £7.99 LED Display £6.99
Reprints Mar/Apr/May 98 – **£3.00 set 3**

PIC TOOLKIT V2

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

KIT 878 . . . £22.99 with 16F84 . . . £29.99 with 16F877

SUPER PIC PROGRAMMER

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

• SEND FOR DETAILED INFORMATION – A SUPERB PRODUCT AT AN UNBEATABLE LOW PRICE.

Kit 862 £29.99

Power Supply £3.99

DISASSEMBLER SOFTWARE £11.75

PIC STEPPING MOTOR DRIVER

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

Kit 863 £18.99

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

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

8-CHANNEL DATA LOGGER

NEW!

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

KIT 877 £49.95 inc. 8 x 256K EEPROMS

MAGENTA

All prices include VAT. Add **£3.00** p&p. Next day **£6.99**

Tel: 01283 565435 Fax: 01283 546932 E-mail: sales@magenta2000.co.uk

World Radio History

042001

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

All Major Credit cards Accepted

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

See Next / Last Months Ad. for COMPONENT ACCESSORIES

4000 Series

4000B	£0.18
4001B	£0.20
4002B	£0.19
4006B	£0.40
4007UB	£0.18
4008B	£0.23
4009UB	£0.23
4010B	£0.23
4011B	£0.20
4012B	£0.16
4013B	£0.20
4014B	£0.30
4015B	£0.32
4016B	£0.28
4017B	£0.29
4018B	£0.27
4019B	£0.25
4020B	£0.36
4021B	£0.31
4022B	£0.32
4023B	£0.19
4024B	£0.30
4025B	£0.20
4026B	£0.79
4027B	£0.25
4028B	£0.33
4029B	£0.33
4030B	£0.17
4035B	£0.31
4040B	£0.32
4041B	£0.31
4042B	£0.22
4043B	£0.28
4044B	£0.35
4046B	£0.38
4047B	£0.32
4048B	£0.34
4049B	£0.29
4049UB	£0.24
4050B	£0.28
4051B	£0.32
4052B	£0.32
4053B	£0.29
4054B	£0.56
4055B	£0.34
4060B	£0.29
4063B	£0.29
4066B	£0.23
4067B	£2.20
4068B	£0.16
4069UB	£0.19
4070B	£0.21
4071B	£0.26
4072B	£0.18
4073B	£0.17
4075B	£0.17
4076B	£0.30
4077B	£0.28
4078B	£0.20
4081B	£0.20
4082B	£0.21
4085B	£0.28
4086B	£0.33
4093B	£0.22
4094B	£0.29
4095B	£0.56
4097B	£1.20
4098B	£0.48
4099B	£0.39
4502B	£0.32
4503B	£0.40
4508B	£1.40
4510B	£0.45
4511B	£0.39
4512B	£0.32
4514B	£0.77
4515B	£0.99
4516B	£0.44
4518B	£0.38
4520B	£0.34
4521B	£0.62
4526B	£0.40
4527B	£0.40
4528B	£0.40
4529B	£0.44
4532B	£0.32
4536B	£1.00
4538B	£0.37
4541B	£0.33
4543B	£0.47
4555B	£0.32
4556B	£0.40
4566B	£1.96
4584B	£0.27
4585B	£0.47
4724B	£0.94
40106B	£0.24
40109B	£0.58
40174B	£0.46
40175B	£0.41

74 Series

7407	£0.40

SAMEDAY DESPATCH

No Minimum Order Value

74HC Series

74HC00	£0.20
74HC02	£0.18
74HC03	£0.21
74HC04	£0.21
74HC08	£0.25
74HC10	£0.16
74HC11	£0.20
74HC14	£0.22
74HC20	£0.28
74HC27	£0.16
74HC30	£0.22
74HC32	£0.20
74HC42	£0.36
74HC73	£0.40
74HC74	£0.22
74HC75	£0.42
74HC76	£0.20
74HC85	£0.24
74HC86	£0.22
74HC107	£0.40
74HC123	£0.33
74HC125	£0.26
74HC126	£0.46
74HC132	£0.35
74HC133	£0.34
74HC137	£0.30
74HC138	£0.25
74HC139	£0.31
74HC151	£0.33
74HC153	£0.30
74HC154	£0.85
74HC157	£0.40
74HC158	£0.23
74HC160	£0.64
74HC161	£0.28
74HC162	£0.45
74HC163	£0.26
74HC164	£0.35
74HC165	£0.35
74HC173	£0.38
74HC174	£0.27
74HC175	£0.35
74HC192	£0.72
74HC195	£0.32
74HC240	£0.37
74HC241	£0.37
74HC244	£0.42
74HC245	£0.42
74HC251	£0.30
74HC253	£0.25
74HC257	£0.25
74HC259	£0.57
74HC273	£0.32
74HC299	£0.64
74HC365	£0.34
74HC367	£0.25
74HC368	£0.25
74HC373	£0.35
74HC374	£0.40
74HC390	£0.52
74HC393	£0.38
74HC541	£0.35
74HC563	£0.56
74HC564	£0.48
74HC573	£0.39
74HC574	£0.38
74HC595	£0.39
74HC688	£0.64
74HC4002	£0.31
74HC4017	£0.42
74HC4020	£0.36
74HC4040	£0.36
74HC4049	£0.31
74HC4051	£0.40
74HC4052	£0.43
74HC4053	£0.38
74HC4060	£0.44
74HC4075	£0.27
74HC4078	£0.32
74HC4511	£0.64
74HC4514	£0.84
74HC4538	£0.41
74HC4543	£0.90

74LS Series

74LS00	£0.23
74LS01	£0.14
74LS02	£0.26
74LS03	£0.29
74LS04	£0.21
74LS05	£0.14
74LS08	£0.23
74LS09	£0.15
74LS10	£0.14
74LS11	£0.17
74LS12	£0.28
74LS13	£0.29
74LS14	£0.25
74LS15	£0.24
74LS20	£0.25
74LS21	£0.14
74LS26	£0.14
74LS27	£0.25
74LS30	£0.20
74LS32	£0.21
74LS37	£0.14
74LS38	£0.18
74LS40	£0.14
74LS42	£0.42
74LS47	£0.48
74LS51	£0.24
74LS73	£0.40
74LS74	£0.32
74LS75	£0.30
74LS76	£0.40
74LS83	£0.38
74LS85	£0.48
74LS86	£0.25
74LS90	£0.40
74LS92	£0.45
74LS93	£0.42
74LS107	£0.30
74LS109	£0.21
74LS112	£0.24
74LS113	£0.23
74LS114	£0.36
74LS122	£0.31
74LS123	£0.31
74LS125	£0.28
74LS126	£0.25
74LS132	£0.26
74LS133	£0.36
74LS136	£0.23
74LS138	£0.33
74LS139	£0.24
74LS145	£0.56
74LS148	£0.64
74LS151	£0.25
74LS153	£0.38
74LS154	£0.70
74LS156	£0.36
74LS157	£0.22
74LS158	£0.21
74LS160	£0.48
74LS161	£0.32
74LS162	£0.44
74LS163	£0.32
74LS164	£0.24
74LS165	£0.48
74LS173	£0.24
74LS174	£0.24
74LS175	£0.24
74LS190	£0.60
74LS191	£0.24
74LS192	£0.60
74LS193	£0.48
74LS195	£0.24
74LS196	£0.24
74LS221	£0.41
74LS240	£0.32
74LS241	£0.32
74LS243	£0.30
74LS244	£0.32
74LS245	£0.32
74LS247	£0.32
74LS251	£0.24
74LS257	£0.24
74LS258	£0.24
74LS259	£0.45
74LS266	£0.14
74LS273	£0.32
74LS279	£0.24
74LS365	£0.21
74LS367	£0.21
74LS368	£0.21
74LS373	£0.33
74LS374	£0.34
74LS378	£0.62
74LS390	£0.24
74LS393	£0.33
74LS395	£0.26

Linear ICs

AD524AD	£23.04
AD548JN	£2.48
AD590JH	£5.28
AD592AN	£4.48
AD595AQ	£13.92
AD620AN	£9 88
AD625JN	£16.20
AD633JN	£7.54
AD648JN	£2.57
AD654JN	£7.18
AD711JN	£1.46
AD712JN	£2.48
AD736JN	£8.75
AD797AN	£8.69
AD811N	£6.24
AD812AN	£6.32
AD817AN	£3.12
AD820AN	£3.41
AD822AN	£5.20
AD829JN	£6.41
AD830AN	£5.44
AD847JN	£5.95
AD9696KN	£7.73
ADEL2020A	£5.06
ADM222AH	£3.55
ADM232AA	£3.55
ADM485JN	£2.97
ADM690AN	£5.13
ADM691AN	£6.48
ADM695AN	£6.48
ADM699AN	£3.58
CA741CE	£0.24
CA747CE	£0.39
CA3046	£0.42
CA3059	£1.33
CA3080E	£0.60
CA3130E	£0.87
CA3140E	£0.52
CA3189E	£1.26
CA3240E	£1.00
DG211CJ	£1.55
DG411DJ	£2.00
ICL7106CPL	£2.80
ICL7107CPL	£2.00
ICL7109CLP	£8.99
ICL7611DCP	£0.75
ICL7621	£0.96
ICL7660SCP	£0.75
ICL8038	£3.84
ICM7555	£0.38
ICM7556	£0.84
L165	£2.56
L272M	£1.21
L293E	£3.84
L297	£6.72
L298N	£6.67
L6219	£4.48
LF347N	£0.46
LF351N	£0.45
LF353N	£0.40
LF356	£0.84
LM301AN	£0.40
LM308N	£0.58
LM311N8	£0.25
LM318	£1.05
LM319N14	£0.90
LM324	£0.26
LM335Z	£0.93
LM339N	£0.25
LM348N	£0.31
LM358N	£0.23
LM380N	£0.86
LM381N	£2.64
LM386	£0.45
LM392N	£0.79
LM393N	£0.21
LM748CN8	£0.37
LM1881	£3.92
LM2917N8	£3.10
LM3900N	£0.72
LM3914	£2.16
LM3915	£2.10
LM13600	£1.10
LMC660CN	£1.44
LMC6032IN	£1.55
LP311N	£0.74
LP324N	£0.72
LP339N	£0.75
LT1013CN8	£4.64
MAX202CPE	£2.97
MAX208CN	£6.99
MAX220CPE	£5.06
MAX222CPE	£5.06
MAX232CPE	£1.82
MAX483CP	£3.13
MAX485CP	£2.08
MAX631ACP	£4.99
MAX635ACP	£4.99
MAX1232CP	£2.80
MC1458N	£0.27
MC1488	£0.40
MC1489	£0.40
MC3302	£0.56
MC3340P	£1.60
MC4558P	£0.33
MV601DP	£2.97
NE521N	£6.39
NE555N	£0.21
NE556N	£0.29
NE565N	£1.94
NE566N	£0.90
NE567N	£0.39
NE571N	£2.72
NE592	£0.62
NE5532N	£0.48
NE5534N	£0.64
NE5539N	£4.35
OP07CN	£0.90
OP27CN	£2.48
OP77GP	£2.18
OP90GP	£3.11
OP97FP	£2.24
OP113GP	£3.44
OP176GP	£2.09
OP177GP	£1.89
OP200GP	£5.60
OP213FP	£5.20
OP275GP	£2.57
OP282GP	£2.27
OP283GP	£5.20
OP290GP	£5.40
OP297GP	£4.64
OP400GP	£11.81
OP495GP	£8.69
RC4136	£1.00
SG3524N	£0.70
SG3543	£6.88
SSM2017P	£3.12
SSM2141P	£3.63
SSM2142P	£6.16
SSM2143P	£3.78
TBA120S	£0.72
TBA800	£0.75
TBA810S	£0.64
TBA820M	£0.38
TDA1170S	£4.80
TDA2004	£2.88
TDA2030	£1.18
TDA2050V	£2.84
TDA2611A	£1.88
TDA2822A	£0.86
TDA2653A	£2.99
TED3718DP	£5.03
TEA5115	£3.11
TL061CP	£0.37
TL062CP	£0.60
TL064CN	£0.72
TL071CP	£0.38
TL072CN	£0.31
TL074CN	£0.48
TL081	£0.29
TL082CN	£0.35
TL084CN	£0.42
TL494CN	£0.70
TL7705ACP	£0.82
TLC271	£0.63
TLC272	£0.90
TS555CN	£0.34
TMP01FP	£5.60
ULN2003	£0.40
ULN2004A	£0.44
ULN2803	£0.60
ULN2804A	£0.39
XR2206	£3.84

EPROM's

2716	£5.22
2732	£5.51
2764-200	£3.99
27C64-250	£2.88
27128-200	£3.99
27C128-15	£3.02
27256-200	£3.99
27C256-20	£3.68
27C512-150	£2.64
27C1001-15	£3.12
27C2001-15	£4.50
27C4001-120	£5.73

RAM

GM76C88.	£3.60
HM62128.-7	£9.14
HT6116-10	£0.88
U6264ADC7	£1.42
KM62256.-7	£3.20
41256-10	£3.52

A/D Converters Data Acquisition

AD420AN	£25.38
AD557JN	£8.75
AD7528JN	£11.42
AD7545AKN	£14.04
AD7828KN	£20.33
DAC0800	£2.72
ICL7109CPL	£7.75
TLC5491P	£2.75
ZN448E	£7.34

µControllers

AT89C2051	£6.43
12C508A-04P	£0.82
12C509A-04P	£0.85
16C54A04P	£3.07
16C54JW	£12.48
16C56-04P	£2.05
16F84-04P	£3.12
16F84-10P	£5.44

PHONE FOR OTHER DEVICES & QUANTITY DISCOUNTS

Voltage Regulators

7805	£0.31
7806	£0.32
7808	£0.35
7812	£0.29
7815	£0.30
78L05	£0.20
78L06	£0.32
78L08	£0.25
78L12	£0.25
78L15	£0.26
78L24	£0.39
78S05	£0.73
78S12	£0.70
78S15	£0.98
7905	£0.32
7912	£0.29
7915	£0.38
7924	£0.38
79L05	£0.23
79L12	£0.23
79L15	£0.28
79L24	£0.30
ADM666AN	£3.44
L200CV	£1.50
L296	£6.30
L387A	£2.72
LM2940CT5	£0.96
LM317LZ	£0.30
LM317T	£0.43
LM317K	£2.48
LM323K	£2.40
LM334Z	£1.35
LM337T	£0.67
LM338K	£5.52
LM338T	£1.48
LM723	£0.29
LP2950CZ	£2.70
REF01CP	£3.44
REF02CP	£4.66
REF12Z	£1.28
REF195GP	£4.72
REF25Z	£1.24
REF50Z	£1.20
TL431CP	£0.20
ZR423	£0.82
ZN458B	£1.41

Diodes

1N914	£0.06
1N916	£0.05
1N4001	£0.04
1N4002	£0.04
1N4003	£0.04
1N4004	£0.04
1N4005	£0.04
1N4006	£0.04
1N4007	£0.05
1N4148	£0.03
1N4149	£0.07
1N5400	£0.09
1N5401	£0.08
1N5402	£0.08
1N5404	£0.09
1N5406	£0.10
1N5407	£0.10
1N5408	£0.11
6A05	£0.27
6A1	£0.27
6A2	£0.27
6A4	£0.28
6A6	£0.29
6A8	£0.30
6A10	£0.35
BA157	£0.10
BA158	£0.08
BA159	£0.14
BAT41	£0.12
BAT42	£0.10
BAT46	£0.20
BAT49	£0.36
BAT85	£0.12
BAV21	£0.07
BAW62	£0.07
BAX13	£0.05
BAX16	£0.05
BY126	£0.13
BY127	£0.18
BY133	£0.10
OA47	£0.48
OA90	£0.24
OA91	£0.26
OA200	£0.56
OA202	£0.30
UF4001	£0.08
UF4002	£0.09
UF4003	£0.09
UF4004	£0.09
UF4005	£0.10
UF4006	£0.10
UF4007	£0.10
Zeners 2.7 to 33V	£0.06
500mW	£0.06
1.3W	£0.10

Bridge Rectifiers

1.5A 50V	£0.19
1.5A 200V	£0.20
1.5A 400V	£0.22
1.5A 600V	£0.22
1.5A 800V	£0.27
1.5A 1kV	£0.24
3A 200V	£0.36
3A 400V	£0.40
3A 600V	£0.33
6A 200V	£0.70
6A 800V	£0.59
10A 400V	£1.39
25A 200V	£1.54
25A 600V	£1.81

Thyristors

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

Triacs

BT136-500	£0.60
BT136-600	£0.50
BT137-500	£0.65
BT137-600	£0.58
BT139-500	£1.00
BT139-600	£1.20
BTA08-600B	£0.84
BTA08-600bw	£0.89
BTA08-600C	£0.89
BTA08-600sw	£0.99
BTA12-600bw	£1.07
BTA16-600cw	£1.50
BTA16-600B	£1.28
BTA26-600B	£2.78
TIC206D	£0.55
TIC206M	£0.80
TIC226D	£0.76
TIC226M	£1.02
TIC246D	£1.00
TIC246M	£1.00
TIC236D	£1.12
ZO105DA	£0.53

Diac

DB3, 32V	£0.16

Transistors

2N1711	£0.26
2N1893	£0.29
2N2218A	£0.28
2N2219A	£0.24
2N2222A	£0.19
2N2646	£1.06
2N2904A	£0.25
2N2905A	£0.25
2N2907A	£0.19
2N3053	£0.27
2N3054	£0.85
2N3055	£0.62
2N3439	£0.62
2N3440	£0.50
2N3702	£0.09
2N3703	£0.10
2N3704	£0.11
2N3705	£0.08
2N3706	£0.10
2N3771	£1.44
2N3772	£1.51
2N3773	£1.70
2N3819	£0.33
2N3820	£0.66
2N3904	£0.08
2N3905	£0.08
2N3906	£0.08
2N4036	£0.34
2N5245	£0.80
2N5296	£0.57
2N5401	£0.12
2N5551	£0.11
2N6491	£1.58
2SB548	£0.30
AC126	£0.74
AC127	£0.50
AC187	£0.68
AC188	£0.97
ACY17	£3.84
AD149	£1.29
AD161	£0.92
AD162	£0.92
BC107	£0.16
BC107B	£0.14
BC108	£0.14
BC108B	£0.14
BC108C	£0.16
BC109	£0.17
BC109C	£0.17
BC114	£0.19
BC115	£0.41
BC118	£0.41
BC132	£0.36
BC134	£0.36
BC135	£0.36
BC140	£0.25
BC141	£0.27
BC142	£0.34
BC143	£0.38
BC154	£0.36
BC157	£0.12
BC159	£0.17
BC160	£0.28
BC170B	£0.16
BC171B	£0.16
BC172B	£0.13
BC177	£0.23
BC178	£0.18
BC179	£0.18
BC182	£0.10
BC182L	£0.09
BC183L	£0.08
BC184	£0.10
BC184L	£0.10
BC204C	£0.72
BC206B	£0.72
BC208	£0.72
BC209A	£0.72
BC212	£0.08
BC212L	£0.08
BC213B	£0.10
BC213LC	£0.11
BC214	£0.08
BC214L	£0.11
BC225	£0.15
BC237B	£0.09
BC238B	£0.11
BC239C	£0.10
BC250A	£0.15
BC252	£0.13
BC261B	£0.30
BC262B	£0.24
BC267B	£0.30
BC307	£0.10
BC319C	£0.13
BC327	£0.08
BC328	£0.12
BC337	£0.09
BC337-25	£0.10
BC338	£0.12
BC348B	£0.14
BC357	£0.25
BC393	£0.73
BC441	£0.40
BFX84	£0.31
BFX85	£0.32
BFY50	£0.30
BFY51	£0.22
BFY52	£0.28
8S107	£0.21
BS170	£0.20
BU208A	£1.24
BU326A	£1.40
BU500	£1.54
BU508A	£1.30
BU508D	£0.98
BU806	£1.06
BUT11A	£0.57
BUT11AF	£1.14
BUX84	£0.78
IRF530	£0.48
IRF540	£0.82
IRF740	£1.88
MJ2501	£1.60
MJ3001	£1.80
MJ11015	£2.45
MJ11016	£2.56
MJE340	£0.40
MJE350	£0.48
MPSA05	£0.14
MPSA06	£0.11
MPSA13	£0.13
MPSA42	£0.15
TIP29A	£0.32
TIP29C	£0.30
TIP30A	£0.47
TIP30C	£0.37
TIP31A	£0.27
TIP31C	£0.35
TIP32A	£0.26
TIP32C	£0.26
TIP33C	£0.74
TIP41A	£0.32
TIP41C	£0.32
TIP42A	£0.32
TIP42C	£0.43
TIP50	£0.31
TIP110	£0.28
TIP120	£0.28
TIP121	£0.34
TIP122	£0.41
TIP125	£0.33
TIP126	£0.31
TIP127	£0.40
TIP132	£0.68
TIP137	£0.64
TIP141	£0.93
TIP142	£1.10
TIP147	£1.12
TIP2955	£0.67
TIP3055	£0.67
ZTX300	£0.15
ZTX302	£0.17
ZTX450	£0.19
ZTX451	£0.19
ZTX453	£0.26
ZTX500	£0.16
ZTX502	£0.17
ZTX550	£0.22
ZTX551	£0.22
ZTX600	£0.33
ZTX600B	£0.37
ZTX605	£0.36
ZTX651	£0.35
ZTX653	£0.33
ZTX689B	£0.37
ZTX690B	£0.37
ZTX705	£0.39
ZTX750	£0.25
ZTX751	£0.34
ZTX753	£0.36
ZTX789A	£0.41
ZTX790A	£0.41
ZTX851	£0.50
ZTX853	£0.50
ZTX951	£0.54
ZTX1048A	£0.48
ZTX1051A	£0.46
ZTX1053A	£0.48

Electrolytic Radial

µF	16v	25v	40v	63v	100v
0.47	---	---	---	£0.05	---
1.0	---	---	---	£0.05	£0.05
2.2	---	---	---	£0.05	---
4.7	---	---	---	£0.05	£0.06
10	£0.05	£0.05	£0.05	£0.05	£0.09
22	£0.05	£0.05	£0.05	£0.05	£0.11
33	£0.05	---	£0.05	---	---
47	£0.05	£0.05	£0.08	£0.11	£0.19
100	£0.07	£0.08	£0.10	£0.13	£0.26
220	£0.09	£0.09	£0.13	£0.28	---
330	£0.09	---	£0.19	---	---
470	£0.13	£0.17	£0.24	£0.33	---
1000	£0.21	£0.33	£0.34	£0.84	---
2200	£0.32	£0.55	£0.70	---	---
3300	---	£0.94	---	---	---
4700	£0.67	£1.05	---	---	---

Electrolytic Axial

µF	16v	25v	40v	63v	100v	250v	450v
0.47	---	---	---	---	---	---	---
1.0	---	---	---	£0.13	---	---	£0.22
2.2	---	---	---	£0.13	---	---	£0.30
4.7	---	---	---	£0.13	---	---	£0.41
10	£0.12	---	£0.12	£0.13	£0.17	£0.40	£0.67
22	£0.12	£0.13	£0.14	£0.15	£0.21	£0.52	£1.06
33	---	---	---	---	---	---	---
47	£0.13	£0.13	£0.15	£0.19	£0.32	£0.57	---
100	£0.14	£0.16	£0.19	£0.26	£0.44	---	---
220	£0.19	£0.20	£0.25	£0.39	£0.48	---	---
330	---	---	---	---	---	---	---
470	£0.24	£0.28	£0.41	£0.53	---	---	---
1000	£0.33	£0.43	£0.59	£1.08	---	---	---
2200	£0.53	£0.69	£1.18	£1.55	---	---	---
3300	---	---	---	---	---	---	---
4700	£0.86	£1.11	---	---	---	---	---

Resistors - Please State Value Required per 100 of one value only

⅛W Carbon Film 5%	E12 Series	10Ω-1M0	£0.02 Each, £0.80 per 100
¼W Carbon Film 5%	E12 Series	1Ω-10M	£0.02 Each, £0.60 per 100
¼W Metal Film 1%	E24 Series	10Ω-1M	£0.04 Each, £1.72 per 100
½W Carbon Film 5%	E12 Series	1Ω-10M	£0.02 Each, £0.95 per 100
2.5W Wirewound 5%	E12 Series	0Ω1-220Ω	£0.23 Each

1W, 2W & 5W also in stock - selected values only, contact sales dept. for details.

Preset Resistors - Please State Value Required

Enclosed, 10mm Square Horz / Vert.	100Ω - 1M0 0.15W	£0.15 Each
Skeleton, 10mm Dia. Horizontal.	100Ω - 1M0 0.1W	£0.11 Each
Sub-min, 6mm Dia, Horizontal	E3 200Ω-1M0 0.1W	£0.13 Each
Multiturn, 10mm Square, Top Adjust.	E3 100Ω-1M0 0.5W	£0.89 Each
Multiturn, 19mm Long, End Adjust.	E3 50Ω-1M0 0.5W	£0.60 Each

Potentiometers - Please State Value Required

Single Gang ¼" Shaft, 25mm Dia.	470Ω-2M2 Linear	£0.56 Each
Single Gang ¼" Shaft, 25mm Dia. 4k7,10k,47k,100k,1M,2M2 Log		£0.56 Each
Dual Gang ¼" Shaft, 20mm Dia.	1k0-2M2 Linear	£1.54 Each
Dual Gang ¼" Shaft, 20mm Dia.	10k-1M0 Logarithmic	£1.54 Each
Switched ¼" Shaft, 20mm Dia.	1k0-2M2 Linear	£1.92 Each
Switched ¼" Shaft, 20mm Dia.	4k7-2M2 Logarithmic	£1.92 Each
PCB Mount, Splined Shaft, 16mm Dia.	470Ω-1M0 Linear	£0.48 Each
PCB Mount, Splined Shaft, 16mm Dia.	470Ω,4k7,100k,1M0 Log	£0.48 Each
Dual PCB, Splined Shaft, 16mm Dia.	10k,50k100k,500k Lin	£0.84 Each
Dual PCB, Splined Shaft, 16mm Dia.	10k,50k,100k,500k Lag	£0.84 Each

Teach-in 2000 & EPE Projects

Hardware & Tools Pack	**Normal £42.34**	Pack Price £33.87
Components Pack (1)	**Normal £21.03**	Pack Price £16.82
Components Pack (2)	**Normal £15.72**	Pack Price £12.58

Full details on our *Web site*

Tel: 0191 2514363 Fax: 0191 2522296 Email: sales@esr.co.uk http: //www.esr.co.uk

World Radio History

EVERYDAY PRACTICAL ELECTRONICS
INCORPORATING ELECTRONICS TODAY INTERNATIONAL
THE No.1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

VOL. 30 No. 4 APRIL 2001

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

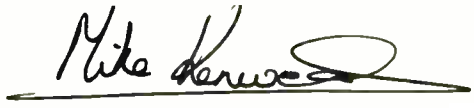
SUPPRESSION

It's not often that we carry an interesting story in *EPE* rather than a technical feature, project or review, but this month our *The End To All Disease?* supplement is just that. It's quite a departure for us, but when you read it you will realise why we feel it is important to publish the full story, rather than simply skim the surface and give an experimental circuit.

The level of interest in this material, following our brief announcement last month, has been amazing and once you are aware of the story some research on the web will throw up many sites with information. We hope that by giving exposure to the original work of Rife it will encourage a more open-minded approach by those in the medical profession and thus further research and development of this important area.

In some parts of the world TENS machines are still regarded as a form of "quackery", whilst in the UK they have been used in the National Health Service and by private individuals for a few years. At one time, these units were quite expensive and only available from specialist suppliers, we hope that we helped to change that by publishing various designs in *EPE* for easy-to-build, inexpensive TENS units (the last one was the *Simple Dual-Output TENS Unit* by Andy Flind in the March '97 issue). Now, of course, you can buy TENS machines on any UK high street without spending a small fortune and the fact that they work well for virtually all users is accepted throughout the medical profession.

Let us hope that the work of Rife will be resurrected and that substantial investment will be made in progressing this important area of medical research to the benefit of everyone. Unfortunately, for too long powerful organisations with vested interests have suppressed development and research in this area. It appears that with the availability of information via the web that is no longer so easy.



AVAILABILITY
Copies of *EPE* are available on subscription anywhere in the world (see below), from all UK newsagents (distributed by COMAG) and from the following electronic component retailers: Omni Electronics and Yebo Electronics (S. Africa). *EPE* can also be purchased from retail magazine outlets around the world. An Internet on-line version can be purchased for just $9.99(US) per year available from **www.epemag.com**

SUBSCRIPTIONS
Subscriptions for delivery direct to any address in the UK: 6 months £14.50, 12 months £27.50, two years £50; Overseas: 6 months £17.50 standard air service or £27 express airmail, 12 months £33.50 standard air service or £51 express airmail, 24 months £62 standard air service or £97 express airmail.
Online subscriptions, for downloading the magazine via the Internet, $9.99(US) for one year available from **www.epemag.com**.
Cheques or bank drafts (in **£ sterling only**) payable to *Everyday Practical Electronics* and sent to EPE Sub. Dept., Allen House, East Borough, Wimborne, Dorset BH21 1PF. Tel: 01202 881749. Fax: 01202 841692. **E-mail:** subs@epemag.wimborne.co.uk. Also via the **Web** at: **http://www.epemag.wimborne.co.uk**. Subscriptions start with the next available issue. We accept MasterCard, Switch or Visa. (For past issues see the *Back Issues* page.)

BINDERS
Binders to hold one volume (12 issues) are available from the above address. These are finished in blue p.v.c., printed with the magazine logo in gold on the spine. Price £5.95 plus £3.50 p&p (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.*

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

Editor: MIKE KENWARD
Deputy Editor: DAVID BARRINGTON
Technical Editor: JOHN BECKER
Business Manager: DAVID J. LEAVER
Subscriptions: MARILYN GOLDBERG
Administration: FAY KENWARD
Editorial/Admin: Wimborne (01202) 881749
Advertisement Manager:
PETER J. MEW, Frinton (01255) 861161
Advertisement Copy Controller:
PETER SHERIDAN, Wimborne (01202) 882299
On-Line Editor: ALAN WINSTANLEY
EPE Online **(Internet version) Editors:**
CLIVE (MAX) MAXFIELD and ALVIN BROWN

READERS' ENQUIRIES
E-mail: techdept@epemag.wimborne.co.uk
We are unable to offer any advice on the use, purchase, repair or modification of commercial equipment or the incorporation or modification of designs published in the magazine. We regret that we cannot provide data or answer queries on articles or projects that are more than five years old. Letters requiring a personal reply *must* be accompanied by a **stamped self-addressed envelope or a self-addressed envelope and international reply coupons.** All reasonable precautions are taken to ensure that the advice and data given to readers is reliable. We cannot, however, guarantee it and we cannot accept legal responsibility for it.

COMPONENT SUPPLIES
We do not supply electronic components or kits for building the projects featured, these can be supplied by advertisers (see *Shoptalk*). We advise readers to check that all parts are still available before commencing any project in a back-dated issue.

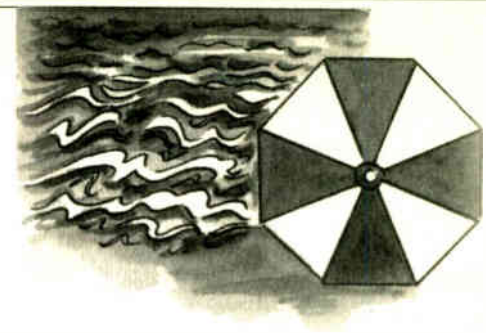
ADVERTISEMENTS
E-mail: adverts@epemag.wimborne.co.uk
Although the proprietors and staff of EVERYDAY PRACTICAL ELECTRONICS take reasonable precautions to protect the interests of readers by ensuring as far as practicable that advertisements are *bona fide*, the magazine and its Publishers cannot give any undertakings in respect of statements or claims made by advertisers, whether these advertisements are printed as part of the magazine, or in inserts.
The Publishers regret that under no circumstances will the magazine accept liability for non-receipt of goods ordered, or for late delivery, or for faults in manufacture.

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

World Radio History

Starter Project

WAVE SOUND EFFECT



ROBERT PENFOLD

Bring the relaxing sounds of the sea into your living room.

IN a world that seems to be ever noisier, using more noise to improve matters might seem like a strategy that is doomed to failure. However, it is a characteristic of human hearing that one sound tends to mask other sounds, and this can be used to good effect in counteracting otherwise obtrusive sounds.

How well or otherwise this masking works depends on a number of factors. If the sounds that you wish to shield yourself from are relatively quiet and some distance away, it is easy to mask them with sounds that are louder and closer.

Many of the annoying sounds we encounter at home originate outside the house and are some distance away. Although their irritation factor is often quite high and they are plainly audible, the actual sound level is often quite low. The masking technique can then be very effective.

COVER UP

Another factor governing how well or otherwise a sound is masked is the relative frequency contents. Masking works best if the sound used to counteract the unwanted noise is a good match for the noise itself.

The obvious problem with the matching approach is that the masking sound could be more irksome than the sound it masks! Another problem is that the annoyance will often be caused by a variety of sounds covering a wide frequency range.

The way around these problems is to use a blanket approach in the masking sound, by using a signal that covers a wide range of frequencies. This usually means a "hissing" noise signal such as pink or white noise.

A steady noise signal is very effective at masking sounds, but after a while this can itself become slightly irritating. The more refined method is to doctor the noise to give a simple sound effect, and waves sweeping onto a beach are the usual choice.

Most people find this sound very relaxing, which is clearly an advantage when trying to counteract irritating sounds. In fact many people simply use a wave effects unit primarily as an aid to relaxation rather than as a means of cutting themselves off from the outside world.

The wave effects unit described here is a simple battery powered device that can be used with headphones or used to feed a spare input of a hi-fi system. It does not provide results that are as convincing as units utilising digital recording techniques or sophisticated synthesiser circuits, but it is quite good for a device that uses just a handful of inexpensive components. It is simple to build and is well suited to beginners.

IN CONTROL

In order to get a wave type sound the noise must be processed to vary its volume in an appropriate manner. Ideally, variable filtering should be applied at the same time.

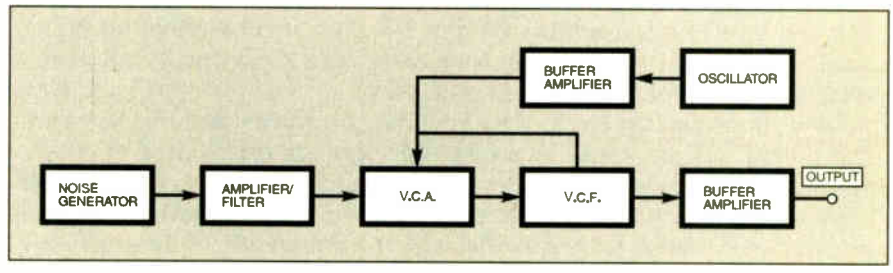


Fig.1. Block diagram for the Wave Sound Effect unit.

SYSTEM OPERATION

The block diagram of Fig.1 shows the general scheme of things used in the Wave Sound Effect unit. Wave sounds consist of noise rather than tones, and the raw signal is therefore produced by a noise generator and not by oscillators. The signal from the noise generator is (more or less) "white" noise, which is sound that has equal power at all frequencies.

Although one might expect this to sound "uncoloured", as suggested by its name, it is perceived by human listeners as having a very strong high frequency bias. The audio range extends from about 20 hertz to about 20 kilohertz, and the high frequency range is from about 2 kilohertz upwards. There are many more frequencies in this range than in the low and middle range combined, giving "white" noise its ferocious high pitched sound.

IN THE PINK

The next stage of the unit amplifies the output of the noise generator to give a more useful signal level, and it also provides some lowpass filtering. This reduces the high frequency content of the signal to give a more gentle "hissing" sound that is more suitable for wave synthesis. This gives something closer to "pink" noise, which is often likened to the sound of gentle rainfall.

Pink noise has equal power in each octave band (e.g. the same amplitude from 100Hz to 200Hz as from 100kHz to 200kHz). The simple filter used here does not give a true "pink" noise signal, but it is near enough for the present application.

The amplitude of the sound increases as the wave approaches, reaching a crescendo as the wave breaks onto the shore. Then the sound diminishes relatively quickly, as the water drains back into the sea. The pitch of the noise decreases as the wave approaches and crashes onto the shore, and increases again as the water flows back into the sea.

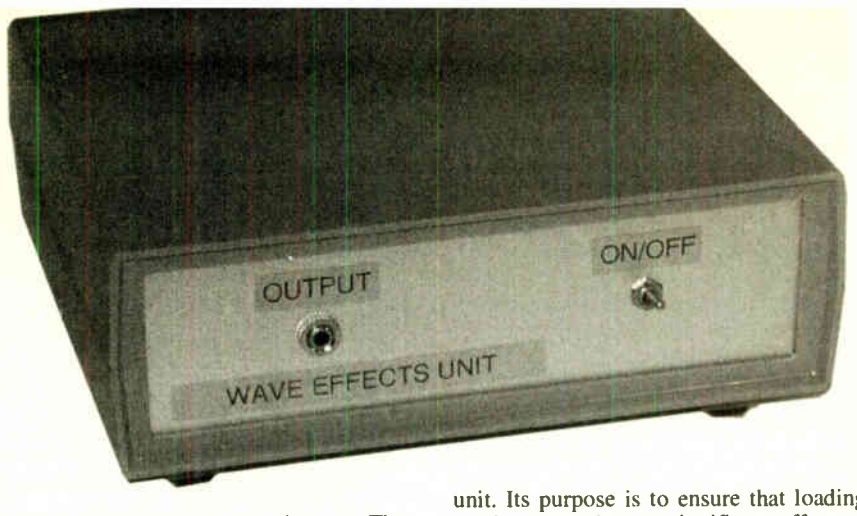
These changes in volume are provided by a voltage controlled attenuator (v.c.a.) that is controlled by a low frequency oscillator via a buffer amplifier. As the output voltage from the oscillator *falls*, the attenuation through the v.c.a. decreases, giving a rising output level. As the output voltage from the oscillator *rises*, the losses through the v.c.a. increase again, reducing the amplitude of the output signal. The output waveform from the oscillator is such that the volume rises slowly and decays much more quickly.

The voltage controlled filter (v.c.f.) provides highpass filtering, but its effect is minimal when the v.c.a. provides high volume levels. As the output level reduces, the highpass filtering gives less and less low and middle frequency content on the output signal. This produces the required drop in pitch as each "wave" crashes onto the

World Radio History

shore, and rising pitch as the water flows back into the sea.

The v.c.a. and v.c.f. are shown as separate stages in Fig.1, but they share a common control element. A buffer stage at the output of the unit provides sufficient output to drive medium impedance headphones, a crystal earphone, or virtually any power amplifier.



CIRCUIT OPERATION

The full circuit diagram for the Wave Sound Effect unit appears in Fig.2. The noise source is based on TR1, which is a silicon *npn* transistor having its base-emitter (b/e) junction reverse biased by resistor R1. There is no connection to the collector (c) terminal.

The base-emitter junction acts rather like a Zener diode having an operating voltage of about 7V or so. Like a Zener diode, transistor TR1 produces a stabilised output voltage that contains a substantial amount of noise.

Using a transistor rather than a Zener diode gives noise over a narrower frequency range, but much greater noise output over the audio range. This is ideal for the present application where high frequencies are of no interest.

Capacitor C2 couples the output signal from TR1 to the input of a high-gain common emitter amplifier based on transistor TR2. Capacitor C3 provides the lowpass filtering, and gives a 6dB per octave attenuation rate.

To produce true "pink" noise an attenuation rate of 3dB per octave over the entire audio range is required, but this characteristic is difficult to achieve. The simple filtering used here avoids the excessive high frequency content of the "white" noise source and gives good results.

ACTIVE RESISTANCE

Transistor TR3 is used as the active element in the combined v.c.a. and v.c.f. Altering the current flowing into its base (b) terminal can vary its collector to emitter resistance. With no current flow an extremely high resistance is produced, but a large input current produces a resistance of a few hundred ohms or less.

An ordinary bipolar transistor is far from ideal for an application of this type because it does not produce pure resistance. The effective resistance varies considerably with changes in the signal voltage. In the present context this is of little consequence because the input signal is noise, and any distortion generated will just be more noise.

The variable highpass filtering is provided by capacitor C4 in conjunction with the resistance provided by transistor TR3. As this resistance decreases, the cut-off frequency of the filter is moved upwards. This increases the pitch of the sound, and in severely attenuating the lower and middle frequencies it also reduces the output level.

The increased loading on the output of TR2 also helps to give a reduction in the output level, and TR3 effectively forms the v.c.a. in conjunction with resistor R3. Transistor TR4 is used in a simple emitter follower buffer stage at the output of the unit. Its purpose is to ensure that loading on the output has no significant effect on the operation of the v.c.a. and v.c.f.

RELAXED OSCILLATOR

The oscillator is a form of relaxation oscillator that uses IC1 in what is almost a standard configuration. IC1 operates as a Schmitt trigger, and the oscillator operates by repeatedly charging and discharging timing capacitor C7.

Normally this type of circuit produces an output waveform of the type shown in Fig.3a. The charge and discharge rates are initially quite high, but gradually reduce as the voltage on timing resistor R12 reduces.

The rising edge of this waveform gives the desired effect, but the falling edge needs to be comparatively short. This is achieved by including steering diode D1 and an additional timing resistor (R13). Diode D1 shunts R13 across R12 when C7

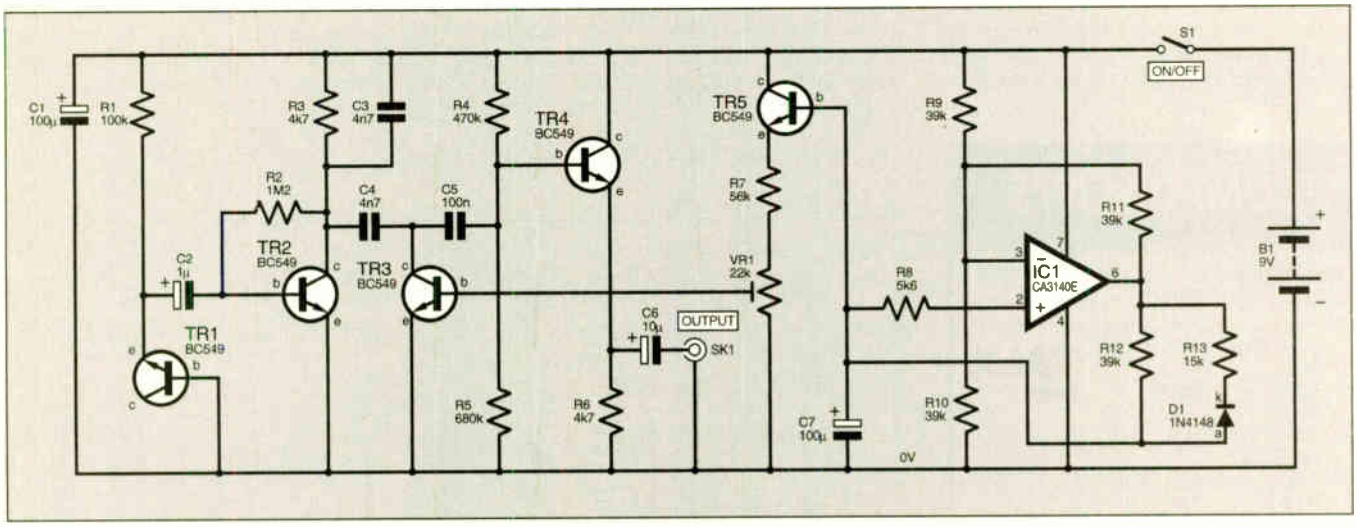


Fig.2. Complete circuit diagram for the Wave Sound Effect unit.

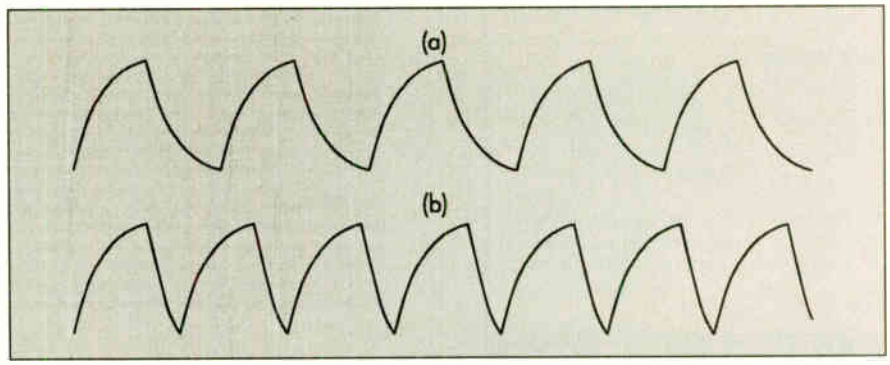


Fig.3. The normal waveform from the oscillator (a), and the waveform produced with steering diode D1 and resistor R13 included (b).

World Radio History

is discharging, but D1 prevents any current flow through R13 when C7 is charging. The rising edge of the waveform is left intact, but the falling edge is shortened, as in Fig.3b.

Transistor TR5 operates as an emitter follower buffer stage at the output of the oscillator. Preset potentiometer VR1 attenuates the output of the oscillator and brings it into a suitable voltage range to control transistor TR3. In practice preset VR1 is adjusted to obtain the most convincing wave effect.

The current consumption of the circuit is around 4mA to 5mA, and a PP3 size battery is therefore adequate as the power source.

CONSTRUCTION

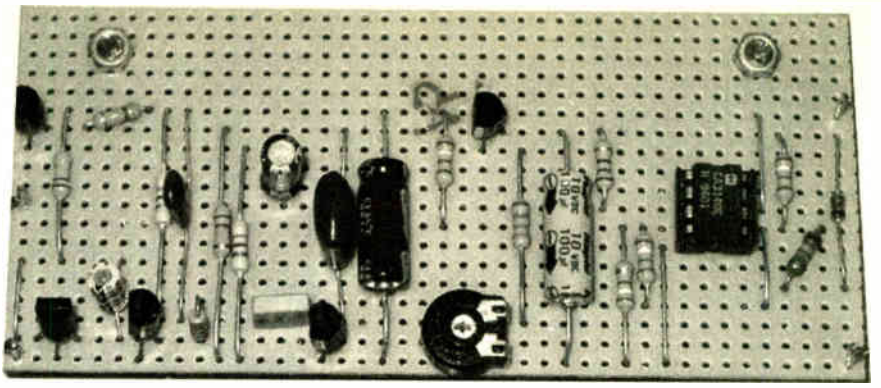
The Wave Sound Effect stripboard component layout is shown in Fig.4, which also shows the small amount of hard wiring and details of breaks required in the copper strips on the underside of the board. The board measures 42 holes by 19 strips and, as this is not one of the standard sizes in which stripboard is sold, it must, therefore, be cut from a larger piece using a hacksaw or a junior hacksaw. Cut along rows of holes and then file any rough edges to a neat finish.

The breaks in the copper strips can be made using the special tool, alternatively a handheld twist drill bit of about 5mm to 5·5mm in diameter does the job quite well. Either way, make sure that the strips are cut across their full width and that no hairline tracks of copper are left. The two mounting holes are three millimetres in diameter and will take either 6BA or metric M2·5 bolts.

Next, the components and link-wires should be added. The CA3140E specified for IC1 is a PMOS device, which is therefore vulnerable to damage from static charges. The normal handling precautions should be observed when dealing with this component, and the most important of these is to fit it onto the board via an i.c. holder.

Do not fit IC1 into its holder until the circuit board has been completed and double-checked for any errors. Try to touch the pins as little as possible, and keep the device away from any obvious sources of static electricity.

In all other respects construction of the board is perfectly straightforward. The



General layout of components on the completed circuit board.

COMPONENTS

See SHOP TALK page

Resistors

R1	100k
R2	1M2
R3, R6	4k7 (2 off)
R4	470k
R5	680k
R7	56k
R8	5k6
R9, R10, R11, R12	39k (4 off)
R13	15k

All 0·25W 5% carbon film

Potentiometer

VR1	22k min. enclosed carbon preset, horizontal

Capacitors

C1, C7	100μ axial elect. 10V (2 off)
C2	1μ radial elect. 50V
C3, C4	4n7 mylar (2 off)
C5	100n mylar
C6	10μ 25V or 100μ 10V radial elect. (see text)

Semiconductors

D1	1N4148 signal diode
TR1 to TR5	BC549 *npn* transistor (5 off)
IC1	CA3140E PMOS op.amp

Miscellaneous

S1	s.p.s.t. min toggle switch
B1	9V battery (PP3 size), with connector clip
SK1	3·5mm stereo jack socket (see text)

Stripboard 0·1-inch matrix, size 42 holes by 19 strips; small or medium size metal or plastic case; 8-pin d.i.l. holder; multi-strand connecting wire; solder pins (4 off); solder; fixings, etc.

Approx. Cost Guidance Only **£8.50** *excluding batt. & case*

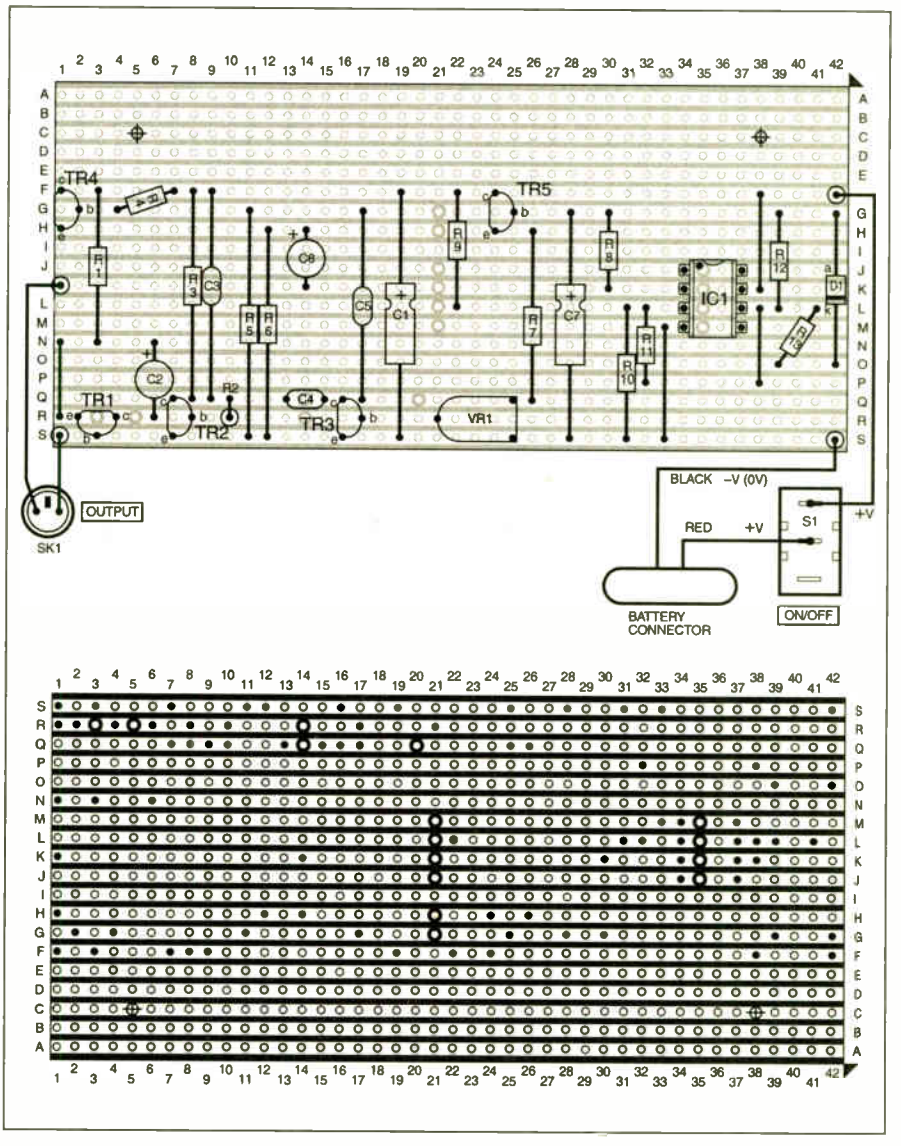


Fig.4. Wave Sound Effect stripboard component layout, wiring and details of breaks required in the underside copper tracks.

World Radio History

link-wires can be made from 24 s.w.g. tinned copper wire or the trimmings from the leads of the resistors. Fit single-sided solder pins to the board at the positions where connections will be made to output socket SK1, switch S1, and the battery connector.

Apart from C4, the non-electrolytic capacitors must have proper leads rather than pins, and Mylar capacitors are the best choice. The board was designed for use with axial lead electrolytic capacitors in the C1 and C7 positions, but radial lead components should fit quite well into the layout. A value of 10µF is suitable for C6 if the unit is to be used with an amplifier or a crystal earphone, but a value of 100µF is better if the output will be used to drive headphones.

CASING UP

Most small and medium size cases are suitable for this project. A small instrument case is used for the prototype, but a simple plastic or metal box is perfectly adequate.

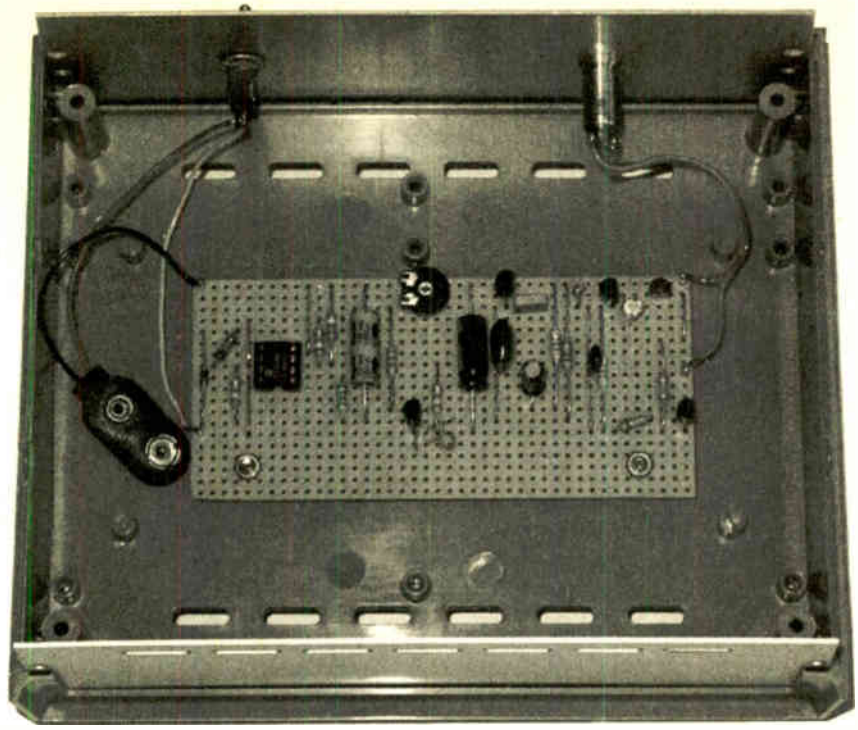
The circuit board is mounted inside the case using 6BA or metric M2·5 bolts, including short spacers or some extra nuts between the case and the board. It is probably best not to use plastic stand-offs, since most types do not work well with stripboard. On/off switch S1 and output socket SK1 are mounted on the front panel.

The best type of socket to use for SK1 depends on the way the unit will be used. For use with the "Aux" input of a hi-fi system a phono socket is the most appropriate. In fact, the easiest way of handling things is to connect the output of the board to two phono sockets. The output of the unit can then be coupled to both stereo channels of the hi-fi system using a standard twin phono lead.

A 3·5mm mono jack socket is needed for a crystal earphone, and a stereo type is required for use with medium impedance headphones, which are the type sold as replacements for personal stereo systems. The wiring shown in Fig.4 is correct for a popular form of 3·5mm stereo jack socket. As the two phones are wired in series the common earth tag is left unused, and the output of the unit is wired to the other two tags.

ADJUSTMENT AND USE

With the unit set up for use and preset VR1 set fully counter-clockwise, there should be a continuous noise sound at a fairly low pitch from the headphones or loudspeakers. If VR1 is tried at various settings in a clockwise direction some sweeping of the pitch and amplitude of the noise should be produced. You need to be patient here, because the sweep rate is quite low and it takes a while for each cycle to be completed.



These is plenty of room inside this small instrument case for the battery.

Adjusting VR1 is really just a matter of using trial and error to obtain the best effect. This means finding a setting that provides the full sweep range without the sound holding for too long at either end of its range, but particularly at the low pitch end.

There is plenty of scope for experimenting with circuit values in an attempt to optimise the effect. Here are a few suggestions:

C3 – A higher value gives an overall reduction in the pitch of the sound, and a lower value has the opposite effect.

C4 – Use a lower value to give a higher maximum pitch, or a higher value for a lower maximum pitch.

C7 – A higher value reduces the frequency of waves, and a lower one gives an increased wave rate.

R11 – A lower value gives a wider sweep range, and a higher value produces a more restricted sweep range.

R13 – A lower value reduces the time taken for waves to recede, and a higher value has the opposite effect. Changing the value of this resistor will also produce some change in the wave rate.

If the signal tends to cut off when the battery voltage falls slightly due to ageing, it is probably worth replacing transistor TR1. Some BC549s have lower breakdown voltages than others, and one having a low breakdown potential gives better battery life.

Incidentally, virtually any small silicon *npn* transistor should work in the TR1 position of this circuit. The other transistors can be any high gain silicon *npn* devices such as a 2N3704, but note that alternative devices will mostly have different encapsulations or leadout configurations. □

EPE BINDERS

KEEP YOUR MAGAZINES SAFE – RING US NOW!

This ring binder uses a special system to allow the issues to be easily removed and re-inserted without any damage. A nylon strip slips over each issue and this passes over the four rings in the binder, thus holding the magazine in place.

The binders are finished in hard-wearing royal blue p.v.c. with the magazine logo in gold on the spine. They will keep your issues neat and tidy but allow you to remove them for use easily.

The price is £5.95 plus £3.50 post and packing. If you order more than one binder add £1 postage for each binder after the *initial* £3.50 postage charge (overseas readers the postage is £6.00 each to everywhere except Australia and Papua New Guinea which costs £10.50 each).

Send your payment in £'s sterling cheque or PO (Overseas readers send £ sterling bank draft, or cheque drawn on a UK bank or pay by card), to **Everyday Practical Electronics, Allen House, East Borough, Wimborne, Dorset BH21 1PF. Tel: 01202 881749. Fax: 01202 841692.**

E-mail: editorial@epemag.wimborne.co.uk.

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

We also accept card payments. Mastercard, Visa or Switch (minimum card order £5). Send your card number and card expiry date plus Switch Issue No. with your order.

World Radio History

New Technology Update

An innovative approach to using liquid crystal display technology has made it possible to create 3-D images, reports Ian Poole.

Lateral Thinking

NOWADAYS, it is likely that there are many dormant ideas waiting for a suitable application. There are possibly many other ideas that already have one area in which they are used, and by using some lateral thinking they could be used in another.

One example of this is liquid crystal technology. Currently l.c.d.s are widely used as displays, but CRL Opto based in Hayes UK, a leading supplier of custom shutters and specialist coatings, has devised a way of using fast switching ferro-electric liquid crystal devices to capture a 3-D image in combination with a *single* lens camera. Normally two cameras, or at least two lenses are required to capture the two images that are required for a 3-D image. This new technology, it is claimed, can be incorporated easily into a variety of applications where a 3-D image is required including ordinary camcorders, more sophisticated television cameras or endoscopes.

L.C.D. Operation

Unlike many other types of display a liquid crystal display (l.c.d.) operates by allowing or blocking the light passing through it. The principle of operation is based around the polarisation of the light.

The most common type of l.c.d. is known as the "twisted nematic" display. Light entering the display first passes through a polarising filter to ensure that all the light is of a given polarisation. A second polarising filter is placed at the back of the display, with a polarisation at 90 degrees to the first one. Under these circumstances no light will pass through the display because the two polarising filters have different polarisations, and the display will appear dark.

The two polarising filters are held a small distance apart, typically only 10 micrometers. This space is filled with a substance known as a liquid crystal. A transparent conducting element is placed on the inside of each of the filters to give the required display patterns.

The liquid crystal has the property that it rotates the polarisation of the light passing through it. About 40 micrometers is sufficient to give a full 360 degree rotation – 10 micrometers gives 90 degrees. With the liquid crystal in place the light passes through the first polarising filter, is rotated through 90 degrees by the liquid crystal and is then able to pass through the second filter which has its line of polarisation at 90 degrees to the first.

However, when a potential is applied across the liquid crystal it looses its ability to rotate the polarisation of the light. Accordingly, when the light reaches the second filter its polarisation is 90 degrees out of line with the second filter and cannot pass through. A dark area is seen. The area that is affected is dependent upon the area across which the potential is applied. Therefore by varying the patterns of the conductors on the inside of the filters and which ones have potentials applied across them, different areas can be made to be light and dark.

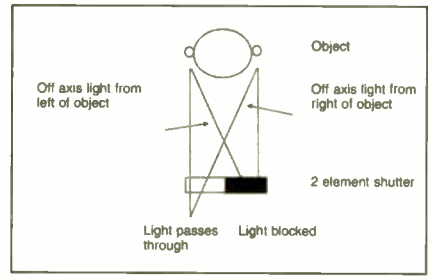


Fig.1. How a two element shutter in the iris plane selects right and left views of the same object through a single lens.

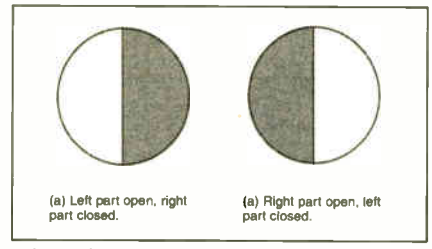


Fig.2. Simple 2-element stereo shutter. The shaded area indicates the non-transmitting region, and the open area indicates where the shutter is open.

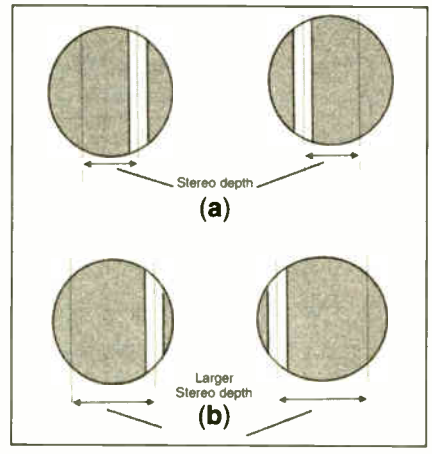


Fig.3. Using multiple vertical strips in the shutter enables the amount of stereo depth to be altered to the application in hand: (b) shows a greater stereo depth than (a).

Operation

The CRL system operates by having a two element shutter placed in the iris plane of the optics so that either a left or right hand view of an object can be seen. By blanking off half the liquid crystal screen or shutter, a left or right hand view of the image is obtained,see Fig.1.

The shutter can switch from one image to the other in less than 100 microseconds enabling switching rates greater than 25Hz to be achieved making it ideal for many camera scanning formats. When employed with an interlaced camera scanning system, the shutter has one half open for the even lines of the frame, and the other half open for the odd lines. This creates a simple basic 2-element "stereo" shutter, see Fig.2. The stored composite signal can then be replayed on a conventional system and viewed using a similar liquid crystal shutter system, or through a more conventional system using red/green glasses.

It is possible to alter the stereo separation (i.e. the stereo depth). This can be achieved by altering the separation between the two images. The shutter can employ strips as shown in Fig.3. By changing the separation between the two strips, the separation and hence the stereo depth can be altered. This is particularly useful when using a zoom lens to ensure that a realistic stereo depth is maintained during a zoom operation.

The problem with using small strips in the shutter is that the amount of light entering the camera is reduced. In cases where light is a problem it is possible for less than half the shutter to be blanked off.

This does reduce the amount of light but it gives a greater degree of flexibility to trade off stereo depth against the amount of light received. This is very analogous to the trade-off between aperture and depth of focus in more traditional cameras.

Summary

This new development shows a particularly innovative approach to using liquid crystal displays. CRL has taken a well-known piece of technology and used it in a totally new way, thereby extending its application. In doing this it provides a new method of producing stereo images using existing equipment technology, but with the addition of the new shutter, and possibly a small amount of additional electronics to synchronise the shutter.

As costs are relatively low it could be a particularly attractive proposition for anyone wanting to produce stereo images. Further information can be found at: **www.crlopto.com**.

World Radio History

from £60 (inc)
Shareware Version
Download & Order Online!

PROTEUS VSM

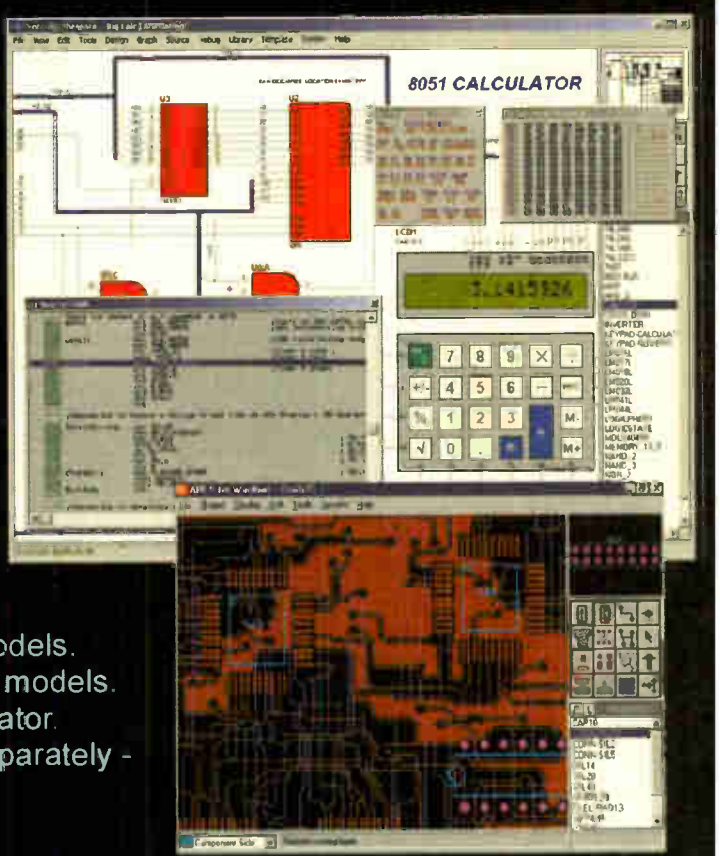
Virtual System Modelling

Build It In Cyberspace

www.labcenter.co.uk

Develop and test complete micro-controller designs without building a physical prototype. PROTEUS VSM simulates the CPU and any additional electronics used in your designs. And it does so in real time. *

- CPU models for PIC and 8051 and series micro-controllers available now. 68HC11 comming soon. More CPU models under development. See website for latest info.
- Interactive device models include LCD displays, RS232 terminal, universal keypad plus a range of switches, buttons, pots, LEDs, 7 segment displays and much more.
- Extensive debugging facilities including register and memory contents, breakpoints and single step modes.
- Source level debugging supported for selected development tools.
- Integrated 'make' utility - compile and simulate with one keystroke.
- Over 4000 standard SPICE models included. Fully compatible with manufacturers' SPICE models.
- DLL interfaces provided for application specific models.
- Based on SPICE3F5 mixed mode circuit simulator.
- CPU and interactive device models are sold separately - build up your VSM system in affordable stages.
- ARES Lite PCB Layout also available.



Labcenter Electronics

*E.g. PROTEUS VSM can simulate an 8051 clocked at 12MHz on a 300MHz Pentium II.

Write, phone or fax for your free demo CD - or email info@labcenter.co.uk.
Tel: 01756 753440. Fax: 01756 752857. 53-55 Main St, Grassington. BD23 5AA.

World Radio History

Prices fully inclusive

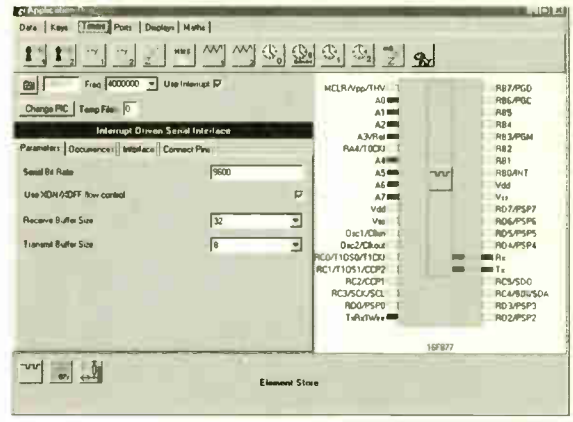
http://www.fored.co.uk

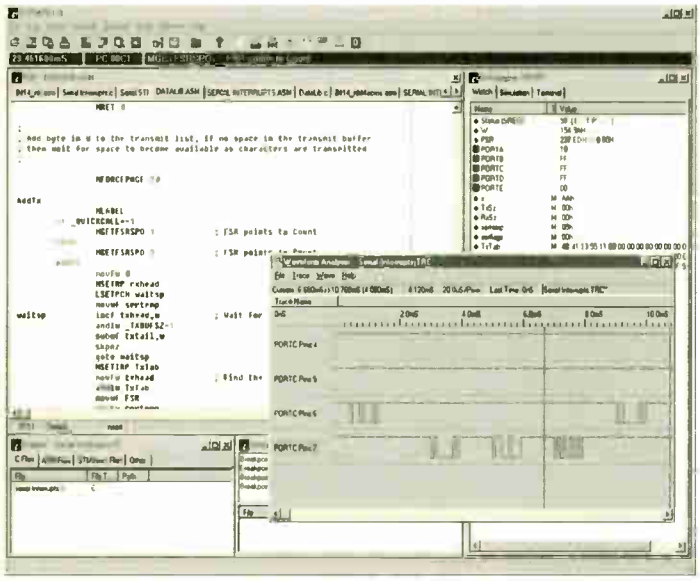
NEW From FED - PIXIE - Visual PIC C Development

Fully featured C Compiler with drag 'n drop components

PIXIE

- An application designer for the FED PIC C Compiler FULLY including the PIC C Compiler
- Drag a software component on to your design
- Set up the parameters using check boxes, drop down boxes and edit boxes (see shot right).
- Connect the component to the PIC pins using the mouse
- Select your own C functions to be triggered when events occur (e.g. Byte received, timer overflow etc.)
- Generate the base application automatically and then add your own functional code
- Supports all 14 bit core PICS, 16F87x, 16C55x, 16C6x, 16F8x, 16C7xx etc.
- Complete development environment includes editor, compiler, assembler, simulator, waveform analyser, and terminal emulator. (Screen below)





- Components include -
  - Software driven serial interfaces
  - Fully buffered hardware driven serial port with XON/XOFF signalling
  - Display drivers - LCD, 7 Segment
  - Switches and keypads with debounce/repeat
  - Timers and clocks
  - I^2C, Clocked and Dallas 1 wire buses
  - Component and event interfaces to PIC hardware
- Includes Element editor to create your own components
- C Compiler designed to ANSI C Standards
- Link into MPLAB

Prices

PIXIE with Introductory manual (C Manuals on CD) - **£70**
C Compiler with all manuals on CD ROM - **£60,**
C Compiler manuals (paper copy) - **£10.00**
Buy PIXIE with WIZPIC or our Programmer - **£50.00** CD-ROM
Upgrade - C Compiler users, **£15.00**
Upgrade - WIZPIC/FED PIC Programmer users, **£50.00**

PIC & AVR Programmers

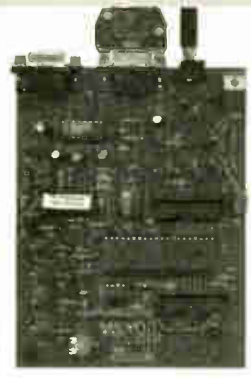
PIC Serial Programmer (Left) including 18Cxxx
Handles serially programmed PIC devices in a 40 pin multi-width ZIF socket. 16C55X, 16C6X, 16C7X, 16C8x, 16F8X, 12C508, 12C509, 16C72XPIC 14000, 16F87X, 18Cxxx etc. Also In-Circuit programming. Operates on PC serial port
Price : **£45/kit**
£50/built & tested

PIC Introductory – Programs 8 and 18-pin devices : 16C505, 16C55X, 16C61, 16C62X, 16C71, 16C71X, 16C8X, 16F8X, 12C508/9, 12C671/2 **£25/kit.**

AVR – AVR1200,2313,4144,8515, 8535, 4434 etc. in ZIF. 4.5V battery powered. **Price: £40 for the kit or £45 built & tested.**

All our Programmers operate on PC serial interface. No hard to handle parallel cable swapping ! Programmers supplied with instructions, + Windows 3.1/95/98/NT software. **Upgrade programmers from our web site !**

NEW – PIC Development Board



Prices
Kit with integrated programmer hardware **£35.00**
CD-ROM including FED IC BASIC compiler **£5.00**
Other options available – please ring or see web site

For ALL 40 pin PIC from 16cxxx, 16Fxxx and 18cxxx

- Includes In-Circuit Programmer – NO separate programmer required
- LCD module interface (1:1) plus contrast control
- Hex keypad interface
- 4 LEDs and driver
- 32 I/O pins available on IDC headers
- Variable resistor for A/D
- Socket for 12C EEPROM
- 1A 5V regulator on board
- 2 serial interfaces
- CD-ROM supplied with FED PIC BASIC and Compiler
- Peripherals operate only on port D and E leaving others free

Manual on CD-ROM or download free from our web site

Forest Electronic Developments
60 Walkford Road, Christchurch, Dorset, BH23 5QG.
Email – info@fored.co.uk, or sales@fored.co.uk
Web Site – http://www.fored.co.uk
01425-274068 (Voice/Fax)

Prices are fully inclusive, Add £3.00 for P&P and handling to each order. Cheques/POs payable to Forest Electronic Developments, or phone with credit card details.

EUROCARD MasterCard VISA

18C452

New architecture (more instructions + Hardware multiply), 40MHz clock, 16K program words, 1536 bytes RAM. Easy to upgrade from 16F877

18C452/JW	£20.00
18C452/OTP	£8.00

World Radio History

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

BT REPORTS REDUCTION IN PHONE KIOSK USE

It's all down to the mobile, reports Barry Fox

THE widespread use of cellphones is providing BT with the opportunity to cut back on the costly installation and maintenance of payphones – as required under BT's licence to operate.

BT had 77,000 payphones in 1984, when the company was privatised. Until recently BT was adding a hundred boxes a year. The current number is 141,000, but there has been no increase since 1999.

BT justifies this by saying that over the same two year period payphone use has declined by 37 per cent.

For most people with a cellphone, it is cheaper to use it than feed a payphone. The minimum payphone charge went up in October 2000 from 10p to 20p, with calls to anywhere in the UK costing a flat fee of 11p a minute. Payphones do not give change for unused payment.

Oftel wants BT to keep providing boxes in rural areas where a public service is needed, and cellphone cover is erratic. BT insists that it will do this.

BT also points to the fact that there are now 600 multi-media payphones, each with a 12-inch touch sensitive colour screen. Until June 14 these can be used to access the Internet or send E-mail for free. But after June 14 the calls will be chargeable, probably at around the same rate as a speech call, and possibly with a few minutes free in return for viewing adverts.

So far the 600 multi-phones are in "safe" locations, in shopping centres, railway and tube stations, airports and motorway services. Vandalism is less likely at these sites, than in remote rural areas.

The biggest risk may come from "scratchiti", the word coined in the USA to describe vandalism by the deliberate scratching of glass windows with diamonds and pumice stone.

BT says it sees the move into multi-media kiosks as helping the Government honour its pledge of offering everyone on-line access by 2005.

PROTEUS

LABCENTER, one of Britain's leading CAD developers, has released Proteus VSM. This latest addition to Labcenter's range is described as a revolutionary system level simulation product, and is the first in the industry.

VSM simulates microcontroller based designs, including the CPU, and all associated electronics at near real-time speeds. It includes animated component models. For example, l.e.d./l.c.d. displays, switches, keypads and virtual instruments, allowing the user to interact with the microprocessor software as if it were a physical prototype. It supports PICs, 8051 and 68HC11 processors.

The system includes an integrated debugger. It is also compatible with the Keil C51 development system.

For more information contact Labcenter Electronics, Dept EPE, 53-55 Main Street, Grassington, N.Yorks BD23 5AA. Tel: 01756 753440. Fax: 01756 752857.

E-mail: info@labcenter.co.uk.

Web: www.labcenter.co.uk.

CHILD'S PLAY

MAPLIN have launched a new range of kits aimed at helping children to understand the basic principles of electronics.

The Experilab kits are said to be ideal for children aged nine and above. No soldering or previous electronic knowledge is required and the inexpensive packs include all the necessary components and easy to follow instructions. The kits are available from Maplin's 59 nationwide stores and via Maplin's web site.

For more information contact Maplin Electronics, Dept EPE, Valley Road, Wombwell, Barnsley S73 0BS. Tel: 01226 751155. Fax: 01226 340167. Web: www.maplin.co.uk.

Greenweld Fires Enthusiasm

GREENWELD continue to rise, phoenix-fashion, from the crisis the company underwent nearly two years ago. Their latest bargains catalogue has increased to 48 pages and is crammed with items that any self-respecting electronics hobbyist loves browsing through in search of those that make our hobby even more interesting and worthwhile.

From modellers' tools and equipment, to electronic components and superb kits, Greenweld say that with their great value prices and mail order service, there's something in the catalogue for everyone. Check it out for yourself:

Greenweld Ltd, Dept EPE, PO Box 144, Hoddesdon EN11 0ZG. Tel: 01277 811042. Fax: 01277 812419. E-mail: service@greenweld.co.uk.

WCN Supplies Catalogue

ISSUE 7 of WCN Supplies' 24-page A4 catalogue includes a broad variety of items that electronics enthusiasts will find appealing. Principally, they are of the "workshop accessories" type, including meters, batteries, computer cables, connectors, power supplies, tools etc.

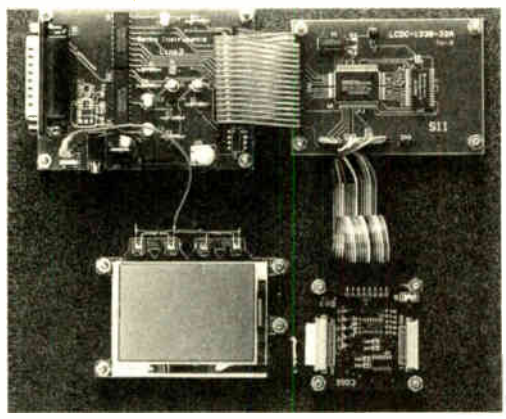
The catalogue appears to be a useful source of supply and can be obtained from WCN Supplies, The Old Grain Store, 62 Rumbridge Street, Totton, Southampton SO40 9DS. Tel/fax: 023 8066 0700.

CHIP-ON-GLASS L.C.D. MODULES

NOW that you've been inspired to investigate graphics l.c.d.s (Feb '01), why not have a browse of Glyn's web site for information about their new Chip-On-Glass L.C.D. Display modules, from Seiko's Vitrium series? COG modules are said to be ideal for portable applications, offering high density performance in the smallest possible package.

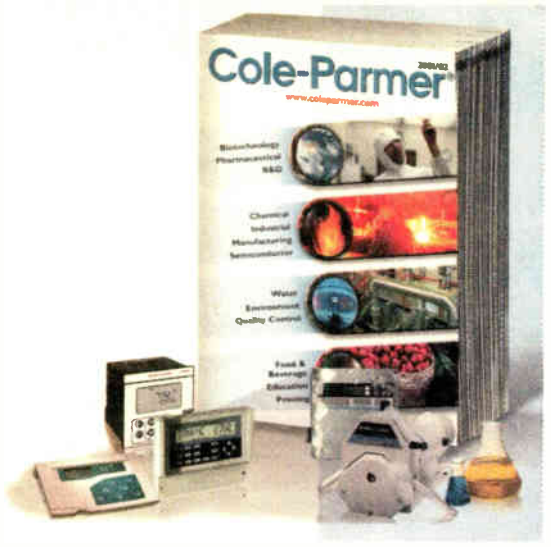
Glyn tell us that the modules "eliminate the need for printed circuit boards . . . are mounted directly on glass, achieving greatly improved optical performance and reliability".

Glyn's web site is at www.glyn.com.



World Radio History

SCIENCE CATALOGUE



COLE-PARMER have released their 2001-2002 catalogue, which they describe as "the best scientific and technical catalogue". It contains over 2000 full colour pages with more than 40,000 innovative products. The general headings highlighted include Manufacturing, Semiconductor, Chemical, Industrial, Environment, Education, Pharmaceutical, R&D, to mention just a few. It's the sort of catalogue which can be invaluable to any hobbyist with an enterprising mind and fertile imagination.

For more information contact Cole-Parmer Instrument Company Ltd., Dept EPE, Unit 3, River Brent Business Park, Trumper's Way, Hanwell, London W7 2QA. Tel: 0500 345300. Fax: 020 8574 7543. E-mail: sales@coleparmer.co.uk. Web: www.coleparmer.com.

Rabbit's Demise

Barry Fox

HONG Kong telecoms giant Hutchison ran the ill-fated Rabbit second generation cordless phone system, before replacing it with the Orange cellphone network. Hutchison also ran a paging system which took on the Orange name. This still has 30,000 customers, of which 5,000 are consumers. But most people now use cellphones and SMS, short messaging service, instead of pagers. So Orange is shutting down the paging service on 30 June.

Customers will be given sweeteners, such as free Orange phones. "Our paging business has been overtaken by developments in technology", says Orange.

In the USA paging is still popular because cellphone users must pay for incoming calls. Cost conscious consumers use a pager along with a cellphone, taking incoming messages free by pager and returning selected calls by cellphone.

Paging also remains the only safe way to communicate in hospitals, because the pager is just receiving, not transmitting. Paging signals, at lower frequencies and lower data rate than cell phones, also penetrate deeper into multi-level concrete buildings.

OOPS-OOPIC!

LAST month we misinterpreted Total Robots' press release about their OOPic object-orientated programmable integrated circuit. The design *is* based on PIC microcontrollers – it uses the PIC16C74. We apologise for this error. For more information browse web site **www.total-robots.co.uk** or phone 01372 741954.

Atmel Acquires Siemens

ATMEL have reached an agreement to acquire Siemens' North Tyneside plant and will resume semiconductor fabrication. This should lead to the creation of between 1000 and 1500 high quality direct jobs within two to three years, with additional spin-off employment as well.

Siemens closed their plant two years ago when the world semiconductor market collapsed. You may recall that Fujitsu also closed their semiconductor plant in County Durham at about the same time.

American headquartered Atmel designs, manufactures and markets advanced logic, mixed signal, non-volatile memory and RF semiconductors. The company's arrival is excellent news for the North East region of the UK, and has been assisted by a £27.8m Government grant.

Educating Quasar

QUASAR Electronics in their latest newsletter remind tutors and teachers that generous discounts are available for bulk purchases of their electronics kits. Schools, colleges and universities are granted automatic 30-day account facilities and discounts of up to 35 per cent.

Of course Quasars kits and other electronics products are of interest to anyone, so get hold of their catalogue and onto the mailing list for regular updates!

Quasar Electronics Ltd., Dept EPE, Unit 14, Sunningdale, Bishops Stortford, Herts CM23 2PA. Tel: 01279 306504. Fa: 07092 203496. E-mail: epesales@quasarelectronics.com. Web: www.quasarelectronics.com.

CHINA'S DVD CHALLENGE

Barry Fox

CHINESE and Taiwanese electronics companies are under attack. They have been undercutting Western suppliers, by selling DVD players for under $100. Now, the 6C Group (Hitachi, JVC, Matsushita, Mitsubishi, Toshiba and Warner) are using their pooled patents to seek a four per cent royalty on hardware. Another group, Philips, Pioneer and Sony separately claim 3·5 per cent. Dolby claims another slice for digital surround, Macrovision for copy protection, the MPEG Licensing Authority for compression. Discovision and Thomson are still claiming royalties on old optical disc patents. The total claim is around 10 per cent of the manufacturing cost for a player.

During meetings in Beijing and Taipei China with Toshiba's Koji Hase, Chairman of the DVD Forum, the Chinese sprang a surprise. They claimed that the Chinese government will set its own modified DVD standard called Advanced Video Disc, and will claim its own royalties if foreign manufacturers try to import AVD players into China.

This is a re-run of the situation when China developed the Super Video CD system to rival the Video CD format developed and patented by JVC, Matsushita, Philips and Sony.

The AVD idea looks suspiciously like an attempt at trading one set of royalties off against another, but it overlooks the basic fact that AVD will still have to use the basic DVD technology patents.

The many companies in Europe and the USA which import DVD players from China, for branding with Western names, may now find themselves legally liable for royalties unpaid by their Far Eastern suppliers.

Mobile Phones Risk Report

THE National Radiological Protection Board (NRPB) has advised us that the results of a study in the USA in respect of brain tumours and the use of mobile phones have been released at **www.nejm.org/content/inskip/1.asp**.

The study does not show an association between them. NRPB state that further study is required.

The NRPB also tells us that it has published a broadsheet, *Medical Radiation*, as part of its *At-a-Glance* series. It is intended for readers with little or no knowledge of the subject and explains how radiation is used to diagnose and treat illnesses. It relies heavily on illustrations and captions as a means of communicating information.

Individual copies of *Medical Radiation* are free of charge and can be obtained direct from the NRPB Information Office.

For more information contact: NRPB, Chilton, Didcot, Oxon OX11 0RQ. Tel: 01235 822744. Fax: 01235 822746.

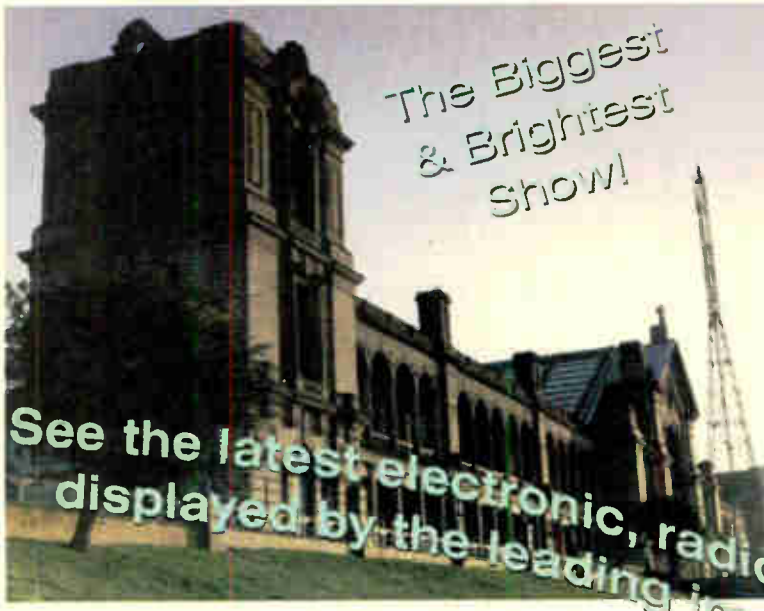
E-mail: information@nrpb.org.uk.

Web: www.nrpb.org.uk.

World Radio History

You'll find stacks of electronic components and innovations at the one and only **Alexandra Palace.**

London
ELECTRONICS, RADIO & COMPUTER SHOW



See the latest electronic, radio & computer technology, displayed by the leading importers and distributors

Alexandra Palace
Wood Green, London N22

Saturday 21st April
& Sunday 22nd April

Supported by numerous exhibitors, including...

RSGB
Short Wave Magazine
Waters & Stanton PLC
WORLDSPACE
RA
Timestep
MOONRAKER
ALINCO
KENWOOD
HAYDON
YAESU
RNARS
ICOM
Practical Wireless
RSARS

FREE LECTURES
EXCELLENT CATERING AND BARS
TALK-IN ON 2M & 70CM
FREE PARKING & COURTESY BUS
PRIORITY ADMISSION FOR DISABLED
SPECIAL INTEREST GROUPS
DISABLED FACILITIES
BBC TELEVISION MUSEUM
BRING & BUY
MORSE TESTS

Daily admission (per person): Groups of 20 or more, **only £2.00!** (booked and paid in advance, see **www.radiosport.co.uk** for details)
Adults, £4.00; Pensioners / U14s, £3.00

Presented by RadioSport Ltd, the organisers of the Picketts Lock Shows, in association with Southgate Amateur Radio Club.
For details contact RadioSport Ltd, 126 Mount Pleasant Lane, Bricket Wood, Herts, AL2 3XD. Tel: 01923 893929 Fax: 01923 678770

World Radio History

Constructional Project

INTRUDER ALARM CONTROL PANEL

JOHN GRIFFITHS

Part One

Microcontrolled security designed to meet British Standards specification BS4737.

THIS Intruder Alarm Control Panel system is based on the Motorola EP520M security microcontroller.

The EP520M is a robust device having its origins at the heart of an automobile engine management system – a hostile environment for any microcontroller to work in. Now masked as an alarm controller, the device operates in high electrical noise and RFI environments, displaying a high degree of immunity to such hazards.

These devices are used in control panels throughout the UK and Europe, and are reputed to be completely reliable and free from false alarming.

The EP520M's extensive features include four detection zones, with one programmable as an Entry-Exit Delay zone, plus a 24-hour monitor for anti-tamper devices and Panic Attack (PA) use. Normally-closed (NC) and normally-open (NO) detectors can be used on all zones. The main features of the system are listed in the Specifications panel.

It can be seen from the block diagram in Fig.1 that the EP520M requires only the addition of a simple keypad and a minimum of readily available components. The circuit has been designed to comply with the installation requirements of British Standards BS4737 Part 1.

Despite the sophistication of the system, the alarm is extremely simple to construct and operate.

ZONES

Zones 1, 2 and 3 are all "immediate" and violation (opening) of the normally-closed (NC) circuit causes an alarm activation. Zones 1 to 4 are positive polarity and if the NC loop is shorted to the negative 24-hour PA anti-tamper circuit NC loop, then a full alarm activation results, and is indicated on the associated zone l.e.d. Consequently, normally-open devices can also be used to activate the zones.

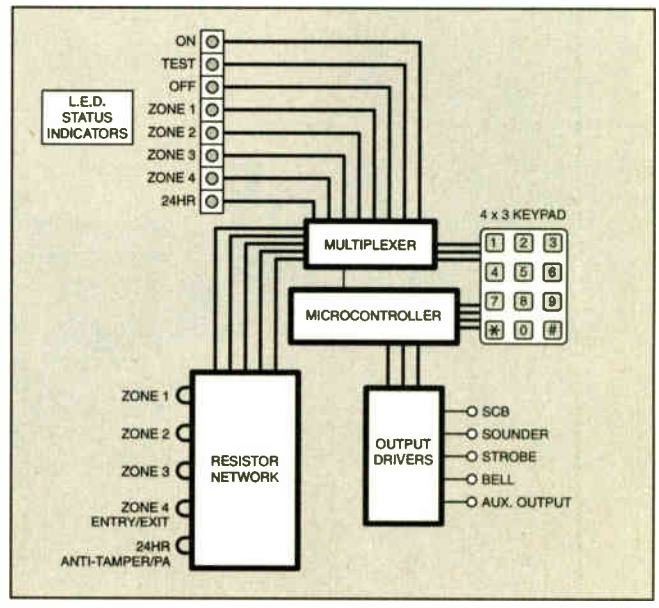


Fig.1. System block diagram.

Zone 4 is used for timed entry-exit control and is programmable to give a delay of between 0 and 255 seconds, in order to enter and leave the alarmed area.

Zones 1 to 4 are for use with any standard type of normally-closed intruder detector, such as magnetic contact switches, pressure pads, passive infra-red (PIR) sensors etc.

Zone 5 comprises a normally-closed 24-hour Anti-Tamper PA loop circuit which causes a full alarm activation if violated. Anti-tamper switches to protect the detection and external sounder devices are wired to this circuit. Panic Attack button switches can also be wired to it.

You can activate the alarm when it is switched off by pressing the PA button. This a very useful security feature when answering a door with a PA button sited nearby.

AUDIO-VISUAL ALARMS

The bell output is the main alarm driver and direct current (d.c.) sounders requiring up to about 1A can be connected to it.

World Radio History

SPECIFICATIONS

4 ZONES 4 × 12hr positive polarity detection circuits for NO and NC devices

24HR CIRCUIT 1 × 24hr anti-tamper circuit for NC devices

NVM Non-volatile memory to retain all programmable data during power failure

AUTO RESET Automatic resetting of the alarm after preset period

BELL SHUT OFF Automatic silencing of alarm after a preset period (selectable)

AUDIBLE WALK TEST Tests all detection zones prior to setting system

LAST TO ALARM MEMORY Shows zone that was violated

NIGHT SET Sets system without the Entry/Exit delay time

OMIT ZONE Allows any zone except 24hr to be omitted

LATCHING STROBE Strobe carries on after Auto Reset or bell switch off

SWITCHED +12V OUTPUT For latching PIRs and other control purposes

SCB INPUT Negative control for self-contained bell

STATUS DISPLAY System status shown on 8 l.e.d. indicators

INTERNAL/EXTERNAL SIREN High and low level siren output to 4Ω to 16Ω speaker

1·2A PSU For charging up to 7AH back-up battery

FINAL DOOR SET OPTION Sets alarm when the Exit door is closed

ENGINEER'S CODE Used to change factory defaults

USER CODE Used to Set and Unset Alarm

12 BUTTON KEYPAD To Set and Unset the alarm and program variables

WALK THROUGH Allows user to violate zone when exiting and entering

PROGRAMMABLE FEATURES

		Default
EXIT TIME	0 to 255 secs	20 secs
ENTRY TIME	0 to 255 secs	20 secs
AUTO RESET	1 to 99 mins	20 mins
BELL SHUT OFF	1 to 99 mins	Off
ACCESS CODE	0000 to 9999	1234
ENGINEER'S CODE	0000 to 9999	54321
WALK THROUGH	Zone 1	Off
TEST TONE	All zones	On
FINAL DOOR CANCEL	Zone 4	Off
EXIT TONE ON	Zone 4	On
ENTRY TONE OFF	Zone 4	On

NOTE: When actually entering the engineer's code in normal use prefix the 4-digit code with the number 5 before the code, e.g. an engineer's code of 4321 entered in the program mode would be entered as 54321 for engineer's access.

An optional 12V d.c. 250mA Xenon strobe may be connected to the Strobe terminals. In the event of an alarm activation the strobe will operate. If the alarm carries on until the Auto Reset period is reached, the alarm sounder will silence but the strobe will carry on operating. This gives an indication to the user returning to the property that something may be amiss and to proceed with caution.

When the alarm is activated, a high and low level 1kHz tone output is generated via an internal loudspeaker. In normal operation, the output level is restricted and gives the test tones and keypad response. However, when a full alarm condition occurs, the full output power is delivered to the speaker.

CIRCUIT DESCRIPTION

The circuit diagram for the Intruder Alarm Control Panel is shown in Fig.2.

The EP520M microcontroller is designated as IC1. It has its own internal clock oscillator whose precise frequency can be set by resistor R1 and preset potentiometer VR1.

Zone 1 to Zone 4 connections are biased on one side to the 12V line via resistors in module RM5, and on the other side to the 0V line via resistors in module RM4. Series resistors in module RM3 feed from the zone loop to the 8-way multiplexer IC2. On the same inputs the resistors in RM2 act as potential dividers in conjunction with those in RM3.

This resistor combination holds the inputs to IC2 at around 4V when the zone loop is in circuit. When the circuit is broken, the inputs are held at 0V.

Zone 5 is biased from the 12V line in the same way, using discrete resistors R12, R13 and R14. However, the 0V connection is made via anti-tamper microswitch S1. In this path an optional link (SCB) can be broken and an external anti-tamper switch connected as well.

COMPONENTS

Approx. Cost Guidance Only **£25** *excluding case*

MAIN BOARD

Resistors

R1	27k
R2, R3, R5 to R7	10k (5 off)
R4	150Ω
R8	68Ω 1W
R9 to R11	3k9 (3 off)
R12	2k7
R13	100k
R14	56k
R15	1k

All 0·25W 5% metal film except R12.

See SHOP TALK page

Resistor modules

RM1	8 × 1k common 9-pin
RM2	4 × 47k individual 8-pin
RM3	4 × 100k individual 8-pin
RM4	4 × 10k individual 8-pin
RM5	4 × 1k individual 8-pin

All single-in-line resistor modules

Potentiometers

VR1	10k preset, min. horiz, 5mm
VR2	1k preset, min. horiz, 5mm

Capacitors

C1	10μ tantalum, 16V
C2	2200μ axial elect. 25V
C3 to C6, C8 to C14	100n ceramic disk (11 off)
C7	1μ axial elect. 25V

Semiconductors

D1 to D4 D8 to D10 D22	1N4148 signal diode (8 off)
D5, D6	8V2 Zener diode (2 off)
D7, D11, D12	1N4001 rectifier diode (3 off)
D13 to D21	red l.e.d. (9 off)
TR1	BC307 *npn* transistor
TR2, TR4	TIP120 *npn* Darlington transistor
TR3	TIP125 *pnp* Darlington transistor
IC1	EP520M alarm system microcontroller (Motorola)
IC2	74HS151 8-way multiplexer
IC3	93C06 non-volatile memory
IC4	7812 +12V 1A voltage regulator
IC5	7805 +5V 1A voltage regulator
REC1	W05 50V 1A bridge rectifier

Miscellaneous

TB1, TB2	2-way screw terminal block, 5mm pin spacing, p.c.b. mounting (2 off)
TB3, TB4	10-way screw terminal block, 5mm pin spacing, p.c.b. mounting (2 off)
FS1	1A fuse, 20mm slow blow
FS2, FS3	500mA fuse, 20mm, slow blow (2 off)
LS1	loudspeaker, 12W 8Ω mylar
S1	s.p. push-to-make switch, p.c.b. mounting, spring activated (Alps)
T1	mains transformer, 12V a.c. 1A secondary

Printed circuit board, available from the *EPE PCB Service*, code 297 (Main); 3 × 4 matrixed keypad, data entry type; fuse clip, 20mm, p.c.b. mounting (3 off); small metal heatsink for IC5 (see text); 8-way pin-header, 0·1in pitch, straight; 8-way pin-header connector, 0·1in pitch, straight (2-off); 7-way cable, thin guage, 30mm long approx; spade connectors for battery, 5/16in (2 off); 8-pin d.i.l. socket; 16-pin d.i.l. socket; 28-pin d.i.l. socket; 6BA nuts and bolts; plastic case (see *Shoptalk*); solder, etc.

World Radio History

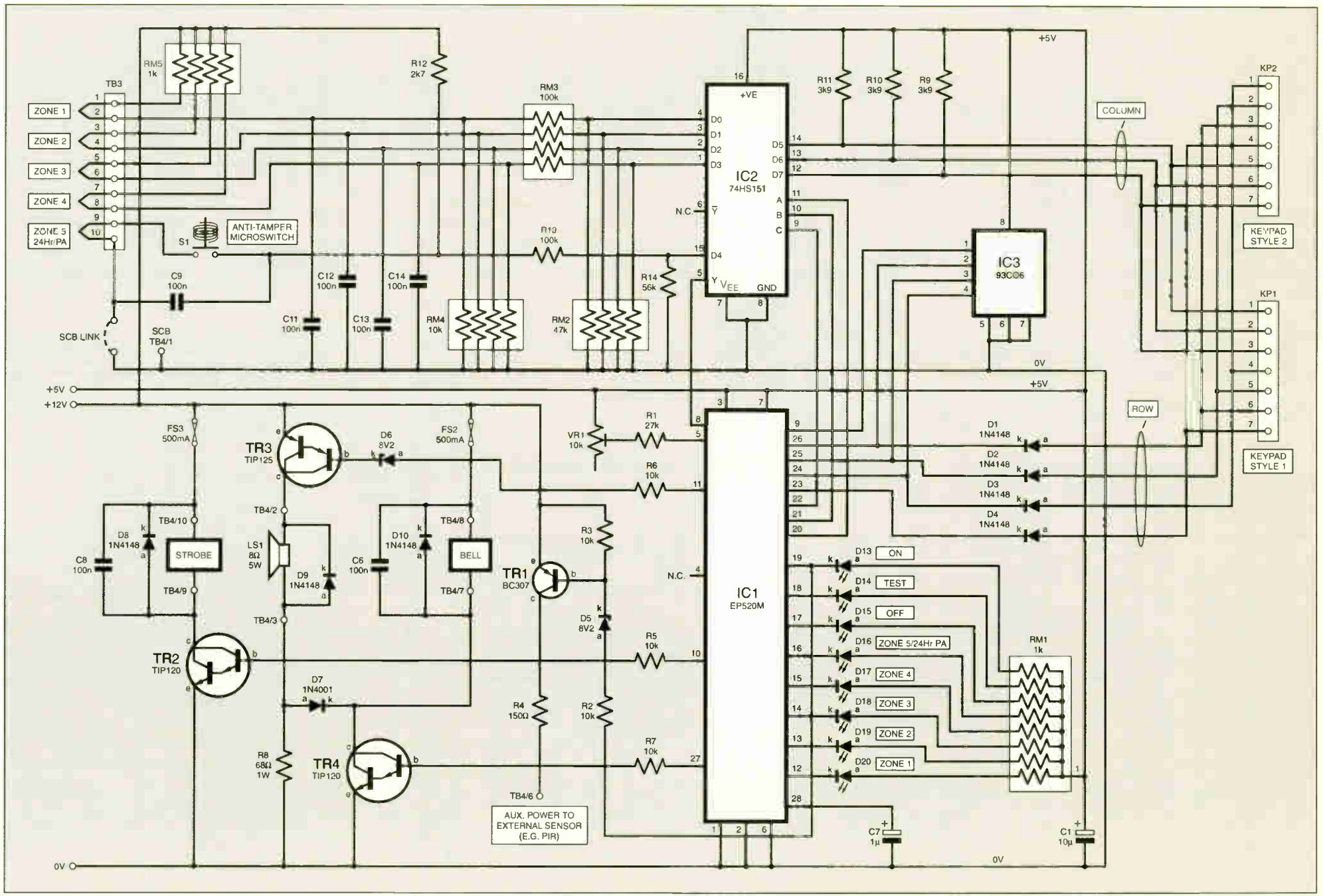


Fig.2. Circuit diagram for the main control unit.

World Radio History

This arrangement holds the Zone 5 input to the multiplexer normally at 0V, going high if the circuit is broken via the anti-tamper or PA switches.

The multiplexer's zone selection is controlled via its ABC inputs by microcontroller IC1, with the selected path routed back to IC1 via output Y.

FALSE TRIGGERING PROTECTION

Loop resistance of up to one kilohm (1kΩ) is permissible on the zone circuits. In practice, though, you would find this would represent several kilometres of wiring. In reality, in a normal domestic alarm installation, the loop resistance would rarely exceed several ohms, representing a loop current flow in the order of 1mA, giving good protection against induced transients.

Additional protection from false triggering on the detection loops is provided by the resident software, which polls the zones and looks for a period of intrusion detection of not less than 200ms. It then times the period during which the circuit is detecting. If after one second the input is still positive, an alarm condition is validated.

KEYPAD MONITORING

A standard 12-switch data-entry keypad is also monitored by IC1 via multiplexer IC2. The keypad has one set of its matrixed lines (Column) connected to the multiplexer. These are biased high by resistors R9 to R11. The other set of matrixed lines from the keypad (Row) are routed to IC1 via diodes D1 to D4.

The keyboard is strobed and key debouncing software routines ensure reliable operation.

Originally the author intended for a choice of two keypad pinout styles to be available, with connections via the pin-header terminals marked as KP1 and KP2. However, only the data-entry keypad style (see later) suiting connector KP1 is recommended.

ALARM INDICATORS

A further eight outputs from IC1 control the status-indicating l.e.d.s D13 to D20, via current limiting 1kΩ resistors in module RM1. The l.e.d.s show the violated zone(s) and also the On, Off and Test mode conditions.

Other IC1 outputs control the internal loudspeaker (LS1), plus the external strobe and bell lines, buffered by *npn* Darlington transistors TR2, TR3 and TR4.

The microcontroller output that turns on l.e.d. D13 (Power On) also turns on transistor TR1 via resistor R2 and voltage limiting Zener diode D5. The transistor routes 12V d.c. to external devices such as passive infra-red detectors. The current supplied is limited by resistor R4.

The circuit is arranged so that in Entry, Exit and Test modes, the loudspeaker only emits a low level audio tone. An audio frequency generated by IC1 controls TR3 via R6, and so activating the speaker but limiting its current flow by the inclusion of resistor R8.

In a full alarm condition, transistor TR4 is also turned on, not only activating the bell but also sinking current from LS1 via diode D7. The speaker thus emits a high level tone, which serves in place of an internal siren.

NO MEMORY LOSS

The third integrated circuit, IC3, is a non-volatile memory (NVM) which is used by the microcontroller to store the keypad and zone status settings, plus the Access and Engineer's pass-codes.

In the event of a complete power failure, the variables are not lost and when the power is restored the original codes are still available, so the system cannot be compromised under such conditions.

EXTERNAL BELL UNIT

Whilst the main circuit can directly control an external bell, the security of the bell itself would be compromised – an intruder could cut the power to it.

To ensure that your alarm installation is really secure and complies with the installation requirements of BS4737, it is recommended that a Self Actuating Bell module (SAB) is fitted. This is intended to thwart the alarm being silenced in the event that an intruder removes the power from the system. It is a bit like an alarm on the alarm, so to speak.

Bear in mind that any intruder system that can be disarmed by removing the power source is as good as useless.

A secondary control unit is thus provided for inclusion with the external bell housing. It allows the bell to be switched on by the main system but it also includes its own battery and anti-tamper circuit, causing the bell to operate if the bell enclosure is interfered with. The circuit diagram is given in Fig.3.

COMPONENTS

EXTERNAL BELL UNIT

Resistors

R1, R2	1k, 0·25W 5% carbon film (2 off)	

See SHOP TALK page

Capacitor

C1	100n ceramic disk

Semiconductors

D1 to D3	1N4148 signal diode (3 off)
D4	red l.e.d.

Miscellaneous

RLA	2-pole changeover relay, 12V coil, 24V 1A contacts, p.c.b. mounting
TB1	6-way screw terminal block, 5mm pin spacing, p.c.b. mounting
TB2	2-way screw terminal block, 5mm pin spacing, p.c.b. mounting

Printed circuit board, available from the *EPE PCB Service*, code 298 (Ancilliary); bell/siren to suit (see text).

Approx. Cost Guidance Only **£9** *excluding case.*

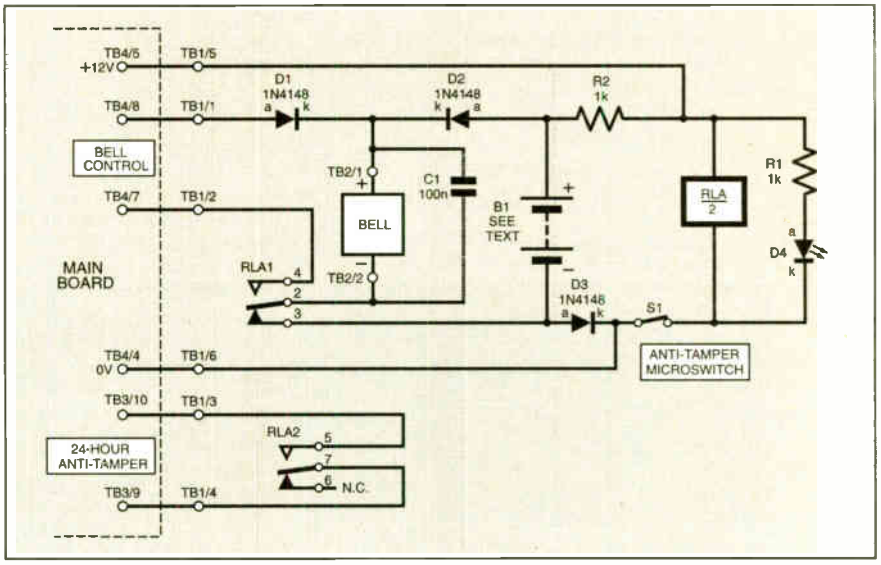


Fig.3. Circuit diagram for the external bell unit.

Power to the bell unit is jointly from the main controller and from the bell battery (B1 in Fig.3). This powers relay RLA, in which condition the bell is turned off by the relay contacts, RLA1. If the main power fails, the bell battery takes over, still activating the relay. Light emitting diode D4 indicates when the power is present across the relay coil.

An anti-tamper microswitch (S1) is included in the bell controller housing. If this normally-closed circuit is broken, the bell will sound, even if the bell battery is the only source of power.

The relay also controls the circuit from the main unit's anti-tamper detection. If the bell is interfered with, the main circuit responds, causing the indoor loudspeaker to sound at full volume.

It is strongly recommended that the bell circuit is used in order to provide the protection required under BS4737.

When fitting the SAB battery, it is suggested that a normal 250mA NiCad pack is used. The amp-hour endurance of this battery size is not unduly long so that, in the event that the main power to the control panel fails for legitimate reasons, the

World Radio History

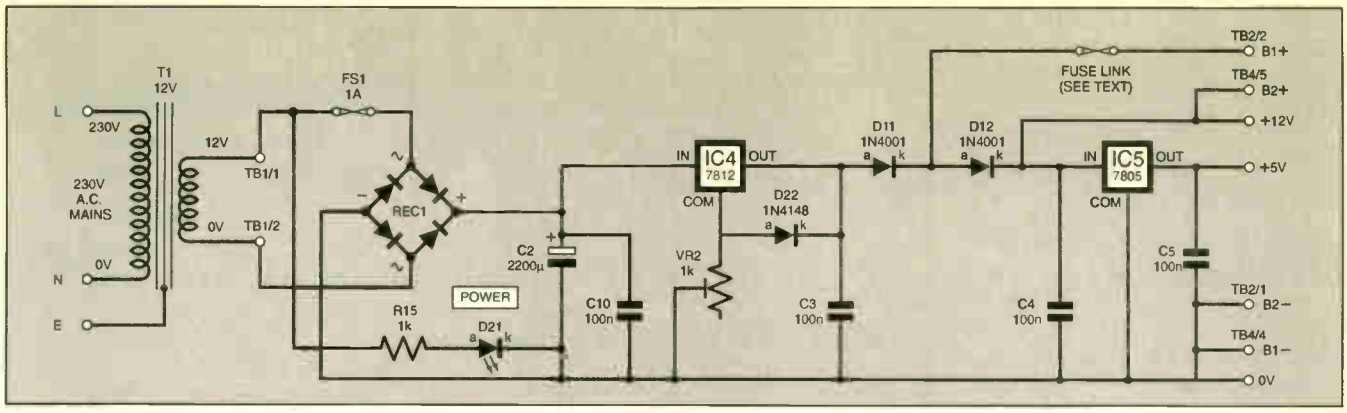


Fig.4. Circuit diagram for the power supply.

sounder will not operate for more than 40 minutes maximum.

The easiest configuration is to use 6-core cable between the panel and the SAB, which should be enclosed in the external bell box.

POWER SUPPLY

The system is principally mains powered, but has additional twin-battery back-up facilities, for which 12V sealed lead acid batteries rated up to 7AH are recommended. In the event of the mains supply failing, the battery back-up takes over.

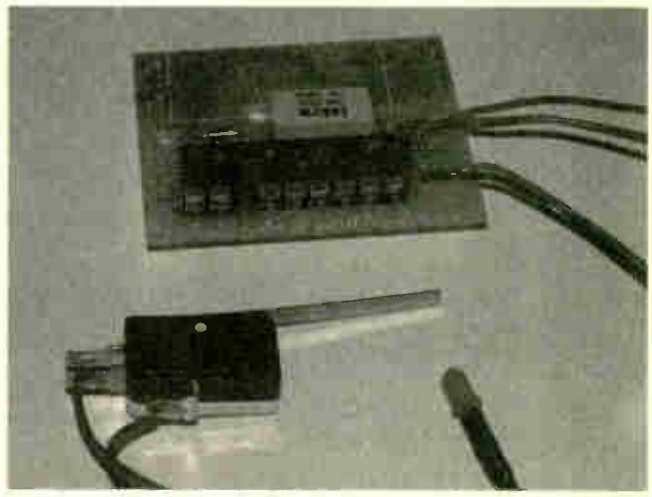
Power requirements for the alarm control panel are 12V at 1A and 5V regulated at up to 1A maximum. The main requirement of the 12V supply is to drive the sounders and strobes.

Referring to Fig.4, the power supply includes transformer T1, bridge rectifier REC1, smoothing capacitor C2. Fuse FS1 protects the system in the event of a power output short-circuit.

The rectified output voltage is regulated at 12V by IC4, which has a maximum output current rating of 1A. The output from IC4 is also connected to another voltage regulator, IC5. This provides +5V to IC1, IC2 and IC3.

Both back-up batteries, B1 and B2, are kept trickle-charged via diodes D11 and D12. Preset potentiometer VR2 allows the correct charging voltage to the principal battery, B1, to be set at 13·85V, as recommended by the manufacturers.

On the printed circuit board, track feeding to the connector for B1 is deliberately "thinned". This acts as a fusible link in the event of a catastrophic short circuit within the system, as might be caused by a malicious intruder.



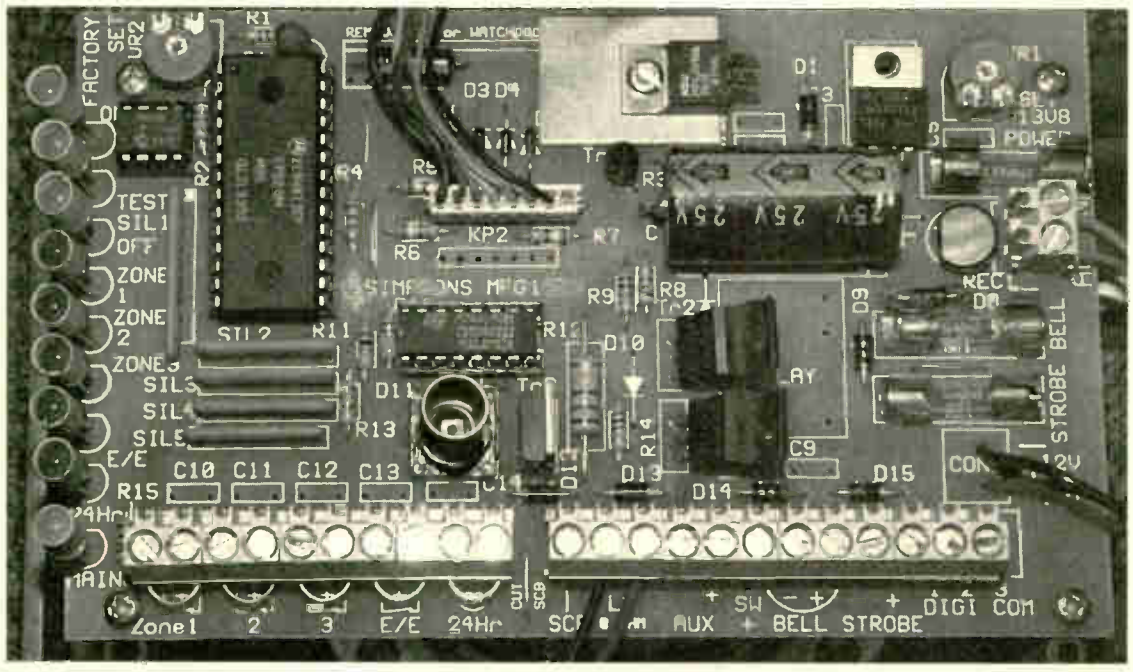
Extension bell unit printed circuit board and anti-tamper microswitch.

The Auxiliary 12V D.C. output normally services the PIRs and other detectors used in the system. Typical current requirements of such devices are in the region of about 20mA per unit.

This alarm unit is mains powered and its construction and testing should only be undertaken by those who fully understand what they are doing.

There are two printed circuit boards for the system, the main control board, and that for the additional bell control unit. Both boards are available, as a pair, from the *EPE PCB Service*, codes 297 (Main) and 298 (Bell).

Next Month: Full constructional details, testing and setting-up.



Component layout on the prototype main alarm printed circuit board. Note that the component numbering is different to the published design and that some components are not shown.

World Radio History

READOUT

E-mail: editorial@epemag.wimborne.co.uk

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

WIN A DIGITAL MULTIMETER

A $3^1/_2$ digit pocket-sized l.c.d. multimeter which measures a.c. and d.c. voltage, d.c. current and resistance. It can also test diodes and bipolar transistors.

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

★ LETTER OF THE MONTH ★

MAINS RATED CAPACITORS

Dear EPE,

As a recently retired safety engineer for BSI, I was somewhat disturbed to see the design for the *Doorbell Extender* in the March '01 issue.

The problem lies in the coupling capacitor C1 in both the transmitter and receiver. I am aware of all the warnings given about using quality components and knowledge of mains circuitry etc., but a 400V capacitor *is not good enough.*

The UK domestic mains is Installation Category 2, which means that it can have up to 1500V spikes with respect to earth on both the live and the neutral. This is one of the reasons why the safety standards require that capacitors connected between mains and earth are certified as "Y" capacitors. They are rated at 250V or 400V but they are tested at 2500V and designed not to fail short circuit. Capacitors across the mains ("X" caps) are also required to be certified because other types have been known to catch fire when they fail.

Any units built to the design given would certainly fail any basic safety test because the requirement is a test at 1500V a.c. or 2121V d.c. between mains and earth. Although there may be no possibility of a shock hazard within the units as built (depending on accessibility to the secondary circuits), there is still a possibility of causing a shock in other equipment.

I was told when I joined BSI that the UK ring mains specification allows for the earth to go to 240V for a period not exceeding 400ms (presumably while the fuse thinks about blowing). If that were to happen then any other equipment on the same ring could have its chassis at 240V for what is admittedly a short time. Unfortunately it doesn't take very long to die!

Furthermore, if the secondary is accessible then the cap should either be a "Y1" cap or two "Y2" caps in series. The basic principle is for there to be two levels of protection for the operator. The "Y1" cap is considered as two levels. Otherwise a "Y2" cap and the earth would normally be OK but with that dodgy cap and secondary circuitry with no other isolation – I for one wouldn't trust it.

Roger Warrington C.Eng MIEE, via the Net

Thank you for your interesting and informative letter. We have to admit that we should have picked up the requirements for this design. (Seee the Please Take Note *on page 281.)*

PLEASE "C" TO IT!

Dear EPE,

In your reply to Alan Bradley's letter in *Readout* Feb '01, you asked for readers thoughts on the C programming language. I would definitely be interested to see some of the software in the magazine written in C. As an electronics student I have to learn C for my course, but I had already been using the language for several years previously. My only other (limited) experience is with BASIC (GWBASIC, QBASIC, etc.) and I found the change to using C a huge improvement.

Ben Heggs, via the Net

Thanks Ben, we'll keep it mind.

However, I've been giving further thought to programming languages in general. I understand that C (and its derivatives) is not necessarily the best way forward.

For some time Object Orientated programming has become increasingly important to professional software designers and I believe that they regard C as being a "procedural" language which can lead to different techniques being employed to achieve the same end. In this context it appears that Object driven programs have greater long term "stability" in that Objects are unique, designed for only one method of use, and so programmers can more readily understand what code structures are meant to do, irrespective of who wrote them. In effect, it appears that they are "black boxes" which perform a single dedicated task, with just one access point.

Whilst such matters may not be of immediate concern to EPE *readers, it is something that I think should be considered as we progress ever onwards into more sophisticated programming languages. I appreciate that readers who have only just grasped one language, such as PIC or QuickBASIC or Visual Basic, may be reluctant to climb the learning curve of yet another, perhaps I should now open up the discussion to include not only C, but also Object Orientated languages as well. So let's be hearing from all who know about such things (which I do not, as yet).*

GRAPHICS L.C.D.S

Dear EPE,

When I read your *Using Graphics Liquid Crystal Displays* (Feb '01) I thought that the following Web addresses might be of relevant interest to your readers:

http://ourworld.compuserve.com/homepages/steve_lawther/t6963C.htm

http://www.digisys.net/timeline/lcd.html

http://www.citilink.com/~jsampson/lcdindex.htm

http://www.apollodisplays.com/apollofrамel.htm

http://www.flat-panel.com/

Prof. Dr Eugenio Martin Cuenca, Universidad de Granada, Spain

Thank you very much, there appears to be some most interesting material available. I wish I had known about it before I started delving into graphics l.c.d.s!

ALFAC TAPES WANTED

Dear EPE,

I am 66 years old, disabled and cannot draw circuit plans. However, I found that by using Alfac precision tapes, circles and i.c. transfer pads I could manage to do a circuit for etching. Now I find that I can no longer obtain them and may have to give up my electronics hobby, which is the only thing I seem to live for now.

As a last resort I thought I would write to see if you could help, or could it be possible to ask if any readers had any they no longer use. If so, would they kindly think of me. I used to buy them from Maplin but they have discontinued selling them and cannot provide me with Alfac's address.

Please, I desperately need help!

John E. Horton, Deal, Kent

Editor Mike received John's plea for help and looked into it. He replied directly saying that this is a problem which we are unable to find a solution to. He did a search on the Web and could not find a UK supplier of Alfac products. Unfortunately these items are simply no longer in use in industry. Can any readers help John?

UFOs AND AURORAS

Dear EPE,

I read with interest, the *UFO Detector/Recorder* (Jan '01). In particular, the ingenuity of Raymond Haigh's chart recorder is inspiring. I built something similar ten years ago for my father, not for detecting UFOs, but for early warning of auroras and the subsequent enhancement of h.f. and r.f. propagation, we're both radio hams.

The original idea for the detector came from an article in an astronomical magazine. It showed a powerful magnet suspended in a jamjar full of oil, to slug the movement, and a linear Hall device to detect the tiny perturbations. The jamjar detector was installed in the attic and detected the presence or absence of my car on the drive 50 feet away, seeing perturbations of the Earth's magnetic field proved to be easy too.

Then came the difficult bit, how do we record the output? A visit to a radio rally provided an old X/t recorder for £5. It just needed restringing. Several yards of fishing line later and exhaustion of my vocabulary of swearwords, I managed to restring it. Rolls of chart were expensive but the results were worth it. So, to the point of this missive. Hard copy recording of analogue events is hard work. What is needed is a cheap and easy method.

Most people these days use a computer and printer. Some people have bought new colour printers and failed to sell their dot matrix printers, they're in their box in the loft. A PIC-based analogue to Centronics "box" would be very nice! Z-fold paper for week-long recording, very cheap A4 for shorter periods. One, two or three inputs and variable "chart" speed? Date stamp? X/t grid? Have a think boffins, it'll make a good project.

Andy Daw, G1DSF, Stone, Staffs

Seems a feasible idea, Andy, and one which I believe I can achieve. Watch EPE*!*

World Radio History

SLOW CLOCKING PICS

Dear EPE,

I am in the process of studying your admirable *PIC Tutorial* (Mar-May '98) for which, as a lone worker, I have cause to be grateful and no doubt is a sentiment shared by hundreds of others. You really are to be congratulated for all the effort and planning which must have gone into covering all that material without losing that fragile thread of novice perception.

It strikes me as I progress, that it would be extremely useful if one could somehow disable the PIC's clock and instead step through the program by means of a debounced press switch during which each file register in use would be displayed showing the updated value (seeing is believing!). Perhaps it could even be refined so that the value could be made to blink on and off during the step it changed.

On a different subject, what is the easiest and/or quickest method of composing a library of electronic symbols for use in drawing schematic circuits on a computer? Also how do you add the annotations when the schematic is completed?

Pat Alley, via the Net

Thanks for your kind comments, PIC Tut *has indeed been well-received. Its CD-ROM version includes the* Virtual PIC *facility which does as you suggest as an on-screen simulation. Also, have a look at* EPE PIC Icebreaker *(Mar '00) which is a real-time PIC in-circuit emulator, programmer, debugger and development system.*

All commercial printed circuit board design software contains symbol library and text annotation facilities (and much, much more). Obtain some of the free-demos from advertisers who supply such programs – you are likely to be astonished at what can be done, and very cheaply too!

SYNCHRONOUS MOTORS

Dear EPE,

I have recently acquired a quite rare and valuable clock from the USA which operates on 110V 60Hz. The principal of operation is that of a mains synchronous motor, and in order to keep accurate time it therefore needs to operate at 60 cycles.

I know there is no problem with the voltage requirement but I have been unable to source a PSU that can deliver 110V at 60Hz. Is this something your magazine has featured in the past, or could you suggest a source/circuit diagram (I could build one myself if need be)? I have been advised by one local components retailer that this will be very expensive to achieve in any event – do you agree with this opinion and if so where does the expense lie?

Chris Betts, via the Net

Regrettably, Chris, your retailer is correct, it would be expensive to convert your clock to run from the UK 230V 50Hz mains supply.

One way of tackling it, though, would be to design a crystal-based logic gate squarewave oscillator, running at 5V (say). A waveform shaper would then be used to convert the squarewave to a well-shaped sinewave. This could then be fed into a step-up transformer to convert the sinewave voltage to 110V a.c.

There are many transformers available in the UK that have a 110V a.c. winding that can be used. Remember that any transformer can be used either way round (a matter discussed in Teach-In 2000 Part 10 – *Aug '00). For example, a transformer designed for 110V a.c. mains input and 6V a.c. output can be used for 6V a.c. input and 110V a.c. output. In this instance, though, the input current required would about 18 times (110/6) that required at the output.*

Presumably you would also want the clock to still run from the a.c. mains. This would require a UK mains power supply to generate a regulated 5V d.c. output to supply power to the oscillator.

So the set-up all becomes a bit bulky, although to build it experienced constructors would not find it too difficult or expensive. But, certainly, to have it commercially designed and made for you could be bank-breaking!

Readers, send suggestions for other ways of tackling the problem to Readout, *please!*

SHORTER BCD CONVERSION

Further to the discussions about binary to decimal conversion in *Readout* Sept, Nov, Dec '00, I have modified Steve Teal's code, which required 1957 cycles, so that it completes in 1242 cycles!

Steve's code doubles his Travelling Total (TT), but this only grows slowly and initially only one digit is needed to handle it. Yet the subroutine always doubles the whole of TT, so almost half the RLF multiplications do 2 × 0 + 0 = 0, and are superfluous. By studying the worst case (all 24 bits = 1) it soon appears that we only need to involve a new decimal digit for every three binary digits. The 08 in Steve's listing could be called **cycles**, to start at 01 and increment after every three bits. Another counter **(octcnt)** ensures the repetition of that whole procedure just eight times.

In the following listing (written in MPASM), the commands to delete are shown "remmed out" with a semicolon, and the new lines are notated as such.

```
bin2dec:
   clrf dec0
   clrf dec1
   clrf dec2
   clrf dec3
   clrf dec4
   clrf dec5
   clrf dec6
   clrf dec7
;  movlw 18          ; deleted
   clrf cycles       ; new
   movlw 08          ; new
.   movwf octcnt     ; new
ctloop:              ; new
   incf cycles       ; new
   movlw 03          ; new
   movwf bitcnt
bitloop:
   rlf bin0
   rlf bin1
   rlf bin3
   movlw dec0
   movwf FSR
;  movlw 08          ; deleted
   movfw cycles      ; new
   movwf deccnt
decloop:
   rlf INDF
   movlw 0xF6
   addwf INDF,0
   btfsc STATUS,0
   movwf INDF
   incf FSR
   decfsz deccnt
   goto decloop
   decfsz bitcnt
   goto bitloop
   decfsz octcnt     ; new
   goto octloop      ; new
   return
```

Michael McLoughlin, St Albans, Herts

Astonishing, Michael, and there we were thinking it couldn't get any faster. Dare we think that's true now for your *code – or not?!*

GRAPHIC GRATITUDE

Dear EPE,

Thank you, thank you, thank you!

I've not written to a magazine before, but have just got hold of the *Using Graphics Displays with PICs* supplement (Feb '01) and it is exactly what I need! Reading the bit on "Data denial", it could have been written by *me* following my experiences with the data sheet. I'm currently debugging my PIC program for the Toshiba T6963, and hopefully, with the help of your article, I should get success soon!

Sian Armstrong, via the Net

Your gratitude makes all the hassle I experienced worthwhile. Thank you Sian!

NO MISSED CALLS

Dear EPE,

David Corder's *Missed Call Indicator* (*IU* Dec '00) does everything claimed and he is fully deserving of the prize awarded for it. With my version, there was an initial hiccup in that it refused to latch, but this was cured by increasing the value of R4 from 1M to 10M. A 3mm red l.e.d. was found to be bright enough when driven from one gate only, hence R9 was omitted.

The current consumption when active averaged about 2mA and when quiescent was of the order of a microamp. To guard against possible problems due to an aged battery, the 3V rail was decoupled with a 100nF and a 4µ7F capacitor.

Vince Wraight, Basildon, Essex

Excellent news! Thanks Vince.

TESLA LIGHTNING

Dear EPE,

I'd like to say what a great project Nick Field's *Tesla Lightning* (Mar '01) looks like being. After months of head crunching PIC routines this is like a breath of fresh air (or should I say ozone). Many thanks.

Mick Tinker, via the Net

We too thought Nick had something significantly different when he offered it to us. Nice to see that a few of you have made contact with Nick via his special web site at ***www.tesla-coil.co.uk/epe/.***

LINUX VIRTUES

Dear EPE,

I've been a subscriber to *EPE* for five years or so, and it's a fantastic read. I've been following the development of programming language debate with interest.

I've been using Linux for six years, and love it. I'm also a big C programmer, but I spent many years (since I was four in fact, I'm now 20) programming Basic, from Sinclair Basic, through a number of others, eventually programming QuickBASIC on DOS 6.22. I've not yet found a reasonable Basic interpreter for Linux, but I haven't been looking, as I can now achieve most things I need in C.

I've done the odd couple of programs that talk "direct to the metal" (so to speak), directly addressing the hardware. Using this method, it's no problem to read/write individual lines on the serial and parallel ports. I find the interface Linux provides to the hardware fairly easy to use (from a C programmer's point of view), certainly having seen some of the VB code to address the hardware without the use of libraries to implement peek/poke/in/out.

Personally, I think that the world is too Microsoft orientated. I'm not saying everyone should use Linux – far from it – Linux is not the most intuitive system in the world. But I object to Microsoft charging the prices it does (even at an educational price) for software that is not always the best written in the world.

I have Linux systems that have been operational for over 180 days without a crash, unlike Windows, which seems to die once or twice a week. Sure – you can crash a program on Linux, but it won't bring down the rest of the system – a big plus when you're writing software that talks to the hardware directly.

I hope these comments might make those who are competent with PCs to stop and think. If they are interested, **http://www.linux.com/** has information about what Linux could do for you.

Matt London, Cheshire, via the Net

Linux is just beginning to be a Readout *subject. Your additional comments are welcomed, Matt. Thanks.*

World Radio History

L.E.T PIC BASIC PRO COMPILER

The Fast and Easy way to Program the PIC Microcontroller

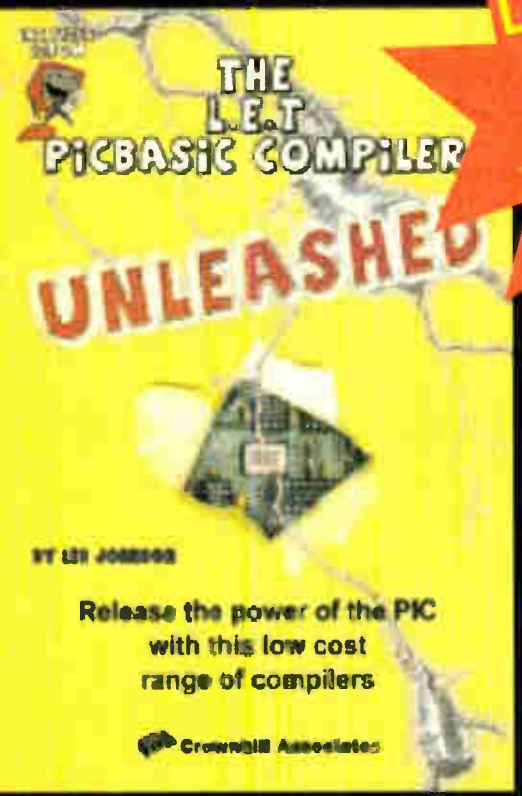
Write and Compile your first Program in under 5 minutes
Distribute your applications ROYALTY FREE
Technical Support direct from the authors
Dedicated user group mailing list
Easy to navigate Windows (GUI)
CDROM Includes software and example programs
Book Includes worked examples and Projects
Supports the popular PIC micro's including Flash devices

INCLUDES:

- LET PIC BASIC Pro Compiler on CD-ROM
- LET PIC BASIC User Guide on CD-ROM
- Data Sheets and support documents on CD-ROM
- Adobe Acrobat reader on CD-ROM
- StampPlot Lite
- LET PIC BASIC Unleashed Book
- Printed User Guide

LAUNCH Price!
£49.95
+ £5.50 p+p
+VAT

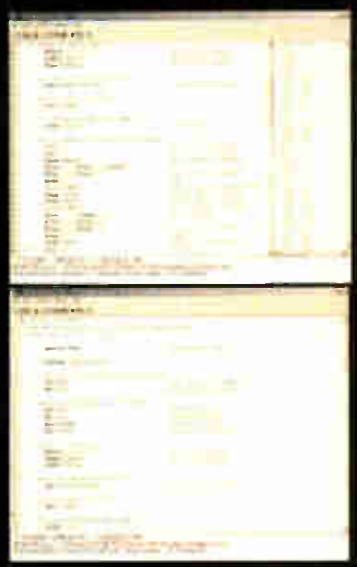
Download StampPlot
Free at www.letbasic.com



LET PIC BASIC Unleashed by Les Johnson

Covering the following subjects:
Interfacing to LCD and LED Displays
Interfacing to Keypads
Infrared Remote Control
Using the 433Mhz Transmitter/Receiver Modules
Interfacing to Serial Devices
Temperature Measurement
Downloading the computer's time
Using the on board A to D Converter
Acvanced Programming Techniques
RS232 serial communications demystified
Implementing interrupts in BASIC
Temperature data Logging Project

LET PICBASIC produces tight concise code from your program written in the easy to learn yet powerful BASIC language. You no longer have to struggle to learn machine code to use the popular PIC Microcontrollers, the compiler will produce code for both the 12 bit and 14 bit micros, therefore it can be used to produce code for any of the popular PIC devices including the 12C508 and 12C509 and the 16F84 and 16F877 and other popular Flash Devices.



FREE Download
L.E.T PIC BASIC LITE
www.letbasic.com

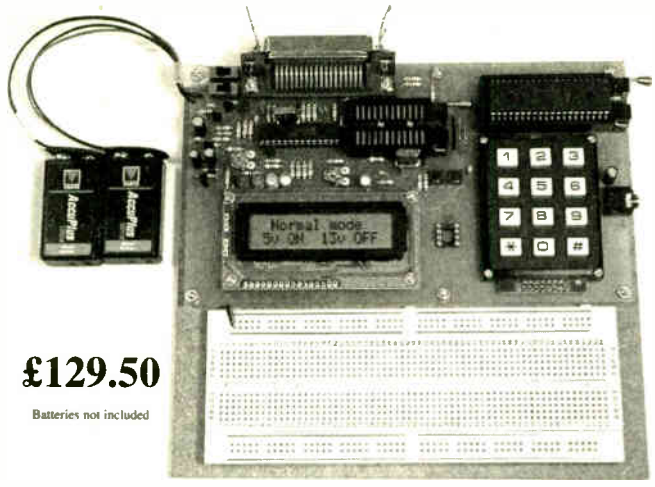
Crownhill Associates Limited
32 Broad Street Ely Cambridge CB7 4AH
Tel:01353 666709 Fax:01353 666710

VISA

MasterCard

ORDER ONLINE www.crownhill.co.uk
All prices are subject to a delivery charge + VAT@17.5%

World Radio History



£129.50

Batteries not included

Universal Mid Range PIC Programmer

This is a new advanced design based on our 16F84/C711 programmer. At the heart of the module is a 28 pin PIC16F872 which is used to handle the timing, programming and voltage switching requirements. The module has two ZIF sockets and an 8 pin socket which between them allow most mid range 8, 18, 28 and 40 pin PICs to be programmed. The plugboard is wired with a 5 volt supply. The price includes the book *Experimenting with the PIC16F877* and an integrated suite of programmes to run on a PC. Beginners should also purchase the book *Experimenting with PIC Microcontrollers*.

The software is an integrated system comprising a text editor, assembler disassembler, simulator and programming software. The register layouts and bit names of most mid range PICs are built into the software which allows the assembler to check that the correct combinations are used. For example ADIE is used with INTCON for the 16C711 and PIE1 for the 16F877 a tricky mistake to find which most assemblers miss. The programming is performed at normal 5 volts and then verified with ±10% applied to ensure that the device is programmed with a good margin and not poised on the edge of failure.

Universal Mid Range PIC Programmer
with Experimenting with the PIC16F877
and universal PIC software suite. £129.50
Experimenting with PIC Microcontrollers (optional). £23.99
UK Postage and insurance. £7.50
(Europe postage & Insurance. . . . £9.50. Rest of world . . . . £15.50)

Experimenting with the PIC16F877

This book is supplied with the universal programmer. We start with the simplest of experiments to get a basic understanding of the PIC16F877 family. Then we look at the 16 bit timer, efficient storage and display of text messages, simple frequency counter, use a keypad for numbers, letters and security codes, and examine the 10 bit A/D converter.

Experimenting with PIC Microcontrollers

This book concentrates on the PIC16F84 and PIC16C711, and is the easy way to get started for anyone who is new to PIC programming. We begin with four simple experiments, then having gained some practical experience we study the basic principles of PIC programming, learn about the 8 bit timer, how to drive the liquid crystal display, create a real time clock, experiment with the watchdog timer, sleep mode, beeps and music, including a rendition of Beethoven's *Für Elise*. Finally there are two projects to work through, using the PIC to create a sinewave generator and investigating the power taken by domestic appliances.

Book: Experimenting with PIC Microcontrollers. £23.99
16F84/711 Programmer Module with 84/711 software. £62.51

Ordering Information

Telephone with Visa, Mastercard or Switch, or send cheque/PO for immediate despatch. All prices include VAT if applicable. Postage must be added to all orders. UK postage £2.50 per book, £1.00 per kit, maximum £7.50. Europe postage £3.50 per book, £1.50 per kit. Rest of world £6.50 per book, £2.50 per kit.

Assembler for the PC

Experimenting with PC Computers with its kit is the easiest way ever to learn assembly language programming, simple circuit design and interfacing to a PC. If you have enough intelligence to understand the English language and you can operate a PC computer then you have all the necessary background knowledge. Flashing LEDs, digital to analogue converters, simple oscilloscope, charging curves, temperature graphs and audio digitising.

Book Experimenting with PCs. £21.50
Kit 1a 'made up' with software. £45.00
Kit 1u 'unmade' with software. £38.00

C & C++ for the PC

Experimenting with C & C++ Programmes uses a similar approach. It teaches us to programme by using C to drive the simple hardware circuits built using the materials supplied in the kit. The circuits build up to a storage oscilloscope using relatively simple C techniques to construct a programme that is by no means simple. When approached in this way C is only marginally more difficult than BASIC and infinitely more powerful. C programmers are always in demand. Ideal for absolute beginners and experienced programmers.

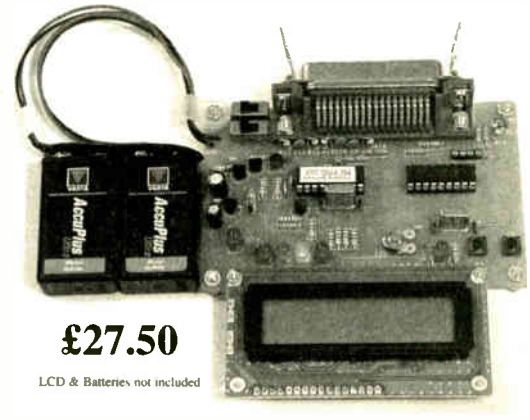
Book Experimenting with C & C++. £24.99
Kit CP2a 'made up' with software. £32.51
Kit CP2u 'unmade' with software. £26.51
Kit CP2t 'top up' with software. £12.99

The Kits

The assembler and C & C++ kits contain the prototyping board, lead assemblies, components and programming software to do all the experiments. The 'made up' kits are supplied ready to start. The 'unmade' Kits require the prototyping board and leads to be assembled and soldered. The 'top up' kit CP2t is for readers who have purchased a kit to go with the first book. The kits do not include the book.

Hardware required

All systems in this advertisement assume you have a PC (386 or better) and a printer lead. The experiments require no soldering.



£27.50

LCD & Batteries not included

Getting Started with Microcontrollers

This is supplied as a kit and builds into a high quality general purpose PIC16F84 programmer. You will need moderate PCB construction skills.

56 page book with construction details, circuit diagrams, flow diagrams, PIC data, 4 experimental programmes, and 5 exercises + software suite with text editor, assembler, disassembler, simulator and programming software + programmer module in kit form.....£27.50 total plus £2.50 postage.

Liquid crystal display optional extra. . . . . £9.00 inc.
ZIF socket (not shown) optional. . . . . £8.00 inc.

Mail order address:

Brunning Software 138 The Street, Little Clacton, Clacton-on-sea, Essex, CO16 9LS. Tel 01255 862308

World Radio History

PRACTICALLY SPEAKING

Robert Penfold looks at the Techniques of Actually Doing It!

PROBABLY one of the biggest disincentives to actually "taking the plunge" and building your first project is the fear of failure. It almost certainly acts as a deterrent to those who have some experience at electronic project construction, and wish to build more ambitious projects than they have attempted in the past.

In both cases the fears are not totally unfounded in that things can go wrong and there is no guarantee that a completed project can be made to function. On the other hand, the chances of success are very good these days.

In the past some methods of construction were not particularly reliable, and there were a few dodgy components on sale. Modern construction methods are relatively easy to copy, and faulty components are extremely rare indeed.

Tarnished Oldies

It is perhaps worth making the point that most of the recently published designs are checked far more thoroughly than some of those published in the past. The record of *EPE* over the years is very good in this respect, but if you "dig up" an old design from another magazine it might have a fair sprinkling of errors.

It is unlikely that there will be anyone willing or able to assist with corrections, so you are on your own with this type of thing. Even if you are a fairly experienced constructor and the parts for an old project can still be obtained, it has to be regarded as a risky venture.

Wherever possible stick to projects that have been published in the last couple of years or so.

Simple Life

Even if you do restrict yourself to recent designs, things can still go wrong if you do not proceed with care and attention. However, most problems are easily spotted and sorted out.

An important piece of advice for beginners at practically any creative hobby is to remember that it is not a race. There is a temptation to rush the job in an attempt to get the finished article as soon as possible. The aim should be to make a neat job of things and get everything right, rather than to finish as soon as possible.

Another temptation for beginners is to start off with a grandiose project that will impress the family and friends. With modern construction methods a large project is not necessarily that much harder to build than a small project, but it is still advisable to start with something fairly simple and straightforward.

The smaller the project, the less the risk of an awkward problem occurring or a mistake being made. The chances of success may not always be massively improved, but they will still be significantly enhanced.

It is certainly worth repeating the warning that *beginners* should *not* build mains powered projects. Battery powered projects should be safe to build, and equally safe to fault-find if the finished unit fails to perform. Mains powered projects are risky to build unless you know exactly what you are doing, and even more risky to check for faults – the mains can kill!.

Heat of the Moment

Having built a project, if it clearly fails to work when it is first switched on it is not a good idea to leave it switched on. There could be a fault that is causing high currents to flow somewhere in the circuit, and this could easily lead to some expensive damage unless the power is switched off fairly rapidly.

If there is the characteristic smell of hot components and the circuit is only intended to operate at low power levels, not only should the unit be switched off, but it should not be switched on again until the likely cause of the problem has been located and corrected.

If you have a multimeter it is good idea to check the current consumption when initially trying out a new project. In cases where the current flow is clearly "over the top", switch off at once. If the current flow seems reasonable but the project does not work properly, it should be safe to leave the unit switched on so that some further checks can be made.

Being realistic, a beginner will not have the necessary technical expertise to make a full range of meaningful voltage checks to track down the problem. Even so, a multimeter is more than a little useful when trying to locate faults. You can check that the supply is making it to the on/off switch, and getting past the on/off switch when the unit is switched on.

Faulty components are rare these days, but battery clips that do not connect properly are not exactly a rarity, and some "cheap and cheerful" switches are perhaps a little less consistent than they should be. With a multimeter you can also check that the supply is reaching the appropriate places on the circuit board, such as the supply pins of the integrated circuits.

A multimeter usually has a continuity tester setting that can be used to check for unwanted short circuits and breaks in wiring or copper tracks on circuit boards. The cheapest of analogue or digital instruments is adequate for this type of thing.

Clean Sweep

Experience shows that the most likely place for faults to occur is on the underside of the circuit board. Circuit boards have become more intricate over the years, with ever more connections crammed into smaller areas. This has greatly increased the risk of short circuits between copper tracks due to small blobs or trails of excess solder.

Really, the circuit board should be cleaned and thoroughly checked for short circuits before it is installed in its case. If this check was not made previously, then it should certainly be carried out early in the proceedings when a new project fails to work. Some dismantling of the project will be required, but it is essential to get good access to the underside of the board in order to check it properly.

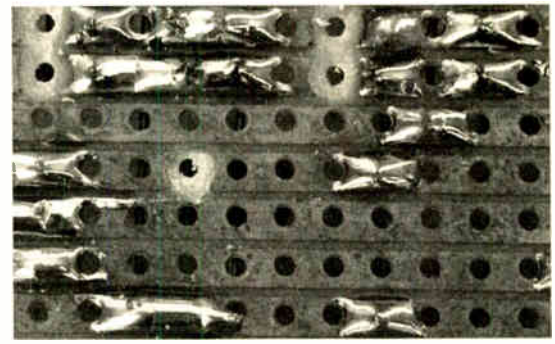


Fig.1. The break just left of centre looks a little dubious, and is!

Excess flux tends to accumulate on the underside of circuit boards, making it difficult to see small pieces of excess solder. Clean away all the excess flux using one of the special cleaning fluids that are available, or simply scrub the underside of the board using an old toothbrush. This second method has the advantage that it will probably remove any loose pieces of solder that are causing problems.

With the board properly cleaned, and even if you have good eyesight, some solder blobs or trails might be almost impossible to spot. A loupe or magnifying glass greatly increases the chances of finding any solder bridges. Search the board methodically so that any short circuits that are present will not be overlooked. If you have a continuity tester or a multimeter with this facility, use it to double-check for short circuits.

Any solder bridges that are found can usually be wiped away with the hot tip of a soldering iron. Alternatively, they can be carefully cut away using a modelling knife.

While inspecting the board keep an eye out for any other problems. In the case of a stripboard, have all the breaks in the strips been cut properly, or are there one or two thin lines of track left in place?

In Fig.1, the break just to the left of centre looks suspicious due to its lack of symmetry. There is actually a very thin line of copper still in place just above the supposed break. That is quite sufficient to maintain continuity.

World Radio History

Modern components and solders make it difficult to produce bad soldered joints, but not impossible. If any joints have an odd appearance, with an asymmetric shape or a dull crazed finish it would be as well to remove the solder and redo the joint.

Some printed circuit boards have extremely fine tracks. Are there any cracks or other breaks in the tracks? A continuity tester can be useful for checking for a proper connection through any "weakest links" in the copper track.

Do some of the joints have an obvious shortage of solder, or have any joints been missed out altogether? Redo any joints where you have been a bit economic with the solder.

Check and Check Again

When you are sure there are no problems on the underside of the board, reassemble the project and recheck the component layout. Are components such as electrolytic capacitors, diodes, transistors and integrated circuits fitted the right way round?

Carefully check the markings on the components against the polarities and orientations shown in the component overlay. With most components the correct orientation is fairly obvious, but we are all capable of making the odd error here and there. With transistors, have any of the leadout wires become crossed over and fitted in the wrong holes?

The markings on most integrated circuits are perfectly clear, but some have extraneous labels and moulding marks that can confuse matters. Look carefully to make sure that the notches, dimples, and lines that indicate pin one really are what you think they are. If in doubt, examine the chip using a loupe or magnifying glass. With a careful visual inspection you should be able to see which marks are "the real thing".

Getting Physical

If there are any link-wires, make sure that they join the right pairs of holes. Check every component to make sure that each one is in the right place. Try giving each component a firm tug. This will often bring to light any "dry" or missing joints, with one lead of the component pulling free of the board. It will also show up any components that have suffered major physical damage.

Most components are physically very tough, but there are some exceptions. In particular, you need to be careful when dealing with glass bodied diodes and open construction capacitors, such as some printed circuit mounting types (see Fig.2). Try to avoid bending the leadout wires close to the body of glass cased diodes, since this can result in the lead breaking away. Avoid doing anything that puts a strain on the glass body.

With the uncased capacitors there are two potential problems. Any outward pressure on the leads tends to tear them away from the body of the component. Taking too long when soldering them into place produces a similar result with the leads effectively being desoldered from the body.

Modern uncased capacitors are tougher than those from a few years ago, but care still has to be exercised when fitting them on a circuit board. If any forming of the leads is required in order to fit them in place, proceed carefully, holding the leads in place on the body.

Do any of the components show signs of overheating? Taking too long to solder components in place can damage them even though there may be little outward sign of any problems. If a component has been subjected to too much heat it will usually change colour slightly. Also, it will usually have a noticeably shinier or duller appearance.

Are there any components that show any of these signs when compared to similar components on the board?. It is probably worthwhile replacing any component that looks a little "off colour".

Testing – Testing

If you have a multimeter it should be capable of resistance measurements, and it may have other ranges that are suitable for component testing. Most test meters have a diode checking facility, and many also have a built-in transistor tester. If you are lucky there will also be capacitance ranges.

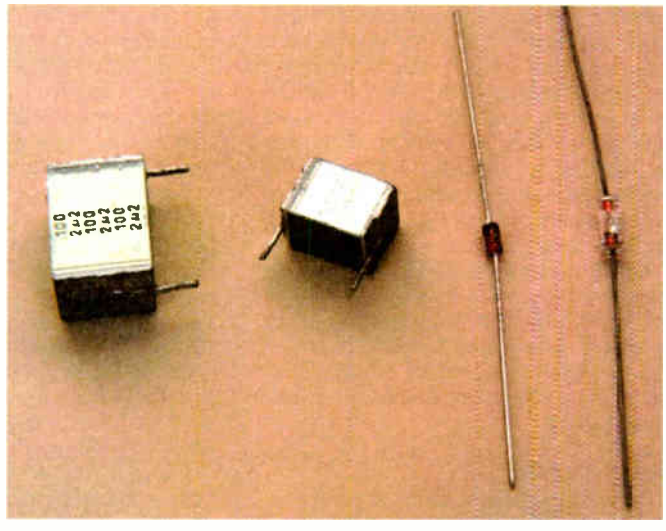


Fig.2. Uncased capacitors (left) and glass diodes are not the toughest of components.

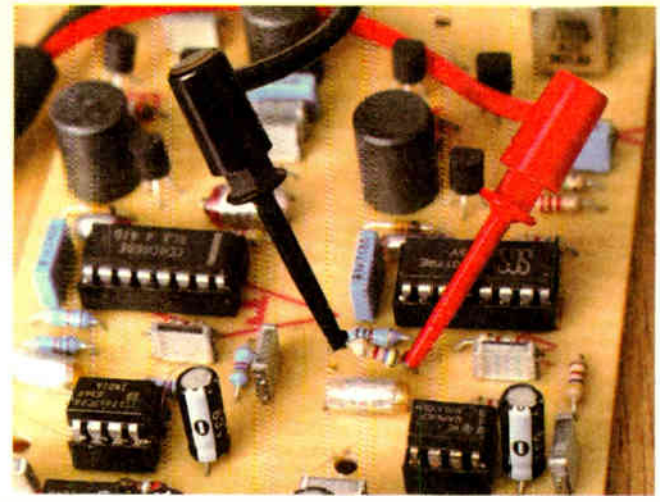


Fig.3. Semi in-circuit testing of a resistor.

Where possible, test any dubious looking components, but bear in mind that they cannot be tested in-circuit. With two-lead components at least one lead must be disconnected from the circuit board before a measurement is made, otherwise readings can be affected by other components in the circuit (see Fig.3). A few test meters have a simple in-circuit test facility for transistors. Where no in-circuit facility is available it is easier to completely remove devices from the board for testing, rather than leaving one lead connected to the board.

Careless errors can easily occur in the hard wiring, so it is well worthwhile checking this very thoroughly, making sure that every connection is present and correct. Where a project works to some extent, but some of the controls seem to work erratically or not at all, the hard wiring is the first place to start checking.

Many constructors find it helpful to check each wire against the wiring diagram and then mark it on the diagram. Where there is a lot of wiring this makes it easier to spot any missing connections.

Rotary switches are a common cause of problems. It is easy to get all the connections to the outer ring of tags shifted by one tag, so check this point very carefully. Do the switches simply operate the opposite way round to what you were expecting (on is off, etc.)?

Finally

Errors in electronics publications are relatively rare these days, but they can still occur. If a project is giving problems it is a good idea to check later issues of the magazine for corrections.

If there seems to be a major discrepancy between the circuit diagram and the wiring and layout diagrams, the publisher will often be able to supply a quick answer if there is a problem. In most cases though, if your project accurately matches the published design it will work. When dealing with a problem project it helps to keep this in mind.

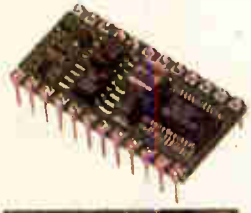
World Radio History

CONTROL & ROBOTICS

Milford Instruments

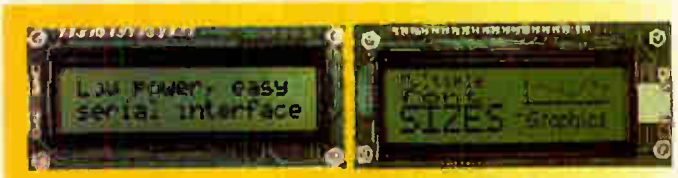
BASIC Stamp Microcontrollers

Still the simplest and easiest way to get your project or development work done. BASIC Stamps are small computers that run BASIC programmes. With either 8 or 16 Input-Output pins they may be connected directly to push-buttons, LEDs, speakers, potentiometers and integrated circuits such as digital thermometers, real-time clocks and analog-digital converters. BASIC Stomps are programmed using an ordinary PC running DOS or Windows. The language has familiar, easy-to-read instructions such as FOR...NEXT, IF...THEN and GOTO. Built-in syntax make it easy to measure and generate pulses, read push-buttons, send/receive serial data etc. Stamps from **£25** (single quantities), Full development kits from **£79**



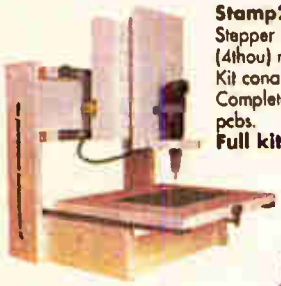
Full information on using BASIC Stamps plus lots of worked projects and practical electronics help. CD-ROM also includes 30+ past magazine articles and Stamp software. **£29.95**

New to PICs or just wanting to learn more tricks? We stock the excellent PIC primer books from David Benson- suitable for the complete beginner to the advanced user.



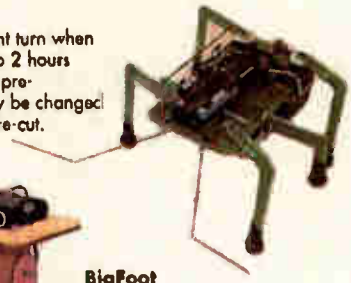
SERIAL LCDs

Bannish the hassle of interfacing to LCD displays. We stock a comprehensive range of alphanumeric and Graphic LCDs - all with an easy-to-use standard RS232 serial interface. Sizes from 2x16 to 4x40 plus 128x64 graphic panels. Prices start at **£25** (single quantity)



Stamp2 based 3-axis machine
Stepper drive to X, Y and Z axes with 0.1mm (4thou) resolution.
Kit conains pre-machined frame components.
Complete with Windows software for drilling pcbs.
Full kit at £249, Part kit at £189

StampBug
Stamp1 based walking insect
Forwards,backwards and left/right turn when feelers detect object in path. Up to 2 hours roving from 4xAA Nicads. Chips pre-programmed but programme may be changed (software supplied). Body parts pre-cut.
Full kit £68



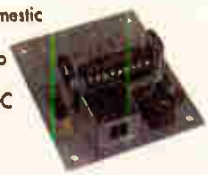
TecArm4
New range of robotic arms for educational and hobbyist use with super powerful servos. Controlled from PC (Windows freeware provided) or from optional keypad. Stands about 450mm high when fully extended. Kit includes all pre-cut body parts, servo controller board, servos and software. Requires 9v Dc. Kits start at **£189**

BigFoot
Stamp1 based walking humanoid
Walks forwards/backwards with left and right turn when detects obstacles. Electronics pcb pre-built and tested. Programme pre-loaded but may be changed with supplied software.
Full kit £68

Alex- Animated Head
Stamp2 based controller with voice record-playback capability, PIR input and/or random playback. 4-servo actions are recorded/edited one track at a time. May also be controlled from PC.
Head kits start at £29. Controllers from £29

On Screen Display
Superimpose text onto standard CCTV from simple RS232 serial line.
Ready built/tested at **£59**

IR Decoder Board
Control your project using a standard domestic IR remote.
7 Output lines (5v @ 20mA) may be set to momentary or toggle action.
Simple teaching routine. Requires 9-12vDC
Supplied built and tested.
£29 single quantity



Servo Driver Board
Control up to 8 standard hobby servos from an RS232 serial data line using this controller board. Simple command structure holds servos in position until update is received. Fully built and tested- requires 9vDC and servos. Supplied with Windows freeware.
£29 single quantity. Optional keypad available.

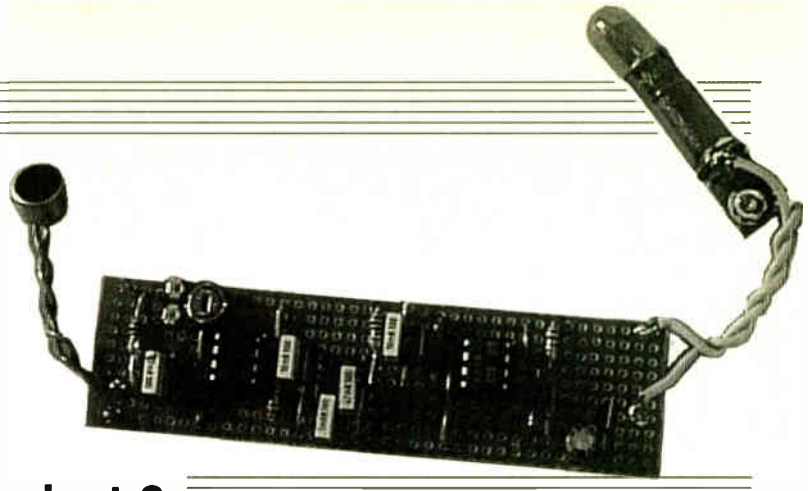
Milford Instruments
120 High Street, South Milford, LEEDS LS25 5AQ
Tel: 01977 683665 Fax: 01977 681465

All prices exclude VAT and shipping.
BASIC Stamp is the registered trademark of Parallax Inc. For further details on the above and other interesting products, please see our web site-
www.millinst.demon.co.uk

World Radio History

Top Tenners

SOUND TRIGGER



OWEN BISHOP — Project 8

This short collection of projects, some useful, some instructive and some amusing, can be made for around the ten pounds mark. The estimated cost does not include an enclosure. All of the projects are built on stripboard, and most have been designed to fit on to boards of standard dimensions. All of the projects are battery-powered, so are safe to build. In a few cases in which, by its nature, the project is to be run for long periods, power may be provided by an inexpensive mains adaptor. Again, the cost of such a unit is not included.

A sound-operated trigger has many applications. The circuit diagram in Fig.1. shows how it can be used to switch on a low voltage lamp. The lamp might be a porch lamp, or a child's bedside night-light, or a lamp on a dark stairway or corridor.

When the circuit is triggered by a sudden sound, the lamp comes on and stays on for about 50 seconds. This allows time for someone to negotiate the stairs or make their way along the corridor, or perhaps to find the switch of the usual lighting and turn it on. A lamp that comes on whenever a noise is heard in the vicinity is also an effective intruder deterrent.

In general, the circuit is most sensitive to a sharp, crisp sound, such as a handclap. It is less likely to be triggered by ordinary conversation or passing traffic.

SWITCHED ON

The output stage of this project is a MOSFET transistor, which is capable of switching up to 500mA. If the project is powered by a 12V supply, a low voltage filament lamp may be used to provide a reasonable amount of light. For brighter lighting, it is possible to substitute a more powerful lamp switched by a transistor such as a VN66AF, which switches up to 2A.

The circuit can be used for switching other electrical devices such as:

- An audible warning device such as an electric bell, a solid-state buzzer or a siren.
- A relay: use this to switch a more powerful lamp, or a motor.
- A model railway locomotive; the circuit is triggered by blowing a whistle, causing the locomotive to start.

The circuit can be run on a 6V supply for switching a device that operates at 6V.

HOW IT WORKS

The Sound Trigger circuit diagram of Fig.1 consists of six distinct stages, and most stages are coupled to the following stage through a capacitor. The first stage is the electret microphone, MIC1, which depends for its action on the changes in capacitance that occur between a fixed plate and a plate that is being vibrated by sound.

There are several kinds of capacitive microphone, but the electret type has a permanent charge across the capacitor, produced by heating the dielectric during manufacture while maintaining a strong electrical field between the plates. The microphone is then cooled and the electric charge remains.

An electret microphone includes an f.e.t. amplifier and requires a current to power it. This is supplied through resistor R1. A voltage signal is generated across the microphone when sound is detected and this signal passes across the capacitor C1 to the operational amplifier, IC1.

AMPLIFIER

This amplifier, which has f.e.t.. inputs, is used in inverting mode with its gain set by the ratio of resistors R2 and R3 to 100.

The trimmer potentiometer VR1 is used to adjust the voltage at the non-inverting (+) input to make it equal to the steady voltage at the inverting (–) input in the

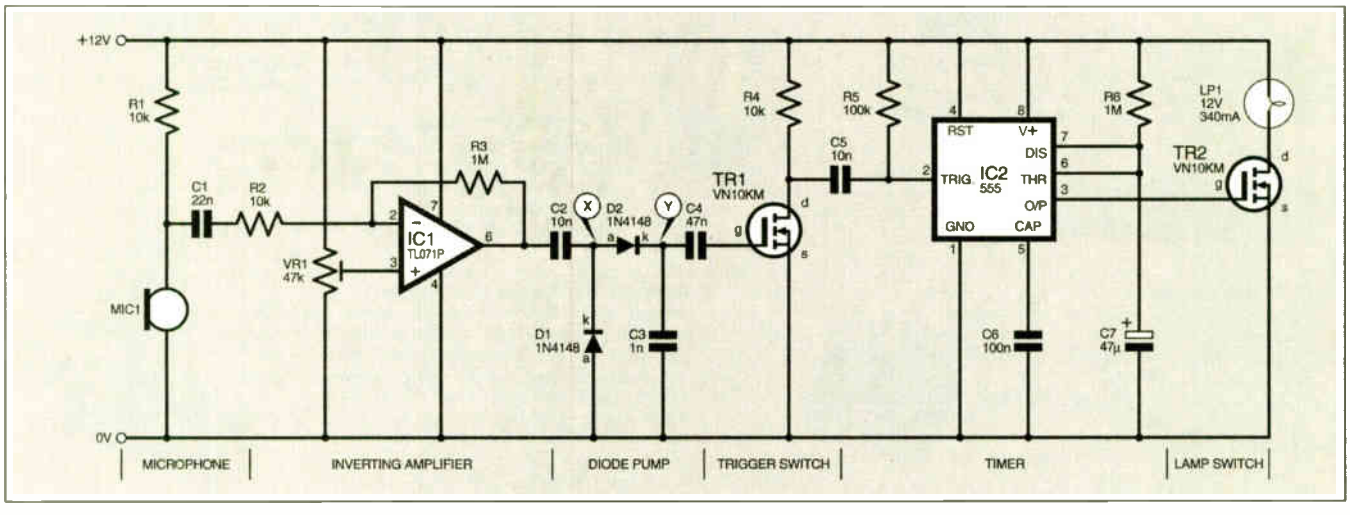


Fig.1. Complete circuit diagram for the Sound Trigger showing the six distinct stages.

World Radio History

absence of sound. The output of the amplifier then sits midway between the two power rails.

When sound is received, the output voltage of the amplifier (at pin 6) swings above and below the midway voltage. This alternating signal passes across capacitor C2 to the next stage.

DIODE PUMP

A single positive swing of the output of the op.amp is too short to trigger the timer, and is cancelled when the voltage swings negative. To avoid this cancelling, we use a "diode pump" to rectify the signal and to produce a cumulative effect.

The action of this depends on two facts:

- Current can flow through a diode in only one direction (apart from a relatively small reverse leakage current).
- When the voltage on one plate of a capacitor is changed suddenly, the voltage on the other plate immediately changes by the same amount and in the same direction.

Consider point X at the junction of diodes D1 and D2, see Fig.1. As the voltage from the op.amp (IC1) swings in the positive direction, the voltage at the junction of capacitor C2 and diode D2 (point X) swings positive by the same amount. Current flows through diode D2 and a charge builds up on capacitor C3, causing the voltage at Y to rise. Because of the charge gradually flowing away through D2, the voltage at X does not rise as high as that of the output of IC1.

When the voltage of the output of IC1 swings low, the voltage at X swings in the negative direction, by *the same amount*. Because X was previously at a lower voltage than the output, this takes X down to a negative voltage. Therefore, current now flows through diode D1 from the 0V line. The voltage on the plate rises towards 0V. On the other hand, the charge that has accumulated on capacitor C3 cannot flow back again through D2.

The overall effect is that the flows of current through the diodes raise the voltage at X as well as the voltage at Y. The two voltage rises are in series, so are added together. The alternating output from the op.amp is converted to a sustained signal of approximately double the peak voltage.

The multiple vibrations of a burst of sound (for example, a blast on a whistle) result in a continuous high voltage developing at Y. In other words, a positive pulse is generated, which switches on MOSFET TR1 via C4.

TIMER

When transistor TR1 is switched on the voltage at its drain (d) terminal falls from +12V to below +4V, which is enough to trigger timer IC2. This is wired as a monostable multivibrator, which then produces a single high output pulse from pin 3. This in turn switches on a second transistor TR2 and current flows through the lamp LP1.

The length of the pulse from IC2 depends on the values of R6 and C6 according to the equation:

$$t = 1{\cdot}1RC$$

With the values given in Fig. 1, the pulse lasts for just over 50s. For other applications, you can select different pulse lengths by choosing appropriate values for R6 or C6.

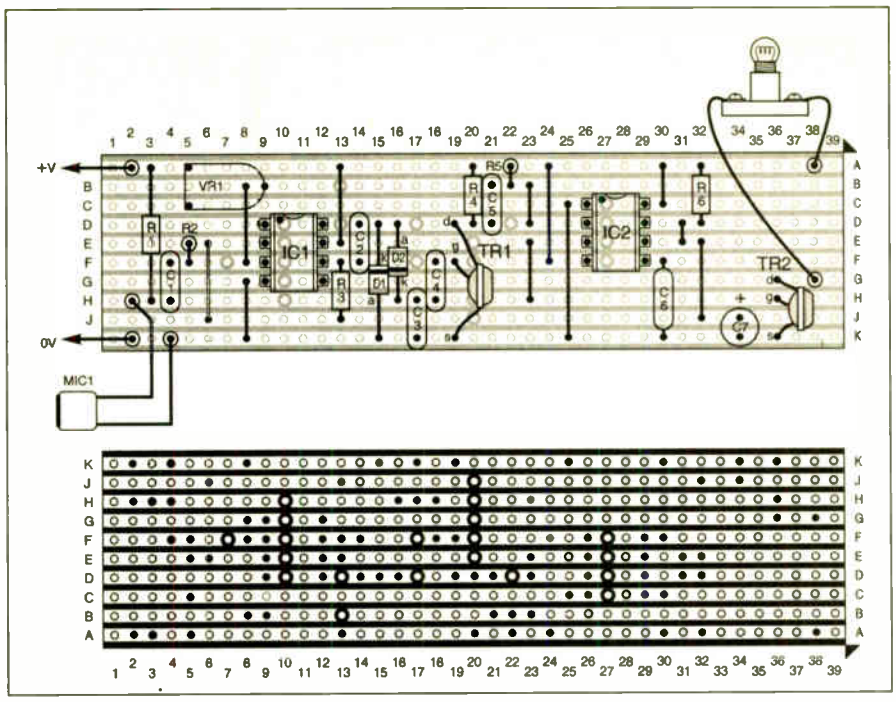


Fig.2. Sound Trigger stripboard component layout, wiring to microphone insert and lampholder, and details of breaks required in copper tracks.

POWER SUPPLY

The circuit takes around 340mA when the lamp is lit. It is, therefore, best powered by a heavy-duty battery, such as two 6V lantern batteries in series.

It will run for just over 200 hours using four D-type alkaline cells in a battery holder. Alternatively, use a 500mA 12V d.c. unregulated mains adapter. For other applications, it may be operated on a 6V supply and then requires less current.

CONSTRUCTION

This simple Sound Trigger is built on a small rectangle of 0·1in matrix stripboard, size 10 copper strips by 39 holes. (Note there is no row *I*.) The component layout, wiring and details of breaks required in the copper tracks are shown in Fig.2. The board layout is fairly straightforward and assembly should cause no problems. The use of i.c. sockets is recommended for IC1 and IC2.

It is best to build the Sound Trigger stage-by-stage, starting with the microphone stage, and testing the output of each stage as you go. Depending on the exact type of microphone used, there is a preferred working voltage, which is obtained by using a suitable value for resistor R1.

The microphone used in the prototype had a preferred voltage of 4·5V, but could be operated over the range 1·5V to 12V. There is a reasonable amount of adaptability here; with the 10 kilohms dropping resistor (R1) the voltage across MIC1 was found to be 7·8V, which is within the acceptable range.

Checking the operation of the circuit is easy if you have an oscilloscope, but its responses can be detected quite well using a digital multimeter. At this stage, tapping the microphone results in very small but irregular variations of voltage at the junction between R1 and MIC1. If you fail to detect a signal, do not worry at this stage.

COMPONENTS

Resistors

R1, R2, R4	10k (3 off)
R3, R6	1M (2 off)
R5	100k

All 0·25W 5% carbon film or better

See SHOP TALK page

Potentiometer

VR1	47k miniature carbon preset, horizontal

Capacitors

C1	22n polyester film
C2, C5	10n polyester film (2 off)
C3	1n polyester film
C4	47n polyester film
C6	100n polyester
C7	47µ radial elect. 35V

Semiconductors

D1, D2	1N4148 silicon diode (2 off)
TR1, TR2	VN10KM, MOSFET *n*-channel transistor (2 off)
IC1	TL071CP, operational amplifier, bi-f.e.t. inputs
IC2	555 timer

Miscellaneous

MIC1	electret microphone insert
LP1	12V 340mA filament lamp

Stripboard, size 10 strips × 39 holes; 1mm terminal pins (5 off); 8-pin d.i.l. i.c. socket (2 off); lamp socket (MBC or to fit LP1); battery holder or connector for d.c. supply unit; connecting wire; solder, etc.

Approx. Cost Guidance Only **£8** *excluding batts.*

World Radio History

Adding the inverting amplifier gives a larger signal.

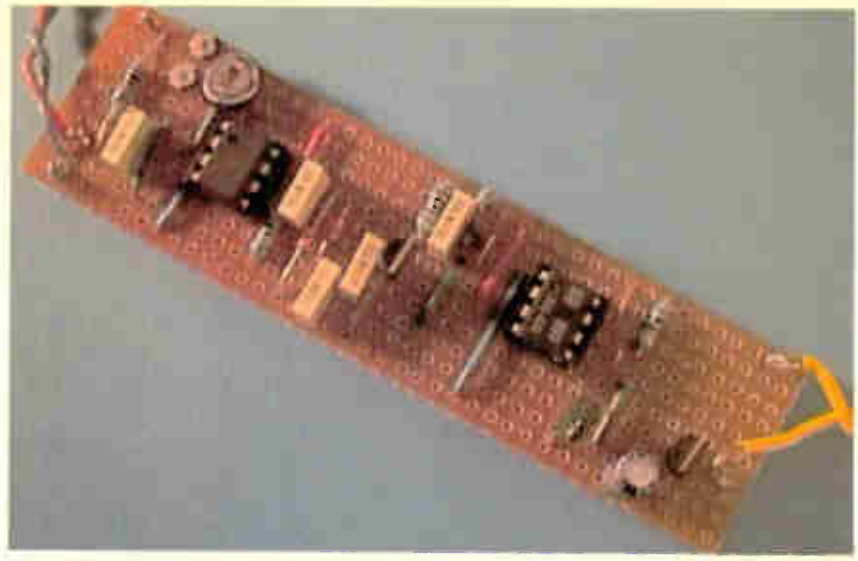
AMPLIFIER

Next, build the amplifier stage (IC1). The purpose of preset VR1 is to allow the voltage at the (+) input of IC1, at pin 3, to be set to equal the quiescent voltage at the (–) input (IC1 pin 2). It also has the function of adjusting the sensitivity of the circuit.

With the two input voltages exactly equal, the output voltage at IC1 pin 6 is close to 6V. This allows sound to make the output swing freely in either direction and gives the most sensitive setting.

As the action of the diode pump depends on the amount of voltage swing, restricting the swing reduces the pumping action. Setting the output voltage higher or lower restricts the amount by which it can swing, so reducing sensitivity. For the present, adjust preset VR1 to bring the output of the op.amp as close as possible to 6V.

When adding the diode pump stage, take care to get the diodes the right way round. They usually have a black band around them at the cathode end (marked *k* in the diagrams). Test the "pump" by monitoring the voltage at point Y. It normally rests at a few tens of millivolts above zero but rises sharply to 5V or more when the microphone is tapped. A digital meter may not readily detect this unless it has a "record" function, but the peak is easy to see on an oscilloscope.



Close-up of the completed circuit board showing the general layout of components.

ON TIME

The next stage is the timer. Before inserting IC2 in its socket, check the voltages at the socket for pin 2. This is normally very close to 12V, with a sharp drop to around 4V when the microphone is tapped. This downward spike is hard to detect with a multimeter.

Insert IC2 in its socket and check that its output at pin 3 rises from 0V to 12V when the microphone is tapped. If it does not, suspect the connections to pin 2 through C4, TR1 and C5.

The circuit will certainly need some checking and preset VR1 may need setting, so it is advisable to solder a 100kΩ resistor (or any other close value) in parallel with resistor R6. This shortens the "on" time to 5s, and makes testing much speedier.

When completed, the circuit responds to claps, bangs and whistles at distances of a few metres from the microphone. It also responds to spoken phrases at distances of around half a metre. □

BK ELECTRONICS

A COMPLETE RANGE OF
INVERTERS
150W TO 1000W - 12V & 24V

A Complete range of regulated inverters to power 220V and 240V AC equipment via a car, lorry or boat battery. Due to their high performance (>90%) the inverters generate very little heat. The high stability of the output frequency (+/-1%) makes them equally suitable to power sensitive devices.

These inverters generate a modified sine wave, which are considerably superior to the square waves which are produced by most other inverters. Due to this superior feature they are capable of powering electrical equipment such as TV,s, videos, desktop & notepad computers, microwave ovens, electrical lamps, pumps, battery chargers, etc.

Low Battery Alarm

The inverters give an audible warning signal when the battery voltage is lower than 10.5V (21V for the 24V version). The inverter automatically shuts off when the battery voltage drops below 10V (20V for the 24V version). Fuse protected input circuitry.

Order Code	Power	Voltage	Price
651.581	150W Continuous	12V	£38.49
651.578	150W Continuous	24V	£38.49
651.582	300W Continuous	12V	£54.36
651.585	300W Continuous	24V	£54.36
651.583	600W Continuous	12V	£118.42
651.593	600W Continuous	24V	£118.42
651.587	1000W Continuous	12V	£174.60
651.597	1000W Continuous	24V	£174.60

ILLUSTRATION SHOWN IS 651.583 600W VERSION

All prices are inclusive of V.A.T. Carriage £6.00 Per Order

Many uses include:- . Fetes . Fairgrounds . Airshows . Picnics . Camping . Caravans . Boats . Carnivals . Field Research and . Amateur Radio field days * Powering Desktop & Notepad Computers.

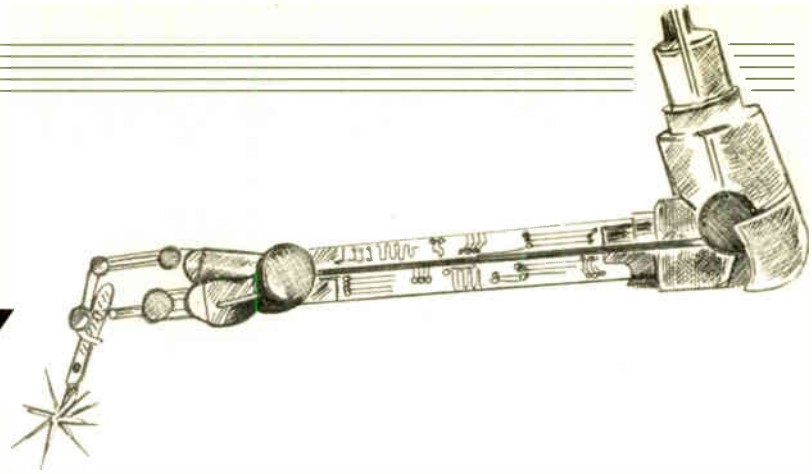
DELIVERY CHARGES ARE £6-00 PER ORDER. OFFICIAL ORDERS FROM SCHOOLS, COLLEGES, GOVT. BODIES, PLC,S ETC. PRICES ARE INCLUSIVE OF V.A.T. SALES COUNTER. VISA AND ACCESS ACCEPTED BY POST, PHONE OR FAX, OR EMAIL US AT SALES@BKELEC.COM ALTERNATIVELY SEND CHEQUE OR POSTAL ORDERS MADE PAYABLE TO BK ELECTRONICS.

B.K. ELECTRONICS
UNIT 1, COMET WAY, SOUTHEND-ON-SEA, ESSEX. SS2 6TR
TEL.: +44(0)1702-527572 FAX.:+44(0)1702-420243

For Full Specifications View our web site at:-
WWW.BKELEC.COM/INVERTERS.HTM

World Radio History

CIRCUIT SURGERY



ALAN WINSTANLEY and IAN BELL

Bravely our surgeons explore the depths of phase-locked loops, or skim the surface anyway.

LAST month we looked at the basic principles of phase-locked loops (PLLs) in response to reader ***Malcolm Wiles***' request. His colleagues would spend their lunchtimes in the pub talking about PLLs but Malcolm never found out what they were until now!

As he suspected, they are pretty useful devices, but they can be quite complex – so there's plenty to talk about (and a vast volume of books and academic papers on the subject if you care to look . . .)

PLLs Continued . . .

This month we will take a look at the 4046, a 16-pin PLL chip from the 4000 CMOS logic series, which is probably one of the most popular PLL devices amongst those hobbyists who use them. The pin-out of the 4046 is shown in Fig. 1, whilst Fig. 2 shows an internal block diagram and the connection of the key external components required in even the most basic 4046-based PLL.

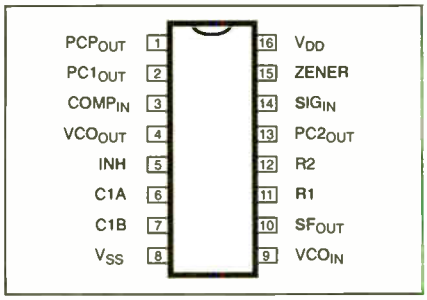


Fig.1. Pinout details for the 4046 CMOS phase-locked loop i.c.

You will recall from last month's column that the main parts of a PLL are the phase comparator, the VCO and the low-pass filter. The 4046 contains the first two of these (in fact there are two phase comparators to choose from); however, the low-pass filter is made using external components (resistor R3 and capacitor C2 in Fig. 2).

Pin 10 (SF_{OUT}) provides a source follower from the low-pass filter output (VCO input), so that this signal appears as the voltage across R_{SF} and can be used elsewhere in your circuit without loading the filter. If pin 10 is not used it should be left open-circuit (i.e R_{SF} is not required).

Pin 15 is connected to an internal Zener diode of about +7V. This may seem a bit strange, but the 4046 is very sensitive to supply voltage variation and the Zener is provided in case it is needed to help regulate the supply to the chip.

Locking On

To use the PLL you need to decide on the "lock" range frequencies (which determines the VCO frequencies and hence C1, R1 and R2), the low-pass filter values (R3 and C2), and which phase comparator to use. None of this is trivial but we do not have the space here to discuss it in great detail.

If you want to get the best out of the 4046 you need to consult the data sheets and application notes from the manufacturers. These are usually available from their web sites, for example going to **www.philips.com** and searching for 4046 or HEF4046B should get you access to data sheets in Adobe Acrobat PDF format. You will need Acrobat Reader for this, and if it is not already on your system it is available as a free download from **www.adobe.com**.

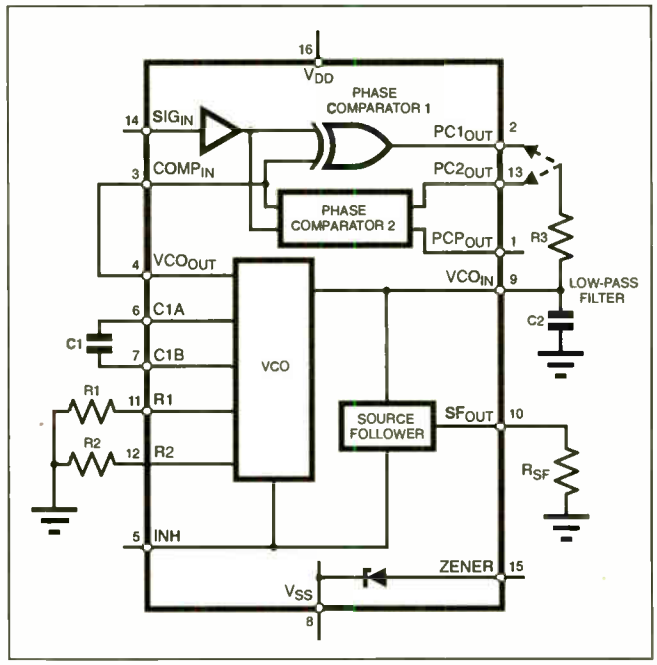


Fig.2. Block schematic of the internal structure of the 4046 phase-locked chip, together with external low-pass filter components (R3 and C2).

That's Typical

In a typical PLL design, you will know either the VCO centre frequency (f_o, which it produces when the control voltage is around half the supply voltage), or you will know the required lock range (f_{min} to f_{max}), which will be centred on the VCO centre frequency.

If you know f_{max} you can select suitable values for resistor R2 and capacitor C1 using graphs provided on the data sheet. The ratio R2/R1 is related to the ratio f_{max}/f_{min} so now you have R2 (and assuming you know f_{min}) you can select R1 using another graph given in the data sheet.

The VCO can also be operated in "no offset" mode with R2 open circuit. In this case you set f_{max} as twice the VCO centre frequency and select R1 and C1 from yet another graph on the data sheet.

The two phase comparators operate on different principles and have different characteristics, benefits and potential problems. Phase comparator 1 is simply an XOR gate as depicted by the internal circuit diagram of the 4046 (Fig.2.). The waveforms associated with it are shown in Fig. 3a.

World Radio History

The VCO output is connected directly to the phase comparator reference input ($COMP_{IN}$) on pin 3. The input signal itself should be capacitively coupled to the signal input (SIG_{IN}) on pin 14. When using phase comparator 1, the signal and reference inputs must both have 50 per cent duty cycle in order to achieve the maximum lock range.

Phase Two

Phase comparator 2 is more complicated than phase comparator 1. It is a *state machine* which changes state when logic transitions occur on either the signal or reference inputs. Depending on the current state of phase comparator 2, it outputs a logic 1, a logic 0 or a high impedance state.

Table 1: Phase Comparator 2 output truth table

Signal frequency (f) and phase (Φ)	*$PC2_{OUT}$*	*PCP_{OUT}*
$f_{signal} > f_{reference}$	Mainly 1	Mainly 0
$f_{signal} < f_{reference}$	Mainly 0	Mainly 0
$f_{signal} = f_{reference}$ Φ_{signal} lags $\Phi_{reference}$	Mainly 1	Mainly 0
$f_{signal} = f_{reference}$ Φ_{signal} leads $\Phi_{reference}$	Mainly 0	Mainly 0
$f_{signal} = f_{reference}$ $\Phi_{signal} = \Phi_{reference}$ PLL is locked	High impedance	1

Table 2: Phase Comparators Compared

Property	*Phase Comparator 1 (pin 2)*	*Phase Comparator 2 (pin 13)*
Lock range	Full VCO range f_{min} to f_{max}	Full VCO range f_{min} to f_{max}
Capture range	Depends on low-pass filter	Equal to lock range
Signal noise rejection	Good	Poor
Will it lock on harmonics of f_o?	Yes	No
Effect of input duty cycle	Best performance at 50%	Does not matter
Output when fully out of lock	f_o (the VCO centre frequency)	f_{min}

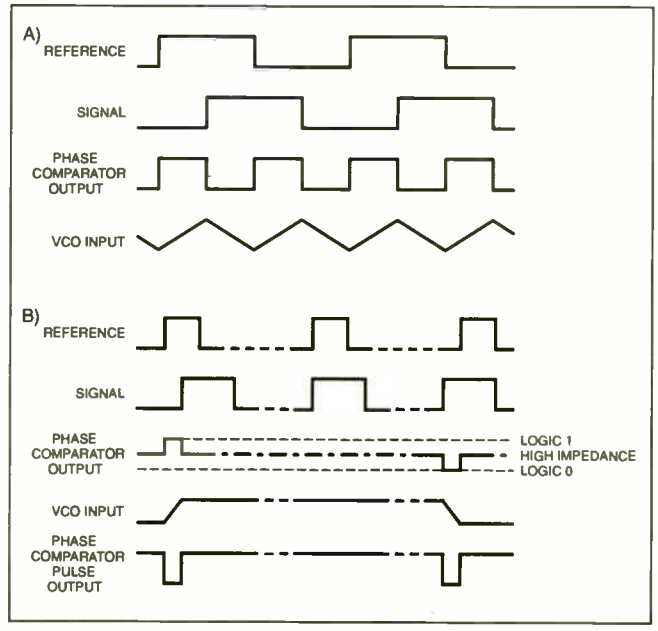


Fig.3. (a) Phase comparator 1 typical waveforms and (b) some typical waveforms for phase comparator 2.

In effect phase comparator 2 produces two bursts of pulses to charge or discharge the filter capacitor as required, but is otherwise disconnected from the filter.

Phase comparator 2 also has another output called PCP_{OUT} (phase comparator pulse output) on pin 1 which can be used to tell when the PLL is locked. Table 1 shows the outputs produced by phase comparator 2 under various conditions. Typical waveforms for phase comparator 2 are shown in Fig.3b. Some of the properties of the phase comparators are compared in Table 2.

Table 1 and Table 2 only scratch the surface when investigating phase-locked loop applications – 500-page text books are available showing much more of the same!

On Time

The loop filter should use the longest *RC* time possible for the application. This depends on the speed with which the input frequency changes.

If the *RC* time constant of the loop filter is too long the PLL will not move fast enough to track changes. If it is too short, the VCO frequency will jump around too much, in the worst case responding to individual cycles of the input signal.

The performance of the PLL can be improved by using a resistor in series with C2 (e.g. from the "negative" side of C2 in series to ground, but not shown on Fig. 2). This produces damping in the loop filter and makes the PLL more stable. A typical value for this resistor is about a tenth of the value of R3.

As you can see Malcolm, phase-locked loops can be as complex as you want to make them. We can't hope to cover them in any further depth in this column, and there's probably no substitute for testing typical device chips on a workbench armed with a signal generator and a good oscilloscope. At least you now have an introduction to them, and you'll be able to bluff your way through dinner time sessions with your hardware colleagues at the pub! *I.M.B.*

THE Revival COMPANY

seeks an

EXPERIENCED AV TECHNICIAN

in the Surrey area for a few hours work per week

Hours and rates negotiable

Please send CV to:

A. Dale
The Revival Co
Unit 6
4 Manorgate Road
Kingston
KT2 7EL
Tel: 020 8549 6465
Fax: 020 8541 5873
a.dale@revivalco.co.uk

CIRCUIT THERAPY

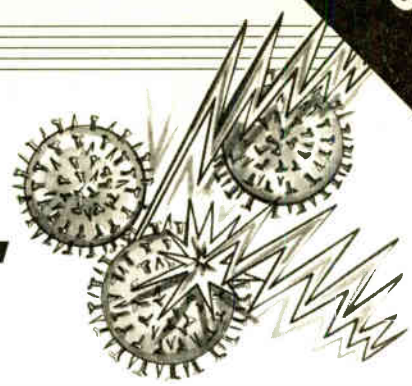
Circuit Surgery is your column. If you have any queries or comments, please write to: Alan Winstanley, *Circuit Surgery*, Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset, BH21 1PF, United Kingdom. E-mail (no attachments) **alan@epemag.demon.co.uk**. Please indicate if your query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

World Radio History

FREE SUPPLEMENT

Special Supplement

THE END TO ALL DISEASE



AUBREY SCOON

Can disease be cured electronically? A story involving electronics, blackmail, intimidation, government conspiracies, arson, vandalism, theft, bribery and murder!

NOBODY can deny that today's doctors know more than ever about the nature and effects of disease, but as technology advances, many people are all too aware that the results often pose more questions than they answer. The fact is, the more we know, the more obvious it becomes that there is even more that we don't know.

The growing migration to "alternative" therapies underlines this all too well. Nowadays an increasing number of people are turning to all kinds of seemingly strange therapies where the deficiencies of traditional medicine are all too obvious.

One area that has seen a revival in recent years is electrotherapy – the idea that disease can be cured through the application of electric, magnetic or electromagnetic fields. There are numerous weird and wonderful devices both on the market and in use today. Some are described in this article, but also, as will become clear, this is far from a new area and is simply a continuation of a trend that started in the late 1700s.

In the 18th century, static electricity was well known. Nobody knows who first proposed experiments to use it as therapy but it was not uncommon for major medical schools in Europe to conduct electric experiments on patients, particularly the poorer ones! This continued well into the 19th century and became all the more prevalent following Faraday's publication of his discovery of electromagnetic induction.

FRANKENSTEIN'S LAB

The early "therapies" in most cases were little more than applied electric shocks. Numerous interesting, novel and in some cases hilarious ways were found to generate and apply electric potentials, both static and alternating, which were applied seemingly haphazardly to patients.

The results were unpredictable to say the least. Many experiments failed badly, and in some cases the "therapy" was more successful at removing the patient permanently than the disease! However, there was at the same time a growing body of evidence that indicated that some of these "quack" cures actually did seem to improve the condition of seriously ill patients who had not responded to the traditional treatments.

The discovery of radioactivity, X-rays and Tesla coils only served to fuel this trend. There was a general perception that if something was mysterious, used hidden rays or energies and involved high technology (or even big sparks!) then, in true Frankenstein style, it had to be good. An attitude which is not entirely absent today! Hence it became almost common practice to expose patients to radiation, electric shocks and magnetic fields.

In Fig.1 is shown a 19th century sketch of a Clarke Machine, a typical generator which would apply a strong voltage to anyone holding two rods shown in the foreground. The operator would crank the machine while the patient held the rods – ouch!

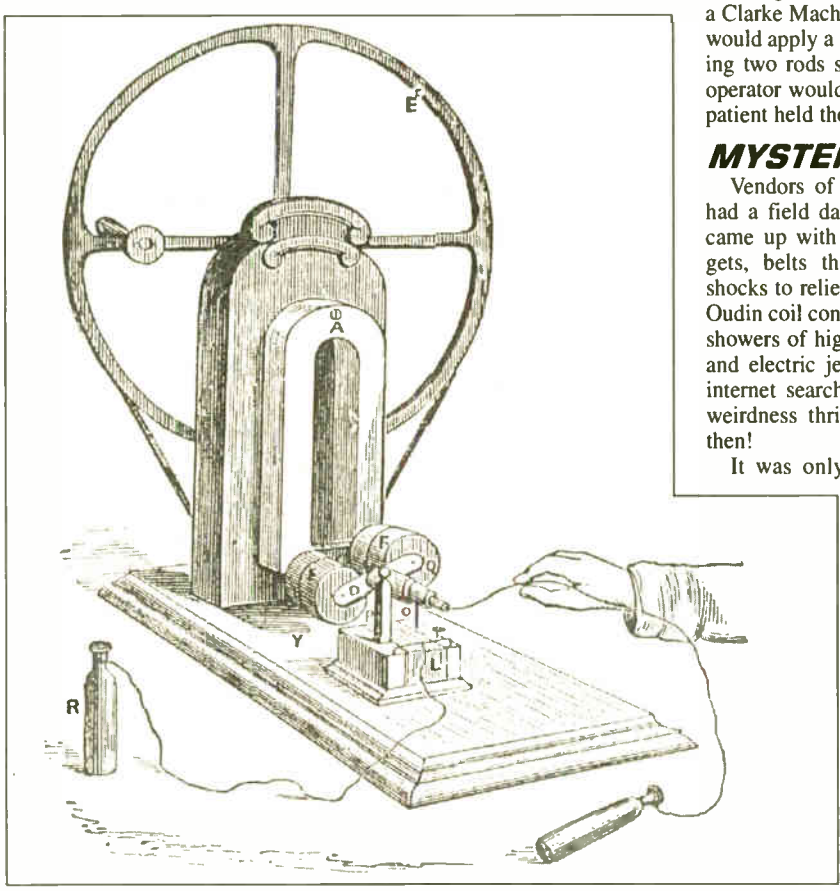


Fig.1. A 19th century sketch of a Clarke Machine, an electric generator which applied a strong voltage to anyone holding the two foreground rods.

MYSTERIOUS ENERGY

Vendors of "mysterious energy" devices had a field day with these machines. They came up with more and more bizarre gadgets, belts that gave the wearer electric shocks to relieve back pain, weird Tesla and Oudin coil contraptions that bathed people in showers of high frequency sparks, magnetic and electric jewellery and so on. A simple internet search will show that this kind of weirdness thrives as much today as it did then!

It was only a matter of time before it became obvious to anyone other than hard core fanatics that these kind of devices were at best useless and in most cases seriously dangerous. Amidst ever mounting calls for regulation, the medical establishment started to firmly entrench itself against this kind of quackery and eventually succeeded in slowing the sale and development of these devices. Unfortunately this was achieved more through suppression and intimidation rather than education.

World Radio History

NEW AGE OR OLD AGE?

Although there was a steady background trade in electrotherapy devices that continued, most people were unaware of it, and it was only in the 1960s when "new age" solutions to everything appeared that it took off again. Ironically, the "new" age material is far from new!

But the excesses of the late 19th and early 20th century had taken their toll. The medical establishment was now more vigilant than ever and ruthlessly determined to stamp out quackery. Unfortunately, this literal counter-reaction had the effect of reinforcing the idea that conventional medical techniques were the only ones worthy of consideration and that any mainstream qualified doctor knew better than anybody else, resulting in its own semi-fanatical mentality. And nobody can deny that many doctors today still show signs of this kind of attitude and are quick to condemn any alternative therapy that they know nothing about.

SUPPRESSION

The worst side effect of this attitude was the suppression of serious research into these therapies whilst many serious theories of the time appear ridiculous in the light of present day knowledge, at the time they deserved a better reception than they got. And, of course, the very real and compelling results obtained by many serious researchers were also ignored.

One or two of the old therapies have actually crept back into medical favour. But only after being introduced slowly and cautiously by conservative researchers who followed the proper protocols of placating the medical establishment.

What is more startling, however, and widely unknown, is that amongst all the snake oil and quackery of the old electrotherapies were a few gems that did not just seem to have a sound medical basis or benefit to them, but might potentially surpass the achievements of the best modern therapies in curing major diseases.

This article concentrates on one of them, a fascinating story about a potential cure for nearly all diseases that is a scientific detective story in itself, including, if it is to be believed, blackmail, intimidation, government conspiracies, arson, vandalism, theft, bribery and murder. It would make a great X-files plot but is truth really stranger than fiction?

A QUICK DISCLAIMER

Whilst I have tried to verify everything in this article that I can, the lack of objective material has meant that I have had to rely on second hand sources for a lot of material. I have not personally witnessed some of the effects claimed and present them here solely as a matter of interest.

ROYAL RAYMOND RIFE

Our story starts with a man called Royal Raymond Rife, pictured in Fig.2 (1960). Rife was not the first to experiment in this field, but his alleged results remain the most intriguing.

His history is sketchy at best, and is mainly reconstructed from his own notes, newspaper reports and anecdotes of his associates. Rife was born on 16 May 1888 in Elkhorn, Nebraska USA. No records remain of his early history (as far as I am aware) but his work became widely known around 1929.

In 1913 Rife was in Germany and was awarded an honorary PhD by the University of Heidelberg. During the course of the next seven years he supposedly spent further time in Europe performing work for the US Government and during this period he worked for a time for the Zeiss optical company. It is claimed that he was trained by Carl Zeiss himself. He later became famous for his development of advanced optical microscopes. By 1920, he ended up living in San Diego, California.

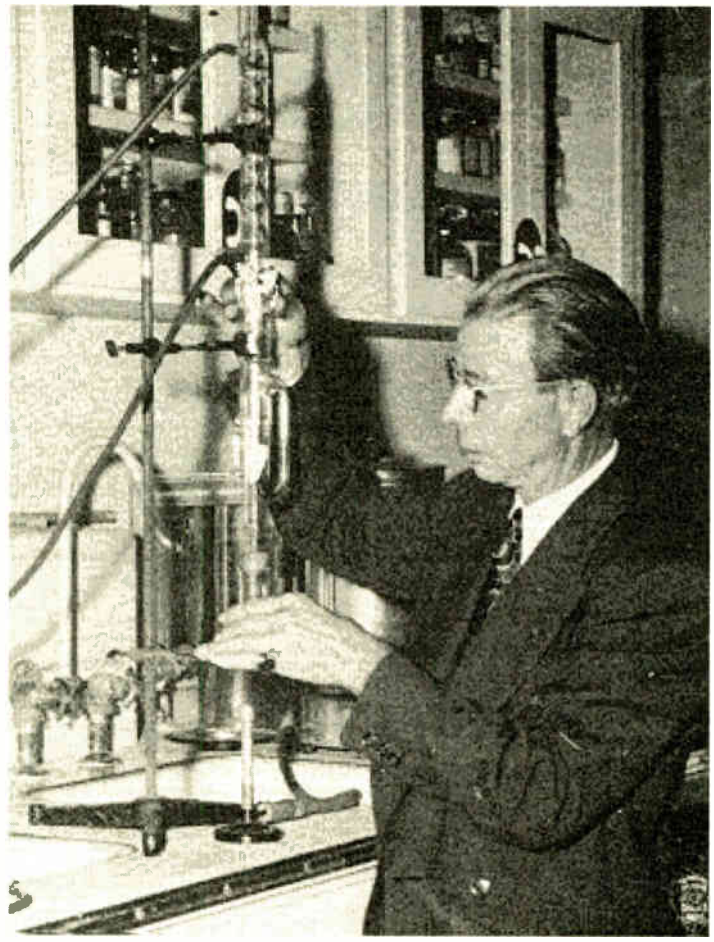


Fig.2. Royal Raymond Rife in his laboratory, 1960.

From his own lectures, Rife says that around 1920 he first became interested in the biological effects of electromagnetic fields and their possible therapeutic effect and from that point developed the microscopes to observe the effects of electric phenomena on bacteria. Rife had certainly been influenced by earlier theories and machines. However, the microscopes were the key to his later research and so make a good starting point.

THE MICROSCOPES

Rife was determined to develop an optical microscope with unprecedented magnification and resolution. He proceeded to look at the problems associated with high magnification microscopy from a unique angle. There are quite a few problems associated with building a high resolution microscope, one of the most important being the light itself.

Purely theoretical work of the time indicated that optical resolutions beyond about 20,000 times were impossible because of limitations imposed by the wavelengths of the light itself and effects such as diffraction etc. Also the amount of light that could be focused into an objective at high magnification was limited i.e., the area being looked at is so small there isn't much room for the light to get in!

Vibration was another problem, even modern electron microscopes suffer badly under ambient vibrations, because an otherwise imperceptible movement becomes all too obvious at high magnification, as anyone who has used a modern zoom camera lens will know. Finally, there is the question of how one is to stain the specimen to make it visible.

To expand on that last point, it is usually necessary to apply some sort of stain to any (optical) microscopical specimen, because many microscopic cells etc., are basically transparent at high magnifications and very little detail can be seen. A stain, however, is just a chemical dye of some sort, and unfortunately since its uptake cannot be precisely controlled, the stain may not properly penetrate the specimen and may even collect in clumps. So under a high enough magnification the stain itself appears as a series of lumps or spots that do not reveal anything much about the specimen. Furthermore, the stain itself, being a chemical, may kill the organism under study.

POLARISATION

Rife decided therefore that he had to dispense with the stain. But how can one see the specimen without a stain? The first obvious answer lay in polarised light.

The theory of polarisation is quite simple. Light is an electromagnetic wave, it consists of an oscillating electric field in one plane, with a corresponding oscillating magnetic field in another plane at right angles to the first.

Normal light consists of a mixture of such waves all travelling with their electric and magnetic fields oriented at arbitrary angles relative to each other. Polarised light on the other hand is light in which all the waves have their electric and magnetic fields in the same planes.

Fortunately, polarised light (or any electromagnetic wave) is easy to produce. All you need is some sort of fine grating in which the spacing of the rails is less than the wavelength of the light itself. The waves that have their electric fields lined up with the spaces of the grating pass through, the ones with

World Radio History

their electric fields at an angle are blocked by the grating in proportion to the angle, at 90° all light is blocked. This is the principle of polarising film and sunglasses, which are simply fine gratings of this type.

Polarised light is useful, because if you pass it into a compound or specimen, chemicals, stresses or density changes in the specimen itself cause the rotation of the incident plane of polarisation, By comparing the variably rotated output from the specimen with a fixed polarising filter, different rotations appear as different shades, and in this way you can see the density changes, stresses or different chemical structures as shades of light.

Incidentally, this technique has been used for many years to identify specific chemical compounds and is the basis of the designations given to amino acids and complex organic molecules i.e. when you see something like L-arginine or D-tryptophan (both amino acids), the L and the D refer to Levorotatory and Dextro-rotatory respectively, polarising molecules that twist light to the left (levo) or right (dextro).

FLUORESCENCE

Rife took the reasoning still further. Not only did he decide to use polarised light, but he also wanted to avoid the limitations of backlighting a tiny object. It was much better if the object could be made to fluoresce in its own light or reflect the incident light. Most biological specimens would fluoresce or reflect, but only in ultra-violet or other invisible light ranges. And this depends on their chemical structure.

So he hit upon the idea of illuminating the object with two polarised beams of monochromatic light in the UV range that would heterodyne each other and the result of which would be fluorescence or reflection in a visible range. It would be the differences in the wavelengths of two or more illuminating sources that would determine the output.

By means of a complex set of polarisers and rotating prisms, Rife developed a way of making any biological sample fluoresce in such a way that its internal structure was clearly visible. He didn't need a stain, the light itself became the stain. So in this way one type of bacteria, for example, would appear a specific shade of blue, another red, and so on. The actual colour of the resulting "light stain" itself gave a lot of information about the chemical structure of the specimen under study and the polarisation helped distinguish fine structural differences.

After a lot of development work, around 1929, Rife finally produced a prototype of what was later to become known as the "Universal Microscope" which used the above principle. Not much is known about the early prototypes but they reportedly succeeded in producing unprecedented magnifications, supposedly up to 60,000 times in some cases. This kind of magnification is comparable to a modern day electron microscope. The photograph in Fig.3 is of one of the later Universal Microscopes and shows just how complex these instruments were.

These optical microscopes had one major advantage over the modern electron microscopes. They allowed the study of live specimens. An electron microscope operates in a vacuum and bombards the specimen with high energy electrons; not much can survive that!

BEAM RAY MACHINE

Now that Rife could clearly see bacteria and cells using his microscope he began experiments in which he exposed the samples to various electric and magnetic fields. He then discovered that he could make bacteria and single-celled organisms react to the fields.

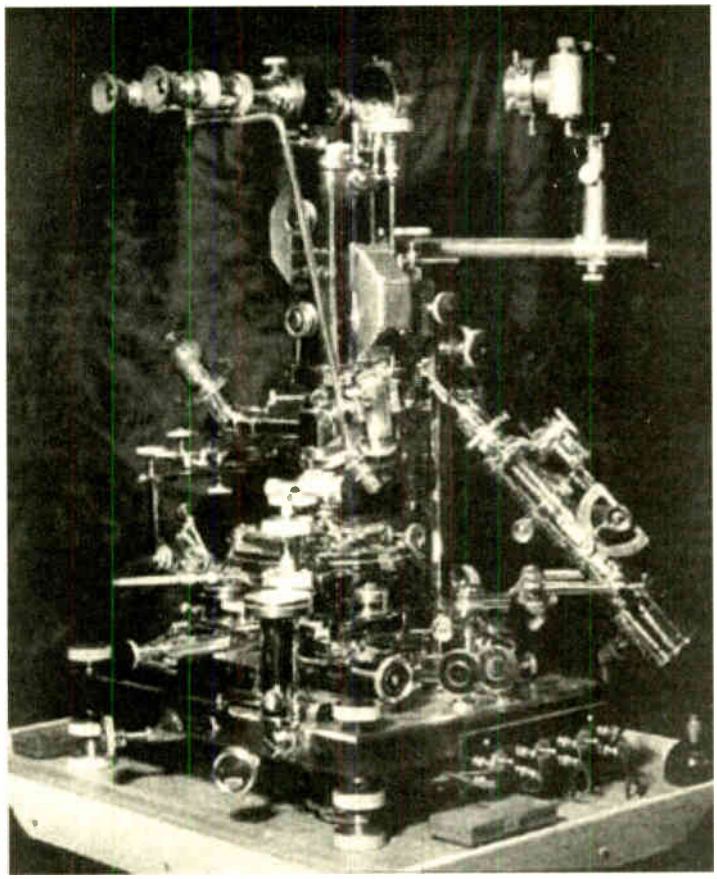


Fig.3. One of Rife's "Universal Microscopes".

Curiously, static fields had little obvious effect, but alternating or pulsed fields caused dramatic changes depending on the frequency he applied. Each different type of bacteria etc., appeared to respond to one specific frequency, and in particular, that frequency ultimately caused the destruction of the organism.

The effect, which modern researchers have duplicated, is very interesting. Supposedly, as you approach the critical frequency of a bacterium for example, it appears under the microscope to have what might be best described as a "seizure". The bacterium changes shape or becomes agitated. A typical example (reported by a modern researcher) is where a rod-like bacterium "seizes" into a "C" shape as the critical frequency is approached.

The frequency range of the effect varies with the specimen and the intensity of the field seems to become pronounced within five or six Hertz of the critical frequency. If you give the specimen a short burst of electromagnetic energy near the critical frequency it seizes and then usually recovers after a few seconds. If, however, you proceed to expose it to the critical frequency, it literally explodes.

SELECTIVE DESTRUCTION

Rife repeated his experiments with thousands of samples and reproduced the same effect every time. What was even more interesting, however, was that he was unable to find any frequency that would cause human (or other mammalian) tissue cells to explode in the same way.

The implications were profound. He had seemingly found a way to selectively destroy bacteria and other pathogens without damaging human cells. If this method could be applied to a live human patient he could potentially eliminate a specific species of invading bacteria and thereby cure whatever disease that bacterium caused in the patient.

His first task was to catalogue the critical frequencies that destroyed specific bacteria. He reasoned that the effect worked through simple resonance and that the bacteria were shattered by a specific frequency much like a wineglass when it is exposed to a specific high pitched sound. So he started compiling a list of what he called the Mortal Oscillatory Rates of specific pathogens (MORs for short).

MODULATED EMISSIONS

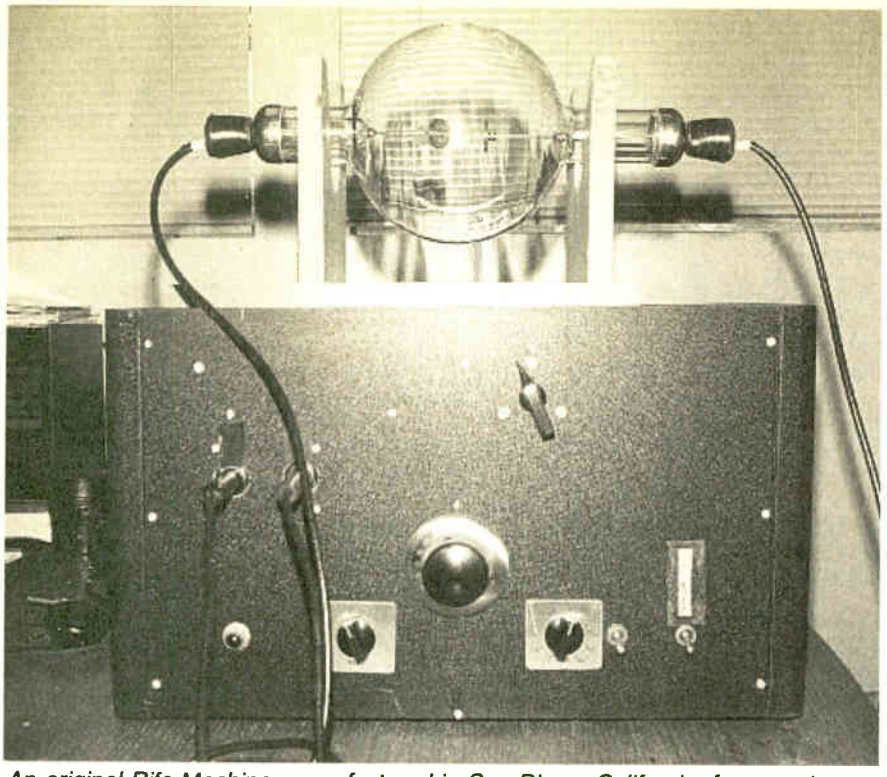
At the same time he wanted to refine his equipment to produce the requisite electromagnetic fields. He commissioned engineers to build a device that would emit a field he could tune. He was convinced that light was an important factor and so he wanted the tuneable device to produce light as well as other forms of radiation.

The development of the device unfortunately is not documented. But the result was that the engineers ended up with an X-ray tube which was filled with low pressure helium gas (a normal X-ray tube has a vacuum) driven by a powerful radio frequency transmitter that caused the gas to ionise and conduct current. The MOR was then created by quenching the carrier at a lower modulating frequency. So the original MORs actually consisted of two parameters, a carrier frequency and a modulating wavelength. The end product became known as the "Rife Beam Ray Device". It allowed Rife to expand upon his experiments.

Rife started conducting lab tests using live animals. Most of his notes were later destroyed and very few remain. But he clearly documented that he was able to apparently cure the animals of specific infections with only short exposures to the beam ray device.

We may never know exactly how many experiments he performed, or all of what he found due to the destruction of his notes. But his associates later told of literally tens of

World Radio History



An original Rife Machine, manufactured in San Diego, California, for an unknown doctor. Exactly how this unit operates is at present not known.

thousands of experiments he performed and that he became obsessed with his work, spending days at a time without sleep, tuning the device and cataloguing effects. His surviving research papers also show evidence of meticulous work.

A CURE FOR CANCER?

Rife became obsessed with the idea of curing cancer. He found from his experiments that cancerous tumours in animals shrank and even disappeared at certain frequencies. But his observations showed that the tumour cells did not explode like the bacteria. Something was killing the tumour cells, but in a different way.

He then turned his attention to viruses. At that time little was known about viruses. The word virus itself is derived from one of their properties, "filter passing". A virus by definition was some infective agent that was so small that it could pass through a filter that would block bacteria and other pathogens.

After thousands of further experiments, Rife finally announced that he had isolated the "filter passing form" of an infective agent that would reliably induce cancer in any animal it was injected into. His conclusion was simple: cancer is caused by a virus and the machine could destroy viruses as effectively as bacteria, ergo, he could cure cancer.

At this point it is worth mentioning that although Rife isolated the cancer pathogen, there were other researchers in the 1920s, notably Thomas Glover and M. J. Scott who had also done so, and probably earlier than Rife – although Rife was probably the first to actually see the agent with his super microscopes.

In the light of this revelation the tumour cell results became clear. The machine did not directly kill tumour cells. It killed the virus that was infecting the tumour cell, and when the virus died it decomposed into a mixture of chemical poisons that effectively poisoned and killed the host cell. The dead tumour cells were subsequently reabsorbed and digested by the host animal's immune system.

INTERMEDIATE SIDE EFFECTS

There was a further implication to this. Rife had noted that when he "cured" animals of various infective agents they often became more ill for a short time after exposure to the beam ray but rapidly recovered. He reasoned that the destruction of the infective pathogens always released poisons (which were normally inside the infecting organism) into the animal's body and blood stream and that the illness was caused by the effect of these poisons.

Since these poisons are often the very same chemicals that are responsible for the symptoms of a particular illness in the first place, it was therefore not unusual to see a worsening of symptoms after exposure that rapidly improved as the body disposed of the toxins. This effect is well known in medicine today, it is known as the Jarisch-Herxheimer reaction and it was originally recorded in the antibiotic treatment of syphilis.

Ultimately, Rife succeeded in identifying two different viral agents that caused cancers. One that caused carcinomas (cancers of covering and lining membranes) and one that caused sarcomas (cancers in bone, connective tissue or muscle). He called these two agents the BX and the BY cancer viruses respectively.

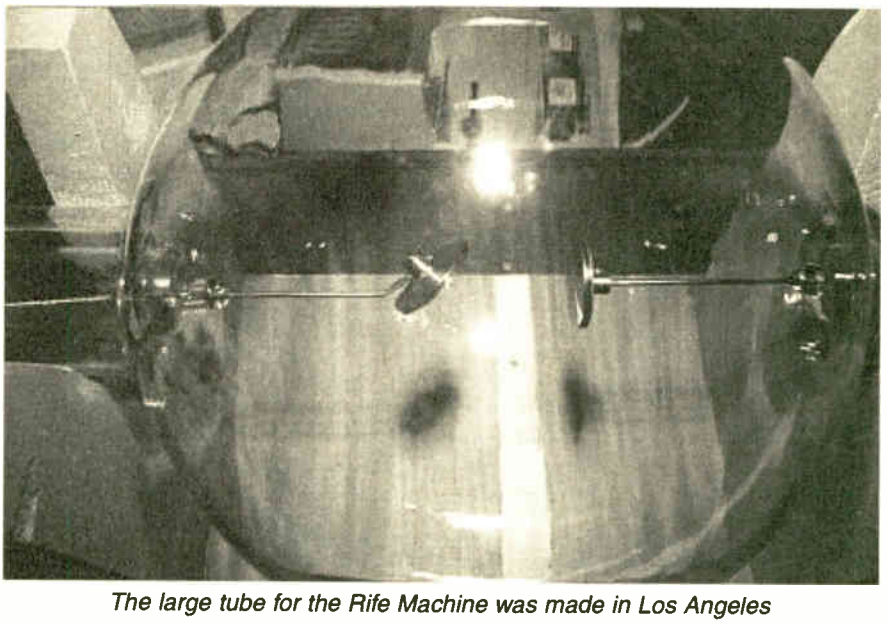
PLEOMORPHISM

Rife also found direct evidence of pleomorphism. Ever since the theory was proposed by Antoine Béchamp (the forerunner of Pasteur and probably the true discoverer of microbial infection) in the 19th century, it had been the subject of much controversy. To put it simplistically, it stated that every pathogen had multiple developmental cycles with different forms in each cycle i.e. a simple bacterium can transform itself literally into a viral equivalent (or vice versa).

Rife insisted that he had observed that each bacterial pathogen had a corresponding viral form, and, depending on the mixture of proteins that the bacterium digested, it could transform reversibly into its viral form and back to bacterial form. He mentioned this in various research papers and concluded that there were only about 10 different classes of pathogens that were responsible for nearly all diseases, and even that it was possible for any pathogen in one class to transform into another pathogen of the same class.

For example, Rife believed that E. Coli, a common bacterium found in most water supplies, was the bacterial form of one cancer virus. It would only produce cancer causing effects in a weakened organism with a specific chemical balance that made it revert to viral form. Whilst discredited at the time, modern researchers are finding increasing evidence that supports the theory of pleomorphism.

It is certainly accepted today that some cancers are caused by viral agents, a theory that was resisted in the 1920s. The "discoverer" of the first officially recognised cancer virus in the late 1940s, Virginia Livingston, had worked with Rife and already knew of



The large tube for the Rife Machine was made in Los Angeles

World Radio History

his results, as well as those of Glover and Scott. As far as I know she gave some credit to the "Glover's theory" but Rife is never mentioned.

THE END TO ALL DISEASE

During this time Rife had periodically released information to the press about his work. He had described and demonstrated his microscopes several times and had received enthusiastic reviews from doctors and researchers who had been allowed to use them. On 3 November 1929 his work was featured on the front page of the *San Diego Union* newspaper, as an article about his microscopes.

Numerous other articles followed around this time, including at least two articles in the *L.A. Times*. He had also mentioned his work on electromagnetic effects and that he hoped one day to be able to cure diseases like cancer, although it is clear that most of the reporters didn't understand the implications of what he was saying.

By 1931, Rife had announced his results to various doctors and university medical departments. He was visited by a stream of eminent doctors and researchers, most of whom enthusiastically endorsed his work. One of Rife's supporters was Dr Millbank Johnson, president of the Southern California branch of the American Medical Association and one of the board of directors of Pasadena Hospital. Another was Dr Arthur Kendall, Director of Medical Research at Northwestern Medical School in Illinois.

On 20 November 1931, Johnson arranged a banquet for Rife at his estate in Pasadena California, which was attended by 44 of the most eminent medical personnel of the day and at which they honoured him as the man who had found "The End to All Diseases".

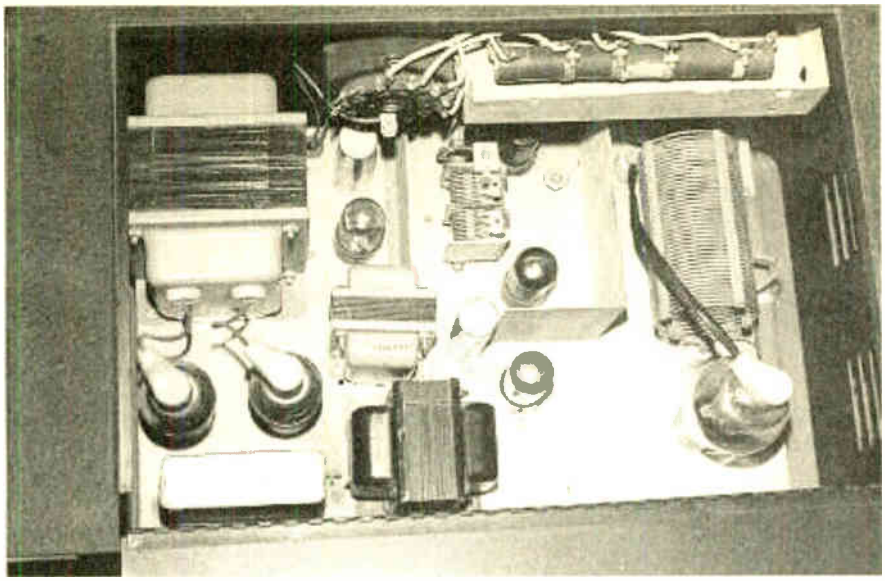
From this point on the story takes a twist. Many incidents referred to are documented and historically verifiable but are the subject of great controversy. Also the chronology is occasionally confused.

A CLINICAL TRIAL

In early 1934, Johnson rented premises in San Diego for Rife to begin clinical treatments. Under his instructions, the University of Southern California arranged formal clinical trials of the Rife Beam Ray device. They appointed a special committee of top doctors to oversee the project including, apart from Johnson and Kendall: Dr Rufus Klein-Schmidt (President, University of Southern California), Dr Edward Kopps (Metabolic Clinic, La Jolla, California), Dr George Fisher (Children's Hospital, NY), Dr Karl Meyer (Hooper Foundation, San Francisco, California), Dr Whalen Morrison (Chief Surgeon, Santa Fe Railway), Dr George Dock and Dr Alvin G. Foord, a pathologist.

Sixteen cancer patients from the Pasadena County Hospital volunteered to be treated with the machine. The brief was for the patients to be treated at Rife's clinic in San Diego and after three months the doctors would perform an in-depth examination of any of the surviving patients at that time. Rife reportedly treated the patients with three minute exposures to the beam ray device at the cancer frequencies once every three days.

Initial daily treatments were suspended due to extreme Jarisch-Herxheimer reactions. At the end of three months, however, all the patients were still alive and were examined.



Interior of the 1947 Rife Machine

The doctors were amazed to pronounce that 14 of the 16 showed no signs of cancer and were pronounced clinically cured. The remaining two went for further treatments.

Rife reasoned that maybe they were infected with a mutated form of the cancer virus and made some slight frequency adjustments. Four weeks later the remaining two patients were examined and also pronounced clinically cured. The results were stunning, it was a major breakthrough.

There is some discrepancy in the accounts of what happened next, but the most likely explanation is that the members agreed to do further work before publicising the results.

CONFLICT BEGINS

Johnson then introduced Rife to Dr Mildred Schram of the International Cancer Foundation in Philadelphia. However, on hearing of the work, Schram allegedly made demands for experiments that Rife insisted would not and could not work. Following much argument, he eventually refused to have anything further to do with the foundation. Schram supposedly admitted years later that Rife had been right.

In the meantime (1935) Johnson had set up a clinic in Los Angeles to treat people using the beam ray device and Kendall and others were continuing experiments and treating people with it. In 1937, the medical committee who oversaw the clinical trials ended up arguing over when and how they should release the results with no actual decision ever being reached. By now they had plenty of evidence to support Rife's claims but they found themselves pressured by the medical authorities and feared that they would not be believed.

A press release went ahead, however, and on Friday 6 May 1938, the *San Diego Evening Tribune* published a front page article entitled "Dread Disease Germs Destroyed by Rays, Claim of S.D. Scientist". However, the clinical trials were not mentioned and Rife was cautious not to claim that the device represented an absolute cure for cancer.

CONSPIRACY THEORY

During this time, a new player emerged. Dr Morris Fishbein was editor of the *Journal of the American Medical Association* between 1924 and 1949. However, Fishbein was a very rich and powerful man who by that time owned all the stock of the AMA and had extremely powerful political connections. Fishbein approached Rife with an offer to buy the exclusive rights to the beam ray technology. Rife refused.

The details of the offer are unknown but Fishbein had made similar offers to other inventors of medical technologies claimed to cure cancer. In one case Fishbein made an offer to the creator of a herbal cancer cure called Harry Hoxey in which Fishbein would receive all profits from the invention for nine years and thereafter, at Fishbein's discretion, he would pay 10 per cent of future profits to Hoxey. When Hoxey refused, Fishbein effectively destroyed him. Hoxey was allegedly arrested 125 times in 16 months at Fishbein's instigation. The charges never stuck but Hoxey was ruined.

Fishbein then did the same to Rife. AMA officials started visiting doctors who were using Rife's machines and informed them they would be struck from the medical register if they did not stop immediately. Many gave in and surrendered the machines to AMA investigators or allowed the machines to be destroyed. Others held out and refused. Many were arrested or had equipment and notes seized and destroyed by FDA (Federal Food and Drug Administration) agents.

Fishbein refused to allow publication of any reference to Rife's work in the AMA journals and also supposedly pressured other medical journals insisting that they should not publish anything about Rife's work because it was all a fraud. A number of doctors actively opposed this, including Johnson. But many of the doctors who had attended Johnson's banquet for Rife in 1931, fearing the loss of their medical licenses, started denying that they had ever heard of Rife, even though many had been photographed with him at the banquet.

BEAM RAY CORPORATION

By this time, Rife had established his own company to market the device. The corporation became known as Beam Rays Inc. However, in 1939, an engineer called Philip Hoyland, an employee of the company, brought a lawsuit against Beam Rays Inc., claiming that he and not Rife had invented the machine and that he had developed the initial theory that was now claimed by Rife.

World Radio History

Despite the fact that he had only joined Rife around 1937 and Rife had published details long before that.

Another factor that emerged at this time was that there was some difference between Rife's original machine and newer Hoyland variants that the company had been shipping. Rife's original machine created the MOR frequency using a variable carrier wave which was then modulated with a super-regeneration wave at other frequencies (ranges of 15kHz to 11MHz appear in Rife's lab notes). Table 1 gives carrier frequencies in kilohertz and super regeneration wavelengths in metres, compiled from his original lab notes.

Table 1. Rife's Original Carrier Frequencies and Super Regeneration Wavelengths.

Pathogen	*Carrier (kHz)*	*SRW (m)*
B. Coli	8,581	27
Bubonic Plague	160	585
Cancer (BX)	11,780	17.6
Typhoid	900	345
Anthrax	900	1,100
Catarrh	1,800	175
Diphtheria	800	275
Syphilis	900	108
Tetanus	700	19,000
Tuberculosis	583	554
Actinomycosis	678	1,607
Gonorrhoea	600	1,990
Glanders	986	407
Influenza	1,674	154
Leprosy	743	1,190
Pneumonia	1,200	785

The MOR frequencies studied by Rife were mostly in the hundreds of kilohertz to megahertz range. The details of the difference between the original Rife and Hoyland machines are unclear, but Rife complains in a letter of 14 May 1939 to Dr Gonin, head of the London School of Tropical Medicine about Hoyland's machines:

"I spoke only Friday Evening to a Mr. John Chanblin, a radio man now connected with Beam Rays inc., about the redesign and building of a device according to the old original Rife Ray principles; as the present instrument has been so deviated away from that old principle that it is nowhere near the same.

"I know nothing about the experimental machines you have, as I was never even asked to see them or to pass on them in any way before they were shipped to you. But Henry stated in one of his last letters that he had tried one of them on a culture of his bacteria and it had failed to do the work. I would consider from that, that those devices which you have are merely working on a harmonic and not a true frequency; and in our research on electronics, we definitely know that there is no possible way of controlling electrical harmonics of a frequency."

Nobody knows why Hoyland started a lawsuit he couldn't possibly win, or why he produced non-working Rife machine variants, except that it is alleged that Hoyland's legal costs were funded by the owner of a major pharmaceutical company. Rife's invention was potentially lethal to the multi-billion dollar pharmaceutical industry. Rife eventually won the lawsuit but the costs bankrupted Beam Rays Inc., putting it out of business. And Rife's reputation had been damaged by inferior machines that had been shipped out by Hoyland using Rife's name. After this, Rife started drinking heavily and became depressed and discouraged.

VANDALISM AND ARSON

Around this same time Rife's laboratory was subject to a spate of thefts, his microscopes vandalised and finally, it was burned to the ground (and most of his notes destroyed) in an arson attack. Nobody was ever caught or prosecuted for it. Another doctor, a Dr Nemes who had set up an independent laboratory and confirmed some of Rife's results was killed in a laboratory fire and all his notes and research lost. A third laboratory working on confirming Rife's work, the Burnett Laboratory, also mysteriously caught fire and burned to the ground with all research destroyed.

In 1940, two other doctors who had supported Rife, Cooperson and Clayton were raided by Federal officers who confiscated their equipment and notes. Later each was found dead, supposedly having committed suicide by poison.

In 1944, Johnson arranged a press conference and let it slip that he would announce publicly the clinical results and that the cure for cancer had been found. There are allegations that Johnson had already been approached by "representatives of the pharmaceutical industry" who offered him money to suppress information about Rife's work. Supposedly he refused. He had also certainly been pressured by Fishbein.

The night before the press conference, however, Johnson died suddenly and mysteriously and all his notes were pronounced as "lost" by the executors of his estate. His death was recorded as "accidental death" although I have no details. There are claims that his body was later exhumed by FBI investigators who concluded that he had been murdered by poison.

Dr Arthur Kendall, one of Rife's most prestigious and influential supporters suddenly accepted an unprecedented pension of $250,000 to retire to Mexico and effectively disappeared from the scene. George Dock, another of Rife's clinical team, and also highly respected and influential, also took a huge and unprecedented gratuity to retire early.

Many of Rife's supporters were convinced this was the work of drug companies who were anxious to suppress a technology that would make virtually all drug treatments obsolete.

Rife was hounded by the FDA and the AMA. He was unable to practice without official intervention and continued a steady decline into alcoholism. This didn't stop him, however, trying to continue his research. In the early 1950s Rife teamed up with a man called John Crane under the auspices of a new company (owned by Crane) called Life Labs Inc.

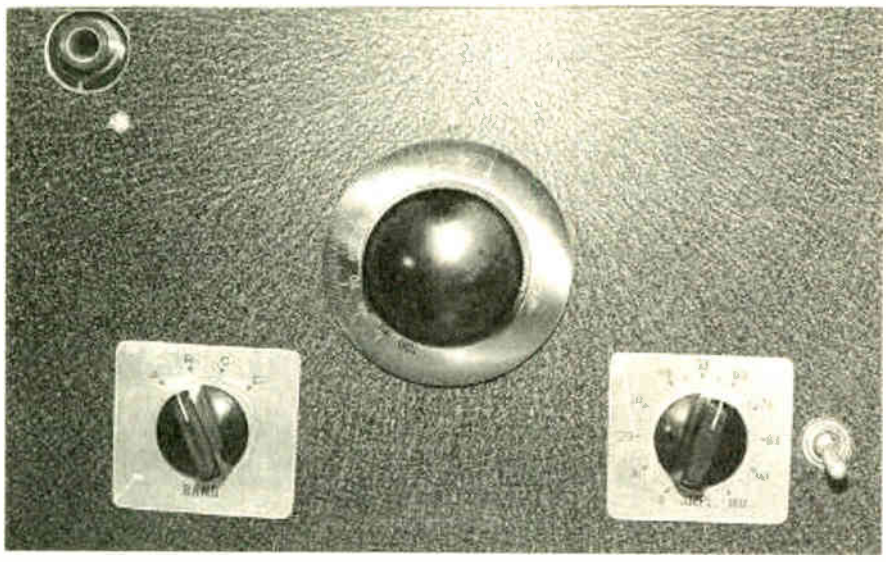
LIFE LABS INC

Here the record becomes confused again. Crane worked on the development of several new machines. One in particular was quite different, it used a pad which had to be placed in contact with the body. Crane claimed that he and Rife had developed the machine together, and Rife was certainly associated with the company because he wrote letters on its behalf. But apart from Crane's statement there is no direct evidence to suggest that Rife developed or endorsed the pad machine. Because of this there is some confusion as to what constitutes a real "Rife Machine" because some people (particularly those selling such devices) claim the former and others the latter.

Users claim both are effective, but the original plasma device has the advantage that it can be used to treat the whole body (or even several bodies at once!) since it has an effective operating radius of around 20 to 30 feet (6m to 9m) depending on power level and does not require any body contact.

Modern researchers who made contact with Crane studied circuit diagrams that Crane gave them and concluded that not only could the circuits not work as they were, but Crane did not seem to know very much about electronics. However, some of the circuits did work with minor modifications, indicating that Crane had probably taken the diagrams from prototype notes of other engineers who had worked for him.

Crane's involvement led to a second source of confusion. Crane published lists of MOR frequencies which were all in the low audio range. Clearly there was a big difference between Crane's frequencies and Rife's. A popular list of frequencies (Table 2) which was obtained from Dr Robert P. Stafford MD, who is claimed to have used a "Rife machine" (probably a "Crane machine") for clinical trials between 1957 and 1963 and which is often advertised as Rife's original



Front panel of the 1947 Rife Machine. The knob on the left changes the frequency band and the knob on the right changes the amplitude or power.

World Radio History

frequency list, is in fact a copy of a document he received from Crane.

Table 2. Crane's List of MOR Frequencies

Microorganism	*Frequency (Hz)*
Tetanus	120
Treponema	660
Gonorrhoea	712
Staphylococci	728
Pneumococci	776
Streptothrix (fungus)	784
Streptococci	880
Typhoid Bacteria	712
Typhoid Virus	1862
Bacillus Coli Rod Form	800
Bacillus Coli Virus	1552
Tuberculosis Rod Form	803
Tuberculosis Virus	1552
	(same as B-Coli)
Sarcoma (all forms)	2008
Carcinoma (all forms)	2128

Interestingly, these frequencies have been claimed to be effective for Rife type plasma machines by modern researchers, but they are obviously not Rife's original frequencies.

In 1971 Rife was admitted to hospital, details are unclear, but I've seen accounts that attributed it either to a car accident or an alcoholic binge. Either way it is reported that he died following accidental injection of a massive overdose of Valium.

THE LOST TECHNOLOGY

Following his death, Rife's work was forgotten. Most of his original notes had been lost in the fires and/or supposedly destroyed by AMA/FDA agents. But some of his associates remained alive, particularly Crane who wrote a book about the work (supposedly very long winded and not very technically accurate according to those who have read it). Crane was arrested numerous times for promoting Rife's work and spent three years in prison for it. And there were still a few old doctors who claimed to have been successfully using the device for treatments (mostly in secret) over the years and still had working machines.

Even Rife's microscopes were forgotten except for odd articles of historic interest. For example, a 1944 report from the board of the Smithsonian Museum stating basically that the microscope worked and that Rife's results had been validated. The author, Dr Raymond Seidel reportedly survived a subsequent assassination attempt in 1945, after which he refused to mention Rife ever again.

An original Rife microscope (which, however, had probably been tampered with by Hoyland) resides today in the Science Museum in London, unfortunately broken and not on display. The microscope was formerly used at the London School of Tropical Medicine, but following a dispute between Dr Gonin, the British doctor who used it and Beam Rays Inc., (probably Hoyland), the machine was supposedly smashed by a mysterious man who arrived from America. It was later donated to the Science Museum by Dr Gonin's family after his death.

Even the newspaper reports were hard to come by. Some of the newspapers told researchers that they had lost the specific editions with reports of Rife's work, *note only those editions*. Luckily there were people who did still have copies.

MODERN REVIVAL

The whole matter was revived suddenly around 1986. As far as I know, the recent efforts appeared after a book about Rife called *The Cancer Cure that Worked* was written by an author called Barry Lynes. Whatever the cause, several modern researchers tried to build duplicates of the original beam ray devices, most of them succeeding in producing allegedly bio-active machines, but none of them truly original.

Eventually these modern researchers managed to make contact with the few surviving doctors who had worked with Rife and his machine and slowly the details began to emerge.

Although Rife had used a variable carrier wave in his original prototype machine, later models of the machine used by other doctors used fixed carriers with amplitude modulation. It is not known whether these machines were Rife's, Hoyland's or Crane's. The modulation was a square wave pulse with fast rise time. Calibration and measurement of dial settings on the old machines revealed that the active frequencies of modulation were all in the low audio range corresponding to the lists published by Crane.

One explanation of the discrepancy between Rife's original notes and the derived frequencies may be explained in terms of harmonics. The higher harmonics of a square wave pulse represent odd multiples of the fundamental frequency (Fourier's theorem) and so the square wave produces a range of different (higher) frequencies for any given fundamental frequency.

Another theory is that the microorganisms have more than one mortal frequency. There is some support for the latter idea in letters written by Johnson which indicate that at one stage, he and Rife stumbled on to a "super-frequency" which would kill almost any microorganism. Unfortunately this frequency was never recorded.

The modern researchers took various approaches to reproducing the machine. Some used old X-ray tubes filled with low pressure helium or argon, others had tubes made, and some even made them themselves.

BARE MACHINE

One of the most popular recent incarnations of the Rife machine was developed by a Dr James Bare. Bare took a minimalist approach to the problem and modified a CB transmitter and power amplifier to increase the bandwidth and to drive the tube at a carrier frequency around 27MHz. Using the audio input of the transmitter to introduce the modulating pulses, he then proceeded to perform experiments to verify Rife's work.

I don't know exactly which experiments he did (I haven't read his book) but he claims that the device worked just as Rife described and he has had photomicrographs taken which allegedly show the device destroying single-celled organisms like Blepharisma. You can download a Windows AVI video file showing the process via the internet (addresses at the end of the article). Bare also sells videos of other experiments.

The book of Lynes, and the work of Bare and others caused a virtual explosion of activity in this field. Today, it is estimated that nearly 5000 people have Rife machines (or at least modern equivalents) in active use and an enormous amount of anecdotal data has been compiled through amateur efforts to cure specific diseases. Although many of the anecdotes are purely subjective, a great many claim to have been verified by doctors and some contain considerable clinical detail.

It is not unusual to see comments in which users have stated definite biometric measurements of their own diseases both before and after treatment with the device. One thing is overwhelmingly clear a large number of people are convinced that the device works. Fantastic as it may seem, many people claim to have experienced improvements in cases of the most dire diseases, such as cancer and even AIDS.

What is even more interesting is the number of people who have reported relief from the symptoms of diseases that are not known to have any viral or bacterial component, or the cause of which is still officially unknown. The devices have also allegedly been widely and successfully employed in veterinary practice as well, implying that the results are not simply due to the placebo effect.

FREQUENCY LISTS

As a result of all these efforts, there now exist a number of frequency lists (all freely available on the internet) which give specific treatment frequencies for just about every disease imaginable. Others are classified by the microorganism species. Another interesting point worthy of note is that whilst Rife's original work only concentrated on MORs for bacteria and viruses (he knew it affected yeasts etc., as well), the modern researchers claim to have found MORs for yeasts and moulds, various protozoa-like amoebas, worms and parasites like flukes and even some insects.

The consensus seems to be that low frequencies are deadly to simple organisms. The more complex organisms like mammals (at first sight, see comments later) seem to be immune to these frequencies.

SIDE EFFECTS

Advocates of the machine are very keen to point out that there do not appear to be any negative side effects (apart from the inevitable Jarisch-Herxheimer reactions) and so far nobody claims to have identified any bad or dangerous frequencies. My own feeling is that this is not strictly true and there is ample evidence of possibly bad frequencies. However, to someone dying of a terminal cancer the risk is worth the potential reward.

HOW IT WORKS

By now you are no doubt longing to know how does it work? The answer is that nobody knows for certain. Although there are many clues to be found in modern research into the effects of electric and magnetic fields on biological systems. Unfortunately, this whole area of research still appears to be vehemently opposed by the mainstream medical establishment and very little (compared to other fields of medical research) serious and rigorous research is being done.

At first sight it appears that the electromagnetic waves emitted by the plasma tube of the device are inducing fields or currents into body cells. However, many researchers are quick to point out that putting the device inside a Faraday Cage (which will block all electromagnetic waves) does not impair its effectiveness. Nor will a simple aerial produce the same effect.

World Radio History

PLASMA WAVES?

Some have speculated that the light from the tube is involved, but once again the device appears to work well with covered tubes. I have seen various theories that claim the existence of a mysterious new type of energy called a plasma wave, but my personal feeling is that this is too fanciful and there is a simpler explanation.

PATENTED HIV CURE

At this point I would like to digress to look at some other machines of a similar nature that may throw some more light on the puzzle before returning to the question of what is actually happening.

On 14 March 1991, two researchers, William Lyman and Steven Kaali, at the Albert Einstein School of Medicine, announced to the *First International Symposium on Combination Therapies* that they had found they were able to inactivate the HIV virus in blood samples, by passing a tiny electric current (less than 100 microamps) through the blood itself. A similar paper was published around the same time by a team in Japan. The interesting thing here was that they didn't kill the virus, they just made it inert.

The virus reportedly was unable to penetrate and infect body cells after exposure. Either way, the result was more or less the same, it provided a clue to a potential cure. The Einstein team were quick to file a patent (US Patent 5,139,684) in which they described a hypothetical device which could be connected to the patient's circulatory system and in which the blood would pass through a set of electrodes which would in turn pass a current through the blood, the "deactivated" blood being returned to the patient's body. Other researchers were also quick to confirm that the effect wasn't just limited to HIV, it worked just as well with other bacteria and viruses as well.

NEW AGE DEVICES?

This led to more amateur experimentation. A host of "new" machines emerged from various experimenters. I qualify the word "new" because all of them are just modern rehashes of the old 19th century electrotherapy machines. They basically fall into two main classes: those that pass a low voltage alternating current through the body (ideally across some major artery) and supposedly purify the blood according to the Lyman/Kaali principle, and others that produce intense magnetic field pulses.

People who claimed to have tried these devices for the most part reported that they provided an amazingly rapid relief from symptoms. Of further interest was the fact that many people reported a consequent Jarisch-Herxheimer reaction. To put it simply, if you kill enough microbes you get a Jarisch-Herxheimer reaction.

SNAKE OIL AND SNAKE BITES

Vendors (the snake oil and quackery industry is still healthy!), claim that these machines (which typically produce about 28 volts peak-to-peak a.c. square waves across the skin for the electric machines), and magnetic pulsers which work by discharging capacitors charged up to a few kilovolts into a magnetic coil, have no deleterious side effects and are completely safe to use.

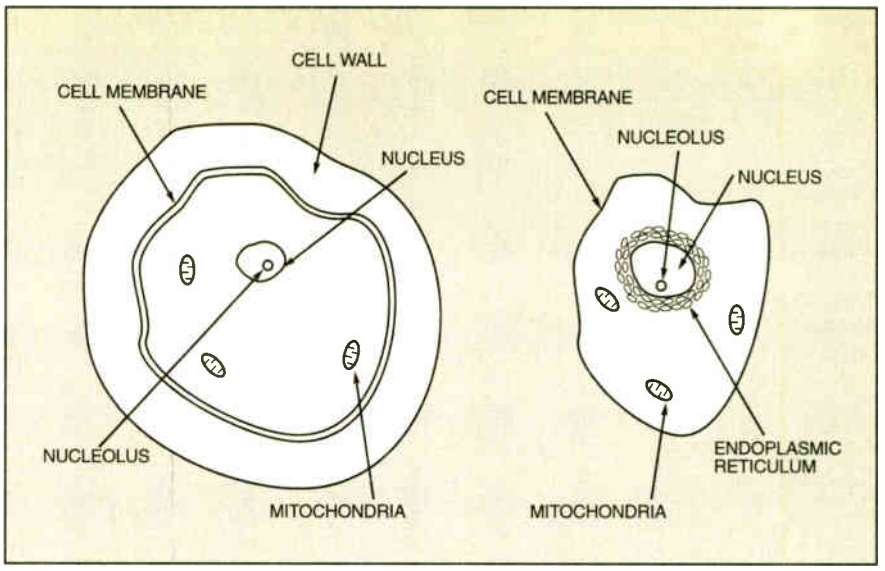


Fig.4. A bacterial/mould/plant cell (left) and (right) an animal cell.

I am personally sceptical about most of the claims made for these devices and very much so about the safety of some of them. I believe that they do provide some of the symptomatic relief that they claim and not simply through a placebo effect. However, the long term effect of using these machines has never been properly studied.

Some of these devices are supposed to be frequency dependent, others not. Although as far as I can tell, the Rife machine still remains the clear winner.

None of these devices have been accepted by the mainstream medical establishment. However, many hospitals today use pulsed magnetic field therapy to speed up the healing of broken bones. This highlights the hypocrisy of some medical people who on one hand declare that there is no possible benefit to these kind of therapies, yet happily use them to heal fractures.

As an interesting aside, there is a modern item of "bush-lore" widely accepted and used by travellers in certain parts of the world, and even endorsed by many doctors, that an excellent therapy for venomous snake bites is to apply a strong electric shock to the site of the bite which apparently somehow neutralises most snake venoms.

You can get manuals on how to perform an instant bush cure using the ignition coil of a car. It's supposed to work great for Rattlesnake bites, although I must admit I haven't found this to be much of a problem in Berkshire!

ELECTROPORATION

Returning to the question of what is happening. I have frequently seen it suggested that electroporation, or voltage dependent gating, may account for the effects of electric and magnetic fields on bacteria. I don't believe this to be the case and I think these ideas arise from an inadequate understanding of cell structure. To explain, let's start by looking at cells.

Bacterial, plant and yeast cells are very different from the kind of cells found in the human (or other animal) body. Pathogens like the ones listed earlier tend to have a thick cell wall and an internal cell membrane that encloses them. There is a major distinction between the cell wall and the cell membrane. The cell wall is typically about 200nm thick, and the cell membrane usually consists of a layer of two protein molecules bonded together and is about 5nm to 10nm thick, depending on which protein is involved.

A typical body cell does not have the cell wall, it only has the cell membrane. Simply put, a bacterium or fungal cell has a coating many times thicker and stronger than a body cell. See Fig.4.

Electroporation, an effect often used by genetic engineers to introduce DNA strands into cells, occurs in cell membranes. Cell membranes have natural pores due to the statistical movement of the molecules that they are made of. The molecules move about leaving momentary holes. If the movement of the molecules is increased by electrical stimulation, they tend to leave bigger (sometimes permanent) holes and the cell membrane becomes more porous. A large enough hole will destroy the cell.

VOLTAGE DEPENDENT GATING

Voltage Dependent Gating (VDG) is a different effect in which a protein molecule just a bit longer than the width of a cell membrane, typically helical in shape, tends to burrow its way through the cell membrane literally like a corkscrew. This creates what is known as an ion bridge and under the influence of an electric potential the ion bridge turns on like a switch and carries ions across the cell membrane. This mechanism occurs in many biological subsystems, most noticeably nerve cells.

The theory I have seen advanced for the operation of the Rife machine is that one or both of these effects results in an ion imbalance in the bacterial cell (but not the body cell) which results in an osmotic pressure differential that ultimately causes the bacterium to blow up like a balloon and then explode.

BALLOONS Vs FOOTBALLS

But the two effects above both operate on cell membranes (I don't know if they operate on cell walls) and so it follows logically that they are much more likely to damage a normal body cell than a pathogen.

To put it more simply, imagine a bacterial cell to be rather like a football, and a body cell to be rather like a child's balloon. If you blow air into both the football and the balloon at the same rate, the balloon is going to

World Radio History

explode much more easily and much sooner than the football, because the football is thicker and stronger.

So this explanation is unlikely because observation supposedly shows the opposite to be happening.

NEW THEORY

If the reports are to be believed, the real explanation must lie in some electrochemical property that cell walls have that cell membranes don't.

The answer may lie in what are known as ion exchange membranes (IEMs for short). The full technical explanation is too long and complex to reproduce here, but to simplify, a cell wall acts like an IEM, a cell membrane doesn't. An IEM promotes the exchange of ions either side of it when an electric potential is applied.

Simplistically speaking, I personally believe that the electric potential induced across a cell wall by an external magnetic field (or local electric current) causes ion exchange across the cell wall, which results in profound changes in the chemical environment of the cell, for example pH (acidity).

Under the influence of such changes, the proteins that hold together both the cell walls and the cell membranes denature, depolarise or lose their hydrogen bonding i.e. they change shape from nice regular helixes into random strands. As such, they firstly lose their ability to properly participate in the chemical reactions that keep the cell alive and, secondly, result in the weakening of the cell wall which eventually ruptures and disintegrates.

This would explain both the Rife exploding bacteria effect and the Lyman/Kaali bacterial inactivation.

Mild denaturing of the cellular proteins will inactivate the pathogen's ability to bond to other cells or participate in chemical exchanges with body cells, a more pronounced denaturing will destroy the pathogen's cell wall.

I have greatly oversimplifed this explanation because molecular electrochemistry is not an easy subject to master. I hope, however that I have conveyed a simplistic picture of what may be happening and why I have doubts about the more conventional explanations.

A CAUTIONARY NOTE

Having said all that, I must urge caution. Whilst the mechanism of these electrotherapy devices may have a greater effect on bacteria etc., than normal body cells, it would be a great mistake to assume that body cells are never damaged by these effects. Any body cell relies on an extremely complex system of electrochemical reactions to operate.

Clearly an electric, magnetic or electromagnetic field applied close to the body will induce electrical potentials across cell membranes (and those of organelles) and will inevitably disrupt normal body cellular electrochemical processes as well as those of bacteria.

Two real questions remain: firstly whether these devices have any beneficial effect at all and secondly whether the gentler devices like the Rife beam ray machine (as opposed to something like the magnetic discharge machines) are really completely safe.

Of course, a degree of "collateral damage" (to borrow a military term!) may well be acceptable when you are treating a serious disease such as cancer. Undoubtedly existing traditional radiation and chemotherapy techniques which are commonly used to treat cancer (and even in some cases antibiotics) do cause serious "collateral damage" to normal body cells.

Another point to consider is that if you can kill a tumour cell by exploding a virus inside it, it follows that you can kill a normal cell the same way.

Up to this point I've been relating stories and theories secondhand. Now I'd like to just mention some experiments that I've done in this field. I would like to stress that I am giving this information for completeness and because it is interesting. *I am not suggesting that anyone else should try this, it might be dangerous.*

SUBJECTIVE EXPERIMENT

As an experiment, I decided to try making a simple machine. Basically I designed a very simple magnetic pulse generator. I made a simple driver circuit that accepts square wave pulses from a TTL input and drives them at about 36 volts with a current capacity of up to four amps into a 35mH magnetic coil. The resulting magnetic field is quite intense.

I then hooked the machine up to a signal generator and tuned it to various known Crane MOR frequencies for common pathogens that most people have and held the coil near to my body in various places.

Interestingly, I felt nothing at most frequencies but got a noticeable reaction when I tuned to certain frequencies, for example 464Hz, which turns out to be the MOR for Candida Albicans (a parasitic yeast that just about everybody has in some degree). I was suffering from a gastric ulcer i.e., gnawing pain under the ribs when my stomach was empty, bleeding etc. I also have a hiatus hernia (weak stomach valve) which for many years has caused almost continuous indigestion and acid burning.

I normally have to take antacids every couple of hours and certainly after every meal. Having had no results from any conventional therapy in the past, I figured I had nothing to lose by trying the machine. I tried setting the machine to 676Hz, the modern MOR frequency for Helicobacter Pylori, which is the usual cause of ulcers.

After about three minutes exposure at 676Hz I felt a bit dizzy. About an hour later I had a particularly bad attack of acid and pain which lasted for about two hours. But next morning when I woke up, the usual pain under the ribs was much less. Later that day I tried again, this time two six-minute exposures, one at 676Hz and the other at 464Hz (the Candida frequency).

I discovered that 676Hz makes me feel dizzy and 464Hz gives me stomach gas. This time I got a much smaller attack of pain but also this time I got a spate of red blotches on the skin followed by itching all over, again lasting for about two hours. I figured the first was a Jarisch-Herxheimer reaction to the 676Hz and the second the reaction to the 464Hz.

The next day, I woke up again with hardly any pain at all. During the whole day I only had to take one antacid tablet which is unprecedented. After four days of similar treatments all pain had gone and I was getting no detectable reaction at all to either of the frequencies. What is more I had no indigestion for the first time in years and there was no more bleeding. I stopped the treatments at that point.

At the time of writing it is now nearly three months since I performed this experiment. I have had no pain, no bleeding and feel better than I have done in years.

A few weeks ago, I got the symptoms of a mild cold for a couple of days. The indigestion returned for a day, although not as badly as before. I tried the machine again, tuning randomly through various frequencies and looking for reactions. I got strong reactions at frequencies which I later discovered were known MORs for Adenovirus (a common respiratory infection) and also Chlamydia Pnuemonia (also a respiratory pathogen). Two days treatment as before at the new frequencies has once again removed all symptoms and the indigestion is gone.

PLACEBO EFFECT?

It's not very scientific but I'm convinced it works. If anything it has convinced me that this whole field is too important to ignore and the more serious research and experimentation that is done the better.

Sceptics will, of course, argue that this is a classic placebo effect, but having tried various remedies over the years without anything like these results, I believe otherwise.

I also tried a further experiment with moulds. I took a piece of bread, dampened it and left it out overnight. I then broke the bread into two similar pieces and put each piece in a separate, sealed, sterile container. I took one container and exposed it to a range of different anti-mould frequencies of the magnetic pulser. The first container was left untouched.

After four days, the containers were compared. The first, untouched container was full of mould, the second was completely clear. Since the only difference between the two was the exposure to the magnetic pulser I concluded that the magnetic pulser had killed all the mould spores in the second container.

PULSER CIRCUIT

For anyone interested in doing further experiments, the circuit diagram of a second, very simple prototype of my pulser is shown in (Fig.5). The input is a simple TTL square wave at the frequency of interest. The circuit consists of two simple buffer/inverter stages, around transistors TR1 and TR2, to translate the TTL signal into a larger voltage swing to drive the two parallel MOSFETs in the output stage, shown combined as TR3, into hard conduction.

The MOSFETs are wired in parallel to increase their current capability and mounted on a big heatsink, although they have a very low on-resistance and so the dissipation of the circuit is low. The 20V Zener diode, D1, wired from the drain to gate of the MOSFETs prevents inductive voltage overshoot and gives the MOSFETs a very hard switch off edge, which is supposed to be ideal for bioactive effect.

The power supply is a simple 21 volt unregulated supply (a rectified 15V a.c. transformer with a 4700µF smoothing capacitor) but which needs to have a high surge capacity as the transients generated by the coil can overload the transformer and rectifier.

The second prototype uses a 200VA transformer and 10A rectifier which works well. My first prototype used only a 100VA transformer and died suddenly in a cloud of smoke!

World Radio History

The coil, L1, consists of approx 333 turns of 22swg enamelled wire wound on a plastic former of about 13cm diameter (a standard plastic waste pipe coupler) in eight layers, across a span of about 25mm. The turns of the coil need to be tightly wound and well varnished into place to prevent oscillation and heating in operation. The prototype coil gets mildly warm in normal use, about 40°C.

DO NOT TRY THIS AT HOME!

Again I urge everyone to take care. I only experiment on myself; the cardinal rule for me is don't try to treat anybody else. I am aware of the risks I take and accept them, other people may not be. I also don't encourage anyone to try this on themselves, but only to perform proper experiments with microorganism samples with due precautions under scientific conditions. There is still too much that is not properly understood about this technology.

I personally believe that the Rife type plasma machine is the safer option. However, these machines are difficult to obtain and very overpriced (ready-built). I have asked a few manufacturers for specs but I've found that many are unwilling to give proper specifications, and in some cases the advertising claims are simply untrue.

If there are any decent r.f. engineers out there (high power r.f. design is not my speciality) I for one would be interested in a modern design for a Rife plasma device built from the ground up and optimised, not just based on modified CB radios. It should also work with lower carrier frequencies as there is some evidence that carriers in the range of 3MHz to 11MHz are more effective than the 27MHz CB range.

Currently, I am working on the design of a high accuracy digital frequency synthesizer that I intend to use for further experiments.

I must add that, despite my opinions, I am not specifically endorsing any of these devices in any way. I am only presenting this information as a matter of interest.

OTHER EVIDENCE

Amongst the scientific literature I have discovered there is a wealth of information as yet not properly compiled together, and usually buried in incomprehensible technical gibberish. I have seen research reports which indicate that weak magnetic field pulses at 16·7Hz can stimulate the body into increased production of T-lymphocytes. I have seen other reports that indicate that other frequencies inhibit the same lymphocytes.

There are also reports that claim similar effects at various frequencies that inhibit cancer cell growth and ones that stimulate it. Most of the current research, however, has focused on the effect of power line frequencies i.e. 50/60Hz. Most reports indicate that these frequencies are dangerous, I have not seen any evidence of any beneficial effects reported at these frequencies.

One thing that does seem to be confirmed repeatedly by research is that weak electric and particularly magnetic fields have a most profound effect on growing cells. The faster the rate of cell growth, the more pronounced the effect. This implies that any low frequency magnetic field may be particularly dangerous to children, and especially to unborn children. Also prolonged exposure to any low frequency magnetic field may cause VDG and/or electroporation and consequent cellular damage.

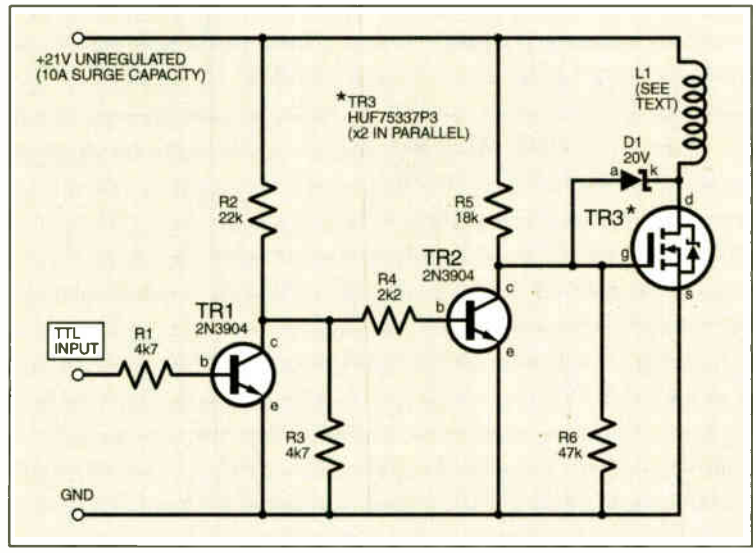


Fig.5. the author's experimental pulser circuit.

It is now widely accepted by many researchers that any field in excess of 150nT is likely to have an immediate bioactive effect on cellular metabolism and much weaker fields may have effects after a longer exposure.

OFFICIAL RECOMMENDATIONS

Despite numerous well founded and intensive research studies on the bioactive effects of l.f. electric and magnetic fields, both the UK NRPB (National Radiological Protection Board) and the US NCRP (National Committee on Radiation Protection) insist that their official position is that there is no proven risk of adverse health effects from l.f. fields.

Many informed observers believe that this is a short sighted view motivated by political considerations, for example, both authorities have close ties to power generation companies that obviously would be reluctant to admit that their product might be dangerous to consumers.

In the United States at least, this has led to conflict between various government agencies, for example the NCRP and the EPA (Environmental Protection Agency). The EPA has allegedly petitioned various US government authorities to classify l.f. radiation as "a possible human carcinogen", but has met with concerted resistance from the power companies and their lobbyists. In addition, numerous lawsuits have been filed by consumers and environmental groups against power generation companies, citing research and statistical studies that supposedly show a strong correlation between childhood leukamia and proximity to power lines emitting l.f. electric and magnetic fields.

The fact remains, that whilst these authorities insist that there is no proven risk from l.f. fields, they are talking in the context of normal domestic power lines, and on the basis of projected field strengths and exposures in normal use. Neither authority is actively denying that l.f. fields have bioactive effects *per se*, although there is controversy over the field strengths that might have an effect, and whether or not the effects are temporary or permanent.

The NRPB in the UK has published reports in which it admits that some strong l.f. fields might have temporary bioactive effects. The NCRP is also at the centre of a controversy over a "leaked" internal draft recommendation of 1995 by its own research teams which makes various recommendations, citing specific bioactive effects of low intensity l.f. fields and which concludes:

Based on available evidence, the committee concludes that it is desirable to reduce human exposure to electric and particularly to magnetic fields over the frequency range from near-zero to 3kHz. This may be accomplished, particularly in areas with frequent and prolonged human occupancy, by recommending an exposure standard, or a set of safety guidelines; or by recommendations that fall short of establishing either a standard or guideline, but offer guidance to limit exposure.

FOOD PRESERVATION

Perhaps the most interesting twist to the whole story comes in the form of two new reports by the US FDA, the very organisation that tried to shut down Rife. These latest two reports consider the use of pulsed electric and magnetic fields for food preservation on the basis that accepted research shows that pulsed electric and magnetic fields can kill bacteria, viruses and other pathogens.

These two reports (which are available on the Internet, addresses later) cite impressive figures for kill rates of specific bacteria at specific pulse rates of a strong magnetic field. But the conclusion of the reports is that pulsed fields do not qualify for approval as a method of food preservation because the mechanism of action is unknown, and also because of inconsistent results, in some cases the fields appear to enhance the action of bacteria, in others they kill them and some appear to have no effect at all.

The interesting conclusion the FDA draws from this is that the effect is obviously frequency dependent and also is influenced by field strength, exposure time and the nature of the material exposed. This is almost exactly what Rife was saying in the first place.

MAGNETIC FIELD REPORT

Here is an extract from the FDA magnetic field report:

Exposure to a magnetic field may stimulate or inhibit the growth and reproduction of microorganisms. A single pulse of intensity of 5T to 50T and frequency of 5kHz to 500kHz generally reduces the number of microorganisms by at least 2-log cycles

World Radio History

(Hoffman 1985). High intensity magnetic fields can affect membrane fluidity and other properties of cells (Frankel and Liburdy 1995). Inconsistent results of other inactivation studies, however, make it impossible to clearly state the microbial inactivation efficiency of magnetic field or to make any predictions about its effects on microbial populations.

FINALLY

I have deliberately tried to keep this article simple, trying to find a balance between completeness, common sense and scientific overkill! I hope that I have at least stimulated some readers to research this fascinating subject themselves.

ACKNOWLEDGEMENT

Photographs of the 1947 Rife Machine were downloaded from **http://www.rt66.com/~rifetech/rife.html** and reproduced by kind permission of James Bare.

REFERENCES

Ions, Electrodes and Membranes. J. Koryta. 1992. John Wiley and Sons, ISBN 0-471-93080-6. A good introductory book on cellular electrochemistry.

http://www.lvstrings.com/quack.htm. Jeff Behary's Turn of the Century Electrotherapy Museum. A wonderful site with descriptions and many photos of the plethora of extremely weird, wonderful and hilarious early electrotherapy devices.

http://www.mtn.org/~quack/. Another wonderful on-line "quackery" museum with links to many sites.

http://www.rife.org/. Site of the Rife Plasma Digest, a very good site with scanned copies of numerous original Rife documents and correspondence.

http://www.rt66.com/~rifetech/. James Bare's web site, lots of information and great links. Check out the AVI video of the exploding Blepharisma!

http://www.rife.de/. The Rife Information Forum Europe, useful links and information about clinical trials.

http://patent.womplex.ibm.com/details?patent_number=5139684. A link with details of the Einstein team's patent for their proposed HIV treatment with details of numerous subsequent similar patents.

http://vm.cfsan.fda.gov/~comm/ift-omf.html. FDA Report (2000) on use of pulsed magnetic fields for food preservation.

http://vm.cfsan.fda.gov/~comm/ift-pef.html. FDA Report (2000) on use of pulsed electric fields for food preservation.

http://www.nrpb.org.uk. The official web page of the UK National Radiological Protection Board (NRPB)

http://www.ncrp.com. The official web page of the US National Committee on Radiological Protection (NCRP).

http://www.microwavenews.com/ncrp.html. A link to a copy of the "leaked" 1995 NCRP Draft recommendations for l.f. field exposures.

Radio Bygones

The leading magazine for vintage radio enthusiasts

Now Also Available To
BUY ONLINE
www.radiobygones.com
Log on, pay by credit card and download the magazine to your PC
ONLY $9.99 (US dollars) FOR 6 ISSUES
A free issue is available

ARTICLES on restoration and repair, history, circuit techniques, personalities, reminiscences and just plain nostalgia – you'll find them all. Plus features on museums and private collections and a full-colour photo-feature in every issue.

IT'S MOSTLY about valves, of course, but 'solid-state' – whether of the coherer and spark-gap variety or early transistors – also has a place.

FROM THE DAYS of Maxwell, Hertz, Lodge and Marconi to what was the state-of-the-art just a few short years ago . . .

THERE IS ALSO a selection of free readers' For Sale and Wanted advertisements in every issue.

Radio Bygones covers it all!

THE MAGAZINE is published six times a year, and is only available by postal subscription. **It is not available at newsagents.**

TO TAKE OUT a subscription, or to request a sample copy, please complete the form below and return it to:

RADIO BYGONES, Allen House, East Borough, Wimborne, Dorset BH21 1PF.

Tel: 01202 881749. Fax 01202 841692. Web sites: www.radiobygones.co.uk www.radiobygones.com

VISA

RADIO BYGONES ORDER FORM

SWITCH EUROCARD MasterCard

A SAMPLE COPY of Radio Bygones £3.25
(Add 70p for overseas Airmail postage)

SUBSCRIPTIONS (post paid):	1 YEAR	2 YEAR
UNITED KINGDOM	£18.50	£35.00
REST OF EUROPE (AIRMAIL)	£20.50	£39.00
REST OF THE WORLD (AIRMAIL)	£24.50	£47.00

☐ Yes, I would like a sample copy of RADIO BYGONES
☐ Yes, I would like to take out a subscription for:
☐ One year (6 issues) ☐ Two years (12 issues)
☐ I enclose a cheque/Eurocheque/PO for £ . . . . . payable to Wimborne Publishing Ltd
☐ Please debit my Visa/Mastercard/Switch card
NOTE *Minimum credit card payment is £5*

My card number is:

. . . . . .

Please print clearly, and check that you have the number correct

The card is valid from: . . . . . .Switch Issue No: . . . .

My name is . . . . . .

My address . . . . . .

. . . . . .

Post Code/Zip . . . . . .Tel . . . . . .

Signed . . . . . .

World Radio History

VIDEOS ON ELECTRONICS

A range of videos selected by *EPE* and designed to provide instruction on electronics theory. Each video gives a sound introduction and grounding in a specialised area of the subject. The tapes make learning both easier and more enjoyable than pure textbook or magazine study. They have proved particularly useful in schools, colleges, training departments and electronics clubs as well as to general hobbyists and those following distance learning courses etc

BASICS

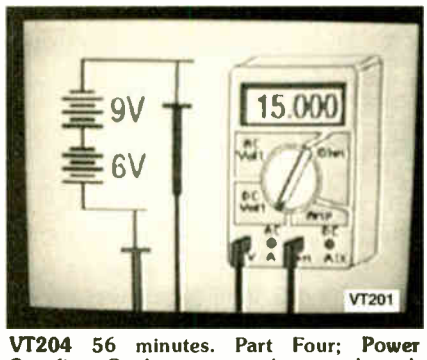
VT201 to VT206 is a basic electronics course and is designed to be used as a complete series, if required.

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

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

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

Order Code VT203



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

Order Code VT204

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

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

£34.95 each
inc. VAT & postage

Order 8 or more get one extra FREE
Order 16 get two extra FREE

VCR MAINTENANCE

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

Order Code VT102

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

Order Code VT103

DIGITAL

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

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

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

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

Order Code VT303

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

Order Code VT304

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

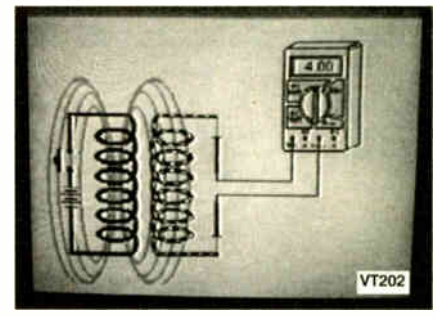
Order Code VT305

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

RADIO

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

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



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

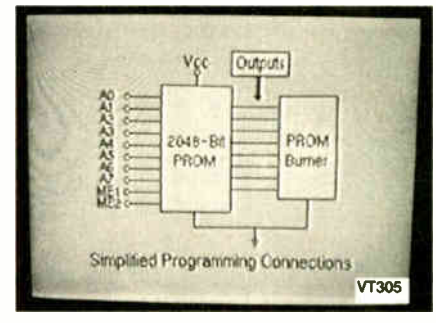
MISCELLANEOUS

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

Order Code VT501

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

Order Code VT502



Each video uses a mixture of animated current flow in circuits plus text, plus cartoon instruction etc., and a very full commentary to get the points across. The tapes are imported by us and originate from VCR Educational Products Co, an American supplier. We are the worldwide distributors of the PAL and SECAM versions of these tapes. (All videos are to the UK PAL standard on VHS tapes unless you specifically request SECAM versions.)

ORDERING: Price includes postage to anywhere in the world.

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

Visa, Mastercard and Switch orders accepted – please give card number, card expiry date and Switch Issue No.

Orders are normally sent within seven days but please allow a maximum of 28 days, longer for overseas orders.

Send your order to: **Direct Book Service,** Allen House, East Borough, Wimborne, Dorset BH21 1PF

Direct Book Service is a division of Wimborne Publishing Ltd., Publishers of *EPE*

Tel: 01202 881749. Fax: 01202 841692

E-mail: dbs@epemag.wimborne.co.uk

World Radio History

Constructional Project

EPE SNUG-BUG

MIKE DELANEY

A 4-channel personal "central heating" system, with sensors, for your tropical pets home.

KEEPING tropical pets is a rewarding and popular hobby. In order that the pets thrive the temperature of the environment must be maintained to within a few degrees and pet stores supply heating pads and thermostatic controllers for this purpose. If more than one habitat is involved then a separate controller/pad system should be used for each, especially if the habitats are located any distance apart or are in different rooms of the house.

This article describes a 4-channel thermostatic controller intended for use with up to four (dry) heat pads. The temperature range is designed to be from about 25°C to 40°C, though each pad may be individually calibrated to the user's requirements.

Fish tanks and other *wet* environments where the heating device needs to be immersed in water are *NOT* dealt with in this article, since there may be certain safety issues unknown to the author – the author's children have snakes and toads only.

DESIGN CONSIDERATIONS

The most important features considered when designing the circuit were:

- Safety – the sensors must be well isolated from harmful voltages.
- Cheap sensors requiring minimal wiring.
- Good noise-immunity on the sensors, allowing long wired connections.
- Easy to interface to the mains supply and no mains interference.
- Good temperature control stability.
- Easy to calibrate and change temperature ranges.
- The circuit should be as simple as possible, requiring only a basic grasp of project construction.

CHOICE OF COMPONENTS

A good deal of thought was given to the type of sensors to use. Three possibilities presented themselves: thermistors, thermocouples and semiconductor sensors. Thermocouples would be a good choice but require special interfacing – a "cold junction compensation" circuit – and expensive cable and connectors to work correctly. Active sensors, like the LM35 from National Semiconductors, need three-core cable, and in the author's experience, can require a lot of attention with regard to decoupling if long cables are used.

This left only one possibility – thermistors. These are easy to use, have good linearity, fast response time and are simple to incorporate in a bridge circuit (more of this later). No special connectors or cables are needed. They are simply resistive devices.

The thermistors chosen are 10 kilohm NTC types. The value of 10k is the manufacturer's quoted typical resistance of the device at either 20°C or 25°C. This value decreases with an increase in temperature (hence NTC – negative temperature coefficient).

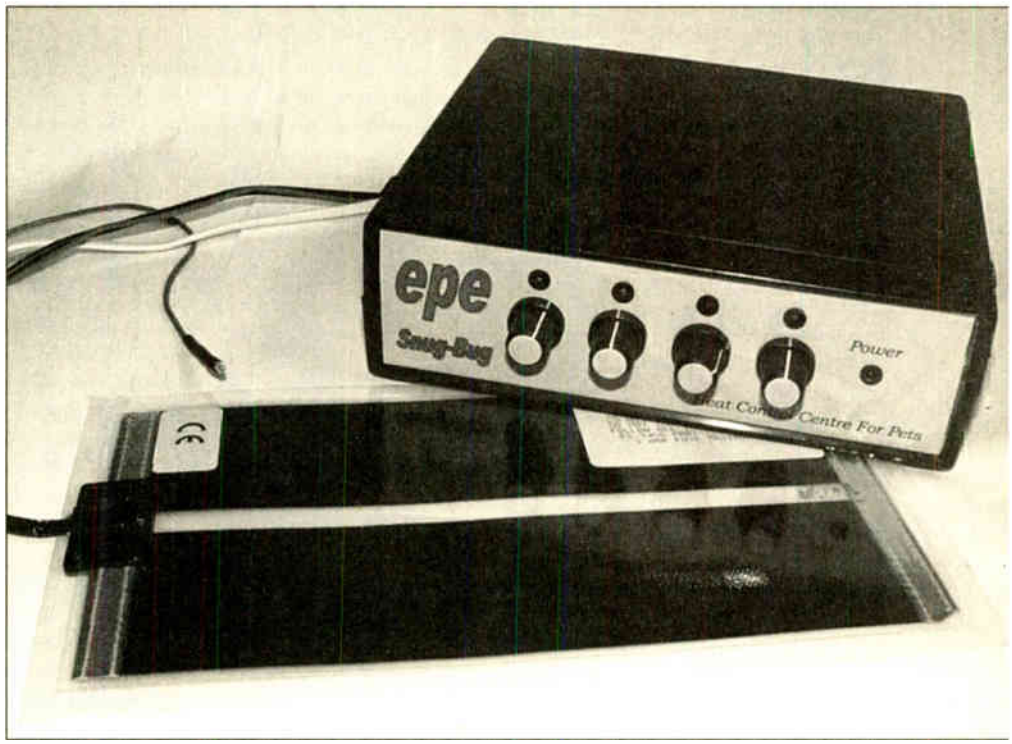
Having this relatively low resistance greatly reduces the risk of noise pick-up on the connecting cables. The prototype has been successfully tested with 25 metres of light-weight mains cable in a typical home environment.

MAINS SWITCHING

Most domestic appliances such as refrigerators and deep-freezers switch the mains current by way of mechanical relays. These will be heard clicking on and off periodically, and on older appliances will also be heard on any a.m. radio within a hundred yards radius! This noise is caused because the relay switches irrespective of the mains supply waveform.

Fortunately to reduce mains-borne noise there is a simple, if more expensive, solution open to us called "solid-state relays". These fully encapsulated devices comprise an optical isolating/coupling device driven by low voltage d.c. and a mains phase sensor which both combine to control an internal triac. A triac is a bi-directional switch which has the ability to switch mains voltage of either phase, giving "full-wave control".

The point on the mains waveform at which switching will take place is governed by an internal phase sensor, and is



World Radio History

allowed to happen only when the phase is very close to zero volts. Thus, it is only a matter of turning on what is effectively an l.e.d. to obtain *silent* switching of the supply to the heater pads.

A GOOD REFERENCE

In order to make sure the temperature remains constant over time a good voltage reference i.c. is used. The actual device chosen needed to satisfy two major criteria: it must be stable, and it must be able to drive a couple of milliamps at least without "running out of steam".

This is necessary because the thermistors are low resistance types, and there are up to four connected at any one time. Of course, it would be possible to use a normal Zener diode circuit with an op.amp buffer, but this was not aesthetically pleasing, it would take up more p.c.b. area and could add to circuit drift.

Looking through some components catalogues produced the ideal device from Analog Devices, the REF-03CNB which is a 2·5V reference with a load current rating of 20mA. Available in a standard 8-pin package, the published stability data is also more than satisfactory for the project.

HOT UNDER THE COLLAR

Calibration of any type, be it frequency, wind speed, altitude etc. brings with it a chicken-or-egg situation. Before it is possible to set up your measuring device it is necessary to know the value of the input, but how do you know its value in the first place?

Fortunately, as far as this project is concerned there are reasonably accurate thermometers available at pet stores for checking the temperature within the ranges which interest us. Absolute accuracy is not critical, it is not as if we are keeping a volatile liquid within very tight limits, so it is sufficient to use a standard thermometer as our reference sensor.

BRIDGE WORK

Temperature measurement is carried out using a resistive bridge circuit, where one leg of the bridge is connected to the thermistor and the other to the reference voltage. By comparing the voltage across the thermistor it is possible to determine whether its resistance, and hence the temperature, is above or below the preset value from the reference. It is then a simple matter of switching the heater on or off as needed.

CIRCUIT DETAILS

The full circuit diagram for the *EPE* Snug-Bug is shown in Fig.2. As each "channel" is identical, only the action of one will be described here.

A reference voltage of 2·5 Volts is produced by IC1, a REF-03 8-pin d.i.p. device from Analog Devices. This reference is used to drive the bridge components in each of the four sensor circuits.

The bridge configuration may not be immediately apparent to the less experienced constructor and one sensor circuit is reproduced, in simplified form, in Fig.1. As this shows, the reference voltage is applied to one end of thermistor TH1, and also to one end of the R13, VR1, R14 divider chain. The bridge is then "closed" on both of these legs to ground (0V) via one end of R1 and one end of R14.

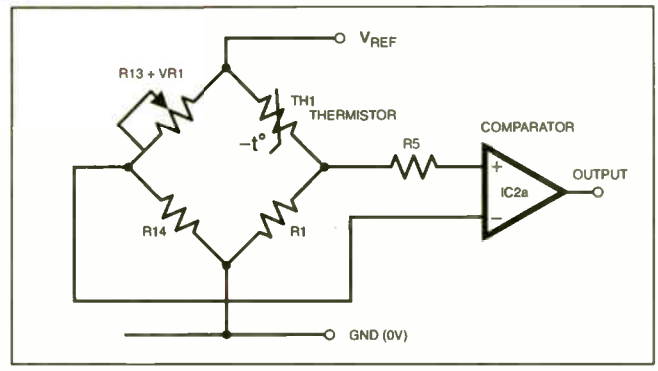
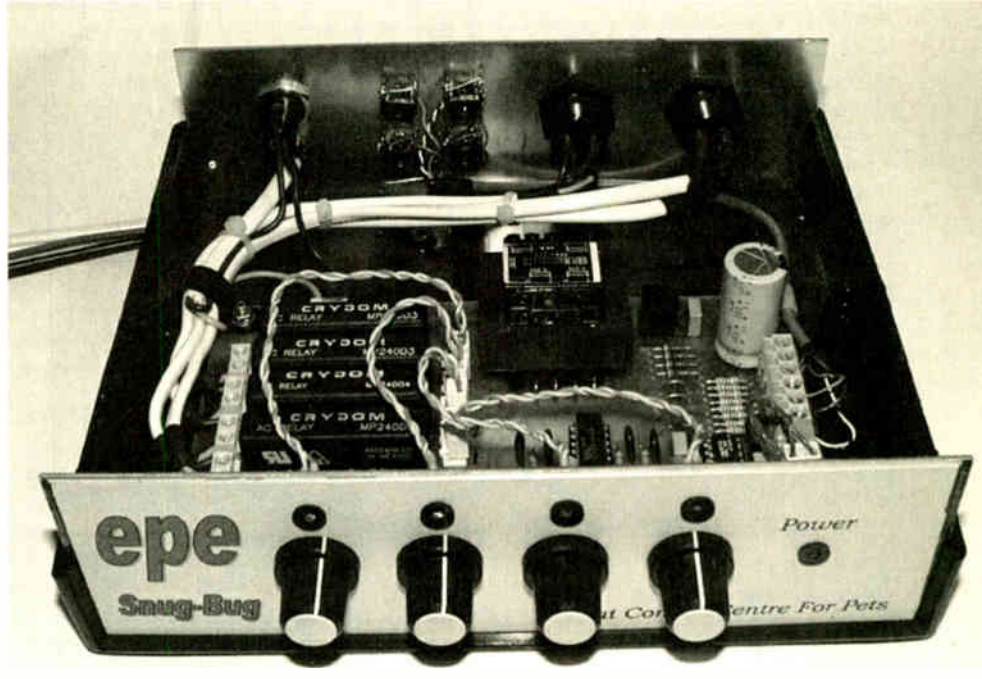


Fig.1. Simplified bridge circuit for one thermistor sensor.

The output of the bridge is applied to IC2a, one quarter of an LM339 comparator, the output from the thermistor connecting to the non-inverting input (pin 5), and VR1 wiper connecting to the inverting input (pin 4). Varying the wiper position of VR1 will, therefore, vary the voltage applied to the inverting input, pin 4, and as the thermistor resistance varies with temperature, the voltage on pin 5 of the IC2a will also vary. When the voltage on the non-inverting input is greater than that on the inverting the output on pin 2 will go high.

Consider what happens as the temperature applied to thermistor TH1 increases. Since the NTC thermistor's resistance *decreases as the temperature increases* the voltage applied to the non-inverting input will *increase* and the output of IC2a will go high when the voltage from the thermocouple is greater than the voltage from the control potentiometer VR1.

Looking at the full circuit diagram, Fig.2, it can be seen that in order for the opto-coupler (l.e.d.) within IC3 to turn on the output from IC2a must be *low* so that it sinks current. Thus, increasing temperature will turn IC3 off, and decreasing temperature will turn it on. In order to turn IC3 off when there is no thermistor plugged in the full reference voltage (V_{REF}) is connected to the non-inverting input automatically through socket, SK1.



The compact and neat wiring inside the completed unit.

World Radio History

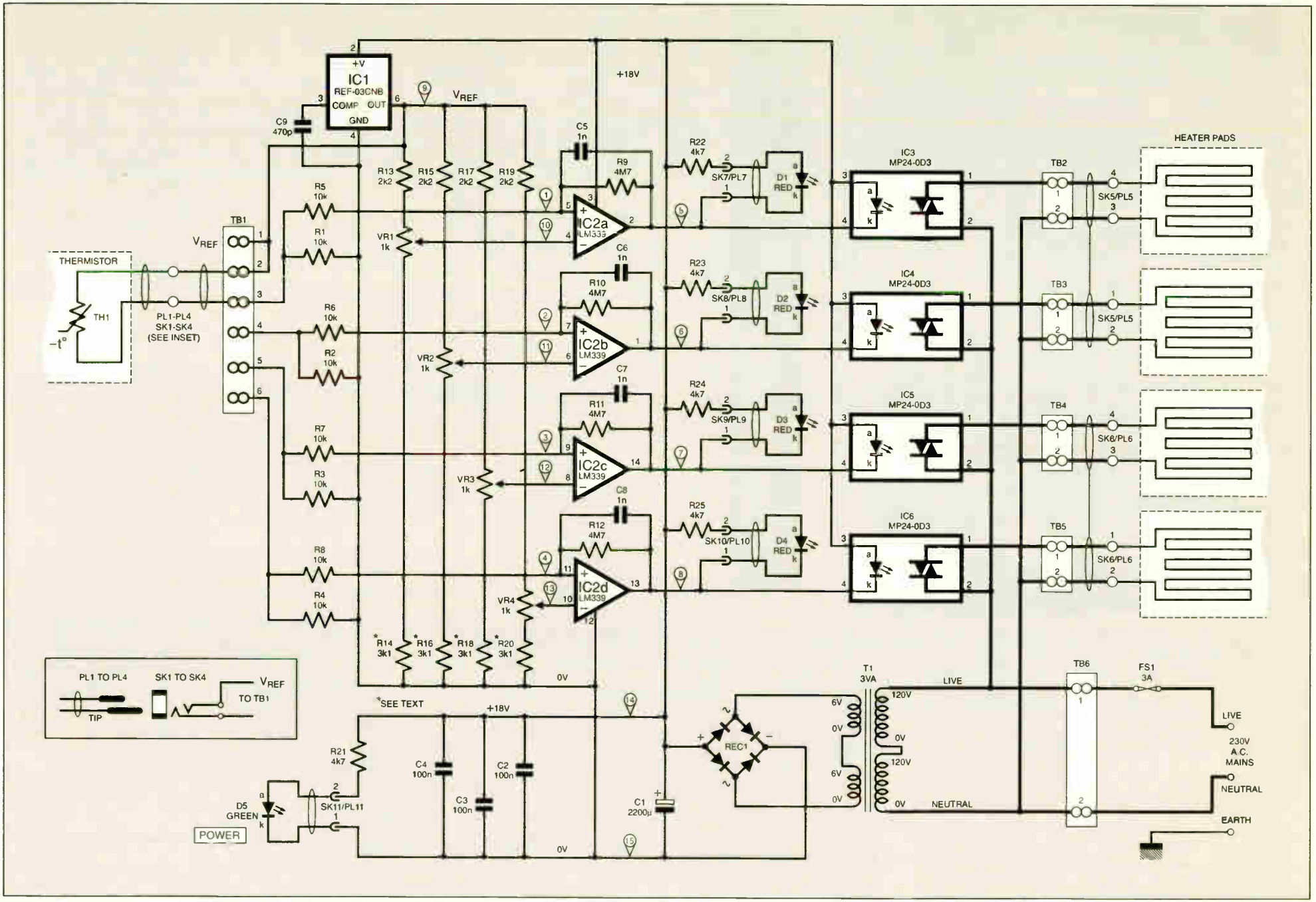


Fig.2. Complete circuit diagram for the EPE Snug-Bug heat control centre for pets.

World Radio History

Resistor R9 provides positive feedback (hysteresis) around comparator IC2a, ensuring that switching is clean with capacitor C5 preventing any tendency for high frequency oscillation of the comparator.

Four l.e.d.s (D1 to D4), with current limiting resistors (R22 to R25) are included in parallel with the opto-triacs IC3 to IC6 to confirm operation of each channel. The l.e.d.s in the working design are high output types to reduce current consumption. If different types are used the four resistors may be changed to suit.

POWER LINKS

The power supply is a very simple affair, comprising a transformer, full-wave rectifier and smoothing components. A power "on" indicator l.e.d. with its associated resistor are also included.

Several wire links have been included in the layout, both to assist in the layout and also to provide useful test points (TP1 to TP15).

CONSTRUCTION

The *EPE* Snug-Bug is built on a Eurocard size printed circuit board (p.c.b.) and the component layout and full-size underside copper foil master is shown in Fig.3. This board is available from the *EPE PCB Service*, code 296.

Assembling the p.c.b. should present no problems. Start by fitting the resistors and wire links and fit the mains transformer last. Use good quality i.c. sockets for IC1 and IC2, turned pin types are preferred. Do not fit the i.c.s until preliminary testing is completed.

Capacitors C5 to C8 may need to have their wires bent slightly in order for them to fit on the p.c.b. This should be done using fine nosed pliers, taking care not to damage the components.

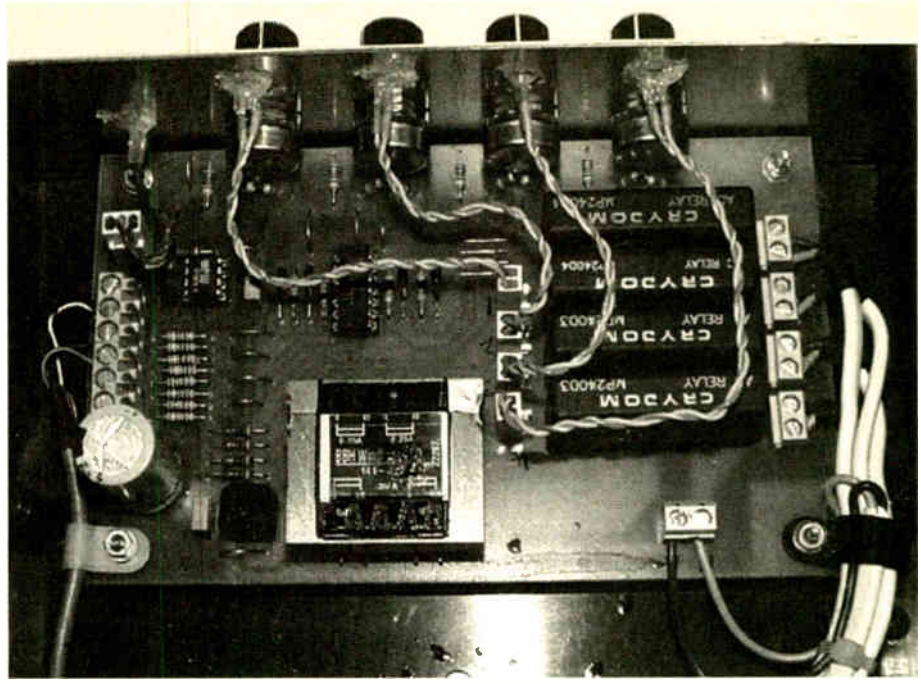
In order to set the maximum and minimum voltages on the control potentiometers' wipers, the prototype used a value of 3·1 kilohms (3k1) for resistors R14, R16, R18 and R20 which is not a preferred value. This value is obtained by using two resistors in series for each, one 1k5 and one 1k6, numbering the second resistor R14a etc. on the board component layout in Fig.3.

INTERWIRING AND BOXING-UP

Interwiring between the front and back panel mounted components and the circuit board is shown in Fig.5. The general positioning of components inside the specified case can be seen in the photographs.

In the prototype unit, the four temperature control potentiometers (VR1 to VR4) are p.c.b.-mounting types and are soldered directly to the p.c.b. and mounted through the fascia with spacers placed between the fascia panel and each control. This makes for a neat and quick assembly, but requires more care when drilling the panel. To assist in this there is a detailed drilling diagram (Fig.4) included, but p.c.b. solder pins and connecting wires may be used if desired.

The front panel l.e.d.s (D1 to D4) are mounted through plastic insulating collars of the type used to isolate TO-3 style screws, and are fixed in place using a glue gun. Each l.e.d. is connected to the p.c.b. using a Molex connector and wire (see



Component layout on the prototype p.c.b. and wiring to the front panel l.e.d.s. You can just see the series resistors in front of the potentiometers.

COMPONENTS

Approx. Cost Guidance Only **£77** *excluding heat-pad & case.*

See SHOP TALK page

Resistors

TH1 to TH4	min. bead thermistor: resistance @ 25°C 10kΩ ±1% (4 off – see text)	
R1 to R8	10k (8 off)	
R9 to R12	4M7 (4 off)	
R13, R15, R17, R19	2k2 (4 off)	
R14, R16, R18, R20	1k6 (4 off)	3k1 see text
R14a, R16a, R18a, R20a	1k5 (4 off)	3k1 see text

All 0·6W 1% metal film, except where stated

Potentiometers

VR1 to VR4	1k min. rotary carbon, lin. (4 off)

Capacitors

C1	2,200 radial elect. 25V, pin pitch 7·5mm
C2 to C4	100n polyester (3 off)
C5 to C8	1n mylar film (4 off)
C9	470p resin-dipped ceramic

Semiconductors

D1 to D4	3mm red l.e.d. (4 off)
D5	3mm green l.e.d.
IC1	REF03GP 2·5V precision voltage reference
IC2	LM339 quad voltage comparator
IC3 to IC6	MP240D3 opto-triac, with zero switching: input 3·5V to 32V d.c.; output switching 3A @ 240V a.c. (4 off)
REC1	100V 2·5A bridge rectifier (1KAB10E)

Miscellaneous

SK1 to SK4	3·5mm mono switched jack socket, plastic body, panel mounting (4 off)
PL1 to PL4	3·5mm mono jack plug (4 off)
SK5, SK6	4-pin 2A 250V mains socket, chassis mounting (Bulgin SA2368 – 2 off)
PL5, PL6	4-pin 2A 250V mains line-plug, with shielded pins (Bulgin SA2367 – 2 off)
SK7 to SK10	2-way 2·54mm (0·1in.) pitch pin header (4 off)
PL7 to PL10	2-way pin connector (4 off) and crimp terminal (8 off)
SK11/PL11	3-way pin header, connector, crimp terminal (remove centre pin – see text)
TB1	6-way 16A terminal block, p.c.b. mounting
TB2 to TB6	2-way 16A terminal block, p.c.b. mounting (5 off)
T1	3VA mains transformer, p.c.b. mounting, with 0V-6V, 0V-6V secondaries
FS1	3A 20mm fuse, with panel mounting fuseholder

Printed circuit board available from the *EPE PCB Service*, code 296; plastic (ABS) case, with aluminium front and back panels, size approx. 203mm (w) x 178mm (d) x 63mm (h); 220V/240V 7W heater pad, size approx. 150mm x 280mm (6in. x 11in.) (4 off); 8-pin d.i.l. socket; 14-pin d.i.l. socket; plastic 15mm diameter, collet fixing, knob (4 off); strain-relief grommet; p-clips (2 off); plastic spacer (4 off); 3mm csk bolts, nuts and washers (4 off each); mains cable (see text); multi-strand connecting wire; heatshrink and rubber sleeving; solder, etc.

World Radio History

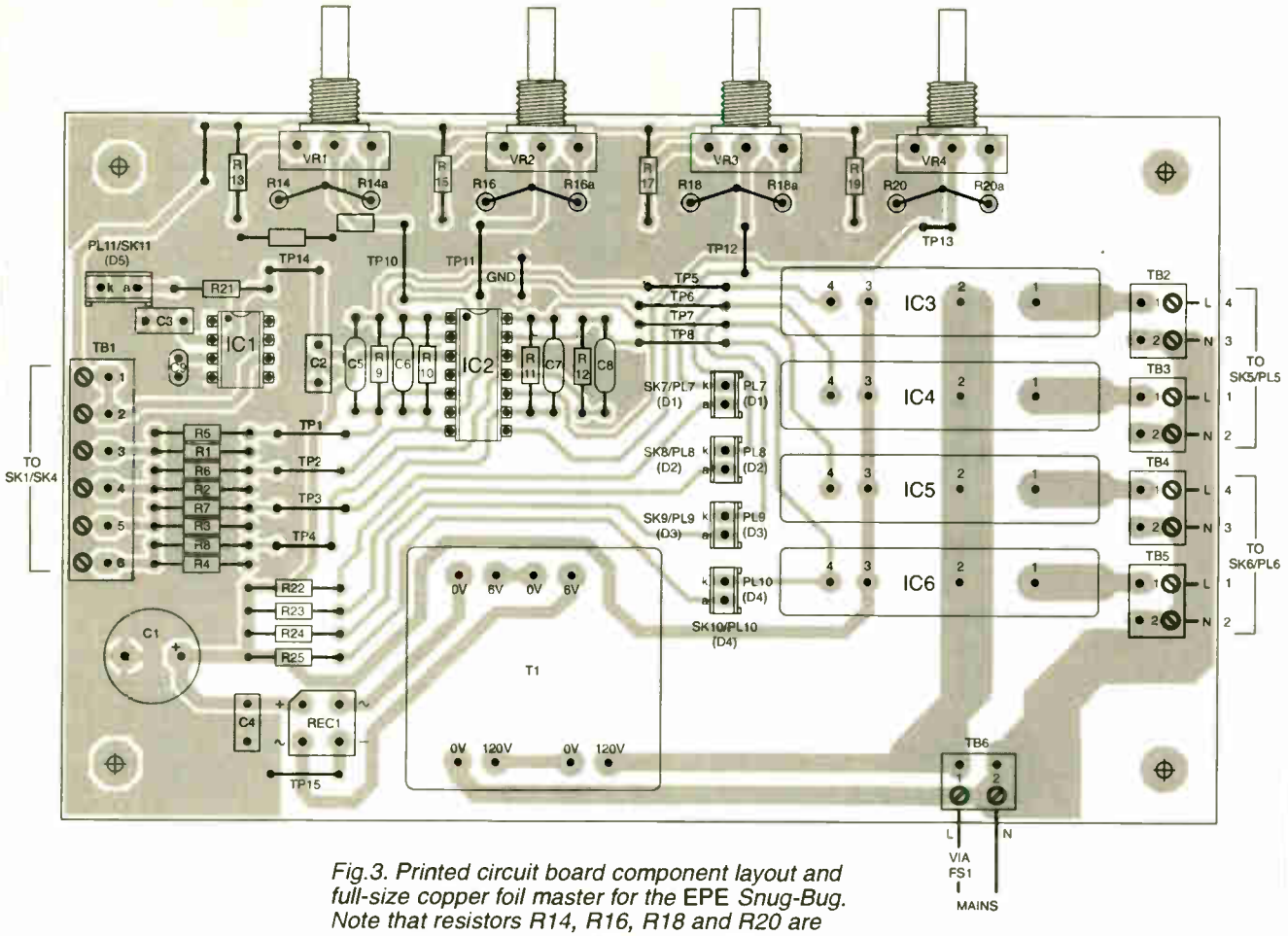
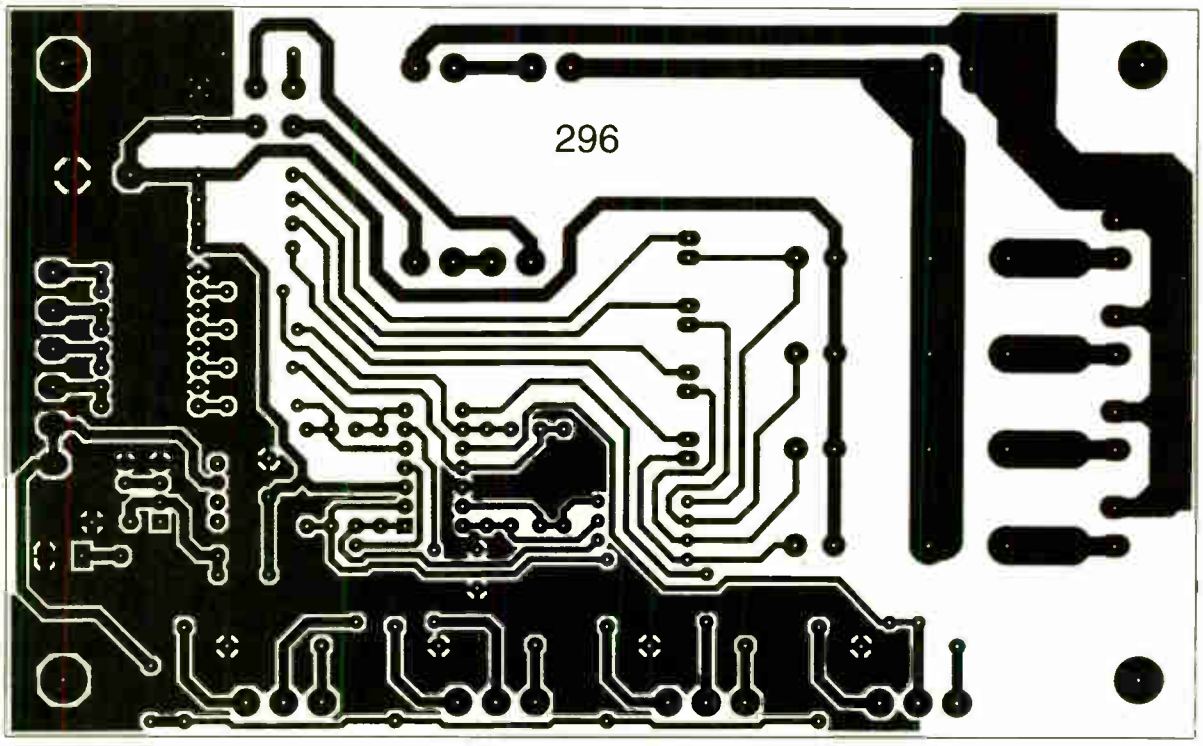


Fig.3. Printed circuit board component layout and full-size copper foil master for the EPE *Snug-Bug. Note that resistors R14, R16, R18 and R20 are made up of two resistors wired in parallel. See text and components list.*



World Radio History

photographs), photographs though again these may be soldered directly to solder pins instead and the l.e.d.s mounted in conventional plastic holders.

The power on indicator l.e.d. is connected using a three-pin Molex plug and socket with the centre pin removed. This was done to facilitate removal of the circuit board during initial testing whilst maintaining a reasonable thickness of ground copper.

The board terminal blocks TB2 to TB5 are 2-way p.c.b. mounting types rated at 16A, with 5mm pin spacing. The connectors SK5 and SK6 for the switched supplies (from TB2 to TB5) to the heater pads are panel mounting four-way mains types rated at 2A. ***Only correctly rated and safety protected connectors for SK5/PL5 and SK6/PL6 should be used!***

Standard 3·5mm mono jack plugs and sockets are used to connect the thermistors, *the sockets should be the type with break contacts*. One word of caution: the author has found that it is possible to buy "standard" plugs which do not make a good connection to the wipers in "standard" sockets. This causes the thermistor to appear intermittent or completely open circuit (see fault-finding later). Buying both plug and socket from the same supplier and careful testing is recommended.

A fuse rated at 5A should be used in the mains input line, along with a cable relief grommet and P-clips and cable ties for all of the cables.

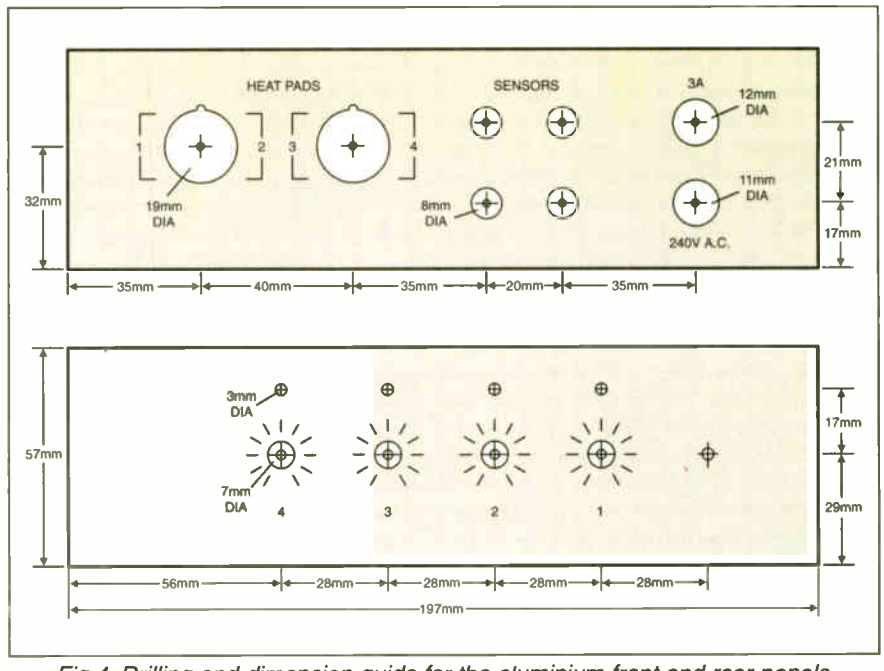


Fig.4. Drilling and dimension guide for the aluminium front and rear panels.

THERMISTOR PROBES

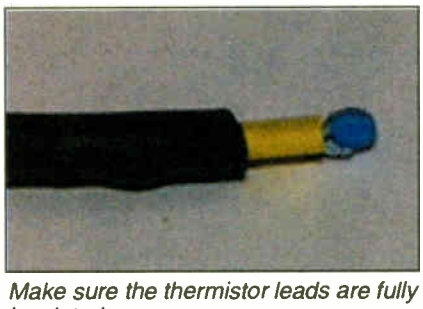
Two types of thermistor are available (see *Shoptalk* page), one has p.t.f.e. insulated leads ready fitted and the other has bare wires. Whichever type you choose it is desirable to insulate *all* connections using heat-shrink sleeving and silicone rubber after soldering. Waterproofing will help to prevent corrosion of the wires and eventual sensor failure.

The type of wire used to connect the thermistors to the control unit is not critical. The author has successfully used single-core screened ("microphone" cable) and also unscreened lightweight mains cable. If a long run is required it is probably better to use mains cable since it is easy to fix to skirting boards etc and is stronger than lightweight types.

Table 1: Test Point Voltages

Test Point TP No.	*TP Name*	*Voltage*	*Comments*
1–4	Non-Inverting (IC2) Inputs	*	Varies with temperature
5–8	Output	1·2V to V_{CC}	Almost rail-to-rail
9	V.Ref.	2·50V	Stable reference voltage.
10–13	Wiper (VR1 to VR4)	1·23V to 1·62V	Varies depending upon pot. wiper position.
14	Supply Voltage (V_{CC})	18V d.c.	
15	Supply Zero	0V	

Notes on the test point voltages: *TP1 to TP4 – this should be approximately 1·25V d.c. but will depend upon the temperature of the thermistor. TP15 – all voltages shown are measured with respect to this point 0V (Gnd).



Make sure the thermistor leads are fully insulated.

TEST AND CALIBRATION

Be aware that mains voltages are present at various points on the circuit board and case back panel. Use insulating tape to cover exposed joints on the underside of the board.

To carry out tests and calibration you will require the following equipment:

Digital multimeter; mono 3·5mm plug, on which the centre (tip) and outer solder connections have been connected together; small lump of Blu-Tack or similar; two 2cm thick (approximately) pieces of polystyrene slightly larger than the heater pad/s; heater pad/s wired to the output plug/s; thermistor/s wired to 3·5mm jack plug/s.

The rear panel sockets, fuse and mains cable positioning.

World Radio History

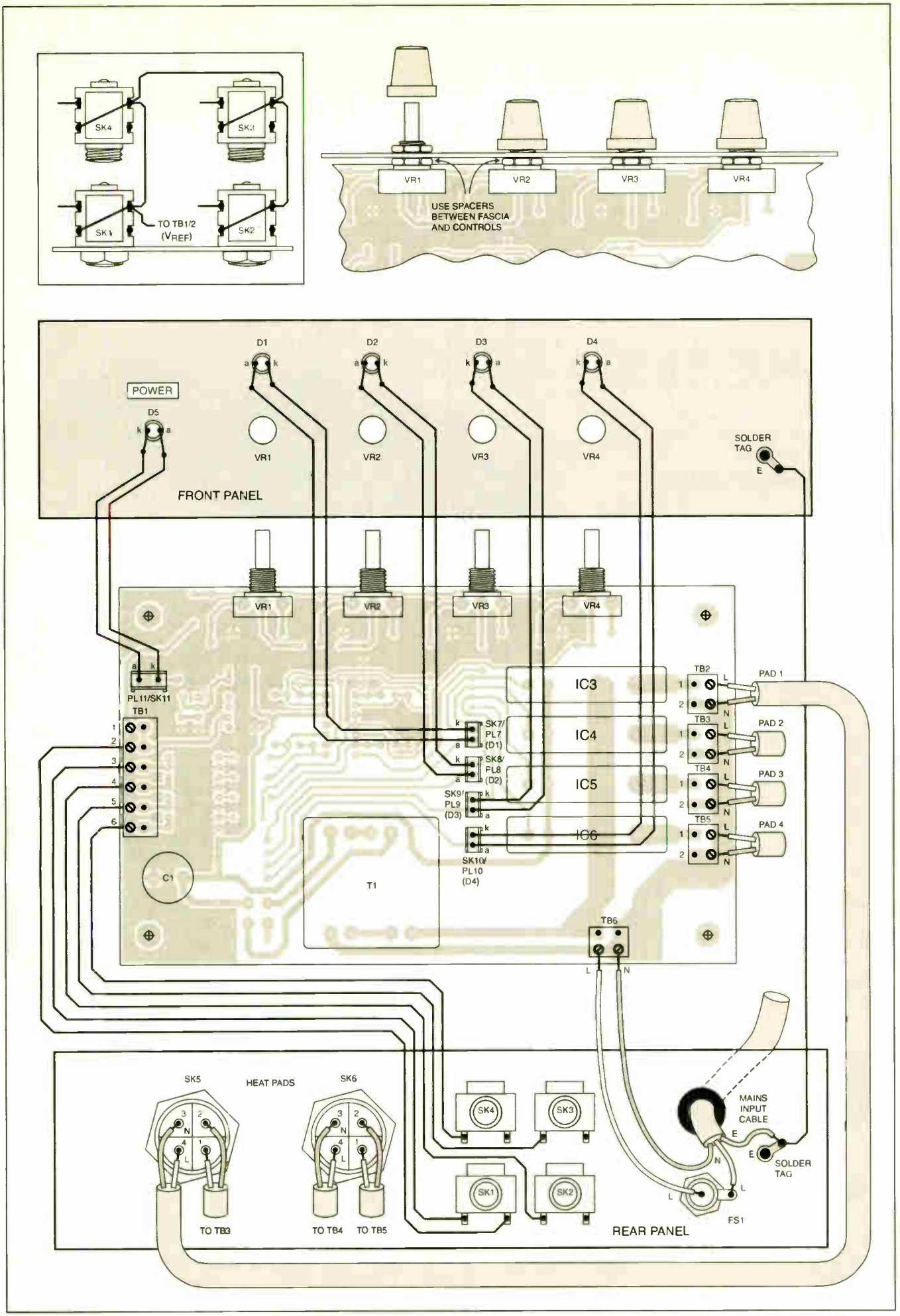


Fig.5. Interwiring from the circuit board to front and rear panel mounted components. The inset diagram (top left) shows the interwiring between to the switched jack socket tags.

World Radio History

Before applying power carefully check that all the components are placed correctly and there are no solder bridges or dry joints.

As mentioned earlier, several wire link test points have been included on the circuit board to assist fault finding. These are shown as numbered "Ice Cream Cornets" (the author's children's description!) on the circuit diagram, Fig.2. Table 1 shows typical voltages and these should be measured using a digital voltmeter.

Initial testing should be carried out without the thermistors connected to confirm that the outputs from the comparators are high and l.e.d.s D1 to D4 are off. Check that each of the outputs from the control pots at test points TP10 to TP13 changes as they are turned and that the l.e.d.s remain off.

Now plug the temporary 3·5mm "shorting plug" into each thermistor socket (SK1 to SK4) in turn and check that the comparator outputs go low and the l.e.d.s turn on. Once again, adjusting pots VR1 to VR4 should not have any effect, the shorted out channel must remain on.

THERMISTOR CHECK

Having completed these checks plug in the thermistor probes. It should be noted that there are two REF connections on terminal block TB1, both pin 1 and pin 2, and it does not matter which is used for which probe. This was done in order to make it easier to connect multiple wires to the one connector.

Embed all of the thermistors and the "standard" glass thermometer bulb in the Blu-Tack and allow time for the temperature to stabilise. When this has settled adjust each of the four controls and confirm that each channel l.e.d. turns on and off, and do so at the same position provided the temperature is between the lower and upper thresholds. If the ambient temperature is outside of these limits re-position the thermistors etc. to suit.

Check the voltage outputs from the thermistors, test points TP1 to TP4 inclusive. The "typical" voltage here (Table 1) applies ONLY to the author's unit measured at 20°C – thermistors vary slightly. Nevertheless, the voltages should be within a few millivolts of those shown when the temperature is 20°C.

HEAT CHECK

If all appears to be correct ***turn off the supply*** and connect one heater pad, say in Channel One position. Using the Blu-Tack stick the thermistor and thermometer to the pad. Insulate the heating pad using two pieces of polystyrene so that it makes a "sandwich" and place a book on top to ensure good thermal contact.

Apply the mains and turn the relevant pot. fully counter-clockwise so that the channel l.e.d. turns off. Now advance the control so that the associated opto-triac switches and power to the heater pad is turned on. Check that the temperature of the pad increases and that the controller switches the power off when the upper temperature limit is reached. Note this temperature from the thermometer.

The temperature of the heater pad will start to fall until the power is once again automatically applied to the heater. When this happens note this temperature also.

Using the digital multimeter now check the voltage present at the test point TP10 (for Channel One) and make a note of this.

It is now possible to check the operation of the other three channels by plugging the thermistor and heater pad into each of the other channels in turn and setting the control pots so that the same voltage is present on all the wipers (TP11 to TP13). This should result in the pad temperature remaining the same to within a degree or so.

FINAL SETTING

Next check the other three heater pads and thermistors by making polystyrene sandwiches and monitoring the temperature of each with the pot wiper voltages set identically to Channel One. This will confirm the accuracy of each thermistor and bridge components.

When you are satisfied that the circuit is functioning correctly set each channel to whatever temperature span is desired by changing the values of series combination resistors R14/a, R16/a, R18/a and R20/a and repeating the calibration process.

INSTALLATION

It is now simply a case of installing the thermistors in the animals' environments, monitoring the temperature switching points and noting the position of the control knobs when the desired temperature is achieved.

When installing the thermistors it is important that the temperature *inside* the environment is monitored, i.e. where the animal is and *not* on the outside. This is most easily achieved by using a small amount of silicone rubber to act as a heat transfer medium and waterproof tape to hold it in place on the floor of the tank/housing.

The heater pad, of course, remains on the outside of the tank as usual. It is *important* that no matter how the sensor is attached to the tank the animal *cannot* lift it off the surface being sensed.

FAULT FINDING

If the circuit does not work, referring to the list of voltages in Table 1 should allow analysis to component level. Incorrectly placed components, solder bridges and bent i.c. pins are the first things to check for.

As mentioned earlier, the only problem encountered during the building of the Snug-Bug was caused by incompatibility between the thermistor jack plugs and sockets. This problem is easy to check for – measure the voltage present at the non-inverting inputs of the comparator (IC1) when the thermistors are plugged in. If any of them gives a zero reading then the thermistor is open-circuit. □

ORDER YOUR COPY NOW

EVERYDAY PRACTICAL ELECTRONICS

Signed .....

Name and Address .....

.....

.....

.....Post Code .....

NEWSAGENTS ORDER FORM

Please reserve/deliver a copy of ***Everyday Practical Electronics*** for me each month

Everyday Practical Electronics is published on the second Thursday of each month and distributed S.O.R. by COMAG

Make sure of your copy of *EPE* each month – cut out or photostat this form, fill it in and hand it to your newsagent.

World Radio History

MARCONI 2019A

AM/FM SYNTHESISED SIGNAL GENERATOR
80 kHz - 1040MHz
NOW ONLY **£400**

H.P. 3312A Function Gen., 0·1Hz-13MHz, AM/FM Sweep/Tri/Gate/Brst etc. £300
H.P. 3310A Function Gen., 0·005Hz-5MHz, Sine/Sq/Tri/Ramp/Pulse £125
FARNELL LFM4 Sine/Sq Oscillator, 10Hz-1MHz, low distortion, TTL output, Amplitude Meter £125
H.P. 545A Logic Probe with 546A Logic Pulser and 547A Current Tracer £90
FLUKE 77 Multimeter, 3¾-digit, handheld ..£60
FLUKE 77 Series II £70
HEME 1000 L.C.D. Clamp Meter, 00-1000A, in carrying case £60

RACAL 9008
Automatic Modulation Meter AM/FM
1-5MHz-2GHz
ONLY **£95**

H.P. 8494A Attenuator, DC-4GHz, 0-11dB, N/SMA £250
H.P. 8492A Attenuator, DC-18GHz, 0-6dB, APC7 ..... £95
MANY OTHER ATTENUATORS, LOADS, COUPLERS ETC. AVAILABLE

DATRON 1061
HIGH QUALITY 5½-DIGIT BENCH MULTIMETER
True RMS/4 wire Res/Current Converter/IEEE
£150

TIME 1051 LOW OHM RES. BOX
0·01 ohm to 1Mohm in 0·01 ohm steps.
£100
UNUSED

STILL AVAILABLE AS PREVIOUSLY ADVERTISED WITH PHOTOS
MARCONI 893C AF Power Meter, Sinad Measurement ..... Unused £100, Used £60
MARCONI 893B, No Sinad £30
MARCONI 2610 True RMS Voltmeter, Autoranging, 5Hz-25MHz £195
GOULD J3B Sine/Sq Osc., 10Hz-100kHz, low distortion ..... £75-£125
AVO 8 Mk. 6 in Every Ready case, with leads etc. ..£80
Other AVOs from £50
GOODWILL GFC8010G Freq. Counter, 1Hz-120MHz, unused £75
GOODWILL GVT427 Dual Ch AC Millivoltmeter, 10mV-300V in 12 ranges, Freq. 10Hz-1MHz ..£100-£125
SOLARTRON 7150 DMM 6½-digit Tru RMS-IEEE ..£95-£150
SOLARTRON 7150 Plus £200

RACAL TRUE RMS VOLTMETERS
9300 5Hz-20MHz usable to 60MHz, 10V-316V £95
9300B Version £150
9301/9302 RF Version to 1·5Hz ..... from £200-£300

HIGH QUALITY RACAL COUNTERS
9904 Universal Timer Counter, 50MHz £50
9916 Counter, 10Hz-520MHz £75
9918 Counter, 10Hz-560MHz, 9-digit £50
FARNELL AMM255 Automatic Mod Meter, 1·5MHz-2GHz, unused £400

CLASSIC AVOMETER DA116
Digital 3·5 Digit
Complete with batteries and leads
ONLY **£30**

SOLARTRON 7045 BENCH MULTIMETER
4½-Digit bright l.e.d. with leads
It's so cheap you should have it as a spare
ONLY **£30**

MARCONI TF2015 AM/FM sig gen, 10-520MHz ..£175
RACAL 9008 Auto Mod Meter, 1·5MHz-2GHz £200
LEVELL TG200DMP RC Oscillator, 1Hz-1MHz £50
Sine/Sq. Meter, battery operated (batts. not supplied)
FARNELL LF1 Sine/Sq.. Oscillator, 10Hz-1MHz £75
RACAL/AIM 9343M LCR Databridge. Digital Auto measurement of R, C, L, Q, D £200
HUNTRON TRACKER Model 1000 ..... £125
H.P. 5315A Universal Counter, 1GHz, 2-ch £80
FLUKE 8050A DMM 4½-digit 2A True RMS £75
FLUKE 8010A DMM 3½-digit 10A £50

RADIO COMMUNICATIONS TEST SETS
MARCONI 2955/2995B £2000
MARCONI 2955A/2960 ..... £2500

MARCONI 2022E Synth AM/FM sig gen 10kHz-1·01GHz l.c.d. display etc ..... £525-£750
H.P. 8672A Synth 2-18GHz sig gen £4000
H.P. 8657A Synth sig gen, 100kHz-1040MHz £2000
H.P. 8656B Synth sig gen, 100kHz-990MHz £1350
H.P. 8656A Synth sig gen, 100kHz-990MHz £995
H.P. 8640A AM/FM sig gen, 500kHz-1024MHz £400
H.P. 8640A AM/FM sig gen, 500kHz-512MHz £250
PHILIPS PM5328 sig gen, 100kHz-180MHz with 200MHz, freq. counter, IEEE £550
RACAL 9081 Synth AM/FM sig g en, 5-520MHz £250
H.P. 3325A Synth function gen, 21MHz £600
MARCONI 6500 Amplitude Analyser £1500
H.P. 4275A LCR Meter, 10kHz-10MHz £2750
H.P. 8903A Distortion Analyser £1000
WAYNE KERR 3245 Inductance Analyser £2000
H.P. 8112A Pulse Generator, 50MHz £1250
DATRON AutoCal Multimeter, 5½-7½-digit, 1065/1061A/1071 ..... from £300-£600
MARCONI 2400 Frequency Counter, 20GHz £1000
H.P. 5350B Frequency Counter, 20GHz £2000
H.P. 5342A 10Hz-18GHz Frequency Counter £800
FARNELL AP100/30 Power Supply £1000
FARNELL AP70/30 Power Supply £800
PHILIPS PM5418TN Colour TV Pattern Generator £1750
PHILIPS PM5418TX1 Colour TV Pattern Generator £2000
B&K Accelerometer, type 4366 ..... £300
H.P. 11692D Dual Directional Coupler, 2MHz-18GHz £1600
H.P. 11691D Dual Directional Coupler, 2MHz-18GHz £1250
TEKTRONIX P6109B Probe, 100MHz readout, unused £60
TEKTRONIX P6106A Probe, 250MHz readout, unused £85
FARNELL AMM2000 Auto Mod Meter, 10Hz-2·4GHz. Unused£950
MARCONI 2035 Mod Meter, 500kHz-2GHz ..... from £750
TEKTRONIX 577 Transistor Curve Tracer £500

ROHDE & SCHWARZ APN 62
Synthesised 1Hz-260kHz Signal Generator.
Balanced/unbalanced output
LCD display
£425

H.P. 6012B DC PSU, 0-60V, 0-50A, 1000W £1000
FARNELL AP60/50 1kW Autoranging £1000
FARNELL H60/50 0-60V, 0-50A £750
FARNELL H60/25 0-60V, 0-25A £400
Power Supply HPS3010 0-30V, 0-10A £140
FARNELL L30-2 0-30V, 0-2A £80
FARNELL L30-1 0-30V, 0-1A £80
Many other Power Supplies available
Isolating Transformer 250V in/Out 500VA £40

WELLER EC3100A
Temperature controlled Soldering Station 200°C-450°C. Unused
£125

SCOPE FOR IMPROVEMENT

GOULD OS 300
Dual Trace, 20MHz
Tested with Manual
FOR THE FIRST TIME EVER ONLY **£95**
It's so cheap you should replace that old scope

SPECTRUM ANALYSERS
TEKTRONIX 492 50kHz-18GHz £3500
EATON/AILTECH 757 0·001-22GHz £2500
ADVANTEST R3261A 9kHz-2·6GHz, synthessed £4000
H.P. 853A (Dig. Frame) with 8559A 100kHz-21GHz £2750
H.P. 8558B with main frame, 100kHz-1500MHz £1250
H.P. 3580A Audio Analyser 5Hz-50kHz, as new £1000
MARCONI 2382 100Hz-400MHz, high resolution £2000
B&K 2033R Signal Analyser £1500
H.P. 182 with 8557 10kHz-350MHz £500
MARCONI 2370 30Hz-110MHz ..... from £500
H.P. 141 SYSTEMS
8553 1kHz-110MHz ..... from £500
8554 500kHz-1250MHz ..... from £750
8555 10MHz-18GHz ..... from £1000

UNUSED OSCILLOSCOPES
TEKTRONIX TDS640A 4-ch., 500MHz, 2G/S £4000
TEKTRONIX TDS380 dual trace, 400MHz, 2G/S £2000
TEKTRONIX TDS350 dual trace, 200MHz, 1G/S £1250
TEKTRONIX TAS485, 4-ch., 200MHz, etc. £900

OSCILLOSCOPES
PHILIPS PM3092 2+2-ch., 200MHz, delay, etc., £800 as new£950
PHILIPS PM3082 2+2-ch., 100MHz, delay etc., £700 as new £800
TEKTRONIX TAS465 dual trace, 100MHz, delay etc. £800
TEKTRONIX 2465B 4-ch., 400MHz, delay cursors etc £1250
TEKTRONIX 2465 4-ch , 300MHz, delay cursors etc. £900
TEKTRONIX 2445/A/B 4-ch 150MHz, delay cursors etc £500-£900
TEKTRONIX 468 dig. storage, dual trace, 100MHz, delay £450
TEKTRONIX 466 Analogue storage, dual trace, 100MHz £250
TEKTRONIX 485 dual trace, 350MHz, delay sweep £600
TEKTRONIX 475 dual trace, 200MHz, delay sweep £400
TEKTRONIX 465B dual trace, 100MHz, delay sweep £325
PHILIPS PM3217 dual trace, 50MHz delay ..... £250-£300
GOULD OS1100 dual trace, 30MHz delay £200
HAMEG HM303.4 dual trace, 30MHz component testerm ...£325
HAMEG HM303 dual trace, 30MHz component tester £300
HAMEG HM203.7 dual trace, 20MHz component tester £250
FARNELL DTV20 dual trace, 20MHz component tester .. £180

PORTABLE APPLIANCE TESTER
Megger Pat 2 ONLY **£180**

STEWART of READING
110 WYKEHAM ROAD, READING, BERKS. RG6 1PL
Telephone: (0118) 9268041. Fax: (0118) 9351696
Callers welcome 9am-5.30pm Monday to Friday (other times by arrangement)

Used Equipment – GUARANTEED. Manuals supplied
This is a VERY SMALL SAMPLE OF STOCK. SAE or Telephone for lists.
Please check availability before ordering.
CARRIAGE all units £16. VAT to be added to Total of Goods and Carriage

SQUIRES

MODEL & CRAFT TOOLS

A COMPREHENSIVE RANGE OF MINIATURE HAND AND POWER TOOLS AND AN EXTENSIVE RANGE OF
ELECTRONIC COMPONENTS
FEATURED IN A FULLY ILLUSTRATED
432-PAGE MAIL ORDER CATALOGUE

2001 ISSUE

SAME DAY DESPATCH
FREE POST AND PACKAGING

Catalogues: FREE OF CHARGE to addresses in the UK.
Overseas: CATALOGUE FREE, postage at cost charged to credit card

Squires, 100 London Road,
Bognor Regis, West Sussex, PO21 1DD
TEL: 01243 842424
FAX: 01243 842525
SHOP NOW OPEN

FRUSTRATED!

Looking for ICs TRANSISTORs?

A phone call to us could get a result. We offer an extensive range and with a world-wide database at our fingertips, we are able to source even more. We specialise in devices with the following prefix (to name but a few).

2N 2SA 2SB 2SC 2SD 2P 2SJ 2SK 3N 3SK 4N 6N 17 40 AD ADC AN AM AY BA BC BD BDT BDV BDW BDX BF BFR BFS BFT BFX BFY BLY BLX BS BR BRX BRY BS BSS BSV BSW BSX BT BTA BTB BRW BU BUK BUT BUV BUW BUX BUY BUZ CA CD CX CXA DAC DG DM DS DTA DTC GL GM HA HCF HD HEF ICL ICM IRF J KA KIA L LA LB LC LD LF LM M M5M MA MAB MAX MB MC MDAJ MJE MJF MM MN MPS MPSA MPSH MPSU MRF NJM NE OM OP PA PAL PIC PN RC S SAA SAB SAD SAJ SAS SDA SG SI SL SN SO STA STK STR STRD STRM STRS SV1 T TA TAA TAG TBA TC TCA TDA TDB TEA TIC TIP TIPL TEA TL TLC TMP TMS TPU U UA UAA UC UDN ULN UM UPA UPC UPD VN X XR Z ZN ZTS + many others

We can also offer equivalents (at customers' risk)
We also stock a full range of other electronic components
Mail, phone, Fax Credit Card orders and callers welcome

Connect

Cricklewood Electronics Ltd
40-42 Cricklewood Broadway London NW2 3ET
Tel: 020 8452 0161 Fax: 020 8208 1441

World Radio History

PEAK electronic design ltd

Now Supports JFETs and Depletion Mode MOSFETs too!

atlas component analyser

All in all, it can be thoroughly recommended.
Everyday Practical Electronics - October 2000

An essential servicing Aid
Television Magazine - December 2000

What does it do?

- Automatic component identification
- Pinout identification
- Transistor gain measurement
- MOSFET gate threshold measurement
- PN junction characteristics measurement
- Just connect the part anyway round and press the button!

What components are supported?

- Bipolar transistors
- Darlington transistors
- Diode protected transistors
- Resistor shunted transistors
- Enhancement mode MOSFETs
- Depletion mode MOSFETs
- Junction FETs
- Low power triacs and thyristors
- Diodes and diode networks
- LEDs including 2 lead and 3 lead bicolours

We know you will fall in love with this. We Guarantee it!!

Visit www.peakelec.co.uk to download the full data sheet and copies of independant reviews. Feel free to contact us for a comprehensive data pack. Alternatively, order a Peak Atlas and you can just send it back to us for a full refund if you are not happy for any reason.

You can pay using a cheque, postal order, credit or debit card. Please contact us for overseas or volume orders - you will be pleasantly surprised.

peak electronic design limited

From UK	From Outside UK	Internet	
Tel. 01298 70012	Tel. +44 1298 70012	Web: www.peakelec.co.uk	West Road House, West Road, Buxton, Derbyshire, SK17 6HF, UK.
Fax. 01298 22044	Fax. +44 1298 22044	Email: sales@peakelec.co.uk	

World Radio History

SHOP TALK
with David Barrington

EPE Snug-Bug

A number of components needed for the *EPE Snug-Bug* project will not be available through readers' usual local sources and will have to be specially ordered. One of the most costly items in this project is the Crydom MP2410D opto-triac ("solid-state" relay), this was purchased from **Farnell** (☎ ***0113 263 6311*** or ***www.farnell.com***), code 269-785.

They also provided the specified, 10kΩ at 25°C, NTC thermistors. Two versions are available, insulated leads code 679-446 and non-insulated leads code 679-409. The prototype case, with aluminium front and rear panels, came from them, code 722-625.

The REF03GP 2·5V voltage reference source (code 411-097), the IR 1KAB10E bridge rectifier (code 371-208) and the 3VA mains transformer, with independent secondary windings, code 141-471 all came from the above source.

The prototype model uses 3·5mm mono, plastic-bodied, switched jack sockets and right-angled matching plugs obtained from **Maplin** (☎ ***0870 264 6000***), codes CX93B and FA37S. They also supplied the 4-pin 2A mains rated Bulgin output socket (SA2368) and line-plug (SA2367), codes HL34M and HL33L respectively.

The Euro-card sized printed circuit board is available from the *EPE PCB Service*, code 296 (see page 305).

Intruder Alarm Control Panel

The reason we are able to quote such a "competitive" price for the *Intruder Alarm Control Panel* project is because **Delta Consultants** have kindly made the "special" components available to constructors at very favourable prices.

The specially masked EP520M security microcontroller chip is available for the sum of only £3.50 and the keypad, together with lead, metal plate and label, is priced at £2.50. They will also supply the anti-tamper, p.c.b. mounting "click" switch and activating spring (60p), the 8 ohm 12W loudspeaker (£2.75) and alarm panel case (£5.50). They can also supply the p.c.b.-mounting relay for the Bell Unit and is quoted at £1.65.

All the above prices include UK postage and packing. Orders should be made out to *Delta Consultants* and sent (Mail Order only) to: **Delta Consultants, Dept EPE, 21 Rachel Drive, Rhyl, Denbighshire, LL18 4UH.** ***Tel/Fax*** 07050 055041. ***E-mail***: HData97476@aol.com.uk.

We understand generous quantity discounts are available, e.g. 10 off EP520M £2.25 each; 50 off £1.50 each.

The 8-pin non-volatile memory i.c. type 93C06EN should be widely stocked. It is certainly listed by **Maplin** (☎ ***0870 264 6000***), code ADP16.

The two printed circuit boards for this project are available from the *EPE PCB Service*, codes 297 (main board) and 298 (ext. bell), see page 305.

Sound Trigger

A problem has arisen regarding a supplier for the VN10KM *n*-channel MOSFET called up in the *Sound Trigger*, this month's Top Tenner project. On investigating a recent request for a source for this low-power MOSFET device, some suppliers indicated that it had been discontinued and others that it was out of stock but were expecting new deliveries eventually.

Further enquiries have revealed that **Farnell** (☎ ***0113 263 6311*** or ***www.farnell.com***) are quoting the VN10KLS as a direct replacement. Their order code is 334-5282; we understand that it is not currently listed in their catalogue. This device has not been tried in this circuit.

You could try the author's suggestion, for driving a more powerful lamp, and use the VN66AF currently listed by Maplin (☎ ***0870 264 6000*** or ***www.maplin.co.uk***), code WQ97F.

Wave Sound Effect

We do not expect readers to experience any component buying problems for the *Wave Sound Effect* unit, this month's Starter Project. Most of our component advertisers should be in a position to supply the parts or suitable equivalents, including a medium size plastic or metal case.

Incidentally, almost any small *npn* silicon transistor should be capable of producing the required "noise" source (TR1) for this circuit. The other transistors can be any high gain silicon *npn* devices, such as the 2N3704. However, you will need to check the pinout identifications before mounting on the circuit board.

PLEASE TAKE NOTE

Body Detector *Mar '01*

Page 178, Fig.7. The lead from the pole of switch S1a should go to the circuit board at point ***R2*** (diode D3 anode end) and not as shown.

Doorbell Extender *Mar '01*

It has been pointed out that as both capacitors C1 are connected between the mains supply and Earth they should be a "*Class Y*" type.

A suitable 10nF Class Y capacitor is currently listed by Maplin (***0870 264 6000*** or ***www.maplin.co.uk***), code JA96E.

NEW

EPE TEACH-IN 2000
Now on CD-ROM

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

Teach-in 2000 covers all the basic principles of electronics from Ohm's Law to Displays, including Op.Amps, Logic Gates etc. Each part has its own section on the interactive software where you can also change component values in the various on-screen demonstration circuits.

The series gives a hands-on approach to electronics with numerous breadboarded circuits to try out, plus a simple computer interface which allows a PC to be used as a basic oscilloscope.

ONLY £12.45 including VAT and p&p

NOTE: This mini CD-ROM is suitable for use on any PC with a CD-ROM drive. It requires Adobe Acrobat Reader (available free from the Internet – **www.adobe.com/acrobat**)

TEACH-IN 2000 CD-ROM ORDER FORM

Please send me ..... (quantity) TEACH-IN 2000 CD-ROM

Price £12.45 (approx $20) each – includes postage to anywhere in the world.

Name .....

Address .....

.....

Post Code ..... Tel. .....

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

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

Card No. .....

Expiry Date ..... Switch Issue No. .....

Note: Minimum order for cards £5.

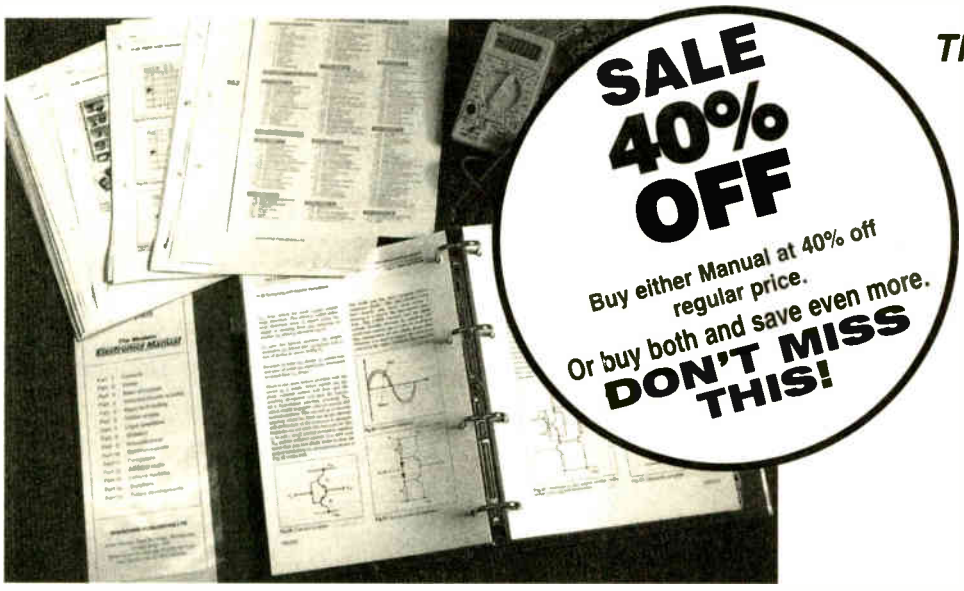
SEND TO: **Everyday Practical Electronics, Allen House, East Borough, Wimborne, Dorset BH21 1PF.**
Tel: 01202 881749. Fax: 01202 841692.
E-mail: orders@epemag.wimborne.co.uk
Online store: www.epemag.wimborne.co.uk/shopdoor.htm

Payments must be by card or in £ Sterling – cheque or bank draft drawn on a UK bank.
Normally supplied within seven days of receipt of order.

World Radio History

WHETHER ELECTRONICS IS YOUR HOBBY OR YOUR LIVELIHOOD . . .
YOU NEED THE MODERN ELECTRONICS MANUAL and the ELECTRONICS SERVICE MANUAL

THE MODERN ELECTRONICS MANUAL



The essential reference work for everyone studying electronics

- *Over 900 pages*
- *In-depth theory*
- *Projects to build*
- *Detailed assembly instructions*
- *Full components checklists*
- *Extensive data tables*
- *Detailed supply information*
- *Easy-to-use format*
- *Clear and simple layout*
- *Comprehensive subject range*
- *Professionally written*
- *Regular Supplements*
- *Sturdy gold blocked ring-binder*

EVERYTHING YOU NEED TO GET STARTED AND GO FURTHER IN ELECTRONICS!

The revised edition of the Modern Electronics Base Manual contains practical, easy-to-follow information on the following subjects:

BASIC PRINCIPLES: Electronic Components and their Characteristics (16 sections from Resistors and Potentiometers to Crystals, Crystal Modules and Resonators), Circuits Using Passive Components (9 sections), Power Supplies, The Amateur Electronics Workshop, The Uses of Semiconductors, Digital Electronics (6 sections), Operational Amplifiers, Introduction to Physics, Semiconductors (6 sections) and Digital Instruments (5 sections).

CIRCUITS TO BUILD: There's nothing to beat the satisfaction of creating your own project. From basic principles, like soldering and making printed circuit boards, to circuit-building, the Modern Electronics Manual and its Supplements describe clearly, with appropriate diagrams, how to assemble radios, loudspeakers, amplifiers, car projects, computer interfaces, measuring instruments, workshop equipment, security systems, etc. The Base Manual describes 13 projects including a Theremin and a Simple TENS Unit.

ESSENTIAL DATA: Extensive tables on diodes, transistors, thyristors and triacs, digital and linear i.c.s.

EXTENSIVE GLOSSARY: Should you come across a technical word, phrase or abbreviation you're not familiar with, simply turn to the glossary included in the Manual and you'll find a comprehensive definition in plain English.

The Manual also covers **Safety** and **Suppliers**.
The most comprehensive reference work ever produced at a price you can afford, the revised edition of **THE MODERN ELECTRONICS MANUAL** provides you with all the ***essential*** information you need.

THE MODERN ELECTRONICS MANUAL

Revised Edition of Basic Work: Contains over 900 pages of information. Edited by John Becker.
Regular Supplements: Approximately 160-page Supplements of additional information which, if requested, are forwarded to you immediately on publication (four times a year). These are billed separately and can be discontinued at any time.
Presentation: Durable looseleaf system in large A4 format

Price of the Basic Work: ~~£39.95~~ **SALE PRICE £23.97** (to include a recent Supplement **FREE**)

Guarantee

Our 30 day money back guarantee gives you **complete peace of mind**. If you are not entirely happy with either Manual, for whatever reason, simply return it to us in good condition within 30 days and we will make **a full refund of your payment** – no small print and no questions asked.
(Overseas buyers do have to pay the overseas postage charge)

Wimborne Publishing Ltd., Dept Y4, Allen House, East Borough, Wimborne, Dorset BH21 1PF. Tel: 01202 881749. Fax: 01202 841692.

World Radio History

ELECTRONICS SERVICE MANUAL

EVERYTHING YOU NEED TO KNOW TO GET STARTED IN REPAIRING AND SERVICING ELECTRONIC EQUIPMENT

SAFETY: Be knowledgeable about Safety Regulations, Electrical Safety and First Aid.

UNDERPINNING KNOWLEDGE: Specific sections enable you to Understand Electrical and Electronic Principles, Active and Passive Components, Circuit Diagrams, Circuit Measurements, Radio, Computers, Valves and manufacturers' Data, etc.

PRACTICAL SKILLS: Learn how to identify Electronic Components, Avoid Static Hazards, Carry Out Soldering and Wiring, Remove and Replace Components.

TEST EQUIPMENT: How to Choose and Use Test Equipment, Assemble a Toolkit, Set Up a Workshop, and Get the Most from Your Multimeter and Oscilloscope, etc.

SERVICING TECHNIQUES: The regular Supplements include vital guidelines on how to Service Audio Amplifiers, Radio Receivers, TV Receivers, Cassette Recorders, Video Recorders, Personal Computers, etc.

TECHNICAL NOTES: Commencing with the IBM PC, this section and the regular Supplements deal with a very wide range of specific types of equipment – radios, TVs, cassette recorders, amplifiers, video recorders etc..

REFERENCE DATA: Detailing vital parameters for Diodes, Small-Signal Transistors, Power Transistors, Thyristors, Triacs and Field Effect Transistors. Supplements include Operational Amplifiers, Logic Circuits, Optoelectronic Devices, etc.

The essential work for servicing and repairing electronic equipment

- *Around 900 pages*
- *Fundamental principles*
- *Troubleshooting techniques*
- *Servicing techniques*
- *Choosing and using test equipment*
- *Reference data*
- *Easy-to-use format*
- *Clear and simple layout*
- *Vital safety precautions*
- *Professionally written*
- *Regular Supplements*
- *Sturdy gold blocked ring-binder*

ELECTRONICS SERVICE MANUAL

Basic Work: Contains around 900 pages of information. Edited by Mike Tooley BA
Regular Supplements: Approximately 160-page Supplements of additional information which, if requested, are forwarded to you immediately on publication (four times a year). These are billed separately and can be discontinued at any time.
Presentation: Durable looseleaf system in large A4 format
Price of the Basic Work: ~~£39.95~~ **SALE PRICE £23.97** (to include a recent Supplement **FREE**)

ORDER BOTH MANUALS TOGETHER AND SAVE ANOTHER £8

A mass of well-organised and clearly explained information is brought to you by expert editorial teams whose combined experience ensures the widest coverage
Regular Supplements to these unique publications, each around 160 pages, keep you abreast of the latest technology and techniques if required

REGULAR SUPPLEMENTS

Unlike a book or encyclopedia, these Manuals are living works – continuously extended with new material. If requested, Supplements are sent to you approximately every three months. Each Supplement contains around 160 pages – all for only £23.50+£2.50 p&p. You can, of course, return any Supplement (within ten days) which you feel is superfluous to your needs. You can also purchase a range of past Supplements to extend your Base Manual on subjects of particular interest to you.

RESPONDING TO YOUR NEEDS

We are able to provide you with the most important and popular, up to date, features in our Supplements. Our unique system is augmented by readers' requests for new information. Through this service you are able to let us know exactly what information you require in your Manuals.

You can also contact the editors directly in writing if you have a specific technical request or query relating to the Manuals.

PLEASE send me

☐ **THE MODERN ELECTRONICS MANUAL** plus a **FREE SUPPLEMENT**

☐ **ELECTRONICS SERVICE MANUAL** plus a **FREE SUPPLEMENT**

I enclose payment of £23.97 (for one Manual) or £39.94 for both Manuals (saving another £8 by ordering both together) plus postage if applicable.

I also require the appropriate Supplements four times a year. These are billed separately and can be discontinued at any time. ***(Please delete if not required.)***

Should I decide not to keep the Manual/s I will return it/them to you within 30 days for a full refund.

FULL NAME .....
(PLEASE PRINT)

ADDRESS .....

.....

.....**POSTCODE** .....

SIGNATURE .....

☐ **I enclose cheque/PO payable to Wimborne Publishing Ltd.**

☐ **Please charge my Visa/Mastercard/Switch** **Switch Issue No.** .....

Card No. ..... **Card Exp. Date** .....

ORDER FORM

Simply complete and return the order form with your payment to the following address:

Wimborne Publishing Ltd, Dept. Y4, Allen House, East Borough, Wimborne, Dorset BH21 1PF

We offer a 30 day MONEY BACK GUARANTEE

– if you are not happy with either Manual simply return it to us in good condition within 30 days for a full refund.

Overseas buyers do have to pay the overseas postage – see below.

POSTAGE CHARGES

	Price PER MANUAL	
Postal Region	**Surface**	**Air**
Mainland UK	FREE	–
Scottish Highlands, UK Islands & Eire	£5.50 each	–
Europe (EU)	–	£20 each
Europe (Non-EU)	£20 each	£26 each
USA & Canada	£25 each	£33 each
Far East & Australasia	£31 each	£35 each
Rest of World	£25 each	£45 each

Please allow four *working* days for UK delivery.

NOTE: Surface mail can take over 10 weeks to some parts of the world. Each Manual weighs about 4kg when packed.

esm2

World Radio History

EVERYDAY PRACTICAL ELECTRONICS

INCORPORATING ELECTRONICS TODAY INTERNATIONAL

THE No.1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

BACK ISSUES

We can supply back issues of *EPE* by post, most issues from the past five years are available. An *EPE* index for the last five years is also available – see order form. Alternatively, indexes are published in the December issue for that year. Where we are unable to provide a back issue a photostat of any *one article* (or *one part* of a series) can be purchased for the same price. Issues from July 2000 onwards are also available to download from **www.epemag.com**.

DID YOU MISS THESE?

DEC '99

PROJECTS • PIC Micro-Probe • Magnetic Field Detector • Loft Guard • Ginormous Stopwatch – Giant Display–2.
FEATURES • Teach-In 2000–Part 2 • Practical Oscillator Designs–6 • Interface • Ingenuity Unlimited (Special) • Circuit Surgery • Network–The Internet • 1999 Annual Index.

JAN '00

PROJECTS • Scratch Blanker • Versatile Burglar Alarm • Flashing Snowman • Vehicle Frost Box.
FEATURES • Ingenuity Unlimited • Teach-In 2000–Part 3 • Circuit Surgery • Practically Speaking • Tina Pro Review • Net Work – The Internet.

FEB '00 Photostats Only

PROJECTS • PIC Video Cleaner • Voltage Monitor • Easy-Typist Tape Controller • Find It – Don't Lose It!
FEATURES • Technology Timelines–1 • Circuit Surgery • Teach-In 2000–Part 4 • Ingenuity Unlimited • Interface • Net Work – The Internet.

MAR '00

PROJECTS • EPE ICEbreaker • High Performance Regenerative Receiver–1 • Parking Warning System • Automatic Train Signal.
FEATURES • Teach-In 2000 – Part 5 • Practically Speaking • Technology Timelines–2 • Ingenuity Unlimited • Circuit Surgery • New Technology Update • Net Work – The Internet.

APRIL '00

PROJECTS • Flash Slave • Garage Link • Micro-PICscope • High Performance Regenerative Receiver–2.
FEATURES • Teach-In 2000–Part 6 • Ingenuity Unlimited • Technology Timelines–3 • Circuit Surgery • Interface • Telcan Home Video • Net Work – The Internet.

MAY '00

PROJECTS • Versatile Mic/Audio Preamplifier • PIR Light Checker • Low-Cost Capacitance Meter • Multi-Channel Transmission System–1.
FEATURES • Teach-In 2000–Part 7 • Technology Timelines–4 • Circuit Surgery • Practically Speaking • Ingenuity Unlimited • Net Work – The Internet • *FREE* Giant Technology Timelines Chart.

JUNE '00

PROJECTS • Atmospheric Electricity Detector–1 • Canute Tide Predictor • Multi-Channel Transmission System–2 • Automatic Nightlight.
FEATURES • Teach-In 2000 – Part 8 • Technology Timelines–5 • Circuit Surgery • Interface • New Technology Update • Ingenuity Unlimited • Net Work – The Internet.

JULY '00

PROJECTS • g-Meter • Camera Shutter Timer PIC-Gen Frequency Generator/Counter • Atmospheric Electricity Detector–2.
FEATURES • Teach-In 2000–Part 9 • Practically Speaking • Ingenuity Unlimited • Circuit Surgery • PICO DrDAQ Reviewed • Net Work – The Internet.

AUG '00

PROJECTS • Handy-Amp • EPE Moodloop • Quiz Game Indicator • Door Protector
FEATURES • Teach-In 2000–Part 10 • Cave Electronics • Ingenuity Unlimited • Circuit Surgery • Interface • New Technology Update • Net Work – The Internet.

SEPT '00

PROJECTS • Active Ferrite Loop Aerial • Steeplechase Game • Remote Control IR Decoder • EPE Moodloop Power Supply.
FEATURES • Teach-In 2000–Part 11 • New Technology Update • Circuit Surgery • Ingenuity Unlimited • Practically Speaking • Net Work – The Internet Page.

OCT '00

PROJECTS • Wind-Up Torch • PIC Dual-Chan Virtual Scope • Fridge/Freezer Alarm • EPE Moodloop Field Strength Indicator.
FEATURES • Teach-In 2000–Part 12 • Interface • Ingenuity Unlimited • New Technology Update • Circuit Surgery • Peak Atlas Component Analyser Review • Net Work – The Internet Page.

NOV '00

PROJECTS • PIC Pulsometer • Opto-Alarm System • Sample-and-Hold • Handclap Switch.
FEATURES • The Schmitt Trigger–Part 1 • Ingenuity Unlimited • PIC Toolkit Mk2 Update V2.4 • Circuit Surgery • New Technology Update • Net Work – The Internet • FREE Transistor Data Chart.

DEC '00

PROJECTS • PIC-Monitored Dual PSU-Part1 • Static Field Detector • Motorists' Buzz-Box • Twinkling Star • Christmas Bubble • Festive Fader • PICtogram.
FEATURES • The Schmitt Trigger–Part 2 • Ingenuity Unlimited • Interface • Circuit Surgery • New Technology Update • Quasar Kits Review • Net Work – The Internet • 2000 Annual Index.

JAN '01

PROJECTS • Versatile Optical Trigger • UFO Detector and Event Recorder • Two-Way Intercom • PIC-Monitored Dual PSU–Part 2.
FEATURES • Using PICs and Keypads • The Schmitt Trigger–Part 3 • New Technology Update • Circuit Surgery • Practically Speaking • Ingenuity Unlimited • CIRSIM Shareware Review • Net Work – The Internet.

FEB '01

PROJECTS • Ice Alert • Using LM3914-6 Bargraph Drivers • Simple Metronome • PC Audio Power Meter.
FEATURES • The Schmitt Trigger–Part 4 • Ingenuity Unlimited • Circuit Surgery • New Technology Update • Net Work – The Internet • *Free* 16-page supplement – How To Use Graphics L.C.D.s With PICs.

MAR '01

PROJECTS • Doorbell Extender • Body Detector • DIY Tesla Lightning • Circuit Tester
FEATURES • Understanding Inductors • The Schmitt Trigger–Part 5 • Circuit Surgery • Interface • New Technology Update • Net Work – The Internet Page.

BACK ISSUES ONLY £3.00 each inc. UK p&p.

Overseas prices £3.50 each surface mail, £4.95 each airmail.

We can also supply issues from earlier years: 1992 (except March, April, June to Sept. and Dec.), 1993 (except Jan. to March, May, Aug., Dec.), 1994 (except April to June, Aug., Oct. to Dec.), 1995 (No Issues), 1996 (except Jan. to May, July, Aug., Nov.), 1997 (except Feb. and March), 1998 (except Jan., March to May, July, Nov., Dec.), 1999.

We can also supply back issues of *ETI* (prior to the merger of the two magazines) for 1998/9 – Vol. 27 Nos 1 to 13 and Vol. 28 No. 1. We are not able to supply any material from *ETI* prior to 1998. Please put *ETI* clearly on your order form if you require *ETI* issues.

Where we do not have an issue a photostat of any ***one article*** or ***one part*** of a series can be provided at the same price.

ORDER FORM – BACK ISSUES – PHOTOSTATS– INDEXES

☐ Send back issues dates .....

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

☐ Send copies of last five years indexes (£3.00 for five inc. p&p – Overseas £3.50 surface, £4.95 airmail)

Name .....

Address .....

..... Tel: .....

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

☐ Please charge my Visa/Mastercard/Switch £ ..... Switch Issue No. .....

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

Note: Minimum order for credit cards £5. Please supply name and address of cardholder if different from that shown above.

SEND TO: **Everyday Practical Electronics, Allen House, East Borough, Wimborne, Dorset BH21 1PF.**

Tel: 01202 881749. Fax: 01202 841692.

E-mail: orders@epemag.wimborne.co.uk **On-line Shop:** www.epemag.wimborne.co.uk/shopdoor.htm

Payments must be in £ sterling – cheque or bank draft drawn on a UK bank. Normally supplied within seven days of receipt of order.

Send a copy of this form, or order by letter if you do not wish to cut your issue.

M04/01

World Radio History

STORE YOUR BACK ISSUES IN YOUR WALLET!

VOL 3 NOW AVAILABLE

ONLY **£12.45** each including VAT and p&p

A great way to buy *EPE* Back Issues – our wallet-sized CD-ROMs contain back issues from our *EPE Online* website plus bonus articles, all the relevant PIC software and web links. All this for just £12.45 each including postage and packing.

VOL 1 CONTENTS

BACK ISSUES – November 1998 to June 1999 (all the projects, features, news, IUs etc. from all eight issues). Note: No advertisements or Free Gifts are included.

PIC PROJECT CODES – All the available codes for the PIC based projects published in issues from November 1998 to June 1999.

EPE ONLINE STORE – Books, PCBs, Subscriptions, etc.

VOL 2 CONTENTS

BACK ISSUES – July 1999 to December 1999 (all the projects, features, news, IUs, etc. from all six issues). Note: No advertisements or Free Gifts are included.

PIC PROJECT CODES – All the available codes for the PIC-based projects published in issues from July to December 1999.

EPE ONLINE STORE – Books, PCBs, Subscriptions, etc.

VOL 3 CONTENTS

BACK ISSUES – January 2000 to June 2000 (all the projects, features, news, IUs, etc. from all six issues). Note: No advertisements or Free Gifts are included.

PIC PROJECT CODES – All the available codes for the PIC-based projects published in issues from January to June 2000.

EXTRA ARTICLES – ON ALL VOLUMES

BASIC SOLDERING GUIDE – Alan Winstanley's internationally acclaimed fully illustrated guide.

UNDERSTANDING PASSIVE COMPONENTS – Introduction to the basic principles of passive components.

HOW TO USE INTELLIGENT L.C.Ds, By Julyan Ilett – An utterly practical guide to interfacing and programming intelligent liquid crystal display modules.

PhyzzyB COMPUTERS BONUS ARTICLE 1 – Signed and Unsigned Binary Numbers. By Clive "Max" Maxfield and Alvin Brown.

PhyzzyB COMPUTERS BONUS ARTICLE 2 – Creating an Event Counter. By Clive "Max" Maxfield and Alvin Brown.

INTERGRAPH COMPUTER SYSTEMS 3D GRAPHICS – A chapter from Intergraph's book that explains computer graphics technology in an interesting and understandable way with full colour graphics.

EXTRA ARTICLE ON VOL 1 & 2

THE LIFE & WORKS OF KONRAD ZUSE – a brilliant pioneer in the evolution of computers. A bonus article on his life and work written by his eldest son, including many previously unpublished photographs.

NOTE: This mini CD-ROM is suitable for use on any PC with a CD-ROM drive. It requires Adobe Acrobat Reader (available free from the Internet – **www.adobe.com/acrobat**)

Order on-line from www.epemag.com or by Phone, Fax, E-mail or Post

BACK ISSUES CD-ROM ORDER FORM

Please send me ..... (quantity) BACK ISSUES CD-ROM **VOL 1**

Please send me ..... (quantity) BACK ISSUES CD-ROM **VOL 2**

Please send me ..... (quantity) BACK ISSUES CD-ROM **VOL 3**

Price £12.45 (approx $20) each – includes postage to anywhere in the world.

Name .....

Address .....

.....

..... Post Code .....

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

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

Card No. .....

Expiry Date ..... Switch Issue No .....

Note: Minimum order for cards £5.

SEND TO: **Everyday Practical Electronics, Allen House, East Borough, Wimborne, Dorset BH21 1PF.**
Tel: 01202 881749. Fax: 01202 841692.
E-mail: orders@epemag.wimborne.co.uk

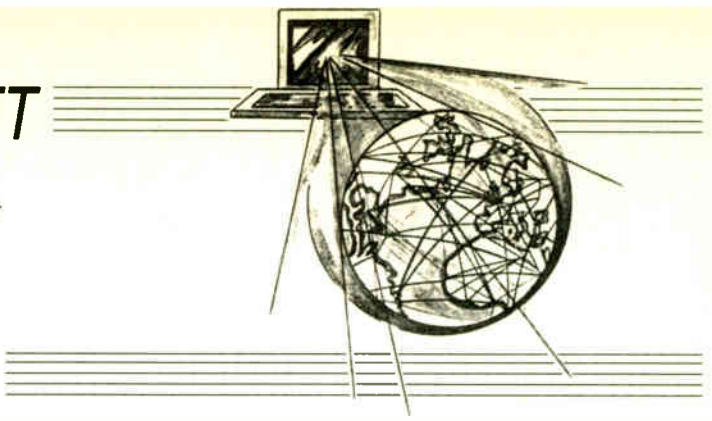
Payments must be by card or in £ Sterling – cheque or bank draft drawn on a UK bank.
Normally supplied within seven days of receipt of order.
Send a copy of this form, or order by letter if you do not wish to cut your issue.

World Radio History

SURFING THE INTERNET

NET WORK

ALAN WINSTANLEY

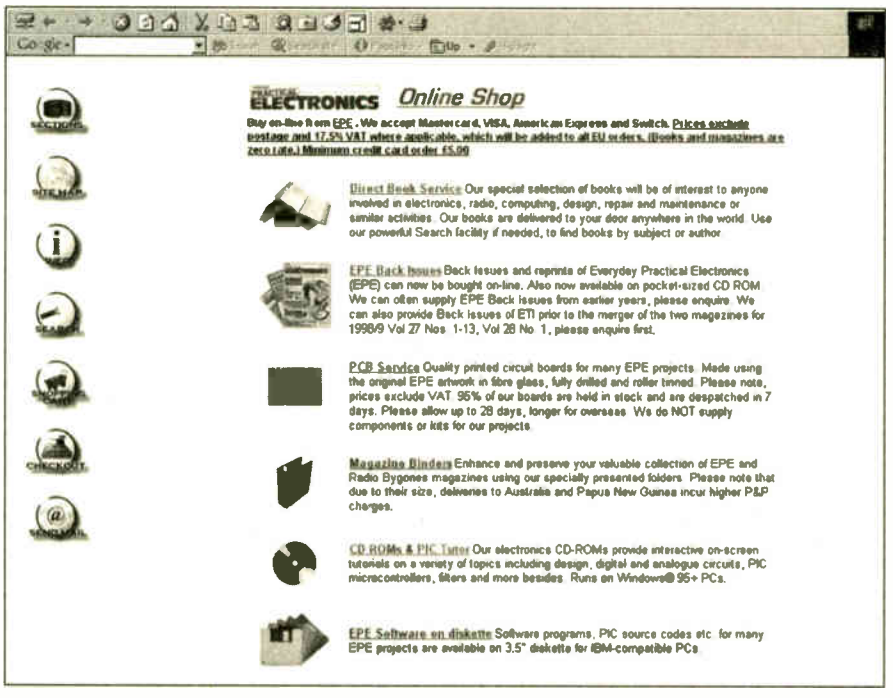


EPE Online Shop

REGULAR users of the *EPE* web site will know that we recently launched our new shopping cart service. Now you can purchase back issues of *EPE* via the Internet, together with project printed circuit boards all at the same time. We have also added the entire range of books from the *Direct Book Service*, including those speciality books offered by our sister magazine *Radio Bygones*. You can read a comprehensive description of a book's contents and usually view a colour image of book and magazine covers. Our selection of magazine binders, CD ROMs and Ucando videotapes completes the line up of products available through the new *EPE* shopping service.

The system offers all the usual facilities that customers would expect in a comprehensive shopping cart. Each distinct product area is contained in a "Section", and you can easily navigate around the shop using the Site Map if needed. A powerful search engine will display all related products (e.g. back issues and corresponding p.c.b.s) when you enter a project name or keyword.

As a further service, you can also order article reprints from any back issues of *EPE* which are now out of print. Simply type in the *issue month* and *article name* when you do your shopping, and it will be added to your shopping cart. Then proceed to the checkout when you are finished, enter your details and payment method, and the order will then be transmitted *securely* to the Orders Department for attention.



The new shop is at **www.epemag.wimborne.co.uk/shopdoor.htm** where you can view service announcements and FAQs, before entering the secure area itself – the shopping cart is held on a secure server, and all customer order data is encrypted at all times for security and peace of mind. *Please be aware this is a different service from our American-based* EPE Online *(www.epemag.com) which sells its own range of books and CD ROMs.*

Postscript

We have worked hard to bring all those "reader essentials" together under one roof, so that you can now place a single order to cover all your requirements. A quick scan through the *EPE* mail order advertisements in this issue will show that there is a very wide variety of electronics-related products available directly from *EPE*, including books, videos and CD ROMs as always, but due to the way that the product range has gradually evolved over the years, there are a number of different postage rates in force. In fact, it is calculated that, across the board, there were nearly one hundred combinations of product and postage available!

Attempting to translate that into a simple on-line shopping cart service has been challenging to say the least, and ultimately a more radical approach needed to be adopted. Therefore, there are some initial differences between our on-line shop and the more traditional mail-order service that *EPE* will continue to offer.

However, we have attempted to iron out the obvious anomalies in postage and deliveries by taking an overall "swings and roundabouts" view. This means we have managed to greatly simplify things for everybody, while keeping magazine mail-order and on-line shop prices broadly in line with each other.

As we say in the FAQ, the choice is now yours, but you should note that prices shown in the on-line shop *apply only to Internet orders*. We think that most customers will soon prefer the great convenience of the on-line shop, but traditional mail order coupon, phone or fax sales will continue to be available for those preferring to purchase that way.

A Taxing Time

For the benefit of our many overseas readers, the most important difference is that all "on-line" prices *exclude* Value Added Tax (VAT, currently 17·5%), as well as postage charges. Orders from customers in all EU (European Union) countries will be subjected to VAT, the value of which will be clearly shown on the on-line shopping cart. Orders from outside the EU, are ***not*** charged VAT.

Next, postage: all on-line prices ***exclude*** postage, as the shopping cart "knows" the weight of each product (or average weight, in the case of magazines and p.c.b.s), so the postage cost is calculated on the *total* weight of the order. Postage also depends on destination – we deliver to most countries around the world, and customers outside the EU will usually be offered a choice of air or surface mail deliveries.

We think this is the fairest and most transparent method to implement. Again, the system is programmed with the postage rates to each country, and so the postage options are calculated by the shopping cart and clearly shown to the customer.

At all times, you can view your current shopping cart, and delete or amend products as necessary, and customers will be able to see the total value of orders, including postage and VAT where levied, before they decide to enter their payment details and confirm their order. You will always be offered a comprehensive receipt and order reference number, which you should print off and keep.

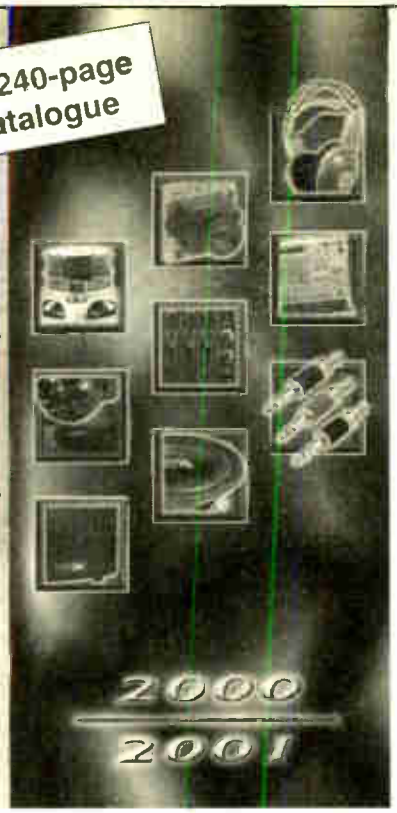
The payment options have also increased: *EPE* can now accept Mastercard, VISA, American Express and Switch debit cards (but *not* Electron cards). So have a go – buy on-line from *EPE*!

World Radio History

FREE 240-page colour catalogue

Great value for Speakers, Microphones, Headphones, Aerials, Transmitters, TV Amps, Plugs, Sockets, Leads, CD Storage Cases, CCTV, Security, Connectors, Adaptors, Switch Boxes, Gadgets, Disco Lighting & Effects, Mixers, Amplifiers, Turntables, Musicians' Leads, Car Audio, Test Equipment, Hobby Kits, Computer Leads & Accessories, Power Supplies, Inverters, Transformers, Battery Chargers, Tools, Soldering, Switches, Fuses, Indicators, Cable & Wire, Crossovers, Speaker Hardware, PA Amps, and a great deal more . . . all for the price of a stamp.

SKY ELECTRONICS
Tel: 020 8450 0995
Fax: 020 8208 1441



ELECTRONICS 2001

Sky Electronics

40-42 Cricklewood Broadway London NW2 3ET
Tel: 020 8450 0995 Fax: 020 8208 1441
www.skyelectronics.co.uk

The Catalogue is FREE to callers or send stamps to the value of £1.85 to cover postage.

VARIABLE VOLTAGE TRANSFORMERS

INPUT 220V/240V AC 50/60Hz OUTPUT 0V-260V PANEL MOUNTING

	Price	P&P
0·5KVA 2·5 amp max	£33.00	£6.00 (£45.84 inc VAT)
1KVA 5 amp max	£45.25	£7.00 (£61.39 inc VAT)
SHROUDED		
0·5KVA 2·5 amp max	£34.00	£6.00 (£47.00 inc VAT)
1KVA 5 amp max	£46.25	£7.00 (£62.57 inc VAT)
2KVA 10 amp max	£65.00	£8.50 (£86.36 inc VAT)
3KVA 15 amp max	£86.50	£8.50 (£111.63 inc VAT)
5KVA 25 amp max	£150.00 (+ Carriage & VAT)	

Buy direct from the Importers. Keenest prices in the country.

500VA ISOLATION TRANSFORMER
Input lead 240V AC. Output via 3-pin 13A socket. 240V AC continuously rated, mounted in fibreglass case with handle. Internally fused Price **£35.00** carriage paid + VAT (£41.13)

TOROIDAL L.T. TRANSFORMER
Primary 0-240V AC. Secondary 0-30V + 0-30V 600VA. Fixing bolt supplied.
Price **£25.00** carriage paid + VAT (£29.38)

COMPREHENSIVE RANGE OF TRANSFORMERS– LT– ISOLATION & AUTO
110V-240V Auto transfer either cased with American socket and mains lead or open frame type. Available for immediate delivery.

ULTRA VIOLET BLACK LIGHT BLUE FLUORESCENT TUBES

4ft. 40 watt **£14.00** (callers only)	(£16.45 inc VAT)
2ft 20 watt **£9.00** (callers only)	(£10.58 inc VAT)
12in 8 watt **£4.80** + 75p p&p	(£6.52 inc VAT)
9in 6 watt **£3.96** + 50p p&p	(£5.24 inc VAT)
6in 4 watt **£3.96** + 50p p&p	(£5.24 inc VAT)

230V AC BALLAST KIT
For either 6in, 9in or 12in tubes **£6.05**+£1.40 p&p (£8.75 inc VAT)
The above Tubes are 3500/4000 angst (350-400um) ideal for detecting security markings, effects lighting & Chemical applications.
Other Wavelengths of UV TUBE available for Germicidal & Photo Sensitive applications. Please telephone your enquiries.

400 WATT BLACK LIGHT BLUE UV LAMP
GES Mercury Vapour lamp suitable for use with a 400W P.F. Ballast.
Only **£39.95** incl. p&p & VAT

5 KVA ISOLATION TRANSFORMER
As New Ex-Equipment, fully shrouded. Line Noise Suppression. Ultra Isolation Transformer with terminal covers and knock-out cable entries. Primary 120V/240V, Secondary 120V/240V, 50/60Hz, 0·005pF Capacitance. Size, L 37cm x W 19cmc x H 16cm, Weight 42 kilos. Price **£120** + VAT. Ex-warehouse. Carriage on request.

24V DC SIEMENS CONTACTOR
Type 3TH8022-0B 2 x NO and 2 x NC 230V AC 10A. Contacts. Screw or Din Rail fixing. Size H 120mm x W 45mm x D 75mm. Brand New Price **£7.63** incl. p&p and VAT.

240V AC WESTOOL SOLENOIDS
Model TT2 Max stroke 16mm, 5lb. pull. Base mounting. Rating 1. **Model TT6** Max. stroke 25mm, 15lb. pull. Base mounting. Rating 1. **Series 400** Max. stroke 28mm, 15lb. pull. Front mounting. Rating 2. Prices inc. p&p & VAT: **TT2 £5.88, TT6 £8.81, Series 400 £8.64.**

AXIAL COOLING FAN
230V AC 120mm square x 38mm 3 blade 10 watt Low Noise fan. Price **£7.29** incl. p&p and VAT.
Other voltages and sizes available from stock. Please telephone your enquiries.

INSTRUMENT CASE
Brand new. Manufactured by Imhof. L 31cm x H 18cm x 19cm Deep. Removable front and rear panel for easy assembly of your components. Grey textured finish, complete with case feet. Price **£16.45** incl. p&p and VAT. 2 off **£28.20** inclusive.

DIECAST ALUMINIUM BOX
with internal PCB guides. Internal size 265mm x 165mm x 50mm deep. Price **£9.93** incl. p&p & VAT. 2 off **£17.80** incl.

230V AC SYNCHRONOUS GEARED MOTORS
Brand new Ovoid Gearbox Crouzet type motors. H 65mm x W 55mm x D 35mm, 4mm dia. shaft x 10mm long. 6 RPM anti cw. **£9.99** incl. p&p & VAT.
20 RPM anti cw. Depth 40mm **£11.16** incl. p&p & VAT.

16 RPM REVERSIBLE Croucet 220V/230V 50Hz geared motor with ovoid geared box 4mm dia. shaft. New manuf. surplus. Sold complete with reversing capacitor, connecting block and circ. Overall size: h 68mm x w 52mm x 43mm deep
PRICE incl. P&P & VAT **£9.99**

EPROM ERASURE KIT
Build your own **EPROM ERASURE** for a fraction of the price of a made-up unit. Kit of parts less case includes 12in. 8watt 2537, Angst Tube Ballast unit, pair of bi-pin leads, neon indicator, on/off switch, safety microswitch and circuit **£15.00**+£2.00 p&p (**£19.98** inc VAT)

WASHING MACHINE WATER PUMP
Brand new 240V AC fan cooled. Can be used for a variety of purposes. Inlet 1½in., outlet 1in. dia. Price includes p&p & VAT. **£11.20** each or 2 for **£20.50** inclusive.

SERVICE TRADING CO
57 BRIDGMAN ROAD, CHISWICK, LONDON W4 5BB
Tel: 020 8995 1560 FAX: 020 8995 0549

Open Monday/Friday

Ample Parking Space

ELECTRONICS SURPLUS CLEARANCE SALE

SCOOP PURCHASE:
FLUKE HAND HELD DIGITAL MULTIMETER, MODEL 8024B
Cancelled export order 750V AC/DC 2 amp AC/DC Resistance 20Megohm plus Siemens range. Also measures temperature –20°C to +1265°C. Temp. probe not included. Calibrated for K-type thermocouple. Peak hold facility. Supplied brand new and boxed but with original purchasing organisation's small identifying mark on case. Test leads and handbook included.
Offered at a fraction of original price: **£47.50**, p&p £6.50

THE ELECTRONICS SURPLUS TRADER – This is a listing of new first class components, books and electronic items at below trade prices. Includes manufacturers' surplus and overstocks. Also obsolete semiconductors, valves and high voltage caps and components. FREE – Large Catalogue.

(Dept E) CHEVET SUPPLIES LTD
157 Dickson Road, BLACKPOOL FY1 2EU
Tel: (01253) 751858. Fax: (01253) 302979
E-mail: chevet@globalnet.co.uk Telephone Orders Accepted
Callers welcome Tues, Thurs, Fri and Sat.

ILP

MANUFACTURER OF HIFI AUDIO MODULES AND TOROIDAL TRANSFORMERS SINCE 1971

CONTACT US NOW FOR A FREE CATALOGUE

ILP DIRECT LTD.
SPONG LANE, ELMSTED, ASHFORD, KENT TN25 5JU
TEL +44 1233 750481 FAX +44 1233 750578

NATIONAL COLLEGE OF TECHNOLOGY

DISTANCE LEARNING SHORT COURSES with BTEC CERTIFICATION

Analogue and Digital Electronics, Fibre Optics, Fault Diagnosis, Mechanics, Mathematics and Programmable Logic Controllers

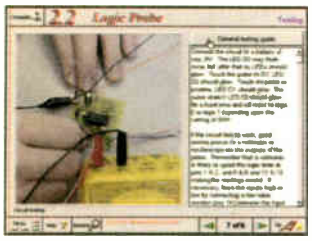
- Suitable for beginners and those wishing to update their knowledge and practical skills
- Courses are very practical and delivered as self contained kits
- No travelling or college attendance
- Learning is at your own pace
- Each course can stand alone or be part of a modular study programme
- Tutor supported and BTEC certified

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

World Radio History

ELECTRONICS CD-ROMS

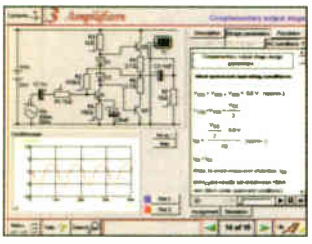
ELECTRONICS PROJECTS



Logic Probe testing

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

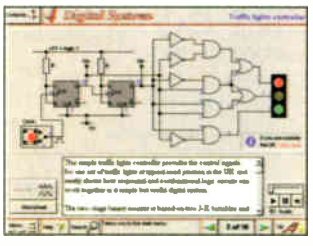
ANALOGUE ELECTRONICS



Complimentary output stage

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

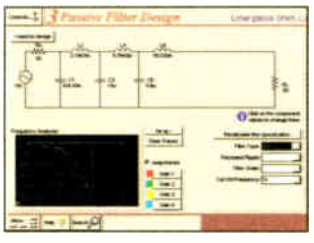
DIGITAL ELECTRONICS



Virtual laboratory – Traffic Lights

Digital Electronics builds on the knowledge of logic gates covered in *Electronic Circuits & Components* (opposite), and takes users through the subject of digital electronics up to the operation and architecture of microprocessors. The virtual laboratories allow users to operate many circuits on screen.
Covers binary and hexadecimal numbering systems, ASCII, basic logic gates, monostable action and circuits, and bistables – including JK and D-type flip-flops. Multiple gate circuits, equivalent logic functions and specialised logic functions. Introduces sequential logic including clocks and clock circuitry, counters, binary coded decimal and shift registers. A/D and D/A converters, traffic light controllers, memories and microprocessors – architecture, bus systems and their arithmetic logic units.

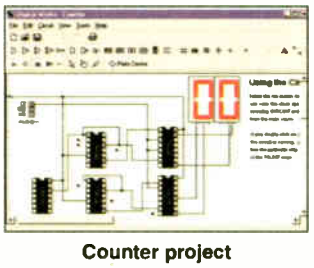
FILTERS



Filter synthesis

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

DIGITAL WORKS 3.0



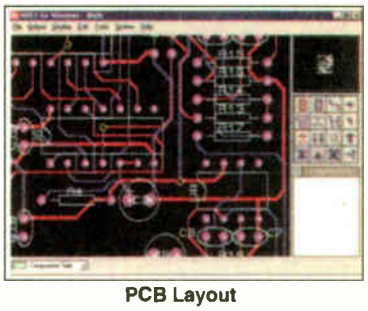
Counter project

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

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

ELECTRONICS CAD PACK

NEW



PCB Layout

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

"C" FOR PICMICRO MICROCONTROLLERS

NEW

C for PICmicro Microcontrollers is designed for students and professionals who need to learn how to use C to program embedded microcontrollers. This product contains a complete course in C that makes use of a virtual C PICmicro which allows students to see code execution step-by-step. Tutorials, exercises and practical projects are included to allow students to test their C programming capabilities. Also includes a complete Integrated Development Environment, a full C compiler, Arizona Microchip's MPLAB assembler, and software that will program a PIC16F84 via the parallel printer port on your PC. (Can be used with the *PICtutor* hardware – see opposite.)
Although the course focuses on the use of the PICmicro series of microcontrollers, this product will provide a relevant background in C programming for any microcontroller.

PRICES

Prices for each of the CD-ROMs above are:

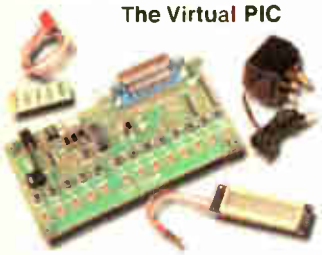
Hobbyist/Student .....£45 inc VAT
Institutional (Schools/HE/FE/Industry).....£99 *plus* VAT
Institutional 10 user (Network Licence).....£199 *plus* VAT

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

World Radio History

Interested in programming PIC microcontrollers? Learn with PICtutor by John Becker

The Virtual PIC



Deluxe PICtutor Hardware

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

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

PICtutor CD-ROM

Hobbyist/Student ..... **£45 inc. VAT**
Institutional (Schools/HE/FE Industry) ... **£99 *plus* VAT**
Institutional 10 user (Network Licence) **£199 *plus* VAT**

HARDWARE

Standard PICtutor Development Kit ..... **£47 inc. VAT**
Deluxe PICtutor Development Kit ..... **£99 *plus* VAT**
Deluxe Export Version ..... **£96 *plus* VAT**

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

ELECTRONIC COMPONENTS PHOTOS

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

Price £19.95 inc. VAT

ELECTRONIC CIRCUITS & COMPONENTS + THE PARTS GALLERY

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

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

Hobbyist/Student.....**£34 inc VAT**
Institutional (Schools/HE/FE/Industry).....**£89 *plus* VAT**
Institutional 10 user (Network Licence).....**£169 *plus* VAT**

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

MODULAR CIRCUIT DESIGN

This CD-ROM contains a range of tried and tested analogue and digital circuit modules, together with the knowledge to use and interface them. Thus allowing anyone with a basic understanding of circuit symbols to design and build their own projects.

Essential information for anyone undertaking GCSE or "A" level electronics or technology and for hobbyists who want to get to grips with project design. Over seventy different Input, Processor and Output modules are illustrated and fully described, together with detailed information on construction, fault finding and components, including circuit symbols, pinouts, power supplies, decoupling etc.

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

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

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

CD-ROM ORDER FORM

B3

Please send me:

- ☐ Electronic Projects
- ☐ Analogue Electronics
- ☐ Digital Electronics
- ☐ Filters
- ☐ Digital Works 3.0
- ☐ Electronics CAD Pack
- ☐ C For PICmicro Microcontrollers
- ☐ PICtutor
- ☐ Electronic Circuits & Components +The Parts Gallery

Version required:
☐ Hobbyist/Student
☐ Institutional
☐ Institutional 10 user

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

☐ PICtutor Development Kit – Standard
☐ PICtutor Development Kit – Deluxe
☐ Deluxe Export

Note: The CD-ROM is not included in the Development Kit prices.

☐ Electronic Components Photos
☐ Modular Circuit Design – Single User
☐ Modular Circuit Design – Multiple User

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

Full name: .....

Address: .....

.....

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

Signature: .....

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

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

Card No: ..... Switch Issue No. .....

ORDERING

ALL PRICES INCLUDE UK POSTAGE

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

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

Send your order to:
Direct Book Service
Allen House, East Borough, Wimborne
Dorset BH21 1PF

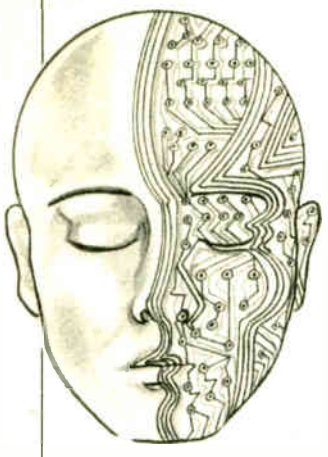
Direct Book Service is a division of Wimborne Publishing Ltd. To order by phone ring

01202 881749. Fax: 01202 841692

Goods are normally sent within seven days
E-mail: orders@epemag.wimborne.co.uk

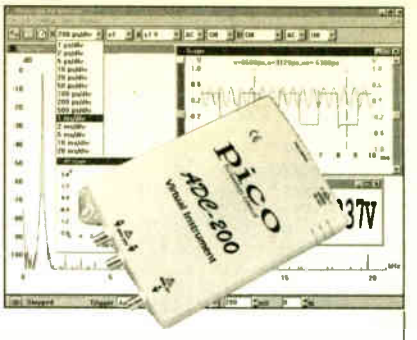
ee50b

World Radio History



INGENUITY UNLIMITED

Our regular round-up of readers' own circuits. We pay between £10 and £50 for all material published, depending on length and technical merit. We're looking for novel applications and circuit designs, not simply mechanical, electrical or software ideas. Ideas *must be the reader's own work* and **must not have been submitted for publication elsewhere.** The circuits shown have NOT been proven by us. *Ingenuity Unlimited* is open to ALL abilities, but items for consideration in this column should be typed or word-processed, with a brief circuit description (between 100 and 500 words maximum) and full circuit diagram showing all relevant component values. **Please draw all circuit schematics as clearly as possible.** Send your circuit ideas to: Alan Winstanley, *Ingenuity Unlimited*, Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset BH21 1PF. (We **do not** accept submissions for *IU* via E-mail.)
Your ideas could earn you some cash **and a prize!**



WIN A PICO PC BASED OSCILLOSCOPE

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

If you have a novel circuit idea which would be of use to other readers then a Pico Technology PC based oscilloscope could be yours.
Every six months, Pico Technology will be awarding an ADC200-50 digital storage oscilloscope for the best IU submission. In addition, two single channel ADC-40s will be presented to the runners-up.

12V Sealed Lead/Acid Charger – Cyclic Battery Use

CONSTRUCTORS have often been advised that it is unwise to charge a sealed 12V lead/acid battery directly from a simple "car type" charger which usually consists of a transformer, bridge rectifier and a meter that gives some indication of the charging current. There are good reasons for this, including the fact that a simple car battery charger is not suitably current limited and can quickly sizzle a badly discharged sealed lead/acid battery.

It is recommended that the charging current for a sealed lead/acid battery is limited to 25 per cent of the battery's Ah (Ampere-Hour) rating. For example, an 8Ah battery can supply one amp over an eight hour period, four amps over two hours and eight amps over one hour and so on.

It is unlikely that the output voltage from a standard charger is suitable for charging a 12V sealed lead/acid battery. A constant and stable voltage of between 2·4V and 2·5V per cell is required for cyclic charging which equates to 14·4V to 15·0V for a 12V battery. However, the circuit diagram of Fig.1 shows a method of charging sealed lead/acid batteries using a basic car battery charger with the aid of an L200 voltage/current regulator chip.

The off-load output voltage from a typical basic car battery charger is 13·0V as measured, which is taken to a 2,200µF 50V electrolytic capacitor C1. This smoothes the charger output and increases its available d.c. voltage to just over 20V, providing enough "headroom" to overcome the voltage drop across the L200 regulator and diode D1.

On The Limit

The value of the current limiting resistor (R1 to R6) is determined by measuring the open circuit voltage across pins 2 and 5 of the L200 (with power applied to its input). This is the reference voltage and should be in the region of 450mV which is divided by the required output current (2·0A maximum). For example, V_{ref}/required current = 0·45/0·2 (200mA) = 2·25 ohms.

The output of the charger has an adjustable current limit, consisting of six low value resistors wired to a 1-pole 6-way wafer switch. This enables the current to be reduced, enabling a good range of sealed lead/acid batteries to be charged. The resistor/switch combination is connected between pin 2 and pin 5 using short leads.

The diode D1 prevents any current flowing from the battery being charged, through the potential divider (R7 and VR1) should the charging source be removed with the battery connected. With the selected current limit resistor in circuit and power applied to the input of the regulator IC1, adjust VR1 for a voltage of between 14·4V to 15·0V as measured between the cathode (k) of diode D1 and 0V line.

When the above adjustments are complete the battery may be connected and the charger switched on and left as the battery will automatically draw less current as it reaches its charged state. A full charge should take about 10 to 14 hours.

This can be monitored by the ammeter of the battery charger, but a more accurate method is to monitor the voltage across the current limiting resistor using an external voltmeter. The actual charging current can then be determined by the application of Ohm's Law, i.e. the voltage across the switched resistor network / the value of resistance in ohms.

(Readers wanting to know more about the L200 should check Andy Flind's feature article "Using The L200CV" *in* EPE *July 1998 – ARW).*

David Allen,
Cheltenham, Glocs.

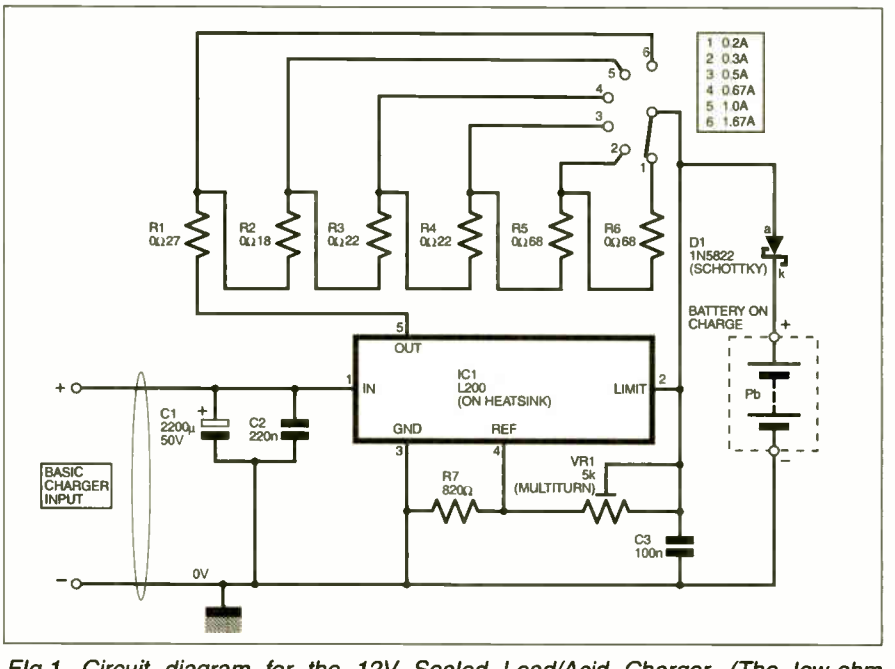


Fig.1. Circuit diagram for the 12V Sealed Lead/Acid Charger. (The low-ohm resistors (R1 to R6) can be from the W21 series.)

World Radio History

Audio Preamplifier – Some Gain

A SIMPLE preamplifier was needed to drive a rather insensitive audio amplifier which required about 500mV peak-to-peak input to obtain a reasonable output. Unfortunately, the source (a rather old guitar pickup) did not deliver much in the way of drive, being only a few millivolts. Using a design that was found to be reliable in the past (a d.c. coupled configuration with an emitter follower output – see Fig. 2a), did not produce nearly enough drive, the voltage gain being in the order of about 100 times.

The first stage of the preamp produces all the voltage gain and is proportional to transistor TR1's load resistor, in this case 6k8 (R4). Increasing the value of this resistor to increase the amplifier gain is, of course, possible, but it was estimated that it would need to be increased by approximately 4 or 5 times.

New Addition

This would restrict the current in TR1 to a few tenths of a milliamp, severely curtailing its gain and defeating the object. This called for a different approach and the result is shown in Fig.2b.

The original 6k8 load resistor was replaced with a transistor (TR3), the object here being twofold: firstly TR3 can be biased to restore the original d.c. conditions, i.e. TR1 will now pass the current originally intended (about 0·7mA).

Second, and most importantly, the load seen by TR1 will now be the a.c. resistance of TR3, which is considerably higher than its d.c. resistance. Therefore, TR1 now sees the output impedance of TR3, and TR1's amplification factor is boosted.

To set up the d.c. conditions, adjust the 20 kilohm *(more likely to be 22k)* variable potentiometer VR1 so that about 4·5V appears on the collector (c) of transistor TR1. If you require a gain control, then a small potentiometer of about 100 kilohms can be connected at the input side of capacitor C1.

The circuit worked well and produced a voltage gain in excess of 600 times, along with good temperature stability – more than adequate for the purpose in hand.

A. Lippett,
Stafford.

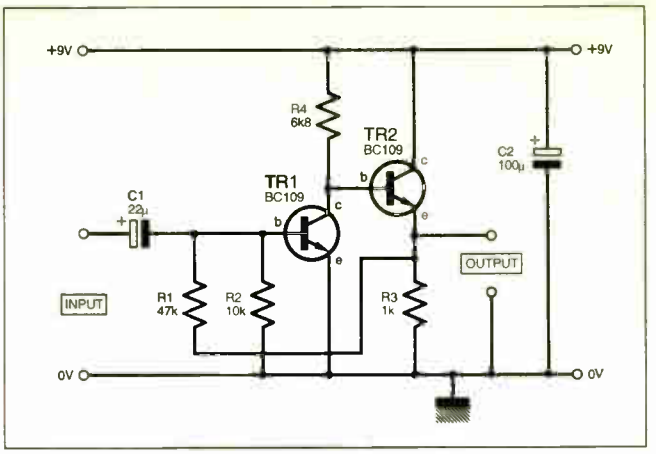


Fig.2a. Original basic preamplifier circuit.

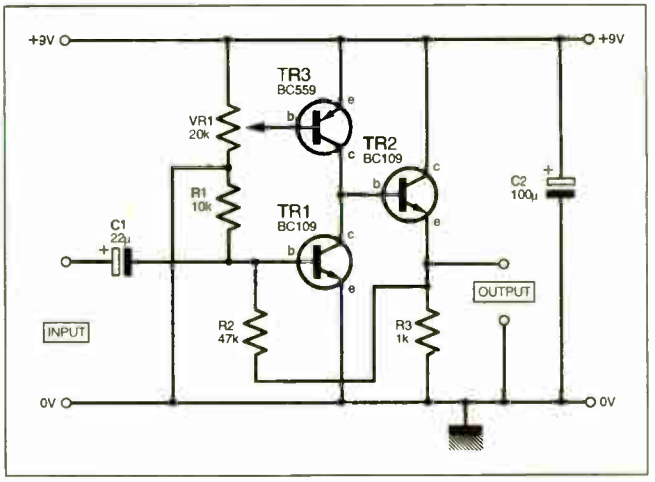


Fig.2b. Circuit diagram for the simple Audio Preamplifier.

Model Police Car L.E.D.s – In A Flash

MY youngest child (aged 8) loves police cars, but his attempts to add blue l.e.d.s to model police cars were simply not realistic enough for the discerning junior enthusiast. So the circuit of Fig.3 was devised to simulate the alternate flashing strobes seen on British police cars. This was well received, and now many of these circuits have been built and look very convincing indeed in the dark!

The circuit around IC1a forms a square wave oscillator, the frequency being adjustable by VR1 to give the best effect. This square wave is buffered by IC1b and in turn drives the decade counter IC2. Outputs from the counter Q0/Q2, and Q7/Q9 are in turn diode ORed to give alternating double pulses.

Capacitors C2 and C3 with resistors R3 and R5 differentiate the pulse time in conjunction with the output drivers IC1c to IC1f. This produces a short pulse (30ms) which enhances the flashing effect and adds to the illusion. The output drivers in turn drive a pair of hyperbright blue l.e.d.s D5 and D6.

It is worth spending a little extra on using really bright l.e.d.s if the best effect is to be obtained. A 6V camera battery or four AAA cells gives a long life in a small package. In use adjust VR1 to give the best effect.

Kate Turner,
St. Leonards on Sea, East Sussex.

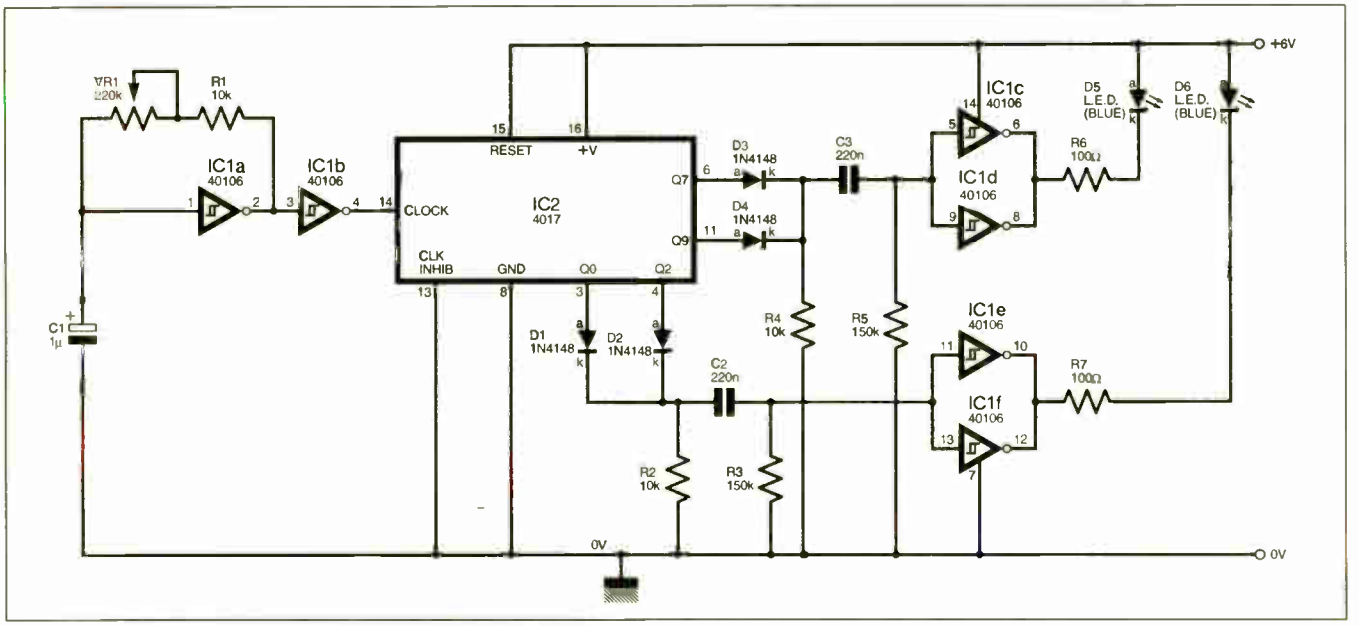
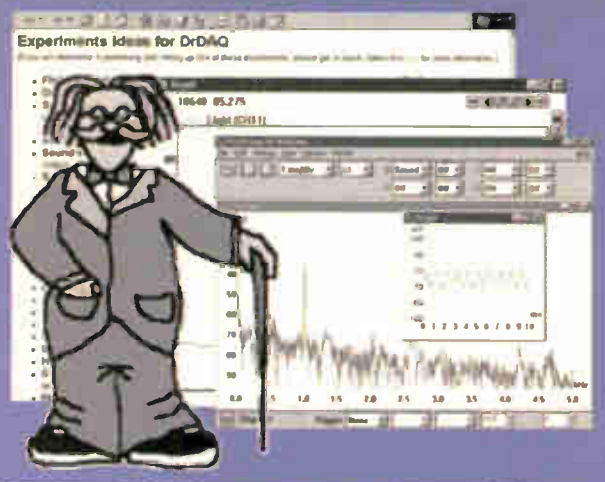


Fig.3. Circuit diagram for a Model Police Car L.E.D.s (Fuzzlite) simulator.

World Radio History

Measure pH, Voltage, Humidity, Sound & Light, on your PC!



- ✔ Very low cost
- ✔ Built in sensors for light, sound (level and waveforms) and temperature
- ✔ Use DrDAQ to capture fast signals (eg sound waveforms)
- ✔ Outputs for control experiments
- ✔ Supplied with both PicoScope (oscilloscope) and PicoLog (data logging) software

Only £59! + VAT

The DrDAQ is a low cost data logger from Pico Technology. It is supplied ready to use with all cables, software and example science experiments.

DrDAQ represents a breakthrough in data logging. Simply plug DrDAQ into any Windows PC, run the supplied software and you are ready to collect and display data. DrDAQ draws its power from the parallel port, so no batteries or power supplies are required.

As well as the built in sensors, DrDAQ has two sockets for external sensors. When a sensor is plugged in, the software detects it and automatically scales readings. For example, if a temperature sensor is plugged in, readings are displayed in °C . Details are provided to allow users to develop their own sensors.

Output
Voltage
Resistance
Light level
Temperature
External sensors:
✦Temperature
✦Humidity
✦Reed Switch
External pH probe
Microphone

A Data Logging Breakthrough

To order the DrDAQ please choose one of the following options:

i) Visit our web site and place an order over the Internet,
ii) Place an order over the phone by ringing the number below,or,
iii) Fill out the order form and either fax it, or post it back to Pico Technology.

DrDAQ Order Form:

Quantity	Package	Price inc VAT	Total
	DrDAQ + Software	£69.32	
	DrDAQ + 2 Temp Sensors	£92.85	
	DrDAQ + 2 Temp, pH Electrode, Hunidity + Reed Switch Sensors	£175.08	
Delivery		£4.11	£4.11
		Grand Total	£

Name	
Address	
Post code	
Phone	

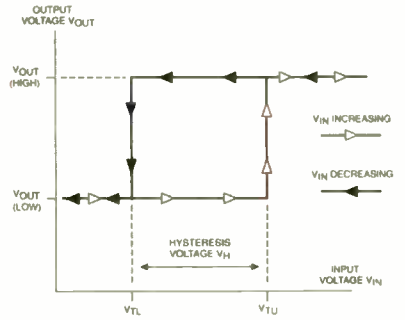
Credit Card	Visa / Mastercard / Switch / Amex		
Card Number			
Expiry Date	/	Start Date & or Issue No.	
Cheque with order	❑		

Pico Technology Ltd, The Mill House, Cambridge Street, St Neots, Cambridgeshire. PE19 1QB
Tel: 01480 396395, Fax: 01480 396296, E-mail: post@picotech.com, Web: www.drdaq.com

Pico Technology Limited

Special Series

THE SCHMITT TRIGGER



ANTHONY H. SMITH

Part 6

In this short series, we investigate the Schmitt trigger's operation; explore the various ways of implementing its special characteristics and also look at how we can use it to create oscillators and pulse width modulators.

Further Digital Applications

IN Part Five of this series we saw how "digital" Schmitt trigger devices from the 4000 series and 74HC/HCT logic families could be used both as interface components, and also as the active elements in various other functions. This month, we'll examine another important interface circuit, the contact debouncer, and we'll see how the Schmitt's unique behaviour can be put to use in a variety of oscillator and modulator circuits. We'll also see how the Schmitt can be used in more complex functions such as a frequency meter and a clock pulser.

ASTABLE MULTIVIBRATOR

We will start by examining the Schmitt's role in what is, perhaps, its simplest application – the astable multivibrator, or square wave oscillator. The basic circuit and its associated waveforms are shown in Fig.6.1, where IC1a could be a Schmitt inverter from the 40106B or 74HC/HCT14, or could be a 2-input Schmitt NAND from the 4093B or 74HC/HCT132 (if a NAND is used, one of the two inputs should be tied high, the other connected to capacitor C1 and resistor R1 as shown).

During period T_H when the output, V_{OUT}, is high, V_C (the voltage across C1) rises exponentially as C1 charges via R1. Eventually, when V_C reaches the Schmitt's positive-going threshold voltage, V_{T+}, the output rapidly changes state and goes low.

Capacitor C1 now begins to discharge via R1, and during period T_L the capacitor voltage V_C decreases exponentially until it reaches the negative-going threshold voltage, V_{T-}. At this point, V_{OUT} goes high again, and the process repeats, producing a rectangular output signal with period $T = T_H + T_L$.

HITTING THE RAILS

The output voltage of CMOS logic devices from the 4000 series and 74HC/HCT family will swing from the negative to the positive supply rail, *provided* the output is not excessively loaded. The actual output characteristics vary from one type of device to another, but as a rule of thumb we can assume the output will swing rail-to-rail if the output current is kept below ±100µA. Consequently, for a lightly loaded output, the time periods T_H and T_L are given by:

$$T_H = \tau \ln \left\{ \frac{V_{CC} - V_{T-}}{V_{CC} - V_{T+}} \right\} \text{ (seconds)}$$

and:

$$T_L = \tau \ln \left\{ \frac{V_{T+}}{V_{T-}} \right\}$$

where τ is the circuit time constant, $\tau = C1 \times R1$, and ln denotes the natural logarithm. V_{CC} is the positive supply voltage (usually denoted V_{DD} for the 4093B and 40106B).

The frequency of oscillation, F_{OUT}, is given by:

$$F_{OUT} = 1/T = 1/(T_H + T_L) = \frac{1}{\tau \ln \frac{V_{T+}(V_{CC} - V_{T-})}{V_{T-}(V_{CC} - V_{T+})}} \text{ (Hz)}$$

The expressions for F_{OUT}, T_H and T_L will provide accurate results provided T_H and T_L are much larger than the *propagation delays* of the device used for IC1a. Therefore, for the 74HC14 and 74HC132, the equations will be accurate up to an operating frequency of about 5MHz; for the 4093B and 40106B, the expressions hold true to about 500kHz.

The astable in Fig.6.1 was built using a 74HC14 inverter for IC1a, and values of 1nF and 100kΩ were selected for C1 and R1, giving a time constant $\tau = 100\mu s$. With the supply voltage, V_{CC}, set to 5V, the switching thresholds were measured as $V_{T-} = 1{\cdot}68V$ and $V_{T+} = 2{\cdot}70V$. Using these values in the timing equations above, we find that $T_H = 36{\cdot}7\mu s$, $T_L = 47{\cdot}4\mu s$, and $F_{OUT} = 11{,}883Hz$. The actual, measured values were $T_H = 38{\cdot}9\mu s$, $T_L = 48{\cdot}4\mu s$ and $F_{OUT} = 11{,}455Hz$.

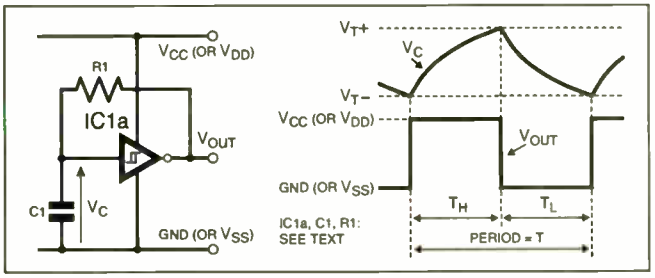


Fig.6.1. Astable multivibrator circuit diagram and waveforms.

A STABLE ASTABLE

Like the pulse stretchers described last month, the astable oscillator is highly tolerant of changes in supply voltage. For applications where V_{CC} (or V_{DD}) is not regulated, such as simple battery-powered circuits, F_{OUT} would, ideally, remain constant as the voltage changes. In this respect, the simple astable performs well.

For example, with the supply voltage *decreased* by 20 per cent from 5V to 4V, the test circuit's output frequency decreased by only 7·5% to 10,593Hz. With V_{CC} *increased* by 20 per cent from 5V to 6V, F_{OUT} was found to increase by just 5·3% to 12,063Hz.

The frequency stability was even better when the 74HC14 was replaced by a 40106B. With the same timing components and a 5V supply, the output frequency was 12,953Hz. With the supply increased by 200 per cent to 15V, the increase in F_{OUT} was only 6·8 per cent! Although the Schmitt-based astable can never compete with a crystal-based oscillator in terms of frequency stability, the performance is remarkably good considering its inexpensive simplicity.

CHOICE OF COMPONENTS

When selecting suitable values for the timing components of Fig.6.1, capacitor C1 should not be too small, otherwise the presence of stray capacitance, together with IC1a's input capacitance,

World Radio History

will have a noticeable effect on the values of T_H and T_L. Generally, these additional (and somewhat unpredictable) capacitances will have negligible effect if C1 is greater than 100pF. There is no upper limit on the value of C1: values of several hundred microfarads can be used where a large time constant is required.

Remember that resistor R1 acts as a load on the output (together with any other load), so small values of timing resistor should be avoided or the output will not swing rail-to-rail. In most cases, R1 should be no less than ten kilohms (10kΩ), although lower values may be used if high frequency operation (i.e., small τ) is required. Where practicable, values of 100kΩ or more will give best results. The upper limit is around one megohm (1MΩ); larger values should be used with caution, since IC1a's input current may have unpredictable effects on the values of T_H and T_L.

Power consumption is also affected by the choice of C1 and R1. For example, with C1 at 100pF and R1 at 100kΩ, giving a time constant τ = 10µs, the test circuit described above oscillated at 117kHz, and the supply current was 576µA.

However, with C1 increased to 10nF and R1 reduced to 1kΩ, again giving a time constant τ = 10µs, the circuit oscillated at roughly the same frequency (107kHz), but the supply current had increased by almost 200 per cent to 1·68mA. Clearly, the larger value of C1 means that more energy is required to charge and discharge the capacitor, resulting in greater power consumption.

VARIATIONS ON A THEME

By adding an extra resistor and one or two diodes, the astable can be adapted to produce different waveforms as shown in Fig.6.2.

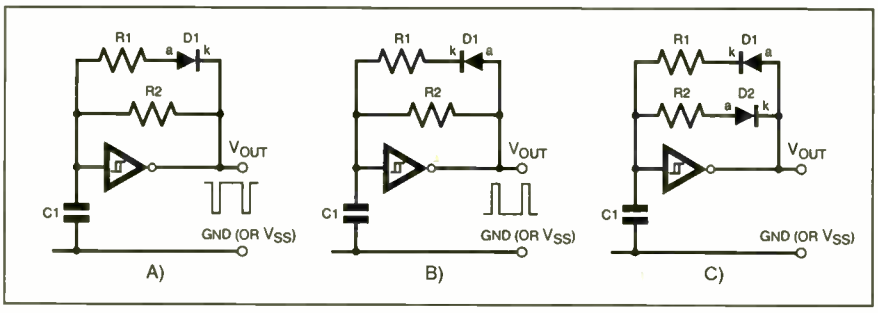


Fig.6.2. Circuit variations on the astable multivibrator.

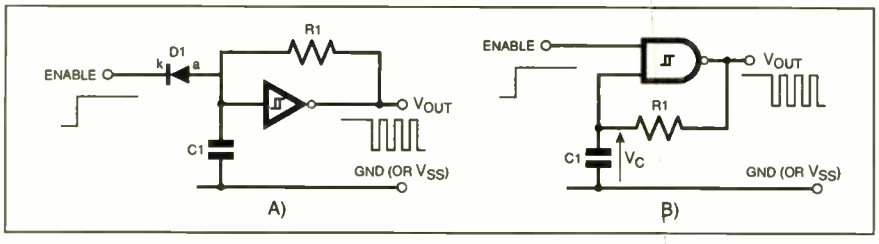


Fig.6.3. Two methods of "gating" an astable oscillator.

In Fig.6.2a, resistor R1 now appears in series with a diode D1, and a second timing resistor R2 is fitted in parallel with them. When the output is high, D1 is reverse biased, blocking any current flow through R1, and capacitor C1 charges via R2 only. However, when V_{OUT} goes low, diode D1 now becomes forward biased, allowing current to flow through resistor R1. Consequently, C1 discharges through the parallel combination of R1 and R2, and as a result, period T_L can be made much shorter than T_H.

Diode D1 has been reversed in Fig.6.2b, such that C1 charges via R1 in parallel with R2 when V_{OUT} is high, but discharges only via R2 when V_{OUT} goes low. Therefore, period T_H can be made much shorter than T_L.

The circuits of Fig.6.2a and Fig.6.2b allow for adjustment of the output duty cycle, and can be used to generate a train of narrow negative-going or positive-going pulses, respectively. However, they have the disadvantage that one of the output periods is affected by changes in the other.

By adding a second diode (D2) as shown in Fig.6.2c, T_H and T_L can be adjusted completely independently of each other. In this circuit, C1 charges only via R1 and discharges only via R2. Therefore, the width of T_H can be adjusted by varying the value of resistor R1 without affecting T_L, and T_L can be adjusted by varying R2 with no effect on T_H.

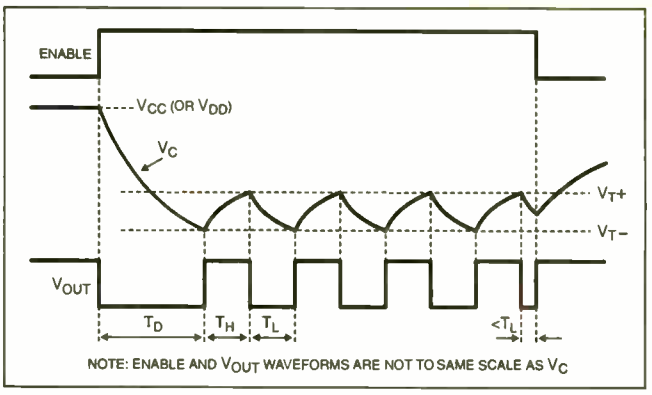


Fig.6.4. Typical waveforms for the NAND gated astable.

GATED OSCILLATORS

Two methods for "gating" an astable oscillator are illustrated in Fig.6.3. In both cases, the astable starts to oscillate when the ENABLE signal goes high, and oscillation stops when ENABLE goes low. Being able to gate the astable is a common circuit requirement, either for functional reasons, or as a means of saving power.

In Fig.6.3a, a low level at the ENABLE input forward biases diode D1, thereby clamping the voltage on capacitor C1 to a diode drop above GND (or V_{SS}). Since this is below the inverter's negative-going threshold voltage, V_{T-}, the output is forced high. However, when ENABLE goes high, D1 becomes reverse biased allowing C1 to charge via R1. The astable is now free to oscillate. If the "direction" of D1 is reversed, the astable will run when the gating signal is low, and will stop when it goes high.

The alternative circuit shown in Fig.6.3b does not require a diode, and instead makes use of the NAND function provided by a 74HC132 or 4093B. When ENABLE is low, the NAND output is forced high, and C1 charges via R1 until V_C equals the high level output voltage, namely V_{CC} (or V_{DD}) when the output is lightly loaded.

When ENABLE goes high, the NAND output is forced low and C1 starts to discharge via R1. The circuit now behaves like the simple, inverter-based astable described above, with capacitor C1 charging and discharging repeatedly. Exactly the same expressions are used to determine T_L, T_H and F_{OUT}.

TRUNCATION

Typical waveforms for the NAND gated astable are shown in Fig.6.4. As soon as ENABLE goes high, V_{OUT} goes low and there follows a delay, T_D, while V_C decays exponentially toward V_{T-}. Proper oscillation then commences, with V_C rising and falling between the two switching thresholds, and the circuit continues to oscillate until ENABLE goes low.

However, if ENABLE goes low part way through a low period (T_L) as shown, V_{OUT} is immediately forced high, thereby shortening the low pulse. This *asynchronous* behaviour "truncates" the period of the last cycle.

For applications where this is unacceptable, the addition of a second NAND gate as shown in Fig.6.5 can be used to eliminate the truncation completely. The two, cross-coupled NAND gates function as an S-R (set-reset) latch, where the active low $\overline{\text{ENABLE}}$ signal provides the "set" input, and the timing capacitor voltage, V_C, constitutes the "reset" input. We can understand how the circuit works by referring to the waveforms in Fig.6.6.

While $\overline{\text{ENABLE}}$ is high, IC1a's output, V_{OUT}(a), is forced low, preventing the astable formed around IC1b from oscillating. When $\overline{\text{ENABLE}}$ goes low, V_{OUT}(a) goes high, allowing the astable to run. IC1b's output, V_{OUT}(b), now oscillates at a frequency F_{OUT} as determined by the equation given earlier. So far, the circuit behaves in exactly the same manner as the single NAND astable described earlier.

However, should $\overline{\text{ENABLE}}$ go high during one of V_{OUT}(b)'s low periods as shown, the last cycle is not truncated. It is only when

World Radio History

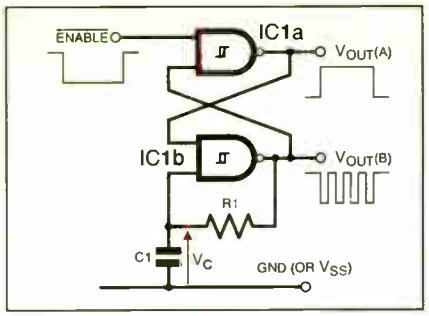


Fig.6.5. Adding a second NAND gate eliminates pulse truncation.

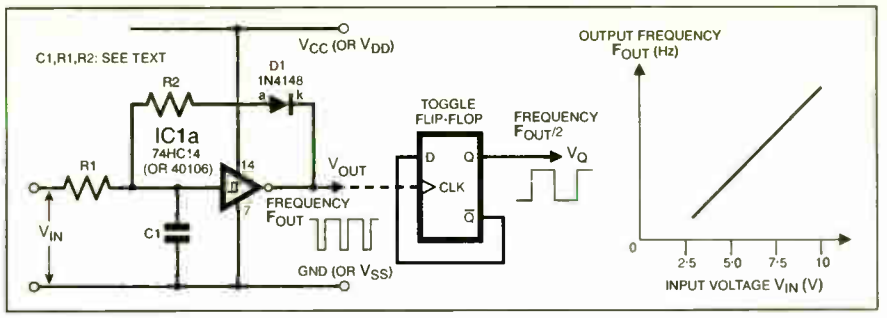


Fig.6.7. Adapting the astable to form a voltage controlled oscillator (v.c.o.).

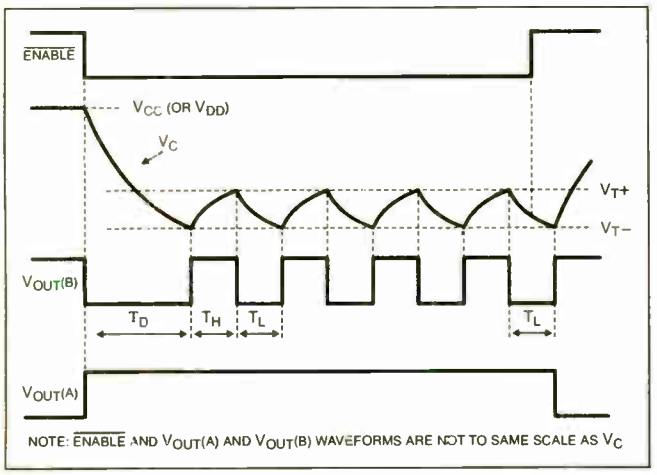


Fig.6.6. Typical waveform for the dual NAND gated astable circuit of Fig.6.5.

V_{OUT}(b) goes high at the end of the low period (T_L) that V_{OUT}(a) goes low (since IC1a's inputs are now both high), thereby disabling the astable. Although the circuit still exhibits a delay, T_D, when first enabled, the last cycle is never truncated and the astable always outputs a series of *whole* cycles.

If the gating signal is a "proper" digital signal, IC1a does not need to be a Schmitt NAND. However, it is often convenient to use two NANDs from the same Schmitt package, such as a 74HC132 or 4093B.

VOLTAGE CONTROLLED OSCILLATOR

By adding an extra resistor and a diode, the simple astable of Fig.6.1 can be converted to a *voltage controlled oscillator*, or v.c.o., as shown in Fig.6.7, where the input voltage, V_{IN}, is a d.c. voltage that can take any value from V_{T-} to more than 20V.

To understand how the circuit works, assume that V_{OUT} is high such that diode D1 is reverse biased. Timing capacitor C1 charges via resistor R1, and the capacitor voltage rises exponentially toward the value of V_{IN}.

However, when the voltage on C1 reaches IC1a's positive-going threshold voltage, V_{T+}, V_{OUT} goes low, forward biasing D1, and C1 starts to discharge via R2 and D1. The capacitor voltage now decreases exponentially; when it reaches IC1a's negative-going threshold voltage, V_{T-}, V_{OUT} goes high, reverse biasing D1, and C1 is now free to charge up again via R1.

Provided resisitor R2 is smaller than R1, the resulting output signal is a series of negative-going pulses of constant width, defined only by IC1a's thresholds, C1, R2 and V_D, the voltage drop across diode D1. However, the width of the positive-going portion of V_{OUT} depends on IC1a's thresholds, C1, R1 and V_{IN}. Since input voltage V_{IN} is variable, the period of the output signal, and hence the output frequency, will change with V_{IN}. As V_{IN} is increased, C1 charges more quickly causing the output period to decrease, and the frequency increases as shown by the graph.

Note that V_{IN} can exceed the positive supply voltage, V_{CC} (or V_{DD}). The maximum value is determined by the ratio of resistor R1 to R2. When V_{OUT} goes low, R1 and R2 form a potential divider which "pulls down" the voltage on C1. If V_{IN} is too high, the divider will be unable to pull the capacitor voltage below V_{T-}, in which case V_{OUT} will remain continually low.

When V_{OUT} is high and D1 is reverse biased, C1 charges only via R1. Therefore, in order for the capacitor voltage to cross IC1a's positive-going threshold, V_{IN} must be $\geq V_{T+}$. This establishes the lower limit for the input voltage.

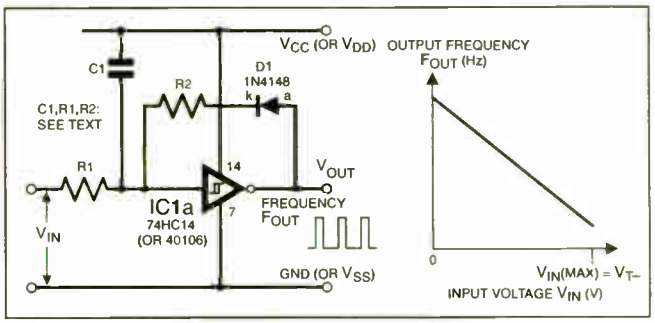


Fig.6.8. Circuit for a voltage controlled oscillator with an inverse voltage/frequency characteristic.

LINEAR RELATIONSHIP

The performance of the circuit shown in Fig.6.7 was tested using an inverter from the 74HC14 for IC1a (although any other Schmitt device could be used). Values of R1 = 100kΩ, R2 = 3·3kΩ, and C1 = 1nF were chosen for the timing components.

With a supply voltage of 5V, the positive-going threshold voltage, V_{T+}, was measured as 2·75V. Therefore, it was decided to set the input voltage's (V_{IN}) lower limit to 3·0V. The upper limit of V_{IN}, at which V_{OUT} went continually low, was found to be 35·6V, although the circuit's response had become highly non-linear below this value.

The relationship between output frequency, F_{OUT}, and V_{IN} was found to be very linear for an input voltage of 3·0V to 5·0V, and reasonably linear over the range of 5·0V to 10·0V. Beyond this, the relationship deteriorated, with the graph starting to curve significantly for values of V_{IN} above 15V. The useful operating range was V_{IN} = 3·0V to 10·0V, corresponding to an output frequency range of 6·0kHz to 62·4kHz.

By feeding the v.c.o. output to a toggle-connected flip-flop as shown in Fig.6.7, a squarewave output can be obtained at V_Q having a constant 50 per cent duty cycle at all frequencies. However, note that the frequency at V_Q will be half that at V_{OUT}.

INVERSE RELATIONSHIP

By connecting capacitor C1 to the positive supply (V_{CC}) and reversing the "direction" of diode D1 as shown in Fig.6.8, we obtain a v.c.o. which has an inverse relationship between V_{IN} and F_{OUT}, that is, F_{OUT} decreases as V_{IN} is increased. To understand the circuit's behaviour, assume that input voltage V_{IN} = 0, and V_{OUT} is low such that D1 is reverse biased.

Capacitor C1 charges up via resistor R1, causing the voltage across C1 to increase exponentially. Consequently, the voltage at IC1a's input *decreases* exponentially. Eventually, when this voltage reaches IC1a's negative-going threshold voltage, V_{T-}, V_{OUT} goes high, forward biasing D1.

Capacitor C1 now starts to discharge via R2 and D1, causing the voltage at IC1a's input to rise exponentially. The rate at which C1 discharges is determined by the supply voltage V_{CC}, by IC1a's thresholds, by the values of C1, R1, R2, and by V_{IN} and V_D, the voltage drop across D1. However, if R1 is much larger than R2, input voltage V_{IN} will have little effect on the rate of C1's discharge which will be controlled mainly by resistor R2.

When IC1a's input voltage reaches the positive-going threshold voltage, V_{T+}, V_{OUT} goes low. Therefore, the output signal consists of

World Radio History

a train of positive-going pulses of almost constant width. Since V_{OUT} is now low, capacitor C1 is free to charge up again via R1 at a rate determined by V_{IN}.

If V_{IN} is at a low level, the voltage drop across R1 – and hence the current through it – will be relatively large, causing C1 to charge rapidly. In turn, this causes the negative-going portion of the output signal to be relatively short, resulting in a high frequency.

On the other hand, if V_{IN} is at a high level, C1's charging current will be relatively small, and it will take longer for IC1a's input voltage to fall to V_{T-}. Therefore, the negative-going portion of the output signal to be relatively long, resulting in a low frequency. Therefore, the output frequency decreases as V_{IN} is increased.

INPUT VOLTAGE CONSTRAINTS

The upper limit of V_{IN} is determined by IC1a's negative-going threshold voltage, V_{T-}: if V_{IN} exceeds V_{T-}, it will be impossible for the inverter's input voltage to go below this threshold, and the output will go continually low.

For a single-rail supply circuit, V_{IN}'s lower limit is simply zero (i.e., GND or V_{SS}). However, if a negative supply is available, V_{IN} may be taken negative (that is, V_{IN} may go below GND or V_{SS}). The maximum negative limit is determined by V_{CC} (or V_{DD}), V_D, V_{T+} and by the ratio of resistor R1 to R2, since when V_{OUT} is high it must be possible for the R1/R2 potential divider to pull the inverter's input voltage above V_{T+}.

Provided these constraints are met, the circuit of Fig.6.8 will produce a fairly linear, inverse relationship between V_{IN} and F_{OUT}. A test circuit was built using an inverter from the 40106B; V_{DD} was set to 15·00V, resulting in thresholds of V_{T-} = 5·75V and V_{T+} = 8·45V. Therefore, the maximum value of V_{IN} is 5·75V.

With values of R1 = 100kΩ, R2 = 3·3kΩ, and C1 = 1nF chosen for the timing components, the circuit performed well with input voltages (V_{IN}) of 0V to 5·5V, producing a corresponding output frequency (F_{OUT}) range of 2·5kHz to 410Hz.

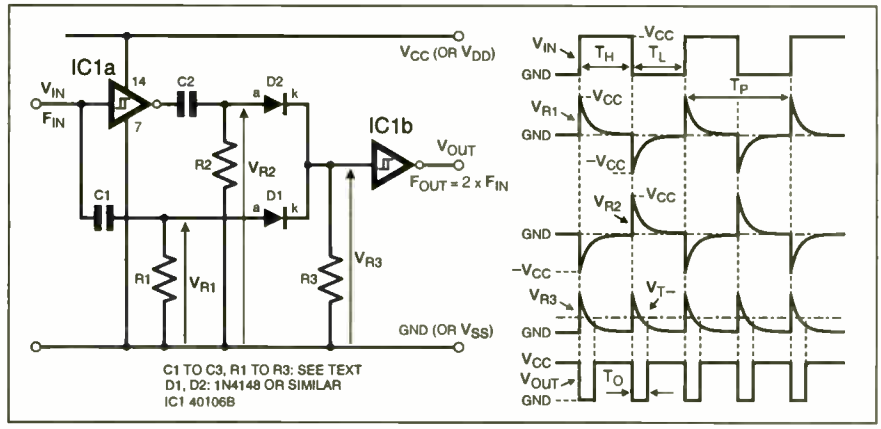


Fig.6.9. Circuit diagram and typical waveforms for a frequency doubler.

FREQUENCY – BY THE DOUBLE!

When clocked by a periodic input signal, the toggle-connected flip-flop mentioned above provides a simple means of halving the clock frequency and producing an output signal with a constant 50 per cent duty cycle.

However, in cases where it is necessary to *double* a signal's frequency, some other technique must be used. A solution which makes use of the "digital differentiator" techniques introduced last month is shown in Fig.6.9.

The logic level input signal, V_{IN}, is applied to inverter IC1a, and also to the C1/R1 differentiator network. IC1a's output is fed to a similar differentiator, C2/R2. The differentiated signals V_{R1} and V_{R2} appearing across resistors R1 and R2 are rectified by diodes D1 and D2 and the resulting unipolar signals are combined at the input to IC1b.

The circuit's operation is illustrated by the accompanying waveforms. The rising edge of V_{IN} is differentiated by C1/R1, producing a positive-going, exponential "spike" across R1, having a peak value equal to V_{CC}. The inverted version of V_{IN} at IC1a's output (not shown) is differentiated by C2/R2, producing a negative-going, exponential spike across R2, having a peak value equal to $-V_{CC}$.

On the falling edge of V_{IN}, the polarities of the spikes are reversed: V_{R1} swings down to $-V_{CC}$, and V_{R2} swings up to V_{CC}. Diodes D1 and D2 ensure that only the positive-going portions of V_{R1} and V_{R2} are coupled through to resistor R3, such that V_{R3} consists of a train of positive-going spikes, each of amplitude $V_{CC} - V_D$, occurring on both the rising *and* falling edges of V_{IN}. These spikes are "squared up" by Schmitt inverter IC1b, whose output consists of a train of negative-going pulses at *twice* the frequency of V_{IN}, that is, $F_{OUT} = 2 \times F_{IN}$.

OUTPUT PULSE WIDTH

The width of the negative-going output pulse, T_O, will depend on the time constants τ_1 (= C1 × R1) and τ_2 (= C2 × R2), and also, to some extent, on the values of T_H and T_L, the width of V_{IN}'s high and low periods, respectively.

The design procedure is to identify the *maximum* input frequency, and hence determine the *minimum* values of T_H and T_L. Then, select C1 and R1 such that τ_1 is roughly equal to $T_H/5$, and select C2 and R2 to make τ_2 roughly equal to $T_L/5$. For the case where V_{IN} is a square wave with a 50 per cent duty cycle (i.e., $T_H = T_L$), simply make $\tau_1 = \tau_2 = T_P/10$, where T_P is the minimum period of the input square wave. Resistor R3 should be approximately ten times the value chosen for R1 or R2.

If the time constants are chosen correctly, the circuit will output a series of constant-width output pulses at a frequency $F_{OUT} = 2 \times F_{IN}$ for all values of F_{IN} up to the maximum value established above.

A test circuit was built from Fig.6.9 using two inverters from the 40106B for IC1a and IC1b (note that IC1a may be a non-Schmitt inverter if V_{IN} is a well-shaped digital signal). The supply voltage, V_{DD}, was set to 5·0V. A 50 per cent duty cycle square wave having a maximum frequency of 250Hz was used as the input signal, such that the minimum value of T_P was 4ms. With 3·3nF capacitors selected for C1 and C2, and 100kΩ resistors chosen for R1 and R2, the time constants were each 330μs (roughly a tenth of T_P). A value of 1MΩ was selected for R3.

TEST CIRCUIT PERFORMANCE

The performance of the test circuit was as follows: at all frequencies up to 250Hz, the output pulse width, T_O, was found to be constant at 210μs, and the pulses occurred at twice the frequency of the input signal as desired. At frequencies higher than 250Hz, the output pulse width started to decrease, although the circuit continued to double the input frequency properly for F_{IN} as high as 1·8kHz.

One thing to bear in mind about this circuit is that T_O becomes a very small fraction of the output signal period at low values of F_{IN}. That is, the duty cycle of the output signal becomes very large as the input frequency is reduced.

PULSE WIDTH MODULATION

We saw in Part Four of this series how an operational amplifier Schmitt trigger can be adapted to form a *pulse width modulator*, that is, a circuit in which the pulse width – and hence the duty cycle – of a rectangular waveform is controlled by a *modulating* voltage. With the addition of a few extra components, the "digital" Schmitt trigger can also form the basis of a PWM (Pulse Width Modulation) circuit.

One example is shown in Fig.6.10, where two, *complementary* transistors, TR1 and TR2, are used to charge and discharge a timing capacitor, C1. To understand how the circuit works, assume that the voltage, V_C, on C1 has been falling and has just reached the negative-going threshold, V_{T-}, of the Schmitt inverter, IC1a, such that V_{OUT} goes high, taking *pnp* transistor TR1's emitter to V_{CC} (or V_{DD}). We are now at the beginning of period T_H.

The base-emitter junction of *npn* transistor TR2 is now reverse biased, so it has no effect on C1's voltage. The base-emitter junction of *pnp* transistor TR1, however, is forward biased, allowing its collector current, I_{C1}, to flow through diode D1 into capacitor C1. The timing capacitor now starts to charge up, and V_C rises linearly at a rate determined by I_{C1} and the value of C1.

Transistor TR1's collector current is determined by the product of its base current, I_{B1}, and its current gain, h_{FE1}, that is, $I_{C1} = I_{B1} \times h_{FE1}$. In turn, base current I_{B1} is determined by resistor R1 and the voltage drop across it. As the input voltage, V_{IN}, increases, the voltage across R1, and hence I_{B1}, decreases. This, in turn, decreases TR1's collector current, I_{C1}, reducing the rate at which C1 charges.

World Radio History

Eventually, when timing capacitor C1 has charged sufficiently for V_C to reach the inverter's positive-going threshold voltage, V_{T+}, the output immediately goes low, and time period T_H ends. Clearly, T_H is *inversely* proportional to I_{C1} (decreasing I_{C1} will reduce the rate at which C1 charges up, causing V_C to rise more slowly, hence making T_H longer). Therefore, increasing V_{IN} (which decreases I_{B1} and I_{C1}) will result in a corresponding increase in T_H.

COMPLEMENTARY BEHAVIOUR

With the output V_{OUT} now low, such that TR2's emitter is at the same potential as GND (or V_{SS}), we are now at the start of the low period, T_L. The base-emitter junction of *pnp* transistor TR1 is now reverse biased, so it has no effect on capacitor C1's voltage. However, the base-emitter junction of *npn* transistor TR2 is forward biased, allowing its collector current, I_{C2}, to flow through diode D2, thereby discharging C1. The capacitor voltage, V_C, now starts to decrease linearly at a rate determined by I_{C2} and the value of C1.

Transistor TR2's collector current is given by $I_{C2} = I_{B2} \times h_{FE2}$, where I_{B2} is the base current and h_{FE2} is the current gain. Now, as the input voltage, V_{IN}, increases, the voltage across R1, and hence I_{B2}, also increases. This, in turn, increases both I_{C2} and the rate at which C1 discharges.

Eventually, when C1 has discharged sufficiently for V_C to fall to the inverter's negative-going threshold voltage, V_{T-}, the output (V_{OUT}) immediately goes high again, and time period T_L ends. We see that T_L is *inversely* proportional to I_{C2} (decreasing I_{C2} will reduce the rate at which C1 discharges, causing V_C to fall more slowly, hence making T_L longer). Therefore, decreasing V_{IN} (which decreases I_{B2} and I_{C2}) will result in a corresponding increase in T_L.

We can summarise this process by noting that the complementary action of TR1 and TR2 means that an increase in V_{IN} causes an increase in T_H and a decrease in T_L; in other words, increasing V_{IN} also increases the output duty cycle. Conversely, decreasing V_{IN} causes a decrease in T_H and an increase in T_L, thereby reducing the output duty cycle.

Diodes D1 and D2 are required to prevent the base-collector junctions of transistor TR1 and TR2 becoming forward biased by V_{IN} and R1 when they turn "off". Also, to prevent "avalanching" of the reverse-biased base-emitter junction of either transistor when "off", it is necessary to limit the supply voltage, V_{CC}, to a maximum of around 5V.

DESIGN PROCEDURE

In order for the circuit of Fig.6.10 to work properly, it is necessary to ensure that the transistors are not turned "hard on" (i.e., saturated), otherwise capacitor C1's charge and discharge currents will be determined by the inverter's output sink and source currents, rather than by the transistors' base currents.

Now, a device like the 74HC14 can sink and source up to 4mA, so it is best to limit I_{C1} and I_{C2} to a value much less than this, say around ±500µA maximum. Therefore, for each transistor, we must ensure that I_B(max) is less than ±500µA/h_{FE}(max). For the BC546 and BC556 transistors shown in Fig.6.10, h_{FE}(max) is around 500, so we must ensure that I_B(max) is less than ±1µA.

When transistor TR1 is "on", $I_{B1} = (V_{IN} - V_{B1})/R1$, where V_{B1} is the base potential of TR1. If we take TR1's forward-biased base-emitter drop, V_{BE1}, as 0·6V, then when TR1's emitter is at 5V (when V_{OUT} is high), we find that V_{B1} = 4·4V. Now, if V_{IN} can take any value from 0V to 5V, then I_{B1}(max) = (0 – 4·4)/R1. Therefore, in order to make I_{B1}(max) < –1µA, we require R1 > 4·4MΩ.

If we perform the same analysis for I_{B2}, we find that I_{B2}(max) = (5 – 0·6)/R1 (assuming TR2's forward-biased base-emitter drop, V_{BE2} = 0·6V). Therefore, in order to make I_{B2}(max) < 1µA, we again require R1 > 4·4MΩ. A suitable, preferred value for R1 is 4·7MΩ.

OUTPUT JITTER

A "test set-up" of the circuit diagram of Fig.6.10 was built using a value of 4·7MΩ for resistor R1 and 100nF for timing capacitor C1. An inverter from the 74HC14 was used for IC1a, and the supply voltage, V_{CC}, was set to 5·0V.

The resulting relationship between V_{IN} and output duty cycle was found to be quite linear; the duty cycle was 14·6 per cent at V_{IN} = 1·0V rising to 90·4 per cent at V_{IN} = 4·0V. The output frequency, however, varied non-linearly with V_{IN}, peaking at 313Hz when V_{IN} was approximately 2·5V (i.e., when $V_{IN} = V_{CC}/2$).

With capacitor C1 reduced to 10nF, the relationship between V_{IN} and duty cycle was largely unchanged, but the output frequency was much higher, peaking at 2·2kHz for V_{IN} = 2·5V. The operating frequency is higher because a smaller capacitor can charge and discharge much more quickly than a large value for a given range of collector current.

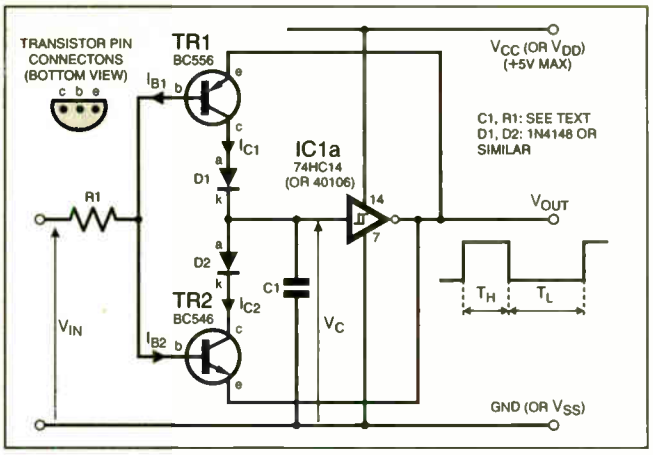


Fig.6.10. Circuit diagram for a pulse width modulator (PWM) employing complementary transistors.

Although the circuit performed reasonably well, the output signal was subject to considerable *jitter* at fairly low (< 1·5V) or fairly large (> 3·5V) values of V_{IN}. This is not surprising, considering that the base current of the appropriate transistor will be very small at this point, perhaps less than 100nA, and hence subject to the effects of circuit noise.

Although the duty cycle is modulated by V_{IN}, it is really the collector currents which control the charging and discharging of C1, and so the duty cycle will be affected by anything which "upsets" these currents. For example, changes in h_{FE} (e.g.: due to temperature drift) will affect I_C, as will changes in V_{BE} (which influence I_B, and hence will affect I_C).

AN IMPROVED PWM CIRCUIT

Another "improved" Schmitt-based PWM circuit, in which a complementary transistor pair again provides the charge and discharge currents for timing capacitor C1, is shown in Fig.6.11. However, unlike the previous circuit (Fig.6.10), the collector currents are largely independent of changes in transistor current gain and base current values, and so the performance tends to be much more stable and predictable.

The potential divider formed by resistors R1 to R4 controls the transistors' base voltages, V_{B1} and V_{B2}. The input voltage, V_{IN}, is applied to the mid-point of the potential divider, such that varying V_{IN} also varies V_{B1} and V_{B2}. Transistors TR1 and TR2 function as switched current sources which charge and discharge timing capacitor C1 at a rate determined by their base voltages. Resistor R5 behaves as a common emitter resistor shared by both transistors.

Assume that V_{OUT} has just gone low at the start of period T_L. Transistor TR1's base-emitter junction is reverse biased, turning it "off". Transistor TR2's base-emitter junction, however, is forward biased, allowing collector current I_{C2} to flow through TR2, discharging C1, and causing capacitor voltage V_C to fall.

If TR2's current gain, h_{FE2}, is large, its collector current will be roughly equal to its emitter current, that is, $I_{C2} \approx I_{E2}$. Now, I_{E2} is set by TR2's emitter voltage and by the value of R5, and in turn, the emitter voltage is given by $V_{B2} - V_{BE2}$, where V_{BE2} is TR2's forward-biased base-emitter voltage. Therefore, $I_{E2} = (V_{B2} - V_{BE2})/R5$. Since V_{BE2} and R5 are fixed, I_{E2} will vary only in response to changes in V_{B2}, which in turn varies with changes in V_{IN}. For example, increasing V_{IN} causes V_{B2} to rise, resulting in a corresponding increase in I_{E2}.

Eventually, when I_{E2} has discharged C1 sufficiently for V_C to fall to the inverter's negative-going threshold voltage, V_{T-}, the output immediately goes high again, and time period T_L ends. We see that T_L is *inversely* proportional to I_{E2} (increasing I_{E2} will increase the rate at which C1 discharges, causing V_C to fall more quickly, hence making T_L shorter). Therefore, increasing V_{IN} (which increases I_{E2}) will result in a corresponding decrease in T_L.

SYMMETRY

With the output (V_{OUT}) now high, at the start of period T_H, TR2's base-emitter junction is now reverse biased, turning it "off". Transistor TR1's base-emitter junction, however, is forward biased, allowing collector current I_{C1} to flow through TR1, charging C1, and causing capacitor voltage V_C to rise.

World Radio History

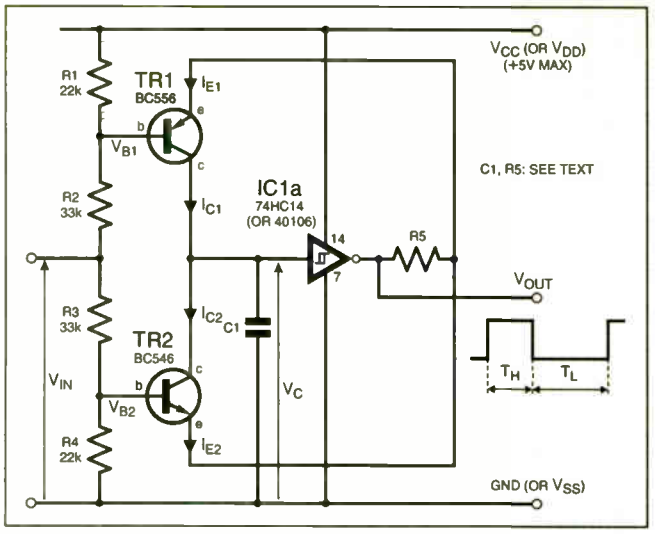


Fig.6.11. An alternative Schmitt-based PWM, again using complementary transistors.

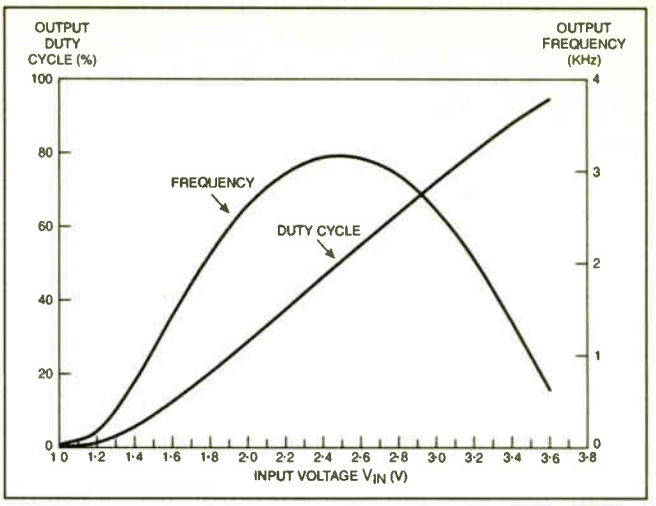


Fig.6.12. Graphs showing frequency and duty cycles versus V_{IN} for the PWM.

Table 6.1: Data used to plot waveforms of Fig.6.12.

V_{IN} (V)	1·0	1·2	1·4	1·6	1·8	2·0	2·2	2·4	2·6	2·8	3·0	3·2	3·4	3·6
Duty Cycle (%)	0·20	1·28	5·72	12·59	20·46	28·80	37·32	46·04	54·68	63·34	71·91	80·20	88·17	94·64
Freq. (kHz)	0·03	0·17	0·71	1·43	2·09	2·62	2·98	3·16	3·15	2·96	2·58	2·04	1·36	0·64

Like transistor TR2, TR1's emitter current, I_{E1}, depends on resistor R5 and the emitter voltage, which in turn depends on V_{B1} and V_{IN}. Increasing V_{IN} will cause a corresponding increase in TR1's emitter voltage, thereby *reducing* the voltage across R5 and causing I_{E1} to decrease. Again, if the transistor current gain is large, then $I_{C1} \approx I_{E1}$, such that C1's charge current is effectively equal to I_{E1}.

Eventually, when I_{E1} has charged C1 sufficiently for V_C to rise to the inverter's positive-going threshold voltage, V_{T+}, the output immediately goes low again, and time period T_H ends. Therefore, T_H is *inversely* proportional to I_{E1} (decreasing I_{E1} will decrease the rate at which C1 charges, causing V_C to rise more slowly, hence making T_H longer). Therefore, increasing V_{IN} (which decreases I_{E2}) will result in a corresponding increase in T_H.

It can be seen that there is a kind of "symmetry" to the way the switched current sources function. Increasing V_{IN} (which increases I_{E2}) results in a corresponding decrease in T_L; at the same time, the decrease in I_{E1} results in a corresponding increase in T_H. The net result is an increase in the output duty cycle. Therefore, varying the input voltage changes the emitter potentials and thus varies the charge and discharge currents, such that the duty cycle varies in direct *linear* proportion to V_{IN}.

VOLTAGE CONTROL

Provided the transistors' current gains are large enough, their base currents will have negligible effect on the circuit's behaviour. In fact, it is only the *voltages* around the transistors which control the charging and discharging of capacitor C1. Changes in h_{FE} and base currents have little effect on the duty cycle; the circuit is stable and exhibits negligible "jitter".

With equal resistor values for R1 and R4, and R2 and R3, as shown in Fig.6.11, the potential divider also behaves "symmetrically". For example, when $V_{IN} = V_{CC}/2$, the voltage across resistor R1 will be the same as that across R4. Therefore, provided the transistors' V_{BE} values are roughly the same, the voltage across R5 when TR1 turns on will be the same as when TR2 turns on, such that $I_{E1} = I_{E2}$. Consequently, C1's charge and discharge currents will be the same, resulting in $T_H = T_L$, that is, 50 per cent duty cycle.

Using the values for R1 to R4 shown in Fig.6.11, the output duty cycle is given by:

$$\text{Duty Cycle} = \frac{0{\cdot}4V_{IN} - V_{BE}}{0{\cdot}4V_{CC} - 2V_{BE}} \times 100\%$$

(V_{BE} = forward-biased base-emitter voltage).

This expression shows that duty cycle is directly proportional to input voltage, and it can be seen that V_{IN} must be greater than $V_{BE}/0{\cdot}4$ for the circuit to work. Taking $V_{BE} = 0{\cdot}6V$, this suggests that V_{IN} must be at least 1·5V, although in breadboard tests the circuit was found to produce very low duty cycles with V_{IN} as low as 1V. Also, substituting $V_{CC}/2$ for V_{IN}, the equation shows that duty cycle = 50 per cent.

The two graphs shown in Fig.6.12 plot the performance of a test circuit built using a 74HC14 inverter with $V_{CC} = 5{\cdot}0V$ (like the previous circuit, the supply voltage should be limited to around 5V to prevent avalanching of the transistors' reverse-biased base-emitter junctions). Values of 10nF and 5·6kΩ were selected for C1 and R5.

Notice how the duty cycle varies linearly from 2% to 95% over a range of V_{IN} from 1·2V to 3·6V. (V_{IN} cannot go much below 1·2V or much above 3·6V, otherwise there is insufficient base voltage to bias the transistors "on".) As predicted by the symmetry of the R1 to R4 potential divider, the duty cycle is roughly 50% when $V_{IN} = 2{\cdot}5V$ (i.e., $V_{CC}/2$).

Like the previous PWM circuit shown in Fig.6.10, the output frequency changes non-linearly with V_{IN}, and varies by as much as 15 to 1 over the range V_{IN} = 1·2V to 3·6V, peaking at about 3·2kHz when V_{IN} is roughly equal to $V_{CC}/2$.

Capacitor C1 and resistor R5 should be selected according to the operating frequency range required. For example, with a value of 5·6kΩ for R5 and C1 reduced to 1nF, the peak frequency is increased to around 31kHz. However, C1 should not be made too small (100pF is a suitable minimum value) otherwise the duty cycle response starts to become non-linear.

SPARE PARTS ONE-SHOT

Last month, we saw how two Schmitt NAND gates could be used to form a non-retriggerable monostable multivibrator (sometimes called a "one-shot"). We now look at an alternative non-retriggerable monostable circuit which requires a single Schmitt inverter, a flip-flop and a transistor.

The circuit diagram and its waveforms are shown in Fig.6.13, and can be particularly useful where these parts are unused, or "left over", elements in a design. As a bonus, the circuit generates two, *complementary* outputs at V_{OUT} and $\overline{V_{OUT}}$.

The flip-flop, IC1a, is a positive-edge triggered, D-type flip-flop from the 74HC74, although most other flip-flops having complementary outputs (Q and $\overline{Q}$) would suffice. To understand the circuit's behaviour, assume that the flip-flop is in its reset state, such that Q is low and $\overline{Q}$ is high.

When the input trigger pulse, V_{IN}, arrives and clocks the flip-flop, Q (V_{OUT}) immediately goes high; at the same moment, $\overline{Q}$ goes low, turning off *npn* transistor TR1. Timing capacitor C1 now starts to charge exponentially via timing resistor R1. Eventually, when the capacitor voltage, V_C, reaches the positive-going threshold, V_{T+}, of IC2a, its output immediately goes low. This resets the flip-flop, causing Q and $\overline{Q}$ to return to their original, stable states, and terminates the output pulse, T_{OUT}.

Provided resistor R1 is large enough not to load IC1a's Q output, we can assume that Q's voltage equals V_{CC} when it goes high, such that:

$$\text{Output Pulse Width, } T_{OUT} = \tau \ln \left\{ \frac{V_{CC}}{V_{CC} - V_{T+}} \right\} \text{ (seconds)}$$

where the time constant $\tau = C1 \times R1$.

World Radio History

At the end of T_{OUT}, when $\overline{V_{OUT}}$ goes high, TR1 turns on and rapidly discharges C1. The capacitor voltage, V_C, quickly falls below IC2a's negative-going threshold, V_{T-}, at which point IC2a's output goes high, bringing the flip-flop out of its reset state.

The device used for TR1 is not critical; any small-signal *npn* transistor with adequate current gain should suffice.

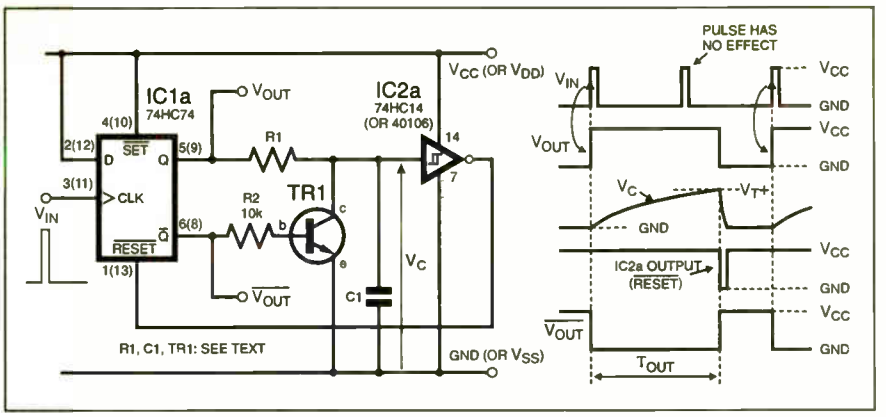


Fig.6.13. Circuit diagram and its waveforms for a non-retriggerable monostable constructed from "unused" parts.

NON-RETRIGGERABLE

Since IC2a's output is low only for a very brief time, the circuit is ready to accept another trigger pulse almost as soon as T_{OUT} has ended. Note that any trigger pulses that arrive while V_{OUT} is high have no effect on the circuit, which cannot be retriggered until T_{OUT} has ended. This is illustrated by the second of the V_{IN} pulses which cannot clock the flip-flop because V_{OUT} is already high.

The actual value of T_{OUT} will be influenced by tolerances in C1 and R1, and also by variations in supply voltage and V_{T+}. Nevertheless, provided resistor R1 is not too large (< 1MΩ), the actual value of T_{OUT} agrees closely with the value predicted by the expression above.

For example, a test circuit was built using a 74HC14 inverter for IC2a, and the supply voltage, V_{CC}, was set to 5·0V, resulting in a value of 2·74V for V_{T+}. Nominal values of 100kΩ and 10nF were chosen for R1 and C1, although the measured values were 99·9kΩ and 10·08nF, such that T_{OUT} predicted by the equation above is 800µs. The actual, measured value was found to be 806µs.

The circuit of Fig.6.13 is extremely good at "stretching" narrow pulses. With R1 and C1 increased to 1MΩ and 10·68µF, a trigger pulse just 100ns wide resulted in an output pulse of 8·9 seconds, some 89 million times greater than the input pulse width!

Although T_{OUT} could be finely tuned by using a variable resistor (potentiometer) for R1, the circuit is not intended for precision timing applications, where a device like the 74HC221 would be a better choice. Nevertheless, where a design happens to have an unused flip-flop and Schmitt inverter available "for free", the circuit provides a simple and cost-effective way of implementing the "one-shot" function.

FREQUENCY METER

With the addition of a few resistors and capacitors, the monostable circuit of Fig.6.13 can be converted to a simple Frequency Meter which displays the reading on a 3½-digit, 200mV DVM (digital volt meter) module. The "add-on" circuit is shown in Fig.6.14, where V_{OUT} is the Q output of flip-flop IC1a in Fig.6.13.

The circuit is effectively a frequency-to-voltage converter, and works on the principle that the *average* value of a series of *constant width, constant amplitude* pulses is directly proportional to their frequency. Therefore, by averaging the voltage of the pulses, the result displayed on a DVM provides a direct indication of frequency.

The averaging function is provided by C2/R3 and C3/R4 which together form a simple, two-pole, low-pass filter. For the circuit to work properly, it is essential that the input pulses are of constant width: this is why the filter circuit must be preceded by a non-retriggerable monostable. Resistors R5 and R6, and trimmer preset VR1, allow the output voltage, V_M, to be adjusted to compensate for tolerances in the monostable circuit.

The circuit is intended to display a full-scale frequency of 2kHz on the DVM, that is, a reading of 199·9mV corresponds to a frequency of 1·999kHz. Therefore, it is important that the monostable's pulse width, T_{OUT}, must not exceed 500µs (the period of 2kHz), or the meter will go overrange. It doesn't matter if T_{OUT} is somewhat less than 500µs, as this can be accommodated by trimming VR1.

COMPONENT VALUES

For the monostable timing components, values of 3·3nF ±5% and 120kΩ ±1% should be used for C1 and R1 respectively. A single inverter from the 74HC14 Hex Schmitt trigger inverter i.c. should be used for IC2a, and the 5V (V_{CC}) supply voltage should be regulated to within ±4% (this can easily be achieved using a 78L05 regulator).

The resistors used in the filter circuit (Fig.6.14) should all be ±1% types, and VR1 should be a multiturn preset potentiometer with a maximum tolerance of ±10%. The tolerance of capacitors C2 and C3 is not critical: ±10% parts are adequate. The DVM must have a full-scale range of 200mV, and its input impedance must be at least 10MΩ (a lower impedance would "load" the filter network and could affect the results).

To calibrate the circuit, flip-flop IC1a should be clocked at a frequency near full-scale (say, 1,950Hz), and preset VR1 should be adjusted to produce a corresponding reading on the DVM (in this example, it would be 195·0mV). The meter will then provide a direct indication of frequency with a reading error of around ±1% maximum.

Note that by preceding the monostable circuit with a series of decade frequency dividers (such as the 74HC190 or 74HC390), the circuit can be adapted to display any frequency in decade ranges up to about 20MHz. Furthermore, if the input signal is fed to the Schmitt trigger interface circuit described in Fig.5.3 of last month's article, the frequency meter is capable of responding to a variety of different waveshapes.

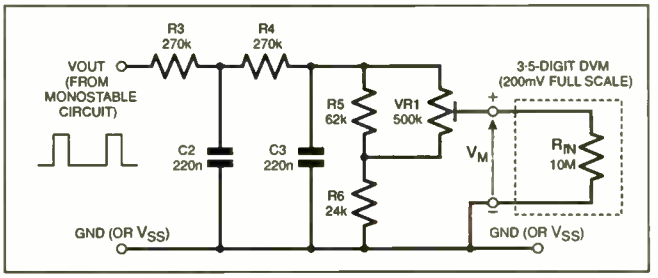


Fig.6.14. An add-on filter circuit for frequency-to-voltage conversion.

BOUNCING CONTACTS

Perhaps one of the Schmitt's most ubiquitous applications is that of contact "bounce" suppression. Switch and relay contacts have inherent elasticity; when they close, the kinetic energy in the moving parts causes the contacts to bounce back and forth many times before finally settling down. The result is a series of contact interruptions, each of which will generate a narrow pulse when used in an electronic circuit.

In certain applications, contact bounce is not a problem, but in others, such as circuits featuring counters and shift registers, the phenomenon can wreak havoc on the circuit's behaviour. The duration of the bounce period (the time during which the contacts are unstable), and the number of pulses generated will depend on the type and quality of contacts used. Bounce periods of several hundred microseconds are common, although this may be as long as 20ms for some contacts.

Incidentally, contact bounce also occurs when contacts open, although this is usually less severe than when they close, and is often a result of changes in contact resistance that occur when the contacts separate.

Many techniques exist for eliminating the effects of contact bounce. In microcontroller or microprocessor circuits, software routines can be employed to "filter out" the glitches produced when the contacts close.

In hardware, monostables, latches, flip-flops and specialised "debouncing" i.c.s can be used to provide immunity to contact

World Radio History

bounce. However, in terms of simplicity, the Schmitt trigger debouncers shown in Fig.6.15 are often hard to beat.

PULSE FILTER

The circuit in Fig.6.15a provides a low-to-high level change in output, V_{OUT}, when the contacts close, whereas that in Fig.6.15b generates a high-to-low level change. Both circuits rely on the low-pass filtering action provided by capacitor C1 and resistor R1.

In Fig.6.15a, R2 is a *pull-up* resistor which ensures V_{OUT} is low while the contacts are open. When the contacts close, the junction of R1/R2 is pulled down below the Schmitt's negative-going threshold, and capacitor C1 filters out the bounce pulses which would otherwise appear, such that the signal at the Schmitt input makes a "smooth" transition from V_{CC} (or V_{DD}) to a low level. Therefore, V_{OUT} makes just one, "clean", low-to-high transition when the contacts are closed.

In Fig.6.15b, C1, R1 and R2 provide exactly the same function, except that R2 behaves as a *pull-down* resistor such that V_{OUT} is held high while the contacts are open. In both cases, the time constant formed by C1 × R1 should be made large enough to filter out the worst-case number of bounce pulses likely to occur. In other words, the time constant must be longer than the maximum anticipated bounce period.

Also, the ratio of R1 to R2 must be chosen carefully such that the inverter's input voltage can be pulled below the *minimum* negative-going threshold (Fig.6.15a) or above the *maximum* positive-going threshold (Fig.6.15b) when the contacts close. For a 74HC14 inverter working on a 5V rail, values in the region of 100kΩ for R1 and 680kΩ for R2 are usually suitable.

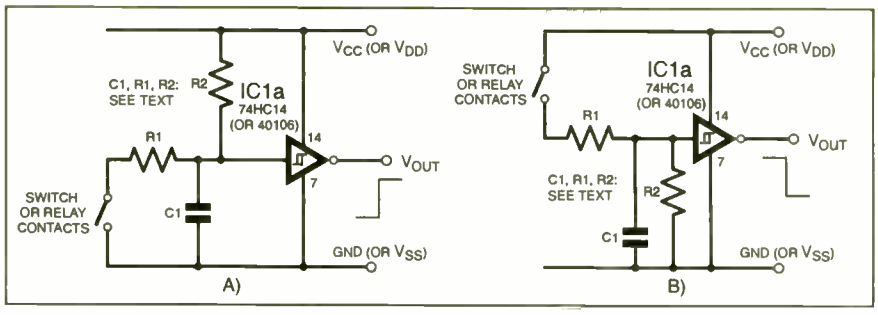


Fig.6.15. Two circuit arrangements for Schmitt-based debouncers.

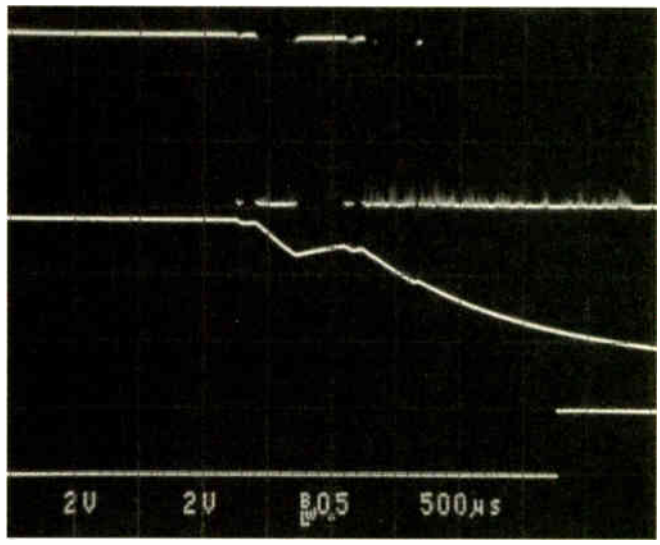


Fig.6.16. Waveforms for contact debouncer shown in Fig.6.15a. Top trace: Switch contact bounce (2V/div.). Middle trace: Filtered signal at Schmitt trigger input (2V/div.). Bottom trace: Schmitt trigger output, V_{OUT} (5V/div.). Timebase: 500µs/div.

WAVEFORMS

The oscillograph in Fig.6.16 shows the waveforms observed for the debouncer circuit of Fig.6.15a, using values of 100kΩ and 680kΩ for R1 and R2, and 10nF for C1. The top trace illustrates the contact bounce: in this example, the bounce period lasts for about 1·5ms, during which the contacts open and close more than twenty times.

The middle trace shows the filtered signal at the inverter's input. In this example, the C1/R1 time constant of 1ms is more than adequate to filter out the bounce pulses, but for more severe cases, C1 could be increased to around 100nF.

The bottom trace shows how V_{OUT} goes high about 2·5ms after the contacts first start to close. In most cases, this delay will be of no consequence, but in certain circuits (e.g.: where contacts are used in timing applications) it may be necessary to take it into account, particularly if a very large value has been chosen for C1 to eliminate excessive bounce.

SINGLE OR MULTIPLE PULSER

We conclude our look at the "digital" Schmitt trigger by combining some of the elementary circuits introduced in this article and the previous one to create a more complex function.

The circuit diagram Fig.6.17 shows an Auto-Repeating Pushbutton Pulser. A single press of the pushbutton switch, S1, generates a single, positive-going pulse of width T1 at the output. However, if switch S1 is held closed long enough, the circuit "auto-repeats", that is, it generates a continuous train of pulses of width T2 until the pushbutton is released.

Components C1, R1, R2 and IC1a form the debouncer: operation is exactly the same as the debouncer in Fig.6.15b, but with the Schmitt NAND replacing the inverter. Therefore, when switch S1 is closed, a high-to-low transition is produced at the output of IC1a. This low-going pulse is differentiated by C4 and R4, producing a negative-going "spike" at the input to IC1d. Since IC1d's other input is high at this point, the NAND function results in a positive-going pulse at V_{OUT}. The width of this pulse, T1, is determined by the C4/R4 time constant; this part of the circuit should be familiar as the "digital differentiator" shown in Fig.5.9 in last month's article.

While switch S1 is closed and IC1a's output is low, capacitor C3 charges via R3, and the voltage at their junction gradually falls. If S1 is opened, IC1a's output goes high and C3 is rapidly discharged via diode D1. However, if S1 remains pressed long enough, C3 will charge sufficiently for the voltage at IC1b's input to fall below its negative-going threshold voltage.

OPENING THE GATE

When this happens, the astable oscillator formed by IC1b, IC1c, C2 and R5 is "gated" on and starts to run (this part of the circuit is the same as the gated astable shown previously in Fig.6.5). The time taken for capacitor C3 to charge sufficiently to "enable" the oscillator constitutes the delay denoted T_D, and depends on the C3/R3 time constant.

During this time, capacitor C4 has become fully charged (the C4/R4 time constant is much smaller than the C3/R3 time constant),

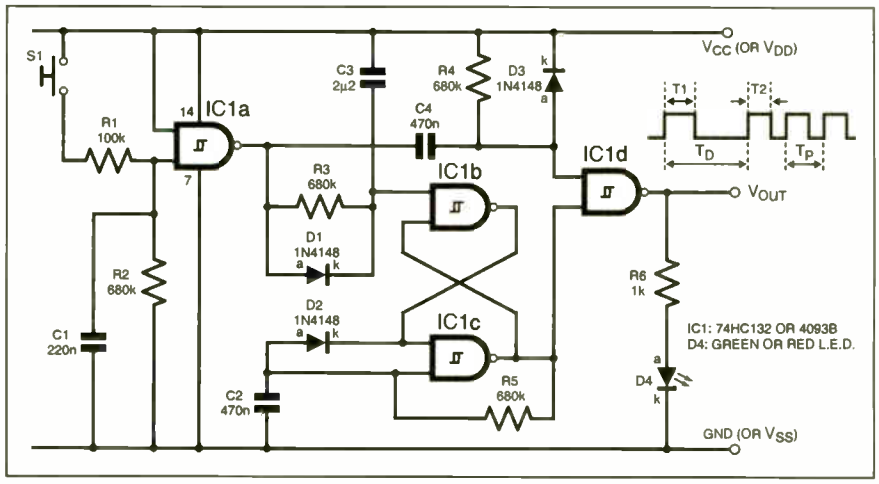


Fig.6.17. Circuit diagram for an auto-repeating pushbutton pulser.

World Radio History

and so the voltage at the junction of C4/R4 is high. This allows the astable pulses output by IC1c to propagate through IC1d, and appear inverted at V_{OUT}.

The width of the auto-repeating pulses, T2, and the period of oscillation, T_P, depend on the values selected for C2 and R5. Diode D2 is not essential, but without it the width of the first astable pulse (T2) will be slightly longer than the pulses that follow.

Notice that the pulser requires only one integrated circuit, either the 74HC132 or the 4093B. The circuit was tested using a 74HC132, with a supply voltage, V_{CC}, of 5·0V. Using the capacitor and resistor values shown in Fig.6.17, the width of the first pulse, T1, was 238ms. The delay, T_D, from the switch being closed to the first of the auto-repeating pulses was 1·85s. Pulse width T2 was measured as 120ms, and the pulses repeated at a rate of 4·7Hz (i.e., T_P = 212ms). Note that these are all typical values. and will vary with component tolerance and changes in Schmitt threshold voltages.

Normally, the pulses at V_{OUT} would be fed to a digital circuit like a counter or shift register. However, light emitting diode D4 can be used to provide visual indication of the pulses; series resistor R6 should be selected for optimum brightness. This kind of auto-repeating function is often found in products like electronic clocks, where a single press of the pushbutton increments or decrements a variable just once, and a continuous press rapidly increases or decreases the variable.

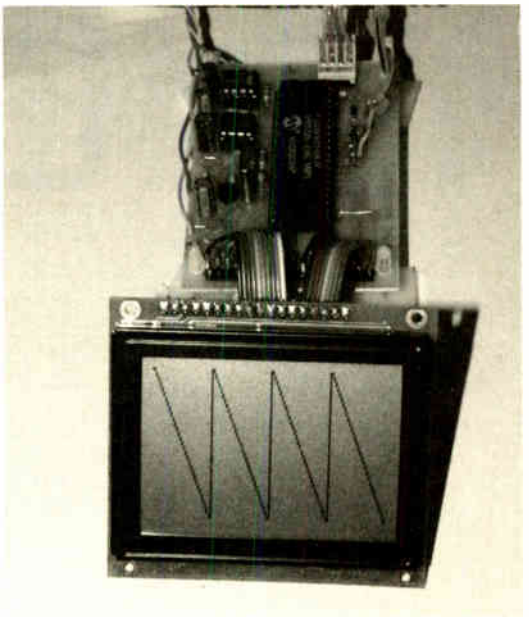
SPECIALITY SCHMITT DEVICES

Throughout this series, we've seen how the Schmitt trigger can be used not just as an interface circuit, but also as the central element in a variety of other functions. In view of its versatility, and the fact that hysteresis is indispensable in many applications, the Schmitt has been integrated into many "specialised" devices.

Next month, in the final part of this series, we'll see how the Schmitt trigger's unique characteristics are used in a wide range of devices, from optocouplers to voltage monitors.

SAVE UP TO 66p AN ISSUE!

EVERYDAY PRACTICAL ELECTRONICS
INCORPORATING ELECTRONICS TODAY INTERNATIONAL
THE No.1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS



NEXT MONTH WE PUT YOU IN THE PICTURE!

★ PIC GRAPHICS L.C.D. SCOPE

PLUS

★ CAMCORDER MIXER

★ D.C. MOTOR CONTROLLER

Annual subscription rates (2001):

6 MONTHS: UK £14.50, Overseas £17.50 (standard air service), £27 (express airmail)

1 YEAR: UK £27.50, Overseas £33.50 (standard air service) £51 (express airmail)

2 YEARS: UK £50.00, Overseas £62.00 (standard air service) £97 (express airmail)

To: Everyday Practical Electronics,
Allen House, East Borough, Wimborne, Dorset BH21 1PF
Tel: 01202 881749 Fax: 01202 841692
E-mail: subs@epemag.wimborne.co.uk
Order online: www.epemag.wimborne.co.uk

MAKE SURE OF YOUR COPY – ORDER A SUBSCRIPTION NOW

SUBSCRIPTION ORDER FORM

I enclose payment of £..... (cheque/PO in £ sterling only), payable to Everyday Practical Electronics

VISA

My card number is:

.....

Please print clearly, and check that you have the number correct

Signature.....

Card Ex. Date.....Switch Issue No. .....

Subscriptions can only start with the next available issue.
For back numbers see the *Back Issues* page.

Name .....

Address .....

.....

Post code .....Tel. 04/01

World Radio History

Everyday Practical Electronics Books

TEACH-IN No. 7
ANALOGUE AND DIGITAL ELECTRONICS COURSE
(published by *Everyday Practical Electronics*)
Alan Winstanley and Keith Dye B.Eng(Tech)AMIEE
This highly acclaimed *EPE Teach-In series, which included the construction and use of the Mini Lab* and *Micro Lab* test and development units, has been put together in book form.

An interesting and thorough tutorial series aimed specifically at the novice or complete beginner in electronics. The series is designed to support those undertaking either GCSE Electronics or GCE Advanced Levels, and starts with fundamental principles.

If you are taking electronics or technology at school or college, this book is for you. If you just want to learn the basics of electronics or technology you must make sure you see it. *Teach-In No. 7* will be invaluable if you are considering a career in electronics or even if you are already training in one. The Mini Lab and software enable the construction and testing of both demonstration and development circuits. These learning aids bring electronics to life in an enjoyable and interesting way: you will both see and hear the electron in action! The Micro Lab microprocessor add-on system will appeal to higher level students and those developing microprocessor projects.

152 pages **Order code TI7** **£4.95**

TEACH-IN 2000 plus FREE software **CD-ROM**
John Becker
The *Teach-In 2000* series is now available on CD-ROM, see advert elsewhere in this issue.

DIRECT BOOK SERVICE

NOTE: ALL PRICES INCLUDE UK POSTAGE

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

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

Robotics

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

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

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

ANDROIDS, ROBOTS AND ANIMATRONS
John Lovine
Build your own working robot or android using both off-the-shelf and workshop constructed materials and devices. Computer control gives these robots and androids two types of artificial intelligence (an expert system and a neural network). A lifelike android hand can be built and programmed to function doing repetitive tasks. A fully animated robot or android can also be built and programmed to perform a wide variety of functions.

The contents include an Overview of State-of-the-Art Robots; Robotic Locomotion; Motors and Power Controllers; All Types of Sensors; Tilt; Bump; Road and Wall Detection; Light; Speech and Sound Recognition; Robotic Intelligence (Expert Type) Using a Single-Board Computer Programmed in BASIC; Robotic Intelligence (Neutral Type) Using Simple Neural Networks (Insect Intelligence); Making a Lifelike Android Hand; A Computer-Controlled Robotic Insect Programmed in BASIC; Telepresence Robots With Actual Arcade and Virtual Reality Applications; A Computer-Controlled Robotic Arm; Animated Robots and Androids; Real-World Robotic Applications.

224 pages **Order code MGH1** **£22.99**

Radio

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

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

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

263 pages **Order code NE30** **£15.99**

PROJECTS FOR RADIO AMATEURS AND S.W.L.S.
R. A. Penfold
This book describes a number of electronic circuits, most of which are quite simple, which can be used to enhance the performance of most short wave radio systems.

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

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

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

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

150 pages **Order code BP257** **£5.49**

SIMPLE SHORT WAVE RECEIVER CONSTRUCTION
R. A. Penfold
Short wave radio is a fascinating hobby, but one that seems to be regarded by many as an expensive pastime these days. In fact it is possible to pursue this hobby for a minimal monetary outlay if you are prepared to undertake a bit of d.i.y., and the receivers described in this book can all be built at low cost. All the sets are easy to construct, full wiring diagrams etc. are provided, and they are suitable for complete beginners. The receivers only require simple aerials, and do not need any complex alignment or other difficult setting up procedures.

The topics covered in this book include: The broadcast bands and their characteristics; The amateur bands and their characteristics; The propagation of radio signals; Simple aerials; Making an earth connection; Short wave crystal set; Simple t.r.f. receivers; Single sideband reception; Direct conversion receiver.Contains everything you need to know in order to get started in this absorbing hobby.

88 pages **Order code BP275** **£4.45**

Computers and Computing

MULTIMEDIA ON THE PC
Ian R. Sinclair
In this book, you'll find out what a CD ROM is, how it works, and why it is such a perfect add-on for a PC, allowing you to buy programmes, text, graphics and sound on a CD. It also describes the installation of a CD ROM drive and a sound card, pointing out the common problems that arise, and then shows how to use them to create a complete multimedia presentation that contains text, photos, a soundtrack with your own voice recorded as a commentary, even animation and edited video footage.

184 pages **Order code PC112** **£12.95**

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

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

224 pages – large format **Order code MGH2** **£21.99**

UNDERSTANDING PC SPECIFICATIONS
R. A. Penfold (Revised Edition)
If you require a microcomputer for business applications, or a high quality home computer, an IBM PC or compatible is often the obvious choice. They are competitively priced, and are backed up by an enormous range of applications programs, hardware add-ons, etc. The main difficulty for the uninitiated is deciding on the specification that will best suit his or her needs. PCs range from simple systems of limited capabilities up to complex systems that can happily run applications that would have been considered beyond the abilities of a microcomputer not so long ago. It would be very easy to choose a PC system that is inadequate to run your applications efficiently, or one which goes beyond your needs and consequently represents poor value for money.

This book explains PC specifications in detail, and the subjects covered include the following: Differences between types of PC (XT, AT, 80386, etc); Maths co-processors; Input devices (keyboards, mice, and digitisers); Memory, including both expanded (EMS) and extended RAM; RAM disks and disk caches; Floppy disk drive formats and compatibility; Hard disk drives (including interleave factors and access times); Display adaptors, including all standard PC types (CGA, Hercules, Super VGA, etc); Contains everything you need to know if you can't tell your EMS from your EGA!

128 pages **Order code BP282** **£5.45**

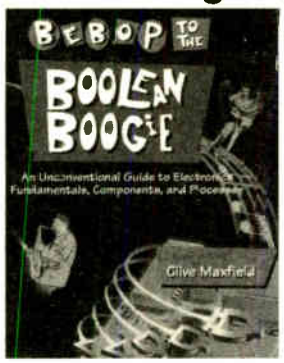
World Radio History

Theory and Reference

Bebop To The Boolean Boogie

By Clive (call me Max) Maxfield

Specially imported by *EPE* – *Excellent value*



An Unconventional Guide to Electronics Fundamentals, Components and Processes

This book gives the "big picture" of digital electronics. This indepth, highly readable, up-to-the-minute guide shows you how electronic devices work and how they're made. You'll discover how transistors operate, how printed circuit boards are fabricated, and what the innards of memory ICs look like. You'll also gain a working knowledge of Boolean Algebra and Karnaugh Maps, and understand what Reed-Muller logic is and how it's used. And there's much, MUCH more (including a recipe for a truly great seafood gumbo!). Hundreds of carefully drawn illustrations clearly show the important points of each topic. The author's tongue-in-cheek British humor makes it a delight to read, but this is a REAL technical book, extremely detailed and accurate. A great reference for your own shelf, and also an ideal gift for a friend or family member who wants to understand what it is you do all day. . . .

470 pages – large format **Order code BEB1** **£26.95**

DIGITAL ELECTRONICS – A PRACTICAL APPROACH
With FREE Software: Number One Systems – EASY-PC Professional XM and Pulsar (Limited Functionality)
Richard Monk

FREE SOFTWARE

Covers binary arithmetic, Boolean algebra and logic gates, combination logic, sequential logic including the design and construction of asynchronous and synchronous circuits and register circuits. Together with a considerable practical content plus the additional attraction of its close association with computer aided design including the FREE software.

There is a 'blow-by-blow' guide to the use of EASY-PC Professional XM (a schematic drawing and printed circuit board design computer package). The guide also conducts the reader through logic circuit simulation using Pulsar software. Chapters on p.c.b. physics and p.c.b. production techniques make the book unique, and with its host of project ideas make it an ideal companion for the integrative assignment and common skills components required by BTEC and the key skills demanded by GNVQ. The principal aim of the book is to provide a straightforward approach to the understanding of digital electronics.

Those who prefer the 'Teach-In' approach or would rather experiment with some simple circuits should find the book's final chapters on printed circuit board production and project ideas especially useful.

250 pages **Order code NE28** **£17.99**

Bebop Bytes Back

FREE CD-ROM

By Clive "Max" Maxfield and Alvin Brown

Specially imported by *EPE* – *Excellent value*

An Unconventional Guide To Computers

Plus **FREE CD-ROM** which includes:
Fully Functional Internet-Ready Virtual Computer with Interactive Labs

This follow-on to *Bebop to the Boolean Boogie* is a multimedia extravaganza of information about how computers work. It picks up where "Bebop I" left off, guiding you through the fascinating world of computer design. . . and you'll have a few chuckles, if not belly laughs, along the way. In addition to over 200 megabytes of mega-cool multimedia, the accompanying CD-ROM (for Windows 95 machines only) contains a virtual microcomputer, simulating the motherboard and standard computer peripherals in an extremely realistic manner. In addition to a wealth of technical information, myriad nuggets of trivia, and hundreds of carefully drawn illustrations, the book contains a set of lab experiments for the virtual microcomputer that let you recreate the experiences of early computer pioneers.

Over 500 pages – large format **Order code BEB2** **£31.95**

DIGITAL GATES AND FLIP-FLOPS
Ian R. Sinclair

This book, intended for enthusiasts, students and technicians, seeks to establish a firm foundation in digital electronics by treating the topics of gates and flip-flops thoroughly and from the beginning.

Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.

No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.

200 pages **Order code PC106** **£9.95**

Music, Audio and Video

AN INTRODUCTION TO LOUDSPEAKERS AND ENCLOSURE DESIGN
V. Capel

This book explores the various features, good points and snags of speaker designs. It examines the whys and wherefores so that the reader can understand the principles involved and so make an informed choice of design, or even design loudspeaker enclosures for him – or herself. Crossover units are also explained, the various types, how they work, the distortions they produce and how to avoid them. Finally there is a step-by-step description of the construction of the *Kapellmeister* loudspeaker enclosure.

148 pages **Temporarily out of print**

ELECTRONIC MUSIC AND MIDI PROJECTS
R. A. Penfold

Whether you wish to save money, boldly go where no musician has gone before, rekindle the pioneering spirit, or simply have fun building some electronic music gadgets, the designs featured in this book should suit your needs. The projects are all easy to build, and some are so simple that even complete beginners at electronic project construction can tackle them with ease. Stripboard layouts are provided for every project, together with a wiring diagram. The mechanical side of construction has largely been left to individual constructors to sort out, simply because the vast majority of project builders prefer to do their own thing in this respect.

None of the designs requires the use of any test equipment in order to get them set up properly. Where any setting up is required, the procedures are very straightforward, and they are described in detail.

Projects covered: Simple MIDI tester, Message grabber, Byte grabber, THRU box, MIDI auto switcher, Auto/manual switcher, Manual switcher, MIDI patchbay, MIDI controlled switcher, MIDI lead tester, Program change pedal, Improved program change pedal, Basic mixer Stereo mixer, Electronic swell pedal, Metronome, Analogue echo unit.

138 pages **Order code PC116** **£10.95**

VIDEO PROJECTS FOR THE ELECTRONICS CONSTRUCTOR
R. A. Penfold

Written by highly respected author R. A. Penfold, this book contains a collection of electronic projects specially designed for video enthusiasts. All the projects can be simply constructed, and most are suitable for the newcomer to project construction, as they are assembled on stripboard.

There are faders, wipers and effects units which will add sparkle and originality to your video recordings, an audio mixer and noise reducer to enhance your soundtracks and a basic computer control interface. Also, there's a useful selection on basic video production techniques to get you started.

Complete with explanations of how the circuit works, shopping lists of components, advice on construction, and guidance on setting up and using the projects, this invaluable book will save you a small fortune.

Circuits include: video enhancer, improved video enhancer, video fader, horizontal wiper, improved video wiper, negative video unit, fade to grey unit, black and white keyer, vertical wiper, audio mixer, stereo headphone amplifier, dynamic noise reducer, automatic fader, pushbutton fader, computer control interface, 12 volt mains power supply.

124 pages **Order code PC115** **£10.95**

COMPUTERS AND MUSIC – AN INTRODUCTION
R. A. Penfold

Computers are playing an increasingly important part in the world of music, and the days when computerised music was strictly for the fanatical few are long gone.

If you are more used to the black and white keys of a synth keyboard than the QWERTY keyboard of a computer, you may be understandably confused by the jargon and terminology bandied about by computer buffs. But fear not, setting up and using a computer-based music making system is not as difficult as you might think.

This book will help you learn the basics of computing, running applications programs, wiring up a MIDI system and using the system to good effect, in fact just about everything you need to know about hardware and the programs, with no previous knowledge of computing needed or assumed. This book will help you to choose the right components for a system to suit your personal needs, and equip you to exploit that system fully

174 pages **Temporarily out of print**

THE INVENTOR OF STEREO – THE LIFE AND WORKS OF ALAN DOWER BLUMLEIN
Robert Charles Alexander

This book is the definitive study of the life and works of one of Britain's most important inventors who, due to a cruel set of circumstances, has all but been overlooked by history.

Alan Dower Blumlein led an extraordinary life in which his inventive output rate easily surpassed that of Edison, but whose early death during the darkest days of World War Two led to a shroud of secrecy which has covered his life and achievements ever since.

His 1931 Patent for a Binaural Recording System was so revolutionary that most of his contemporaries regarded it as more than 20 years ahead of its time. Even years after his death, the full magnitude of its detail had not been fully utilized. Among his 128 patents are the principal electronic circuits critical to the development of the world's first electronic television system. During his short working life, Blumlein produced patent after patent breaking entirely new ground in electronic and audio engineering.

During the Second World War, Alan Blumlein was deeply engaged in the very secret work of radar development and contributed enormously to the system eventually to become 'H2S' – blind-bombing radar. Tragically, during an experimental H2S flight in June 1942, the Halifax bomber in which Blumlein and several colleagues were flying, crashed and all aboard were killed. He was just days short of his thirty-ninth birthday.

420 pages **Order code NE32** **£15.99**

HIGH POWER AUDIO AMPLIFIER CONSTRUCTION
R. A. Penfold

Practical construction details of how to build a number of audio power amplifiers ranging from about 50 to 300/400 watts r.m.s. includes MOSFET and bipolar transistor designs.

96 pages **Order code BP277** **£4.49**

World Radio History

Circuits, Data and Design

PRACTICAL ELECTRONIC FILTERS
Owen Bishop
This book deals with the subject in a non-mathematical way. It reviews the main types of filter, explaining in simple terms how each type works and how it is used.

The book also presents a dozen filter-based projects with applications in and around the home or in the constructor's workshop. These include a number of audio projects such as a rythm sequencer and a multi-voiced electronic organ.

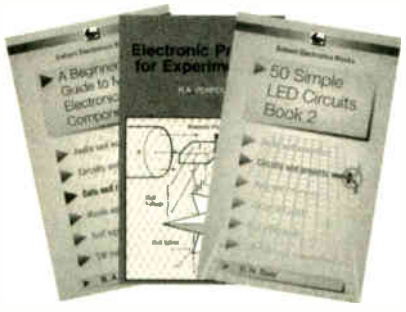
Concluding the book is a practical step-by-step guide to designing simple filters for a wide range of purposes, with circuit diagrams and worked examples.

88 pages **Order code BP299** **£5.49**

ELECTRONIC HOBBYISTS DATA BOOK
R. A. Penfold
This book should tell you everything you are ever likely to want to know about hobby electronics, but did not know where to ask or refer. Comprehensive contents pages makes it easy to quickly locate the data you require.

The subjects covered include: Common circuits, and related data (including helpful graphs and tables of values); Colour codes for resistors, capacitors and inductors; Pinout details for a wide range of CMOS and TTL devices, plus basic data on the various logic families; Pinout details and basic data for a wide range of operational amplifiers; Data and leadout information for a wide range of transistors, FETs, power FETs, triacs, thyristors, diodes, etc; General data including MIDI message coding, radio data, ASCII/Baudot coding, decibel ratios, etc.

242 pages **Order code BP396** **£6.45**



50 SIMPLE LED CIRCUITS
R. N. Soar
Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components – the light-emitting diode (LED). Also includes circuits for the 707 common anode display.

64 pages **Temporarily out of print**

BOOK 2 50 more l.e.d. circuits.

50 pages **Order code BP87** **£3.49**

CIRCUIT SOURCE BOOK 1
A. Penfold
Written to help you create and experiment with your own electronic designs by combining and using the various standard "building block" circuits provided. Where applicable, advice on how to alter the circuit parameters is given.

The circuits covered in this book are mainly concerned with analogue signal processing and include: Audio amplifiers (op.amp and bipolar transistors); audio power amplifiers; d.c. amplifiers; highpass, lowpass, bandpass and notch filters; tone controls; voltage controlled amplifiers and filters; triggers and voltage comparators; gates and electronic switching; bargraphs; mixers; phase shifters, current mirrors, hold circuits, etc.

Over 150 circuits are provided, which it is hoped will be useful to all those involved in circuit design and application, be they professionals, students or hobbyists.

182 pages **Order code BP321** **£5.49**

A BEGINNER'S GUIDE TO TTL DIGITAL ICs
R. A. Penfold
This book first covers the basics of simple logic circuits in general, and then progresses to specific TTL logic integrated circuits. The devices covered include gates, oscillators, timers, flip/flops, dividers, and decoder circuits. Some practical circuits are used to illustrate the use of TTL devices in the "real world".

142 pages **Order code BP332** **£5.45**

HOW TO USE OP.AMPS
E. A. Parr
This book has been written as a designer's guide covering many operational amplifiers, serving both as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.

160 pages **Order code BP88** **£4.49**

CIRCUIT SOURCE BOOK 2
R. A. Penfold
This book will help you to create and experiment with your own electronic designs by combining and using the various standard "building blocks" circuits provided. Where applicable, advice on how to alter the circuit parameters is provided.

The circuits covered are mainly concerned with signal generation, power supplies, and digital electronics.

The topics covered in this book include: 555 oscillators; sinewave oscillators; function generators; CMOS oscillators; voltage controlled oscillators; radio frequency oscillators; 555 monostables; CMOS monostables; TTL monostables; precision long timers; power supply and regulator circuits; negative supply generators and voltage boosters; digital dividers; decoders, etc; counters and display drivers; D/A and A/D converters; opto-isolators, flip/flops, noise generators, tone decoders, etc.

Over 170 circuits are provided, which it is hoped will be useful to all those involved in circuit design and application, be they professionals, students or hobbyists.

192 pages **Order code BP322** **£5.45**

Project Building & Testing

ELECTRONIC PROJECTS FOR EXPERIMENTERS
R. A. Penfold
Many electronic hobbyists who have been pursuing their hobby for a number of years seem to suffer from the dreaded "seen it all before" syndrome. This book is fairly and squarely aimed at sufferers of this complaint, plus any other electronics enthusiasts who yearn to try something a bit different. No doubt many of the projects featured here have practical applications, but they are all worth a try for their interest value alone.

The subjects covered include:- Magnetic field detector, Basic Hall effect compass, Hall effect audio isolator, Voice scrambler/descrambler, Bat detector, Bat style echo location, Noise cancelling, LED stroboscope, Infra-red "torch", Electronic breeze detector, Class D power amplifier, Strain gauge amplifier, Super hearing aid.

138 pages **Order code BP371** **£5.45**

PRACTICAL FIBRE-OPTIC PROJECTS
R. A. Penfold
While fibre-optic cables may have potential advantages over ordinary electric cables, for the electronics enthusiast it is probably their novelty value that makes them worthy of exploration. Fibre-optic cables provide an innovative interesting alternative to electric cables, but in most cases they also represent a practical approach to the problem. This book provides a number of tried and tested circuits for projects that utilize fibre-optic cables.

The projects include:- Simple audio links, F.M. audio link, P.W.M. audio links, Simple d.c. links, P.W.M. d.c. link, P.W.M. motor speed control, RS232C data links, MIDI link, Loop alarms, R.P.M. meter.

All the components used in these designs are readily available, none of them require the constructor to take out a second mortgage.

132 pages **Order code BP374** **£5.45**

ELECTRONIC PROJECT BUILDING FOR BEGINNERS
R. A. Penfold
This book is for complete beginners to electronic project building. It provides a complete introduction to the practical side of this fascinating hobby, including the following topics:

Component identification, and buying the right parts; resistor colour codes, capacitor value markings, etc; advice on buying the right tools for the job; soldering; making easy work of the hard wiring; construction methods, including stripboard, custom printed circuit boards, plain matrix boards, surface mount boards and wire-wrapping; finishing off, and adding panel labels; getting "problem" projects to work, including simple methods of fault-finding.

In fact everything you need to know in order to get started in this absorbing and creative hobby.

135 pages **Order code BP392** **£5.49**

A BEGINNER'S GUIDE TO MODERN ELECTRONIC COMPONENTS
R. A. Penfold
The purpose of this book is to provide practical information to help the reader sort out the bewildering array of components currently on offer. An advanced knowledge of the theory of electronics is not needed, and this book is not intended to be a course in electronic theory. The main aim is to explain the differences between components of the same basic type (e.g. carbon, carbon film, metal film, and wire-wound resistors) so that the right component for a given application can be selected. A wide range of components are included, with the emphasis firmly on those components that are used a great deal in projects for the home constructor.

166 pages **Order code BP285** **£5.49**

HOW TO USE OSCILLOSCOPES AND OTHER TEST EQUIPMENT
R. A. Penfold
This book explains the basic function of an oscilloscope, gives a detailed explanation of all the standard controls, and provides advice on buying. A separate chapter deals with using an oscilloscope for fault finding on linear and logic circuits, plenty of example waveforms help to illustrate the control functions and the effects of various fault conditions. The function and use of various other pieces of test equipment are also covered, including signal generators, logic probes, logic pulsers, and crystal calibrators.

104 pages **Order code BP267** **£4.00**

BOOK ORDERING DETAILS

All prices include UK postage. For postage to Europe (air) and the rest of the world (surface) please add £1 per book. For the rest of the world airmail add £2 per book. Send a PO, cheque, international money order (£ sterling only) made payable to **Direct Book Service** or card details, Visa, Mastercard or Switch – minimum card order is £5 – to: **DIRECT BOOK SERVICE, ALLEN HOUSE, EAST BOROUGH, WIMBORNE, DORSET BH21 1PF.**

Books are normally sent within seven days of receipt of order, but please allow 28 days for delivery – more for overseas orders. *Please check price and availability (see latest issue of* Everyday Practical Electronics*) before ordering from old lists.*

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

DIRECT BOOK SERVICE IS A DIVISION OF WIMBORNE PUBLISHING LTD.

Tel 01202 881749 Fax 01202 841692. E-mail: dbs@epemag.wimborne.co.uk

Order from our online shop at: www.epemag.wimborne.co.uk/shopdoor.htm

BOOK ORDER FORM

Full name: .....

Address: .....

.....

.....

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

Signature: .....

☐ I enclose cheque/PO payable to DIRECT BOOK SERVICE for £ .....

☐ Please charge my Visa/Mastercard/Switch £ ..... Card expiry date.....

Card Number ..... Switch Issue No.....

Please send book order codes: .....

.....

Please continue on separate sheet of paper if necessary

World Radio History

PCB SERVICE

Printed circuit boards for most recent *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; E-mail: orders@epemag.wimborne.co.uk. On-line Shop: www.epemag.wimborne.co.uk/shopdoor.htm.** 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
★PIC16x84 Toolkit		196	£6.96
★Greenhouse Computer Control Board		197	£9.08
Float Charger	AUG '98	199	£6.59
Lightbulb Saver		202	£3.00
Personal Stereo Amplifier (Multi-project PCB)	SEPT '98	932	£3.00
★Greenhouse Radio Link		200	£8.32
★PIC Altimeter		201	£8.15
Voice Processor	OCT '98	203	£7.18
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 A – PCB B – CD-ROM C – Prog. Microcontroller		Bee (A)(B)(C)	£14.95 each
15-Way IR Remote Control Switch Matrix		211	£3.00
15-Way Rec/Decoder		212	£4.00
Damp Stat	DEC '98	209	£4.50
Handheld Function Generator		213	£4.00
★Fading Christmas Lights		215	£5.16
PhizzyB I/O Board (4-section)		216	£3.95
Twinkle Twinkle Reaction Game	JAN '99	210	£7.55
★EPE Mind PICkler		214	£6.30
PhizzyB I/O Board (4-section)		216	£3.95
Alternative Courtesy Light Controller		217	£6.72
Light Alarm	FEB '99	218	£6.78
★Wireless Monitoring System Transmitter		219+a	£9.92
Receiver		220+a	£8.56
★PIC MIDI Sustain Pedal **Software only**		–	–
★Wireless Monitoring System-2	MAR '99		See Feb '99
F.M. Trans/Rec Adaptors		219a/220a	£7.37
★Time and Date Generator		221	£6.36
Auto Cupboard Light		222	£5.94
Smoke Absorber		223	£5.15
Ironing Board Saver	APR '99	224	£5.12
Voice Record/Playback Module		225	£7.40
Mechanical Radio (pair)		226A&B	£6.82
★Versatile Event Counter		207	£8.95
PIC Toolkit Mk2	MAY '99	227	£3.00
A.M./F.M. Radio Remote Control Transmitter		228	£3.20
Receiver		229	£9.51
★Musical Sundial	JUNE '99	231	£8.79
PC Audio Frequency Meter		232	£6.78
★EPE Mood PICker	JULY '99	233	£6.72
12V Battery Tester		234	£7.10
Intruder Deterrent		235	£3.00
L.E.D. Stroboscope (Multi-project PCB)		932	£5.00
Ultrasonic Puncture Finder	AUG '99	236	£8.88
★8-Channel Analogue Data Logger		237	£6.96
Buffer Amplifier (Oscillators Pt 2)		238	£6.77
Magnetic Field Detective		239	£6.53
Sound Activated Switch		240	£3.00
Freezer Alarm (Multi-project PCB)		932	£7.51
Child Guard	SEPT '99	241	£7.64
Variable Dual Power Supply		242	£3.50
Micro Power Supply	OCT '99	243	£7.88
★Interior Lamp Delay		244	£3.00
Mains Cable Locator (Multi-project PCB)		932	£6.93
Vibralarm	NOV '99	230	£6.78
Demister One-Shot		245	£7.82
★Ginormous Stopwatch – Part 1		246	
★Ginormous Stopwatch – Part 2	DEC '99		£7.85
Giant Display		247	£3.96
Serial Port Converter		248	£4.44
Loft Guard		249	£4.83
Scratch Blanker	JAN '00	250	£3.00
Flashing Snowman (Multi-project PCB)		932	£5.63
★Video Cleaner	FEB '00	251	£4.20
Find It		252	£4.52
★Teach-In 2000 – Part 4		253	£5.49
High Performance Regenerative Receiver	MAR '00	254, 255 256	Set
★*EPE* Icebreaker – PCB257, programmed PIC16F877 and floppy disc		Set only	£22.99
Parking Warning System		258	£5.08

PROJECT TITLE		Order Code	Cost
★Micro-PICscope	APR '00	259	£4.99
Garage Link – Transmitter		261	Set £5.87
Receiver		262	
Versatile Mic/Audio Preamplifier	MAY '00	260	£3.33
PIR Light Checker		263	£3.17
★Multi-Channel Transmission System – Transmitter		264	
Receiver		265	Set £6.34
Interface		266	
★Canute Tide Predictor	JUNE '00	267	£3.05
★PIC-Gen Frequency Generator/Counter	JULY '00	268	£5.07
g-Meter		269	£4.36
★EPE Moodloop	AUG '00	271	£5.47
Quiz Game Indicator		272	£4.52
Handy-Amp		273	£4.52
Active Ferrite Loop Aerial	SEPT '00	274	£4.67
★Remote Control IR Decoder **Software only**		–	–
★PIC Dual-Channel Virtual Scope	OCT '00	275	£5.15
Handclap Switch	NOV '00	270	£3.96
★PIC Pulsometer **Software only**		–	–
Twinkling Star	DEC '00	276	£4.28
Festive Fader		277	£5.71
Motorists' Buzz-Box		278	£5.39
★PICtogram		279	£4.91
★PIC-Monitored Dual PSU–1 PSU		280	£4.75
Monitor Unit		281	£5.23
Static Field Detector (Multi-project PCB)		932	£3.00
Two-Way Intercom	JAN '01	282	£4.76
UFO Detector and Event Recorder Magnetic Anomaly Detector		283	
Event Recorder		284	Set £6.19
Audio Alarm		285	
★Using PICs and Keypads **Software only**		–	–
Ice Alarm	FEB '01	287	£4.60
★Graphics L.C.D. Display with PICs (Supp)		288	£5.23
Using the LM3914-6 L.E.D. Bargraph Drivers Multi-purpose Main p.c.b.		289	
Relay Control		290	Set £7.14
L.E.D. Display		291	
★PC Audio Power Meter **Software only**		–	–
Doorbell Extender: Transmitter	MAR '01	292	£4.20
Receiver		293	£4.60
Trans/Remote		294	£4.28
Rec./Relay		295	£4.92
EPE Snug-bug Heat Control for Pets	APR '01	296	£6.50
Intruder Alarm Control Panel Main Board		297	£6.97
External Bell Unit		298	£4.76

EPE SOFTWARE

Software programs for *EPE* projects marked with an asterisk ★ are available on 3.5 inch PC-compatible disks or *free* from our Internet site. The following disks are available: **PIC Tutorial** (Mar-May '98 issues); **PIC Toolkit Mk2** (May-Jun '99 issues); ***EPE* Disk 1** (Apr '95-Dec '98 issues); ***EPE* Disk 2** (Jan-Dec '99); ***EPE* Disk 3** (Jan-Dec '00). ***EPE* Disk 4** (Jan '01 issue to current cover date); ***EPE* Teach-In 2000; *EPE* Interface Disk 1** (October '00 issue to current cover date). The disks are obtainable from the *EPE PCB Service* at £3.00 each (UK) to cover our admin costs (the software itself is *free*). Overseas (each): £3.50 surface mail, £4.95 each airmail. All files can be downloaded *free* from our Internet FTP site: **ftp://ftp.epemag.wimborne.co.uk.**

EPE PRINTED CIRCUIT BOARD SERVICE

Order Code Project Quantity Price

.....

Name .....

Address .....

.....

I enclose payment of £..... (cheque/PO in **£ sterling only**) to:

VISA

MasterCard

Everyday Practical Electronics

MasterCard, Visa or Switch No.

Switch

Minimum order for cards £5 Switch Issue No. ....

Card No. .....

Signature..... Card Exp. Date.....

NOTE: You can also order p.c.b.s by phone, Fax, E-mail or via our Internet site on a secure server:
http://www.epemag.wimborne.co.uk

World Radio History

EVERYDAY PRACTICAL ELECTRONICS
INCORPORATING ELECTRONICS TODAY INTERNATIONAL

CLASSIFIED

Everyday Practical Electronics reaches twice as many UK readers as any other UK monthly hobby electronics magazine, our audited sales figures prove it. We have been the leading monthly magazine in this market for the last sixteen years.

If you want your advertisements to be seen by the largest readership at the most economical price our classified and semi-display pages offer the best value. The prepaid rate for semi-display space is £8 (+VAT) per single column centimetre (minimum 2·5cm). The prepaid rate for classified adverts is 30p (+VAT) per word (minimum 12 words).

All cheques, postal orders, etc., to be made payable to Everyday Practical Electronics. **VAT must be added.** Advertisements, together with remittance, should be sent to Everyday Practical Electronics Advertisements, Mill Lodge, Mill Lane, Thorpe-le-Soken, Essex CO16 0ED. Phone/Fax (01255) 861161.

For rates and information on display and classified advertising please contact our Advertisement Manager, Peter Mew as above.

Valve Output Transformers: Single ended 50mA, £4.50; push/pull 15W, £27; 30W, £32; 50W, £38; 100W, £53. Mains Transformers: Sec 220V 30mA 6V 1A, £3; 250V 60mA 6V 2A, £5; 250V 80mA 6V 2A, £6. High Voltage Caps: 50μF 350V, 68μF 500V, 150μF 385V, 330μF 400V, 470μF 385V, all £3 ea., 32+32μF 450V £5. Postage extra.
Record Decks and Spares: BSR, Garrard, Goldring, motors, arms, wheels, headshells, spindles, etc. Send or phone your want list for quote.

RADIO COMPONENT SPECIALISTS
337 WHITEHORSE ROAD, CROYDON SURREY, CR0 2HS. Tel: (020) 8684 1665
Lots of transformers, high volt caps, valves, output transformers, speakers. In stock. Phone or send your wants list for quote.

Z88 NOW AVAILABLE WITH 128K AND 512K – OZ4
ALSO SPECTRUM AND QL PARTS
W. N. RICHARDSON & CO.
PHONE/FAX 01494 871319
E-mail: wnr@compuserve.com
RAVENSMEAD, CHALFONT ST PETER, BUCKS, SL9 0NB

TIS – Midlinbank Farm
Ryeland, Strathaven ML10 6RD
Manuals on anything electronic
Circuits – VCR £8, CTV £6
Service Manuals from £10
Repair Manuals from £5
P&P any order £2.50
Write, or ring 01357 440280 for full details of our lending service and FREE quote for any data

BTEC ELECTRONICS TECHNICIAN TRAINING
GNVQ ADVANCED ENGINEERING (ELECTRONIC) – PART-TIME
HND ELECTRONICS – FULL-TIME
B.Eng FOUNDATION – FULL-TIME
Please telephone for commencement date of next course
FULL PROSPECTUS FROM
LONDON ELECTRONICS COLLEGE (Dept EPE) 20 PENYWERN ROAD EARLS COURT, LONDON SW5 9SU
TEL: (020) 7373 8721

THE BRITISH AMATEUR ELECTRONICS CLUB
exists to help electronics enthusiasts by personal contact and through a quarterly Newsletter.
For membership details, write to the Secretary:
Mr. M. P. Moses,
5 Park View, Cwmaman,
Aberdare CF44 6PP
Space donated by
Everyday Practical Electronics

Miscellaneous

X-10® Home Automation
We put *you* in control™
Why tolerate when you can automate?
An extensive range of 230V X-10 products and starter kits available. Uses proven Power Line Carrier technology, no wires required.
Products Catalogue available Online.
Worldwide delivery.
Laser Business Systems Ltd.
E-Mail: info@laser.com
http://www.laser.com
Tel: (020) 8441 9788
Fax: (020) 8449 0430
VISA DELTA

PROTOTYPE PRINTED CIRCUIT BOARDS one offs and quantities, for details send s.a.e. to B. M. Ansbro, 38 Poynings Drive, Hove, Sussex BN3 8GR, or phone 01273 883871, Mobile 07949 598309. E-mail b.m.a@cwctv.net.

SURPLUS ELECTRONIC COMPONENTS FOR SALE – Visit our website at www.cns farnell.co.uk/surplus_component.htm for a full list. Pick what you want or take the lot! All offers considered.

PRINTED CIRCUIT BOARDS – QUICK SERVICE. Prototype and production artwork raised from magazines or draft designs at low cost. PCBs designed from schematics. Production assembly, wiring and software programming. For details contact Patrick at Agar Circuits, Unit 5, East Belfast Enterprise Park, 308 Albertbridge Road, Belfast, BT5 4GX. Phone 028 9073 8897, Fax 028 9073 1802, E-mail agar@argonet.co.uk.

FREE PROTOTYPE PRINTED CIRCUIT BOARDS! Free prototype p.c.b. with quantity orders. Call Patrick on 028 9073 8897 for details. Agar Circuits, Unit 5, East Belfast Enterprise Park, 308 Albertbridge Road, Belfast BT5 4GX.

VALVE ENTHUSIASTS: Capacitors and other parts in stock. For free advice/lists please ring, Geoff Davies (Radio), Tel. 01788 574774.

MIXED SEMICONDUCTORS (inc. l.e.d.s, transistors, CMOS), £1.65; 7812 regulator, 3 – 60p; CMOS 4066, 30p; 4017, 2 – 50p; postage 95p. TM Industries, 15 Wimberley Way, South Witham, NG33 5PU.

COMPUTER CLEARANCE PARCELS, can include CPUs, hard drives, modems, boards, etc., £25 or £40, postage £4. TM Industries, 15 Wimberley Way, South Witham, NG33 5PU.

G.C.S.E. ELECTRONIC KITS, at pocket money prices. S.A.E. for FREE catalogue. SIR-KIT Electronics, 52 Severn Road, Clacton, CO15 3RB.

EPE NET ADDRESSES

EPE FTP site: **ftp://ftp.epemag.wimborne.co.uk**

Access the FTP site by typing the above into your web browser, or by setting up an FTP session using appropriate FTP software, then go into quoted sub-directories:

PIC-project source code files: **/pub/PICS**

PIC projects each have their own folder; navigate to the correct folder and open it, then fetch all the files contained within. *Do not try to download the folder itself!*

EPE text files: **/pub/docs**

Basic Soldering Guide: **solder.txt**

Ingenuity Unlimited submission guidance: **ing_unlt.txt**

New readers and subscribers info: **epe_info.txt**

Newsgroups or Usenet users advice: **usenet.txt**

Ni-Cad discussion: **nicadfaq.zip** and **nicad2.zip**

Writing for *EPE* advice: **write4us.txt**

Shop now on-line: **www.epemag.wimborne.co.uk/shopdoor.htm**

On-line readers! Try the EPE *Chat Zone* – a virtually real-time Internet "discussion board" in a simple to use web-based forum!
http://www.epemag.wimborne.co.uk/wwwboard
Or buy *EPE Online*: www.epemag.com

Ensure you set your FTP software to ASCII transfer when fetching text files, or they may be unreadable.

Note that any file which ends in **.zip** needs unzipping before use. Unzip utilities can be downloaded from:
http://www.winzip.com or
http://www.pkware.com

World Radio History

TRAIN TODAY FOR A BETTER FUTURE

Now you can get the skills and qualifications you need for career success with an ICS Home Study Course. Learn in the comfort of your own home at the pace and times that suit you. ICS is the world's largest, most experienced home study school. Over the past 100 years ICS have helped nearly 10 million people to improve their job prospects. Find out how we can help YOU. Post or phone today for FREE INFORMATION on the course of your choice.

- Electrical Contracting & Installation
- Electrical Engineering
- C&G/ICS Basic Electronic Engineering
- C&G/ICS Basic Mechanical Engineering
- TV and Video Servicing
- Radio and Hi-Fi Servicing
- Refrigeration Heating & Air Conditioning
- Motorcycle Maintenance

FREEPHONE 0500 581 557

Or write to: International Correspondence Schools, FREEPOST 882, 8 Elliot Place, Clydeway Skypark, Glasgow, G3 8BR. Tel: 0500 581 557 or Tel/Fax: Dublin 285 2533

Please send me my Free Information on your Electronics Courses.

Mr/Mrs/Ms/Miss (BLOCK CAPITALS PLEASE) Date of Birth / /

Address

Postcode

Occupation Tel. No.

From time to time, we permit other carefully screened organisations to write to you about products and services. If you would prefer not to hear from such organisations please tick box ☐ Dept. ZEEVC1C1

We stock thousands of products - send now for our FREE catalogue. Telephone, fax, email or write today!

Specialist Mail Order Supplier Of Electronic Components

Power Supplies • Surplus Bargains
Electronic Components & Equipment
Tools • Valve Radio Kits • Etc

Delivered direct from our new warehouse and distribution facility in Brentwood, Essex

48 pages filled with useful tools, electronic kits, books, hardware, batteries, etc, etc

Visit our website: www.greenweld.co.uk

GREENWELD

Greenweld Limited
Unit 24 Horndon Industrial Park
West Horndon Brentwood
Essex CM13 3XD
Tel: 01277 811042 · Fax: 01277 812419
Email: service@greenweld.co.uk
Office Hours: Monday - Friday 08.00 to 17.00

LOW PRICES!

www.epemag.com

Get your magazine "instantly" anywhere in the world – buy from the web.

TAKE A LOOK, A FREE ISSSUE IS AVAILABLE

A one year subscription (12 issues) costs just $9.99 (US)

Watch Slides on TV.

Make videos of your slides. Digitise your slides (using a video capture card)
"Liesgang diatv" automatic slide viewer with built in high quality colour TV camera. It has a composite video output to a phono plug (SCART & BNC adaptors are available). They are in very good condition with few signs of use. More details see **www.diatv.co.uk**.
£91.91 + VAT = **£108.00**

Board cameras all with 512 x 582 pixels 8·5mm 1/3 inch sensor and composite video out. All need to be housed in your own enclosure and have fragile exposed surface mount parts. They all require a power supply of between 10V and 12V DC 150mA.
47MIR size 60 x 36 x 27mm with 6 infra red LEDs (gives the same illumination as a small torch but is not visible to the human eye) £37.00 + VAT = **£43.48**
30MP size 32 x 32 x 14mm spy camera with a fixed focus pin hole lens for hiding behind a very small hole £35.00 + VAT = **£41.13**
40MC size 39 x 38 x 27mm camera for 'C' mount lens these give a much sharper image than with the smaller lenses £32.00 + VAT = **£37.60**
Economy C mount lenses all fixed focus & fixed iris
VSL1220F 12mm F1.6 12 x 15 degrees viewing angle £15.97 + VAT **£18.76**
VSL4022F 4mm F1·22 63 x 47 degrees viewing angle £17.65 + VAT **£20.74**
VSL6022F 6mm F1·22 42 x 32 degrees viewing angle £19.05 + VAT **£22.38**
VSL8020F 8mm F1·22 32 x 24 degrees viewing angle £19.90 + VAT **£23.38**

Better quality C Mount lenses

VSL1614F 16mm F1·6 30 x 24 degrees viewing angle £26.43 + VAT **£31.06**
VWL813M 8mm F1.3 with iris 56 x 42 degrees viewing angle £77.45 + VAT = **£91.00**
1206 surface mount resistors E12 values 10 ohm to 1M ohm
100 of 1 value **£1.00** + VAT 1000 of 1 value **£5.00** + VAT

866 battery pack originally intended to be used with an orbitel mobile telephone it contains 10 1·6Ah sub C batteries (42 x 22 dia. the size usually used in cordless screwdrivers etc.) the pack is new and unused and can be broken open quite easily
£7.46 + VAT = **£8.77**

Please add £1.66 + vat = £1.95 postage & packing per order

JPG Electronics
276-278 Chatsworth Road, Chesterfield, S40 2BH.
Tel 01246 211202 Fax 01246 550959
Mastercard/Visa/Switch
Callers welcome 9.30 a.m. to 5.30 p.m. Monday to Saturday

COVERT VIDEO CAMERAS

Black and White Pin Hole Board Cameras with Audio. Cameras in P.I.R., Radios, Clocks, Briefcases etc. Transmitting Cameras with Receiver (Wireless). Cameras as above with colour. Audio Surveillance Kits and Ready Built Units, Bug Detector etc.

A.L. ELECTRONICS

Please phone **0181 203 6008** for free catalogue.
Fax **0181 201 5359**
E-mail: surveillance@btclick.com www.uspy.com
New DTI approved Video Transmitters and Receivers (Wireless)
Major credit cards now taken

N. R. BARDWELL LTD (EPE)

100	Signal Diodes 1N4148	£1.00
75	Rectifier Diodes 1N4001	£1.00
50	Rectifier Diodes 1N4007	£1.00
10	W01 Bridge Rectifiers	£1.00
10	555 Timer I.C.s	£1.00
4	741 Op Amps	£1.00
50	Assorted Zener Diodes 400mW	£1.00
12	Assorted 7-segment Displays	£1.00
25	5mm l.e.d.s, red, green or yellow	£1.00
25	3mm l.e.d.s, red, green or yellow	£1.00
50	Axial l.e.d.s, 2mcd red Diode Package	£1.00
25	Assid. High Brightness l.e.d.s, var cols	£1.00
20	BC182L Transistors	£1.00
25	BC212L Transistors	£1.00
30	BC237 Transistors	£1.00
20	BC327 Transistors	£1.00
30	BC328 Transistors	£1.00
30	BC547 Transistors	£1.00
30	BC548 Transistors	£1.00
30	BC549 Transistors	£1.00
25	BC557 Transistors	£1.00
30	BC558 Transistors	£1.00
30	BC559 Transistors	£1.00
20	2N3904 Transistors	£1.00
100	1nf 50V wkg Axial Capacitors	£1.00
100	4N7 50V wkg Axial Capacitors	£1.00
12	1uf 250V encapsulated radial plastic cased capacitors	£1.00
80	Assid capacitors electrolytic	£1.00
80	Assid. capacitors 1nF to 1uF	£1.00
200	Assid. disc ceramic capacitors	£1.00
50	Assid. Skel Presets (sm, stand, cermet)	£1.00
50	Assid. RF chokes (inductors)	£1.00
50	Assid. grommets	£1.00
80	Assid. solder tags, p/conns, terminals	£1.00
10	Assid. crystals – plug in	£1.00
24	Assid. coil formers	£1.00
8	Assid. dil switches	£1.00
20	Miniature slide switches sp/co	£1.00
10	Standard slide switches dp/dt	£1.00
100	Assid. beads (ceramic, teflon, fish spine)	£1.00
80	Assid. small stand offs, t/throughs etc	£1.00
30	Assid. dil sockets up to 40 way	£1.00
10	TV coax plugs, plastic	£1.00
40	metres very thin connecting wire, red	£1.00
20	1in. glass reed switches	£1.00
20	Magnetic ear pips with lead and plug	£1.00
100	Any one value 1/4W 5% cf resistors range 1R to 10M	£0.45
10	7812 Voltage Regulators	£1.00

288 Abbeydale Road, Sheffield S7 1FL
Phone: 0114 255 2886 ★ Fax: 0114 250 0689
e-mail: sales@bardwells.co.uk ★ Web: www.bardwells.co.uk
Prices include VAT. Postage £1.65
44p stamp for lists or disk

DIGITAL TEST METER

Built-in transistor test socket and diode test position.
DC volts 200mV to 1000V.
AC volts 200V to 750V.
DC current 200mA to 10A.
Resistance 200 ohms to 2000K ohms.

£6.99 incl. VAT

World Radio History

Video Surveillance

- CMOS B&W Camera 15mm ×15mm £29.00
- CMOS Colour Camera 15mm × 15mm £65.00
- Board Camera, B&W, 32mm × 32mm £24.00
- Board Camera, Colour, with Audio, 32mm £65.00
- 23cm (1·3GHz) Video/Audio Transmitter £35.00
- 13cm (2·4GHz) Video/Audio Transmitter £35.00
- 1W Booster for 2·4GHz £120.00
- 2W Booster for 1·3GHz £130.00
- 1·3GHz/4-channel Receiver and Switcher £85.00
- 2·4GHz/4-channel Receiver and Switcher £85.00
- Quad (B&W) £95.00
- 4in. boxed TFT Colour Monitor with Audio £110.00
- 2in. TFT Colour Monitor Module £85.00

Order your list for 100 electronics kits free of charge

Also we stock RF parts, power modules and more CCTV/security products

BITZ TECHNOLOGY LTD

Tel: 01753 522902 Fax: 01753 571567
E-mail: sales@bitztechnology.com
Website: www.bitztechnology.com

SHERWOOD ELECTRONICS

FREE COMPONENTS

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

SP1	15 x 5mm Red LEDs	SP133	20 x 1N4004 diodes
SP2	12 x 5mm Green LEDs	SP134	15 x 1N4007 diodes
SP3	12 x 5mm Yellow LEDs	SP136	3 x BFY50 transistors
SP6	15 x 3mm Red LEDs	SP137	4 x W005 1·5A bridge rectifiers
SP7	12 x 3mm Green LEDs	SP138	20 x 2·2/63V radial elect. caps.
SP8	10 x 3mm Yellow LEDs	SP140	3 x W04 1·5A bridge rectifiers
SP10	100 x 1N4148 diodes	SP142	2 x CMOS 4017
SP11	30 x 1N4001 diodes	SP143	5 Pairs min. crocodile clips (Red & Black)
SP12	30 x 1N4002 diodes		
SP20	20 x BC184 transistors	SP145	6 x ZTX300 transistors
SP21	20 x BC212 transistors	SP146	10 x 2N3704 transistors
SP23	20 x BC549 transistors	SP147	5 x Stripboard 9 strips x 25 holes
SP24	4 x CMOS 4001		
SP25	4 x 555 timers	SP151	4 x 8mm Red LEDs
SP26	4 x 741 Op.Amps	SP152	4 x 8mm Green LEDs
SP28	4 x CMOS 4011	SP153	4 x 8mm Yellow LEDs
SP29	3 x CMOS 4013	SP154	15 x BC548 transistors
SP31	4 x CMOS 4071	SP156	3 x Stripboard, 14 strips x 27 holes
SP36	25 x 10/25V radial elect. caps.		
SP37	15 x 100/35V radial elect. caps.	SP160	10 x 2N3904 transistors
SP39	10 x 470/16V radial elect. caps.	SP161	10 x 2N3906 transistors
SP40	15 x BC237 transistors	SP165	2 x LF351 Op.Amps
SP41	20 x Mixed transistors	SP166	20 x 1N4003 diodes
SP42	200 x Mixed 0·25W C.F. resistors	SP167	6 x BC107 transistors
SP47	5 x Min. PB switches	SP168	6 x BC108 transistors
SP102	20 x 8-pin DIL sockets	SP172	4 x Standard slide switches
SP103	15 x 14-pin DIL sockets	SP175	20 x 1/63V radial elect. caps.
SP104	15 x 16-pin DIL sockets	SP177	10 x 1A 20mm quick blow fuses
SP105	4 x 74LS00	SP182	20 x 4·7/63V radial elect. caps.
SP109	15 x BC557 transistors	SP183	20 x BC547 transistors
SP111	12 x Assorted polyester caps	SP187	15 x BC239 transistors
SP112	4 x CMOS 4093	SP191	3 x CMOS 4023
SP115	3 x 10mm Red LEDs	SP192	3 x CMOS 4066
SP116	3 x 10mm Green LEDs	SP193	20 x BC213 transistors
SP118	2 x CMOS 4047	SP195	3 x 10mm Yellow LEDs
SP120	3 x 74LS93	SP197	6 x 20 pin DIL sockets
SP124	20 x Assorted ceramic disc caps	SP198	5 x 24 pin DIL sockets
SP130	100 x Mixed 0·5W C.F. resistors	SP199	5 x 2·5mm mono jack plugs
SP131	2 x TL071 Op.Amps		

RESISTOR PACKS – C.Film

RP3	5 each value – total 365 0·25W	£2.95
RP7	10 each value – total 730 0·25W	£4.20
RP10	1000 popular values 0·25W	£5.95
RP4	5 each value-total 365 0·5W	£3.90
RP8	10 each value-total 730 0·5W	£6.55
RP11	1000 popular values 0·5W	£8.25

2001 Catalogue now available £1 inc. P&P or **FREE** with first order. P&P £1.25 per order. NO VAT
Orders to:
Sherwood Electronics, 7 Williamson St., Mansfield, Notts. NG19 6TD.

Millions of quality components at lowest ever prices!

Plus anything from bankruptcy – theft recovery – frustrated orders – over productions etc.
Send 54p stamped self-addressed label or envelope for clearance lists.

Brian J Reed
6 Queensmead Avenue, East Ewell, Epsom, Surrey KT17 3EQ
Tel: 07775 945386 or 0208 393 9055
Mail Order UK only.

Lists are updated and only 40 are sent out every 2 weeks. This normally ensures that orders can be fulfilled where only a few thousands of an item is available. (Payment is returned if sold out. I do not deal in credit notes).

ADVERTISERS INDEX

A.L. ELECTRONICS 307
N. R. BARDWELL 307
BITZ TECHNOLOGY 308
B.K. ELECTRONICS .....Cover (iii)/268
BRIAN J. REED 308
BRUNNING SOFTWARE 262
BULL ELECTRICAL .....Cover (ii)
CHEVET SUPPLIES 287
CRICKLEWOOD ELECTRONICS 279
CROWNHILL ASSOCIATES 261
DISPLAY ELECTRONICS 234
EPTSOFT .....Cover (iv)
ESR ELECTRONIC COMPONENTS 242
FOREST ELECTRONIC DEVELOPMENTS ...250
GREENWELD 307
ICS 307
ILP DIRECT 287
J&N FACTORS 239
JPG ELECTRONICS 307
LABCENTER ELECTRONICS 249
MAGENTA ELECTRONICS 240/241
MILFORD INSTRUMENTS 265
NATIONAL COLLEGE OF TECHNOLOGY ...287
PEAK ELECTRONIC DESIGN 280
PICO TECHNOLOGY 292
QUASAR ELECTRONICS 236/237
RADIOSPORT 253
REVIVAL COMPANY 270
SERVICE TRADING CO 287
SHERWOOD ELECTRONICS 308
SKY ELECTRONICS 287
SQUIRES 279
STEWART OF READING 279
SUMA DESIGNS 238

ADVERTISEMENT MANAGER: PETER J. MEW
ADVERTISEMENT OFFICES:
EVERYDAY PRACTICAL ELECTRONICS, ADVERTISEMENTS, MILL LODGE, MILL LANE, THORPE-LE-SOKEN, ESSEX CO16 0ED.
Phone/Fax: (01255) 861161

For Editorial address and phone numbers see page 243

Published on approximately the second Thursday of each month by Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset BH21 1PF. Printed in England by Apple Web Offset Ltd., Warrington, WA1 4RW. Distributed by COMAG Magazine Marketing, Tavistock Rd., West Drayton, UB7 7QE. **Subscriptions** INLAND: £14.50 (6 months); £27.50 (12 months); £50 (2 years). OVERSEAS: Standard air service, £17.50 (6 months); £33.50 (12 months); £62 (2 years). Express airmail, £27 (6 months); £51 (12 months); £97 (2 years). Payments payable to "Everyday Practical Electronics". Subs Dept, Allen House, East Borough, Wimborne, Dorset BH21 1PF. **E-mail:** subs@epemag.wimborne.co.uk.

EVERYDAY PRACTICAL ELECTRONICS is sold subject to the following conditions, namely that it shall not, without the written consent of the Publishers first having been given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on the cover, and that it shall not be lent, resold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

World Radio History

POWER AMPLIFIER MODULES-LOUDSPEAKERS-MIXERS 19 INCH STEREO AMPLIFIERS-ACTIVE CROSS/OVERS.

BK ELECTRONICS

* PRICES INCLUDE V.A.T.
* PROMPT DELIVERY

OMP MOS-FET POWER AMPLIFIERS
HIGH POWER, TWO CHANNEL 19 INCH RACK

10,000's SOLD TO PRO USERS

THE RENOWNED MXF SERIES OF POWER AMPLIFIERS

FOUR MODELS:- MXF200 (100W + 100W) MXF400 (200W + 200W) MXF600 (300W + 300W) MXF900 (450W + 450W)

ALL POWER RATINGS ARE R.M.S. INTO 4 OHMS. WITH BOTH CHANNELS DRIVEN

FEATURES:- * Independent power supplies with two toroidal transformers * Twin L.E.D. Vu Meters * Level controls * Illuminated on/off switch * Jack / XLR inputs * Speakon Outputs *Standard 775mv inputs *Open and Short circuit proof * Latest Mos-Fets for stress free delivery into virtually any load * High slew rate * Very low distortion * Aluminium cases * MXF600 & MXF900 fan cooled with D.C. Loudspeaker and thermal protection.

USED THE WORLD OVER IN CLUBS. PUBS, CINEMAS. DISCOS ETC

SIZES:-
MXF200 W19" D11" H3½" (2U)
MXF400 W19" D12" H5¼" (3U)
MXF600 W19" D13" H5¼" (3U)
MXF900 W19" D14" H5¼" (3U)

PRICES:- MXF200 £175.00 MXF400 £233.85
MXF600 £329.00 MXF900 £449.15
SPECIALIST CARRIER DEL £12.50 Each

OMP XO3-S STEREO 3 WAY ACTIVE CROSSOVER SWITCHABLE 2-WAY

BASS / MID / TOP — CONFIGURED 3 WAY
BASS/MID / TOP — 2 WAY BASS/MID COMBINED
BASS / MID/TOP — 2 WAY MID/TOP COMBINED

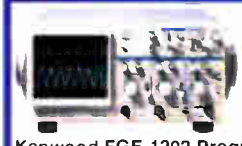
FEATURES:-

Advanced 3-Way Stereo Active Cross-Over (Switchable two way), housed in a 19" x 1U case. Each channel has three level controls: Bass, Mid & Top. The removable front facia allows access to the programmable DIL switches to adjust the cross-over frequency: There are two versions available:- XO3 S Bass-Mid 125/250/500Hz, Mid-Top 1.8/3/5kHz. all at 24 dB per octave. XO3 Bass-Mid 250/500/800Hz, Mid-Top 1.8/3/5kHz. all at 24 dB per Octave. *Please make sure you ask for the correct model when ordering.* The 2/3 way selector switches are also accessed by removing the front facia. Each stereo channel can be configured separately. Bass invert Switches are incorporated on each channel. Nominal 775mV input/output. Fully compatible with the OMP Rack Amplifier and Modules.

BOTH MODELS PRICED AT :- £117.44 + £5.00 P&P

TEST AND MEASUREMENT

Kenwood CS-4125 20Mhz Oscilloscope



Inheriting the design concept of the higher-version models the CS-4100 series 2-channel oscilloscopes provide excellent performance for general purpose applications. They feature high quality components ensuring long term reliability plus relay attenuators which minimise the need for re-calibration. The CS-4100 Series with excellent cost efficiency were designed to meet the needs of engineers over the widest range of applications. **CS-4125 Price : £351.33 Free Delivery**

Kenwood FGE-1202 Programmable function generator

The FGE-1202 is a microprocessor controlled programmable function generator providing a full featured, accurate generator in compact low cost instrument. The design incorporates an LED back lite 16x2 LCD giving clear easily read characters. The main output has wave-shapes of sine, square, triangle and DC. The output frequency is continuously displayed along with the current edit parameters. As standard an RS-232 interface allowing remote control via a computer. Output has offset, amplitude and symmetry control. An external input allows for external sweep and modulation (AM and FM). Internal sweep is also provided with a sweep rate of 20mS to 20Seconds with sweep modes log and lin.

FGE-1202
Price : £280.83
Free Delivery

For full specifications and more equipment view our web site at www.bkelec.com and press the Test & Measurement button

100 WATT ACTIVE SUB BASS AMPLIFIER PANEL

AN ACTIVE SUB BASS AMPLIFIER WITH A TRUE 100W RMS OUTPUT. SUPERB CONSTRUCTION WITH THE FACILITIES TO INTEGRATE SEEMLESSLY INTO MOST HI-FI OR HOME CINEMA SETUPS. USE THIS PANEL PLUS ONE OF OUR LOUDSPEAKERS TO MAKE YOUR OWN SUB WOOFER THAT WILL MATCH OR BEAT MOST COMMERCIALLY AVAILABLE SUB WOOFERS.

FEATURES:- * 100W RMS INTO 8 OHMS * HIGH AND LOW LEVEL INPUTS * TOROIDAL TRANSFORMER * SHORT CIRCUIT PROTECTION * D.C. SPEAKER PROTECTION * FREQUENCY ROLL OFF, LOWER 10Hz, UPPER 60Hz TO 240Hz (FULLY ADJUSTABLE) * AC3 COMPATIBLE FILTER CAN BE BYPASSED FOR 5-1 FORMATS. * AIRTIGHT CONSTRUCTION * TENS OF THOUSANDS OF OUR PANELS ALREADY IN USE. * COMPLETE WITH LEADS

SPECIFICATIONS:- * POWER 100W RMS @ 8 OHMS *FREQ RESP. 10Hz 15KHz -3dB * DAMPING FACTOR >200 * DISTORTION 0.05% * S/N A WEIGHTED >100dB * SUPPLY 230V A.C. *WEIGHT 2.7Kg * SIZE H254 X W254 X D94mm

THERE ARE 2 VERSIONS OF THE ABOVE PANEL AVAILABLE :-BSB100/8 8 OHM VERSION BSB100/4 4 OHM VERSION BOTH PANELS ARE PRICED AT £117.44 + £5.00 P&P INCL. V.A.T

VISA

DELIVERY CHARGES:- PLEASE INCLUDE AS ABOVE, TO A MAXIMUM AMOUNT £30.00. OFFICIAL ORDERS FROM SCHOOL, COLLEGES, GOVT., PLCs ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER. CREDIT CARD ORDERS ACCEPTED BY POST PHONE OR FAX.

EUROCARD MasterCard

ibl FLIGHTCASED LOUDSPEAKERS

A new range of quality loudspeakers designed to take advantage of latest loudspeaker technology and enclosure designs. All models utilise high quality studio cast aluminium loudspeakers with factory fitted grilles, wide dispersion constant directivity horns, extruded aluminium corner protection and steel ball corners, complimented with heavy duty black covering. The enclosures are fitted as standard with top hats for optional loudspeaker stands. The FC15-300 incorporates a large 16 X 6 inch horn. All cabinets are fitted with the latest Speakon connectors for your convenience and safety. Five models to choose from.

WEDGE MONITOR

PLEASE NOTE:- POWER RATINGS QUOTED ARE IN WATTS R.M.S. FOR EACH INDIVIDUAL CABINET ALL ENCLOSURES ARE 8 OHMS

15=15 Inch speaker
12=12 Inch speaker

ibl FC15-300 WATTS Freq Range 35Hz-20kHz,Sens 101dB, Size H695 W502 D415mm
Price:- £299.00 per pair

ibl FC12-300 WATTS Freq Range 45Hz-20kHz, Sens 96dB, Size H600 W405 D300mm
Price:- £249.00 per pair

ibl FC12-200 WATTS Freq Range 40Hz-20kHz, Sens 97dB, Size H600 W405 D300mm
Price:- £199.00 per pair

ibl FC12-100 WATTS Freq Range 45Hz-20kHz, Sens 100dB, Size H546 W380 D300mm
Price:- £179.00 per pair

ibl WM12-200 WATTS Freq Range 40Hz-20kHz, Sens 97dB, Size H418 W600 D385mm
Price:- £125.00 Each

SPECIALIST CARRIER DEL:- £12.50 per pair, wedge monitor £7.00 each
Optional Metal Stands PRICE:- £49.00 per pair Delivery:- £6.00

10 INCH AND 12 INCH 100W RMS SUB BASS LOUDSPEAKERS

TWO SUPERB SUB WOOFER LOUDSPEAKER DRIVERS TO ACCOMPANY OUR SUB BASS AMPLIFIER PANEL BELOW. BOTH DRIVERS OFFER GOOD BASS RESPONSE AT A REASONABLE COST. THE BSB12-100 HAS BEEN USED FOR MANY YEARS IN AN AWARD WINNING SUB BASS SYSTEM

FOR TH/SM SPECIFICATIONS VIEW OUR WEB SITE AT http://www.bkelec.com

12 INCH LOUDSPEAKER BSB12-100

POWER	100W
IMPEDANCE	8 OHMS
SENSITIVITY	90dB
WEIGHT	3.0Kg
PRICE	£24.95
CARRIAGE	£5.00

10 INCH LOUDSPEAKER BSB10-100

POWER	100W
IMPEDANCE	8 OHMS
SENSITIVITY	89dB
WEIGHT	2.3Kg
PRICE	£19.99
CARRIAGE	£5.00

OMP MOS-FET POWER AMPLIFIER MODULES

SUPPLIED READY BUILT AND TESTED

These modules now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models are available to suit the needs of the professional and hobby market ie. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE that all models include toroidal power supply, integral heatsink, glass fibre P.C.B. and drive circuits to power a compatible Vu meter. All models are open and short circuit proof

THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS

OMP/MF 100 Mos-Fet Output Power 110 watts R.M.S. into 4 ohms frequency response 1Hz - 100kHz -3dB, Damping Factor >300, Slew Rate 45V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. 110dB. Size 300 x 123 x 60mm.
Price:- £42.85 + £4.00 P&P

OMP/MF 200 Mos-Fet Output Power 200 watts R.M.S. into 4 ohms,frequency response 1Hz - 100kHz -3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV. S.N.R. 110dB. Size 300 x 155 x 100mm.
Price:- £66.35 + £4.00 P&P

OMP/MF 300 Mos-Fet Output Power 300 watts R.M.S. into 4 ohms,frequency response 1Hz - 100kHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. 110dB. Size 330 x 175 x 100mm.
Price:- £83.75 + £5.00 P&P

OMP/MF 450 Mos-Fet Output Power 450 watts R.M.S. into 4 ohms,frequency response 1Hz - 100kHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. 110dB. Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti Thump Delay. Size 385 x 210 x 105mm.
Price:- £135.85 + £6.00 P&P

OMP/MF 1000 Mos-Fet Output Power 1000 watts R.M.S. into 2 ohms, frequency response 1Hz - 100kHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV. S.N.R. 110dB. Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti Thump Delay. Size 422 x 300 x 125mm.
Price:- £251.00 + £12.00 P&P

NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 500mV,BANDWIDTH 100kHz OR PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BANDWIDTH 50kHz ORDER STANDARD OR PEC

B.K. ELECTRONICS

UNIT 1 COMET WAY, SOUTHEND-ON-SEA, ESSEX. SS2 6TR.
TEL.: 01702-527572 FAX.: 01702-420243
Web:- http://www.bkelec.com E-Mail sales@bkelec.com

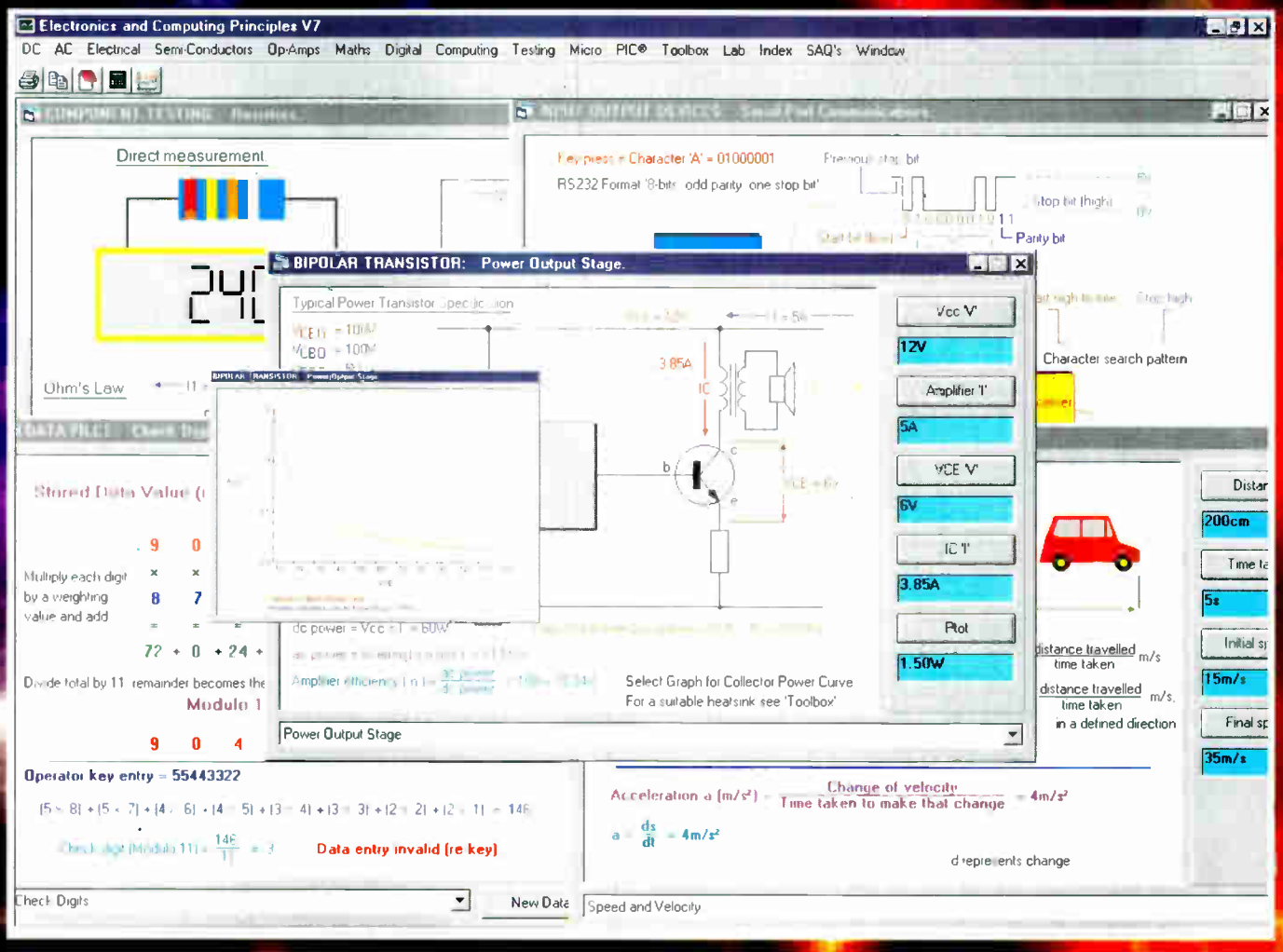
REF D4

World Radio History

‘Electronics and Computing Principles V7’

‘95, ’98, NT or 2000

Studying electronics or computing or just want to keep up-to-date in a easy and enjoyable way, then this fully interactive software is for you.



Visit eptsoft.com or telephone for full details of more than a thousand menu items.

Electronics:-
Atomic Structures, DC Current flow, Basic Electronics, Simple DC Circuits, Types of Switching, Variable Voltages, Ohm's Law, DC Voltage, DC Current, Series/Parallel Resistors, AC Measurements, AC Voltage and Current, AC Theory, RCL Series/Parallel Circuits, Capacitance, Capacitors, Inductance, Inductors, Impedance, Communication System, Signals, Attenuators, Passive/Active Filters, Tuned Circuits, Coupling and Selectivity, Oscillators, Circuit Theorems. Diode Theory, Diode Applications, Transistor Theory, Bipolar Transistor, Transistor Configurations, Transistor Circuits, Field Effect Transistors, Operational Amplifier Theory and Applications, Sum and Difference Amplifiers.

Electrical:-
DC and AC Power, SCR, Power Supplies, Voltage Regulators, Magnetism, Motors/Generators, Transformers, Three Phase Systems.

Digital Techniques:-
Logic Gates, Flip Flops, Combinational Logic, Counters, Counting, Shift Registers, Logic Interfacing, Timers, Boolean Algebra and DeMorgan's Theorems.

Microprocessors and PIC Microcontrollers:-
Basic Micro-Computer, Busses, A.L.U, Clock and Reset, Instructions and Control, Memory Cells, ROM and RAM, Memory Addressing, Instructions, PIC Introduction, PIC16F84 Architecture, PIC16C71 A/D, Byte, Bit Literal and Control Instructions.

Personal user £99.95 +VAT
Education £299.95 +VAT
(Includes unlimited multi-user site licence.)

Measurement and Component Testing:-
Analogue multi-meter, Measurement, Component Testing.

Mathematics:-
Simple Numbers, Number Types, Roots, Triangle Ratio's, Triangle Angles, Area, Surface Area and Symmetry, Volume, Percentages, Ratio's, Fractions, Vectors, Circle Angles, Laws, Algebra Rules, Powers, Simplifying, Equations, Graphing, Slope and Transposition, Angles, Complex Numbers, Statistics, Lottery Number Probability, Science.

Computer Science:-
Hardware Devices, Data Structures, Data Files, Binary, Number Systems, Binary Arithmetic.

Toolbox:-
DC Calculations, AC Calculations, Numbers, Applications.

Self-Assessment Questions:-
DC, AC, Power, Semi-Conductors, Op-Amps, Digital, Mathematics.

Components and Equipment Picture Dictionary:-
High quality digital camera images and explanatory text.

ELECTRONICS LAB (Optional add-on hardware).

eptsoft limited. Pump House, Lockram Lane, Witham, Essex. UK. CM8 2BJ.
Tel: +44 (0)1376 514008. Fax: +44 (0)870 0509660. Email: info@eptsoft.com.

Switch, Delta, Visa and MasterCard accepted.
No additional postage or airmail charges.

World Radio History