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NOVEMBER 1997

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AN INTRODUCTION TO DIGITAL ELECTRONICS

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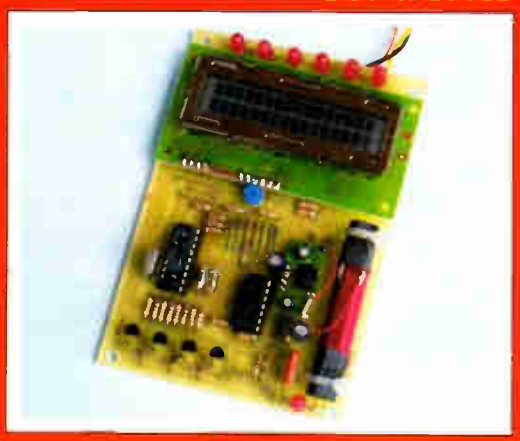

EPE TIME MACHINE

Millenium Countdown Timer

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GAS HOBS Standard domestic units, new and boxed, 3 burner, household gas, brown. Bargain at just £12.95 ref BAR316

INFRA RED FILM 6" square piece of flexible infra red film that will only allow IR light through. Perfect for converting ordinary torches, lights, headlights etc to infra red output only using standard light bulbs Easily cut to shape. 6" square £15 ref IRF2

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

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

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

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

NEW GEIGER COUNTERS IN STOCK Hand held unit with LCD screen, auto ranging, low battery alarm, audible 'click' output. New and guaranteed. £129 ref GE1

RUSSIAN BORDER GUARD BINOCULARS £1799 Probably the best binoculars in the world! ring for colour brochure.

RUSSIAN MULTIBAND WORLD COMMUNICATIONS RECEIVER, Exceptional coverage of 9 wave bands, (5 short, 1 LW, 1FM, 1MW) internal ferrite and external telescopic aerials, mains/ battery. £45 ref VEGA

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

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

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

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

PC KEYBOARDS PS2 connector, top quality suitable for all 286/ 386/486 etc £10 ref PCKB. 10 for £65.

NEW LOW COST VEHICLE TRACKING TRANSMITTER KIT £29 range 1.5-5 miles, 5,000 hours on AA batteries, transmits info on car direction, left and right turns, start and stop information. Works with any good FM radio. £29 ref LOT101a

HIGH SECURITY ELECTRIC DOOR LOCKS Complete brand new Italian lock and latch assembly with both Yale type lock (keys inc) and 12v operated deadlock. £10 ref LOT99

***NEW HIGH POWER WIRELESS VIDEO AND AUDIO BUG KIT 1/2 MILE RANGE** Transmits video and audio signals from a minature CCTV camera (included) to any standard television! Supplied with telescopic aerial. £169

CCTV PAN AND TILT KIT Motorize your CCTV camera with this simple 12vdc kit. 2 hermentically sealed DC linear servo motors 5mm threaded output 5 secs stop to stop, can be stopped anywhere, 10mm travel, powerful. £12 ref LOT125

CCTV CAMERA MODULES 46X70X29mm, 30 grams, 12v 100mA. auto electronic shutter, 3.6mm F2 lens, CCIR, 512x492 pixels, video output is 1v p-p (75 ohm). Works directly into a scart or video input on a tv or video. IR sensitive. £79.95 ref EF137.

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

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

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

SUPER WIDEBAND RADAR DETECTOR Detects both radar and laser , X K and KA bands, speed camaras, and all known speed detection systems. 360 degree coverage, front & earwaveguides,

1 1"x2.7"x4.6" fits on sun visor or dash £149 ref

CHIEFTAN TANK DOUBLE LASERS 9 WATT+3 WATT+LASER OPTICS

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

NEW LOW PRICED COMPUTER/WORKSHOP/HI-FI RCB UNITS Complete protection from faulty equipment for everybody! Inline unit fits in standard IEC lead (extends it by 750mm), fitted in less than 10 seconds, reset/test button, 10A rating. £6.99 each ref LOT5. Or a pack of 10 at £49.90 ref LOT6. If you want a box of 100 you can have one for £250!

TWO CHANNEL FULL FUNCTION B GRADE RADIO CONTROLLED CARS From World famous manufacturer these are returns so they will need attention (usually physical damage) cheap way of buying TX and RX plus servos etc for new projects etc. £12 each sold as seen ref LOT2.

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

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 EP7

HIGH POWER DC MOTORS, PERMANENT MAGNET 12 - 24v operation, probably about 1/4 horse power, body measures 100m x 75mm with a 60mm x 5mm output shaft with a machined flat on it. Fixing is simple using the two threaded bolts protruding from the front of the motor 4mm x 12mm). These motors are perfect for model engineering etc they may even be suitable as a cycle motor? We expect high demand so if you would like one or think you may require one in the future place your order today! £22 ref MOT4 10 pack £185 ref MOT5B

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

RUSSIAN 900X MAGNIFICATION ZOOM MICROSCOPE metal construction, built in light, mirror etc. Russian shrimp farm!, group viewing screen, lots of accessories £29 ref ANAYLT

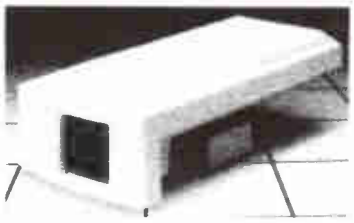
AA NICAD PACK Pack of 4 tagged AA nicads £2.99 ref BAR34

RUSSIAN NIGHTSIGHTS Model TZS4 with infra red illuminator, views up to 75 metres in full darkness in infrared mode, 150m range, 45mm lens, 13 deg angle of view, focussing range 1.5m to infinity. 2 AA batteries required. 950g weight £199 ref BAR61 1 years warranty

LIQUID CRYSTAL DISPLAYS Bargain prices,
20 character 2 line, 83x19mm £3.99 ref SMC2024A
16 character 4 line, 62x25mm £5.99 ref SMC1640A

TAL-1, 110MM NEWTONIAN REFLECTOR TELESCOPE Russian. Superb astronomical 'scope. everything you need for some serious star gazing! up to 169x magnification. Send or fax for further information.20kg, 885x800x1650mm ref TAL-1, £249

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



COLOUR CCTV VIDEO CAMERAS
BRAND NEW AND CASED FROM £39

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

YUASHA SEALED LEAD ACIDS FROM £2.50
12v 6.5Ah ex equipment batteries to clear at just £9.99 for a pack of four! ref XX1

A MAGNET THAT LIFTS 33 KILO'S!

Just in this week are these incredible magnets that lift 33 kilo's! Price is £14.99 ref MAG33

25 SQUARE FOOT SOLAR ENERGY BANK KIT 100 6"x6" 6v Amorphous 100mA panels, 100 diodes, connection details etc to build a 25 square foot solar cell for just £99 ref EF112

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

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

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

YUASHA SEALED LEAD ACID BATTERIES 12v 15AH at £18 ref LOT8 and below spec 6v 10AH at £5 a pair

ELECTRIC CAR WINDOW DE-ICERS Complete with cable, plug etc SALE PRICE JUST £4.99 REF SA28

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

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

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

GIANT HOT AIR BALLOON KIT Build a 4.5m circumfrence, fully functioning balloon, can be launched with home made burner etc. Reusable (until you loose it!) £12.50 ref HA1

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

***NEW MEGA POWER VIDEO AND AUDIO SENDER UNIT.** Transmits both audio and video signals from either a video camera, video recorder, TV or Computer etc to any standard TV set in a 500m range! (tune TV to channel 31) 12v DC op. Price is £65 REF: MAG16 12v psu is £5 extra REF: MAG6P2

***MINATURE RADIO TRANSCEIVERS** A pair of walkie talkies with a range up to 2 km in open country. Units measure 22x52x155mm. Including cases and earp'ces. 2xPP3 req'd. £37.00 pr. REF: MAG30

***FM TRANSMITTER KIT** housed in a standard working 13A adapter!! the bug runs directly off the mains so lasts forever! why pay £700? or price is £18 REF: EF82 (kit) Transmits to any FM radio. Built and tested version now available at £45 ref EXM34

***FM BUG BUILT AND TESTED** superior design to kit. Supplied to detective agencies. 9v battery req'd. £14 REF: MAG14

GAT AIR PISTOL PACK Complete with pistol, darts and pellets £14.95 Ref EF82B extra pellets (500) £4.50 ref EF80.

HEAT PUMPS These are mains operated air to air units that consist of a aluminium plate (cooling side) and a radiator (warming side) connected together with a compressor. The plate if inserted into water will freeze it. Probably about 3-400 watts so could produce 1kw in ideal conditions. £30 ref HP1

3 FOOT SOLAR PANEL Amorphous silicon, 3' x 1' housed in an aluminium frame, 13v 700mA ouput. £55 ref MAG45

SOLAR/WIND REGULATOR Prevents batteries from over charging. On reaching capacity the regulator diverts excess power into heat avoiding damage. Max power is 60 watts £27.99 ref S/CA11-/05

4X28 TELESCOPIC SIGHTS Suitable for all air rifles, ground lenses, good light gathering properties. £24.95 ref R/7.

NICAD CHARGERS AND BATTERIES Standard universal mains operated charger, takes 4 batts + 1 PP3, £10 ref PO11D. Nicads- AA size (4 pack) £4 ref 4P44, C size (2 pack) £4 ref 4P73, D size (4 pack) £9 ref 9P12.

PHOTOGRAPHIC RADAR TRAPS CAN COST YOU YOUR LICENCE! The new multiband 2000 radar detector can prevent even the most responsible of drivers from losing their licence! Adjustable audible alarm with 8 flashing leds gives instant warning of radar zones. Detects X, K, and Ka bands, 3 mile range, 'over the hill' 'around bends' and 'rear trap facilities. micro size just 4.25"x2.5"x 75", Can pay for itself in just one day! £89 ref EP3.

STEREO MICROSOPES BACK IN STOCK Russian, 200x complete with lenses, lights, filters etc etc very comprehensive microscope that would normally be around the £700 mark, our price is just £299 (full money back guarantee) full details in catalogue.

SECOND GENERATION NIGHT SIGHTS FROM £748

RETRON Russian night sight, 1.8x, infra red lamp, 10m-inf. standard M42 lens. 1.1kg. £349 ref RET1

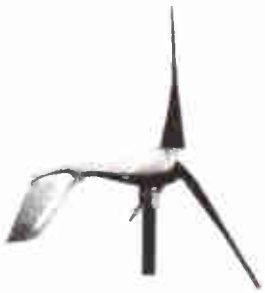
MAINS MOTORS 180 RPM 90X70mm, 50X5mm 50x5mm output shaft, start cap included. £22 ref MGM1

PC POWER SUPPLIES, CUSTOMER RETURNS, ALL FAN COOLED, OUR CHOICE, BARGAIN AT 8 PSU'S FOR £9.99 REF XX16

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

JUMBO LED PACK 15 10mm bicolour leds, plus 5 giant (55mm) seven segment displays all on a pcb £8 ref JUM1. Pack of 30 55mm seven seg displays on pcbs is £19 ref LED4, pack of 50 £31 ref LED50

12VDC 40MM FANS MADE BY PANAFLO, NEW. £4. REF FAN12



WIND GENERATORS 380 WATT

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

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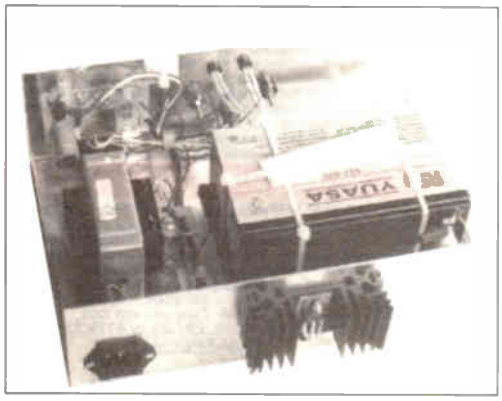
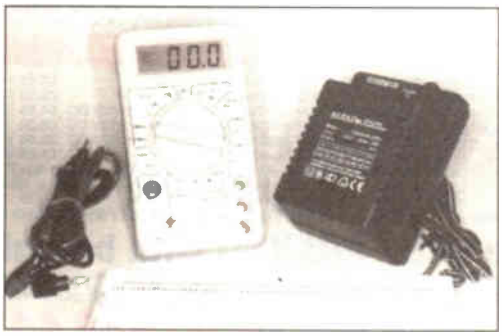
The No. 1 Magazine for Electronics Technology and Computer Projects





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Our December '97 issue will be published on Friday, 7 November 1997. See page 778 for details.

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SPECIAL BUY 'AT 286'

40Mb HD + 3Mb Ram

LIMITED QUANTITY only of these 12Mhz HI GRADE 286 systems Made in the USA to an industrial specification, the system was designed for *total reliability*. The compact case houses the motherboard, PSU and EGA video card with single 5¼" 1.2 Mb floppy disk drive & integral 40Mb hard disk drive to the front. Real time clock with battery backup is provided as standard. Supplied in good used condition complete with enhanced keyboard, 640k + 2Mb RAM, DOS 4.01 and 90 DAY Full Guarantee. *Ready to Run !*

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Optional Fitted extras: VGA graphics card	£29.00
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Wordperfect 6.0 for Dos - when 3½" FDD option ordered	£22.50
NE2000 Ethernet (thick, thin or twisted) network card	£29.00

LOW COST 486DX-33 SYSTEM

Limited quantity of this 2nd user, supurb small size desktop unit. Fully featured with standard simm connectors 30 & 72 pin. Supplied with keyboard, 4 Mb of RAM, SVGA monitor output, 256k cache and integral 120 Mb IDE drive with single 1.44 Mb 3.5" floppy disk drive. Fully tested and guaranteed. *Fully expandable*

Many other options available - call for details. Only **£399.00** (E)

FLOPPY DISK DRIVES 3½" - 8"

5¼" or 3½" from only £18.95 !

Massive purchases of standard 5¼" and 3½" drives enables us to present prime product at industry beating low prices! All units (unless stated) are ***BRAND NEW*** or removed from often brand new equipment and are fully tested, aligned and shipped to you with a 90 day guarantee and operate from standard voltages and are of standard size. **All are IBM-PC compatible** (if 3½" supported on your PC).

3½" **Panasonic** JU363/4 720K or equivalent RFE	£24.95(B)
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3½" **Mitsubishi** MF355C-D. 1.4 Meg. Non laptop	£18.95(B)
5¼" **Teac** FD-55GFR 1.2 Meg (for IBM pc's) RFE	£18.95(B)
5¼" **Teac** FD-55F-03-U 720K 40/80 (for BBC's etc) RFE	£29.95(B)
5¼" **BRAND NEW Mitsubishi** MF501B 360K	£22.95(B)
Table top case with integral PSU for HH 5¼" Flopp or HD	£29.95(B)
8" **Shugart** 800/801 8" SS refurbished & tested	£195.00(E)
8" **Shugart** 810 8" SS HH *Brand New*	£195.00(E)
8" **Shugart** 851 8" double sided refurbished & tested	£250.00(E)
Mitsubishi M2894-63 8" double sided *NEW*	£275.00(E)
Mitsubishi M2896-63-02U 8" DS slimline *NEW*	£285.00(E)
Dual 8" cased drives with integral power supply 2 Mb	£499.00(E)

HARD DISK DRIVES

End of line purchase scoop! *Brand new* **NEC D2246 8" 85 Mbyte drive with industry standard SMD interface, replaces Fujitsu** equivalent model. Full manual. Only **£299.00 or 2 for £525.00 (E)**

3½" **FUJI** FK-309-26 20mb MFM I/F RFE	£59.95(C)
3½" **CONNER** CP3024 20 mb IDE I/F (or equiv)RFE	£59.95(C)
3½" **CONNER** CP3044 40mb IDE I/F (or equiv.)RFE	£69.00(C)
3½" **RODIME** RO3057S 45mb SCSI I/F (Mac & Acorn)	£69.00(C)
3½" **WESTERN DIGITAL 850mb IDE I/F** ***Brand New***	£185.00(C)
5¼" **MINISCRIBE** 3425 20mb MFM I/F (or equiv.) RFE	£49.95(C)
5¼" **SEAGATE** ST-238R 30 mb RLL I/F Refurb	£69.95(C)
5¼" **CDC** 94205-51 40mb HH MFM I/F RFE tested	£69.95(C)
5¼" **HP** 9754B 850 Mb SCSI RFE tested	£89.00(C)
5¼" **HP** C3010 2 Gbyte SCSI *differential* RFE tested	£195.00(C)
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Hard disc controllers for MFM , IDE, SCSI, RLL etc. from	£16.95

THE AMAZING TELEBOX

Converts your colour monitor into a QUALITY COLOUR TV!!

TV SOUND & VIDEO TUNER CABLE COMPATIBLE*

The **TELEBOX** is an attractive fully cased mains powered unit, containing all electronics ready to plug into a host of video monitors made by makers such as **MICROVITEC, ATARI, SANYO, SONY, COMMODORE, PHILIPS, TATUNG, AMSTRAD etc.** The composite video output will also plug directly into most video recorders, allowing reception of TV channels not normally receivable on most television receivers* (TELEBOX MB). Push button controls on the front panel allow reception of 8 fully tuneable 'off air' UHF colour television channels. **TELEBOX MB** covers virtually all television frequencies VHF and UHF including the **HYPERBAND** as used by most cable TV operators. A composite video output is located on the rear panel for direct connection to most makes of monitor or desktop computer video systems. For complete compatibility - even for monitors without sound - an integral 4 watt audio amplifier and low level Hi Fi audio output are provided as standard.

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

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

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VIDEO MONITOR SPECIALS

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

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

Tilt & Swivel Base £4.75 **Only £119** (E) Order as MITS-SVGA

VGA cable for IBM PC included.

External cables for other types of computers CALL

As New - Used on film set for 1 week only!! 15" 0.28 SVGA 1024 x 768 res. colour monitors. Swivel & tilt etc. Full 90 day guarantee. £145.00 (E)

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

PHILIPS HCS35 (same style as CM8833) attractively styled 14" colour monitor with both RGB and standard composite 15.625 Khz video inputs via SCART socket and separate phono jacks. Integral audio power amp and speaker for all audio visual uses. Will connect direct to Amiga and Atari BBC computers. Ideal for all video monitoring / security applications with direct connection to most colour cameras. High quality with many features such as front concealed flap controls, VCR correction button etc. Good used condition - fully tested - guaranteed **Only £95** (E)

Dimensions: W14" x H12¾" x 15½" D.

PHILIPS HCS31 Ultra compact 9" colour video monitor with standard composite 15.625 Khz video input via SCART socket. Ideal for all monitoring / security applications. High quality, ex-equipment fully tested & guaranteed (possible minor screen 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)

SPECIAL INTEREST ITEMS

MITS. **FA3445ETKL** 14" Industrial spec SVGA monitors	£245
2kW to 400 kW - 400 Hz 3 phase power sources - ex stock	£POA
IBM 8230 Type 1, Token ring base unit driver	£950
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
Trend DSA 274 Data Analyser with G703(2M) 64 i/o	£POA
Marconi 6310 Programmable 2 to 22 GHz sweep generator	£6500
HP1650B Logic Analyser	£3750
HP3781A Pattern generator & HP3782A Error Detector	£POA
HP APOLLO RX700 system units	£950
HP6621A Dual Programmable GPIB PSU 0-7 V 160 watts	£1800
HP3081A Industrial workstation c/w Barcode swipe reader	£175
HP6264 Rack mount variable 0-20V @ 20A metered PSU	£675
HP54121A DC to 22 GHz four channel test set	£POA
HP7580A A1 8 pen HPGL high speed drum plotter	£1850
EG+G Brookdeal 9503SC Precision lock in amp	£650
View Eng. Mod 1200 computerised inspection system	£POA
Ling Dynamics 2kW programmable vibration test system	£POA
Computer controlled 1056 x 560 mm X Y table & controller	£1425
Kelthley 590 CV capacitor / voltage analyser	£POA
Racal RCR40 dual 40 channel voice recorder system	£3750
Fiskers 45KVA 3 ph On Line UPS - New batts Dec.1995	£9500
ICI R5030UV34 Cleanline ultrasonic cleaning system	£POA
Mann Tally MT645 High speed line printer	£2200
Intel SBC 486/133SE Multibus 486 system. 8Mb Ram	£1200
Zeta 3220-05 A0 4 pen **HPGL** *fast* drum plotters	£1150
Nikon HFX-11 (Ephiphot) exposure control unit	£1450
Motorola VME Bus Boards & Components List. SAE / CALL	£POA
Trio 0-18 vdc linear, metered 30 amp bench PSU. New	£550
Fujitsu M3041R 600 LPM band printer	£1950
Fujitsu M3041D 600 LPM printer with network interface	£1250
Perkin Elmer 2998 Infrared spectrophotometer	£POA
VG Electronics 1035 TELETEXT Decoding Margin Meter	£3750
Andrews LARGE 3.1 m Satellite Dish + mount (For Voyager!)	£950
Sekonic SD 150H 18 channel digital Hybrid chart recorder	£1995
TAYLOR HOBSON Talysurf amplifier / recorder	£750
System Video 1152 PAL waveform monitor	£485
Test Lab - 2 mtr square quietised acoustic test cabinets	£300
Kenwood 9601 PAL Vectorscope - NEW	£650

Please call for further details on the above items

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:**

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OPT Rack 2 Rack, Less side panels	£225.00 (G)

32U - High Quality - All steel RakCab

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

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Over 1000 racks **- 19" 22" & 24" wide 3 to 44 U high. Available from stock !! Call with your requirements.**

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The ultimate in 'Touch Screen Technology' made by the experts - ***MicroTouch*** - but sold at a price below cost !! System consists of a flat translucent glass laminated panel measuring 29.5 x 23.5 cm connected to an electronic controller PCB. The controller produces a standard serial RS232 or TTL output which continuously gives simple serial data containing positional X & Y co-ordinates as to where a finger is touching the panel - as the finger moves, the data instantly changes. The X & Y information is given at an incredible matrix resolution of 1024 x 1024 positions over the entire screen size !! A host of available translation software enables direct connection to a PC for a myriad of applications including: control panels, pointing devices, POS systems, controllers for the disabled or computer un-trained etc etc. Imagine using your finger with 'Windows', instead of a mouse !! (a driver is indeed available !) ***The applications for this amazing product are only limited by your imagination!!*** Complete system including Controller, Power Supply and Data supplied at an incredible price of only: **£145.00** (B)

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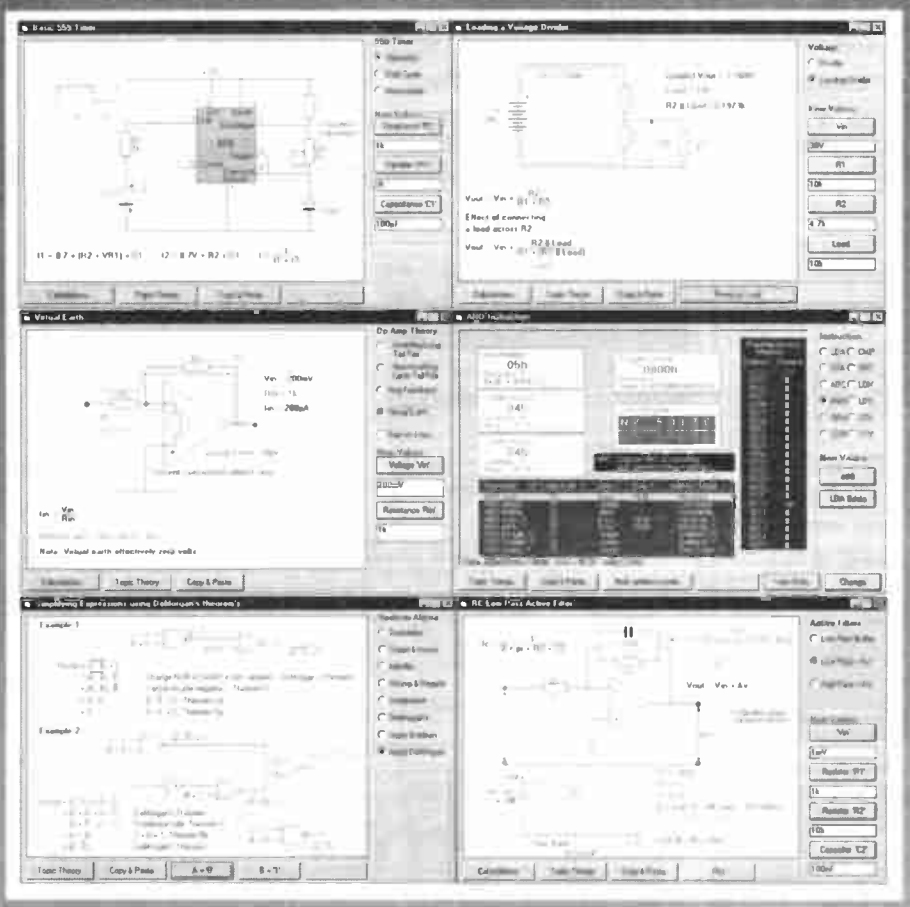

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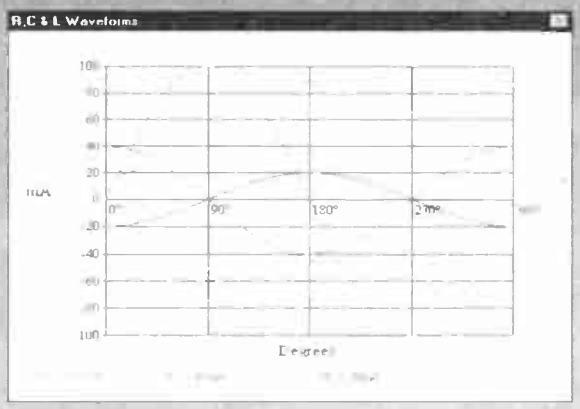

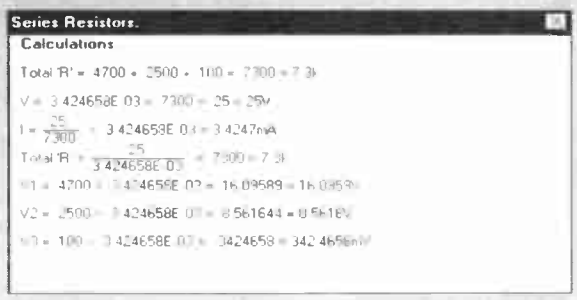

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HITACHI LM225X LCD SCREENS 270x150mm, standard 12 way connector, 640x200 dots, tec spec sheet. £15 each ref LM2

HOME DECK CLEARANCE These units must be cleared! leads, an infra red remote qwerty keyboard and receiver, a standard UHF modulator, a standard 1200/75 BT approved modem and loads of chips, capacitors, diodes, resistors etc all for just £10 ref BAR33.

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

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COPPER VAPOUR LASER PLANS Produces 100mw of visible green light. High coherency and spectral quality similar to Argon laser but easier and less costly to build yet far more efficient. This particular design was developed at the Atomic Energy Commision of NEGEV in Israel. £10/set Ref F/CVL1

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DYNAMO FLASHLIGHT Interesting concept, no batteries needed just squeeze the trigger for instant light apparently even works under water in an emergancy although we haven't tried it yet! £6.99 ref SC152

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

Water pump motors, mains powered, 165x75mm, 5mm shaft. £6 ea ref MM10. Pack of 3 for £12 ref MM11.

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

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

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MOD TRANSMITTING VALVES 5J180E £80 ref LOT112

SWITCHED MODE PSU'S 244 watt, +5 32A, +12 6A, -5 0 2A, -12 0 2A. There is also an optional 3.3v 25A rail avaiable. 120/240v I/P. Cased, 175x90x145mm. IEC inlet. Suitable for PC use (6 d/drive connectors 1 m/board). £16 ref LOT135

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

MINI FM TRANSMITTER KIT Very high gain preamp, supplied complete with FET electret microphone. Designed to cover 88-108 Mhz but easily changed to cover 63-130 Mhz. Works with a common 9v (PP3) battery. 0.2W RF. £9 Ref 1001

3-30V POWER SUPPLY KIT Variable, stebilized power supply for lab use. Short circuit protected, suitable for profesional or amateur use 24v 3A transformer is needed to complete the kit. £14 Ref 1007.

1 WATT FM TRANSMITTER KIT Supplied with piezo electric mic. 8-30vdc. At 25-30v you will get nearly 2 watts! £15 ref 1009.

FM/AM SCANNER KIT Well not quite, you have to turn the knob your self but you will hear things on this radio that you would not hear on an ordinary radio (even TV). Covers 50-160mhz on both AM and FM. Built in 5 watt amplifier, inc speaker. £18 ref 1013.

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Catch two is that the three coinslots accept £1, 50p and 10p's this is fine except that the 10p slot is for the older 10p piece so you would need to glue a small piece of plastic across the bottom of the slot on the inside to reduce the hole size. Full programming instructions are included with every coinbox. Bargain price £4.99 ref CBT1

4 WATT FM TRANSMITTER KIT Small but powerful FM transmitter. 3 RF stages, microphone and audio preamp included. £24 Ref 1028

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PHONE BUG DETECTOR KIT This device will warn you if somebody is eavesdropping on your line. £9 ref 1130.

ROBOT VOICE KIT Interesting circuit that distorts your voice! adjustable, answer the phone with a different voice! 12vdc £9 ref 1131

TELEPHONE BUG KIT Small bug powered by the 'phone line, starts transmitting as soon as the phone is picked up! £12 Ref 1135

12V FLOURESCENT LAMP DRIVER KIT Light up 4 foot tubes from your car battery! 9v 2a transformer also required. £8 ref 1069

VOX SWITCH KIT Sound activated switch ideal for making bugging tape recorders etc, adjustable sensitivity. £10 ref 1073.

SOUND EFFECTS GENERATOR KIT Produces sounds ranging from bird chips to sirens. Complete with speaker, add sound effects to your projects for just £9 ref 1045

15 WATT FM TRANSMITTER (BUILT) 4 stage high power, preamp required 12-18vdc, can use ground plane, yagi or open dipole. £69 ref 1021.

HUMIDITY METER KIT Builds into a precision LCD humidity meter, 9 ic design, pcb, lcd display and all components included. £29

PC TIMER KIT Four channel output controlled by your PC, will switch high current mains with relays (supplied). Software supplied so you can program the channels to do what you want whenever you want. Minimum system configeration is 286, VGA, 4 1,640k, serial port, hard drive with min 100k free. £24.99

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ELECTRONIC ACCUPUNCTURE KIT Builds into an electronic version instead of needles! good to experiment with. £9 ref 7P30

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HIGH POWER CATAPULTS Hinged arm brace for stability, tempered steel yoke, super strength latex power bands. Departure speed of ammunition is in excess of 200 miles per hour! Range of over 200 metres! £8.99 ref R/9

COMPAQ POWER SUPPLIES WITH 12V DC FANS Ex equipment psu's, some ok some not but worth it for the fan alone! probably about 300 watt PC unit with IEC input. £3.50 each ref CQ1

9-0-9V 4A TRANSFORMERS, chassis mount. £7 ref LOT19A.

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MEGA LED DISPLAYS Build your self a clock or something with these mega 7 seg displays 55mm high, 38mm wide. 5 on a pcb for just £4.99 ref LOT16 or a bumper pack of 50 displays for just £29 ref LOT17.

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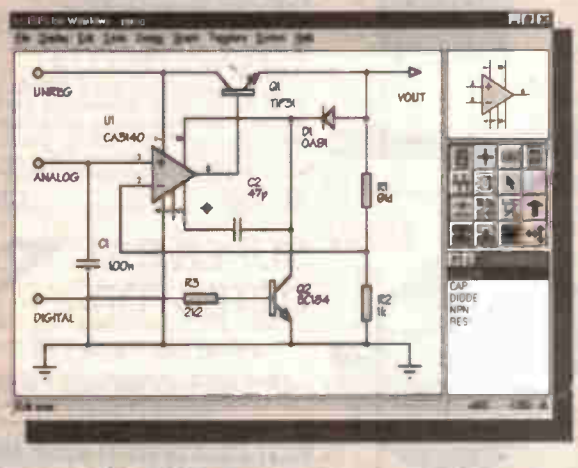

●Produces attractive schematics like you see in the magazines. ●Netlist, Parts List & ERC reports. ●Hierarchical Design. ●Full support for buses including bus pins. ●Extensive component/model libraries. ●Advanced Property Management. ●Seamless integration with simulation and PCB design.

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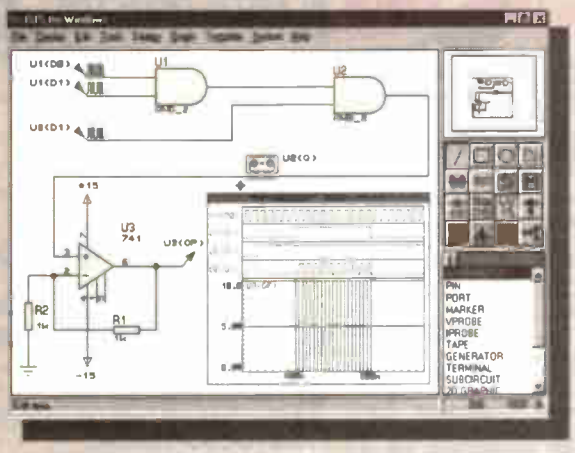

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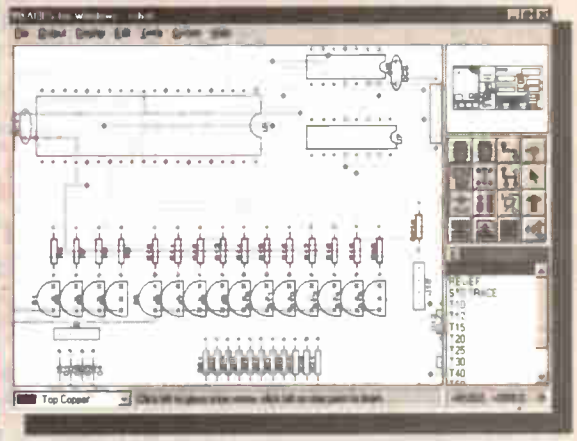

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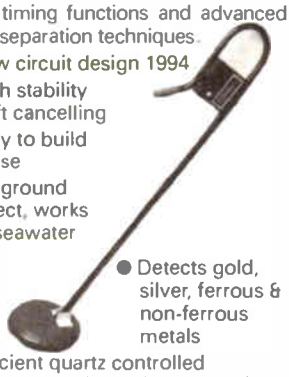

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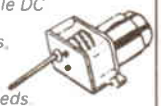

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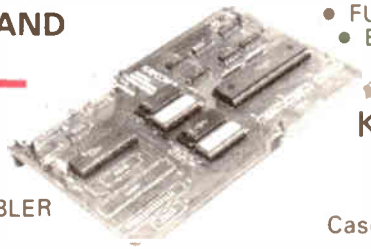

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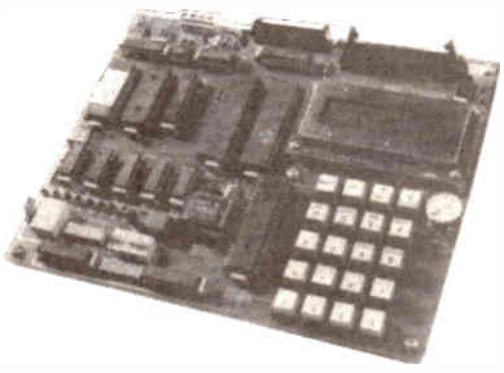

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AGAIN AND AGAIN

Here we go again! It's time for yet another *Teach-In* series. We started publishing *Teach-Ins* in 1971, when *Everyday Electronics* was first produced, and we have continued roughly every other year since then. Why do we continue to publish series on the same subject? Well, for a start, it's never *exactly* the same subject – this particular series (*Teach-In '98*) is based on the City & Guilds 726 Digital Electronics course but will also interest everyone from hobbyist beginners, just getting interested in electronics, through to GCSE, A Level and BTEC students. Also, each new series puts over the facts in a different way so, what you might not have fully absorbed or struggled with in one series, can be crystal clear from another author. It is also well worth taking a "refresher" course from time to time, no matter what your level of knowledge is.

For the first time, this series has been devised and produced by a team of "Teach-Inners" based at Hull University, with the strings being pulled, and everything being coordinated, by Alan Winstanley who has himself been contributing to *EPE* for over twenty years (he must have started very young because he doesn't look that old!).

FREE

This month's issue carries the Greenweld 1998 catalogue free inside – just pull it out to get an invaluable insight into electronic components, plus some ex-equipment bargains. We are sure beginners will glean much from its pages as many components are described and illustrated. It's always worth collecting as many catalogues as you can – most of them provide information which will be valuable to the beginner and more advanced constructor.

Next month we will give away a free *Giant Data Chart* containing just about all the formulae you will need to go with *Teach-In '98* and beyond. The following month we will produce a second free *Giant Data Chart* for PIC users. Don't miss out on these special issues.

Mike Kenward

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Constructional Project

PORTABLE 12V PSU/CHARGER

DAVID SILVESTER

A special custom chip and a sealed battery let you build a "go-anywhere" combined power supply and charger

SOONER or later all of us need some form of battery power pack to give us a supply away from the mains. This may be for the radio amateur who needs power for his QRP rig, the fisherman or camper who wants electric lights, or the model aircraft builder who needs power to start his engines.

Whilst NiCad battery packs are small and efficient they are only suitable for low energy levels. The typical AA NiCad has a power capacity of 500mAh (milliamp hours), i.e. it can give a current of 500mA for one hour, but it is more likely that this rating is based on a 10 hour discharge time with the battery giving 50mA.

GELL-CELL

For high power and longer life we need to look at other battery types. Of the available options the "gel-cell" lead acid battery is hard to beat. Related to the battery in your car, the gel-cell battery contains a jelly like electrolyte that cannot be spilt unless you actually crack the battery case.

They can also be operated in any position and have a high capacity. A typical 12V by 7Ah battery is equivalent to ten AA cells in series but is capable of delivering about 14 times the current output, in a package size just 6.5cm × 15cm × 10cm.

The problem is to maintain the battery with a full charge so that it is always available for use. Unitrode, a semiconductor manufacturer that is not very well known to the amateur constructor in many countries, have come to the rescue by providing a special control chip for the charging of gel-cell batteries or, incidentally, wet lead acid batteries as their charging requirements are the same.

Two versions of the charger are discussed, both using the same p.c.b. (printed circuit board), the differences being that one is a self-contained 12V PSU/Charger designed to charge at 1A whilst the other is a charger-only unit but with higher charging currents. They vary mostly in the selection of the power carrying components.

ON CHARGE

The heart of our charger is the Unitrode UC3906 which contains a lot of circuitry within its 16-pin package. It has the basic reference and control circuitry and allows the user to adapt the external circuit components to suit their own particular application.

Described here is a prototype charger power pack designed to maintain an internal 12V 7Ah gel-cell battery, charged at a maximum of 1A approx. There was no need for a rapid charge of the battery but rather a power supply that was always ready to "Get Up and Go".

The choice of components in this prototype is for a power supply that would be transported by car and be carried for only short distances. Thus, the battery and charger were incorporated in a single case that only needs plugging into the mains after use to recharge and left there on trickle charge until required again.

CIRCUIT DESCRIPTION

Gel-cell and lead acid batteries are normally charged from a constant voltage source rather than the constant current charging of NiCads. Refer to the circuit diagram for the Portable 12V PSU/Charger shown in Fig. 1 and the related charging voltages depicted in Fig. 2. The UC3906 (IC1) emulates the constant voltage charging mode by controlling the charging current Darlington transistor TR1. The bridge rectifier REC1 and capacitor C1 produce around 24V d.c. across C1 from the 18V a.c. input from the secondary windings of the mains transformer T1.

This 24V unregulated supply is applied to IC1 input pin 5 and should the supply be disconnected the i.c. shuts down until the voltage at pin 5 exceeds 5V. When the input exceeds 5V then pin 7 is held low and the Power On indicator l.e.d. D1 turns on.

Next, IC1 checks the voltage at pin 12 and compares this to an internal 2·3V reference. With the values of resistors R5 and R6 used here, if the battery voltage is below approximately 10V then pin 12 is held below 2·3V and fast charging at 1A cannot start. In this case the battery is trickle charged via R4 and IC1 pin 11 until the trigger point of 10V is exceeded.

BULK CHARGING

Once the 10V trip has been exceeded the charger enters the first stage of fast charging, called by Unitrode the "bulk charging" mode. IC1 controls the Darlington transistor TR1 so that a current flows through power resistor R1, the transistor, diode D3 and into the battery, such that the voltage

UC3906 Characteristics

Maximum Input (between pins 5 & 6 (GND))	40V
Current Sense Output (max. current (pin 1 CSout))	40mA
Trickle Charge Current (pin 11)	40mA
Max. Current in Driver Transistor (guaranteed) (pins 15 and 16)	25mA or 40mA (typical)
Driver Saturation Voltage (Min. volt between pins 16 & 15)	2·2V
Open Collector max. output currents (pins 7, 9 & 10)	2·5mA
Acceptable Input Voltages (pins 2, 3, 4, 12 & 13)	−0·3V to 40V (Note a reversed battery will cause an i.c. failure)
Internal Ref. Voltage	2·27V to 2·33V (plus compensation for temp. at −3·9 mV/°C

across R1 is 0·25V. With R1 having a value of 0·22 ohms the charging current is around 1A (0·25/0·22 allowing for component tolerances).

During this state pin 10 of IC1 is grounded, paralleling resistors R7 and R9. Thus battery B1 must reach 14·4V for the Voltage Sense input, pin 13, to reach the 2·3V reference. Additionally, during this phase, the trip point reference is reduced to 95 per cent of 2·3V by the internal workings of IC1 so that the battery has only to reach 13·7V before the next stage is entered.

When the battery reaches 13·7V the i.c. trips into the Overcharge State. The Overcharge indicator l.e.d. D2 lights and IC1 pin 10 becomes open circuit.

Now the battery must reach 13·8V before the Vsense pin 13 of IC1 reaches 2·3V as R7 no longer influences the resistor chain of R8 and R9. Also the charging now proceeds in a different way.

TRICKLE CHARGE

Initially the charge current remains at 1A, but once the voltage at pin 13 reaches 13·8V IC1 begins to reduce the charging current, holding the battery voltage at 13·8V. The current through resistor R1 is monitored by the voltage across pin 2 and pin 3 of IC1 and when the voltage across R1 reduces to 25mV (at one-tenth of the original current) an output at pin 1 trips the overcharge terminate function on pin 8.

The i.c. now enters the trickle charge state. The trip point on pin 13 now resets to 90 per cent of the reference so that the battery remains in trickle charge until the battery voltage falls to 12·4V as the battery delivers power to a load. At this voltage the bulk charge state is re-entered if the charger is supplied with mains power.

Without a load the battery is kept topped up by the trickle charge until it is needed. Plugged in, and with mains applied, the power supply can provide a current of 1A at a nominal 12V continuously and should the mains fail can deliver the same current for up to seven hours using the battery.

The transistor TR1 is a power Darlington and contains internal resistors to assist in its operation. Thus when no mains power is applied there can be sufficient current flow backwards through these to turn on the Power l.e.d. and the i.c. To prevent this and reduce the battery discharge when not in use diode D3 is included. The two capacitors C2 and C3 help with noise immunity and stability of the circuit.

UPPING THE POWER

The alternative, uprated, charger-only version, mentioned at the beginning, is used to charge higher amp-hour batteries where only the battery is to be carried due to weight considerations. Since the charger part will now be kept at home and the weight is no longer a consideration, the size and rating of the mains transformer and other power components can be increased to fit any charging current desired.

The first consideration is the charging current that you want for the battery as this controls the rest of the calculations. The UC3906 must have 17V d.c. as an absolute minimum input at pin 5 or the circuit will not operate correctly assuming that you are charging a 12V battery.

If you base the reservoir capacitor rating on 2000µF for each 1A of current required, then a.c. ripple on the unregulated d.c. and the i.c.'s minimum voltage requirements mean that the mains transformer must have an output of 16V a.c. For the model, the next available voltage, which is 18V from two windings of 9V each was chosen.

The transformer power rating in the bridge rectifier unregulated d.c. supply application is such that the rating must exceed the rectified d.c. voltage times the current used. Also, when using a higher charging current in the unit, it is necessary to change the charge detecting resistor R1, the bridge rectifier REC1 and diode D3 to higher current rating types. Likewise, the value of the capacitor C1 should be

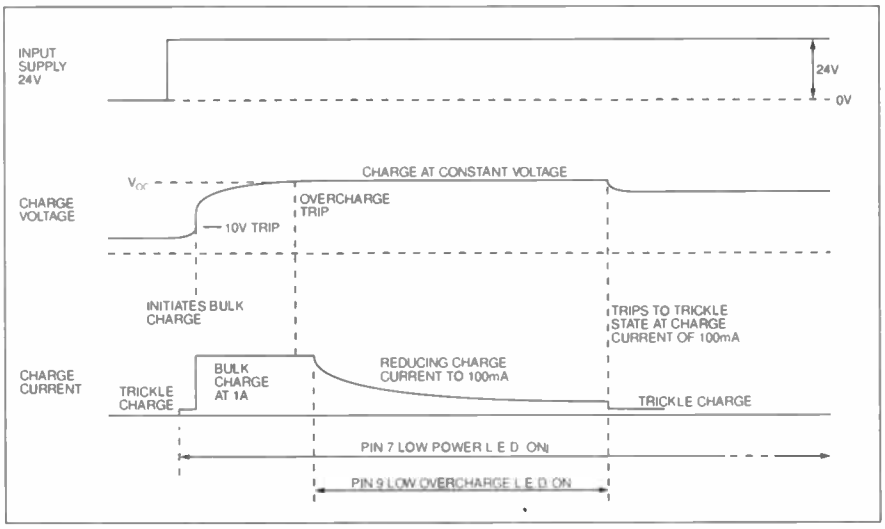


Fig.2. Typical charging voltages and current characteristics waveforms.

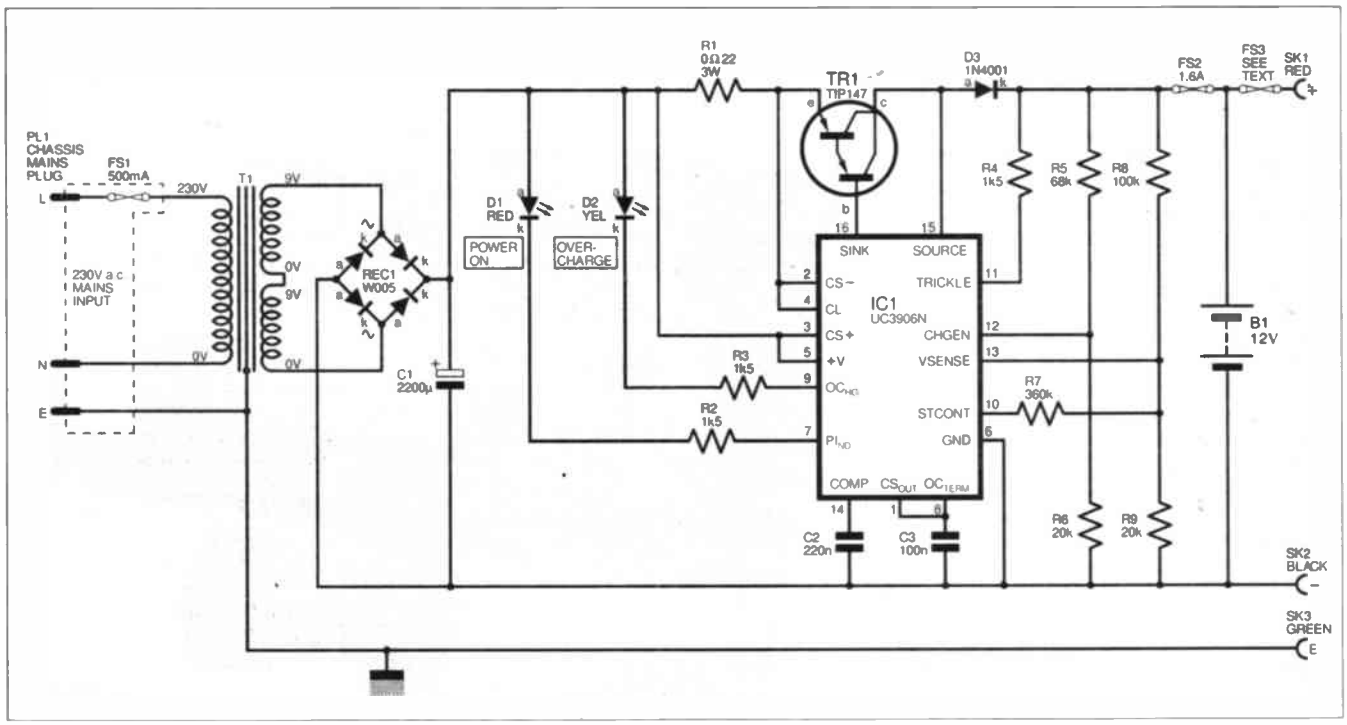


Fig.1. Full circuit diagram for the Portable 12V PSU/Charger

increased in the ratio of the current to maintain the same value of ripple on the unregulated d.c. supply.

It is recommended that in this case the high current components are mounted separately in the case, using some of the space vacated by the battery, and then hard wiring them to the p.c.b. The bridge rectifier can be soldered directly across the tags of the reservoir capacitor that replaces C1 on the p.c.b. The thick tags will prevent any movement once soldered into place.

For higher currents still, it will require a bridge rectifier that screws down onto the metal chassis/base to assist cooling. The wires from the mains transformer secondary winding(s) connect to the bridge's a.c. input tags. The bridge d.c. output is wired to the p.c.b.

trip to 2·3V by removing resistor R6, or to a voltage between 10V and 2·3V by using a higher value for R6. Remember, however, that with a low trip voltage you could end up charging a battery with one or two failed cells.

Additionally, you may wish to add an ammeter into the output from the charger circuit to indicate the actual charge current at any time.

CONSTRUCTION

The construction differences for the high current charger have been discussed above, so only the constructional details for the all-in-one Portable 12V PSU/Charger will be given. The printed circuit board topside component layout and full size underside copper foil master pattern are shown in Fig. 3. This board is available from the *EPE PCB Service*, code 173.

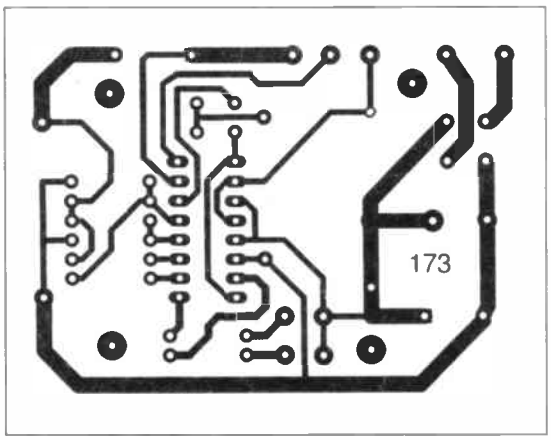
This p.c.b. contains almost all of the components, except the two l.e.d.s, the Darlington transistor on its heatsink, the mains transformer and the battery. Connections to the p.c.b. are via solder pins; the use of terminal pins make it easier to make the interwiring connections at a later stage of construction.

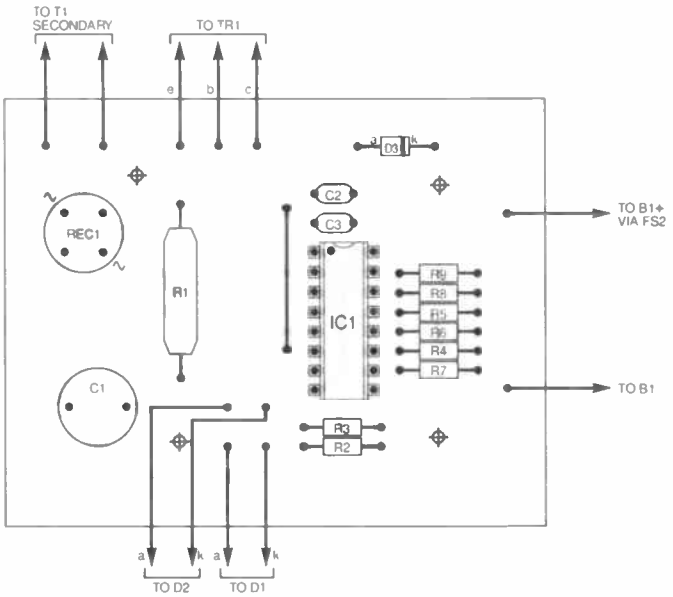
There is a single wire link on the top of the board close to IC1 pin 6.

The layout of components within the *metal* case is not critical as the charger works at d.c. and the circuit has been made stable by the two capacitors C2 and C3. The component layout and interwiring for the model shown in the photographs is given in Fig. 4.

For safety the mains input to the transformer needs to be fused (FS1). Also the output from the battery needs to have a fuse (FS3) as the gel-cell battery can deliver very high currents if a short occurs across the output. Additionally, a fuse (FS2) is placed in the output of the charger circuit to protect the battery and external circuit in case of failure of the Darlington power transistor.

Fig.3. Printed circuit board component layout and full size foil master for the Portable 12V PSU/Charger.





HIGH POWER

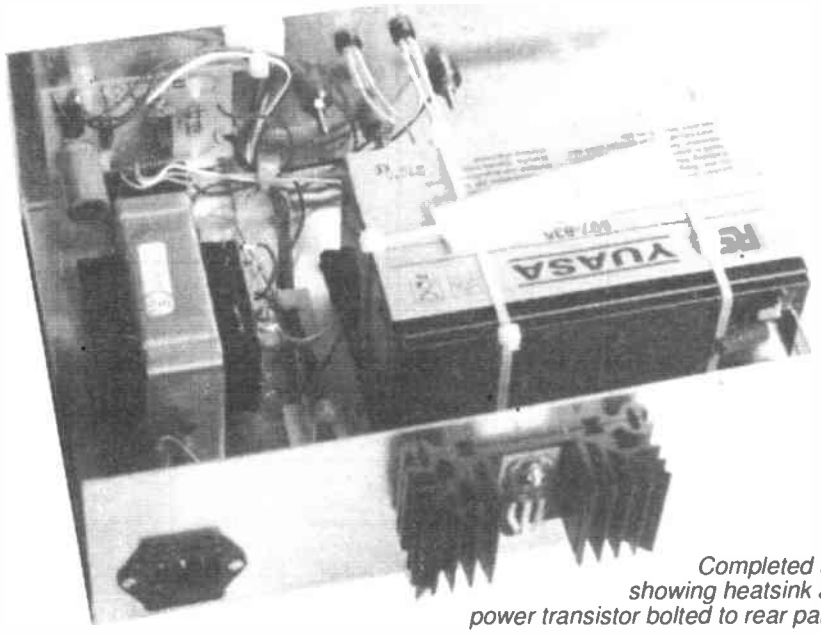
The heatsink for the upgraded power transistor needs to be rated to keep the transistor at a safe junction temperature. You will need to calculate a suitable heatsink size from the charging current you decide to use.

The other component that needs to be changed is the high current resistor R1. You will remember that the UC3906 maintains the voltage across R1 at 0·25V during bulk charging and the value of this component is fundamental in the setting of the charging current.

The lack of a range of low ohm wire-ended resistors means that the constructor will need to carefully calculate the value of R1 needed for his or her application. The next lowest value that could be found in the wire-ended range was 0·1 ohm and that will give a current of 2·5A on charge.

A better range of low value resistors is available in the 10W types that screw to a heatsink or chassis. You will not need the power rating but these types make construction of the internal wiring easy.

If the battery is completely discharged then the charger will only go into bulk charge once the trickle charge has brought the battery voltage up to 10V, and that can take a long time for a fully discharged high power battery. The option is to reduce the



Completed unit showing heatsink and power transistor bolted to rear panel.

In the prototype the p.c.b., transformer and battery are fitted inside the case, leaving a fused power input plug and heatsink with the power transistor on the rear outer panel. This leaves the red and black 4mm terminal posts/sockets for the output and the two fuseholders on the front panel.

The third green terminal post SK3, on the front panel, is a connection to mains Earth as the battery is isolated from mains by the transformer. Thus you can connect the earth terminal to the positive or negative terminal for an output voltage above or below "ground".

One of these connections should be made if the power supply is used at the same time as it is plugged into the mains to retain the charge. This is satisfactory if the unit is to be transported by car as the extra weight of the transformer and heatsink makes little difference.

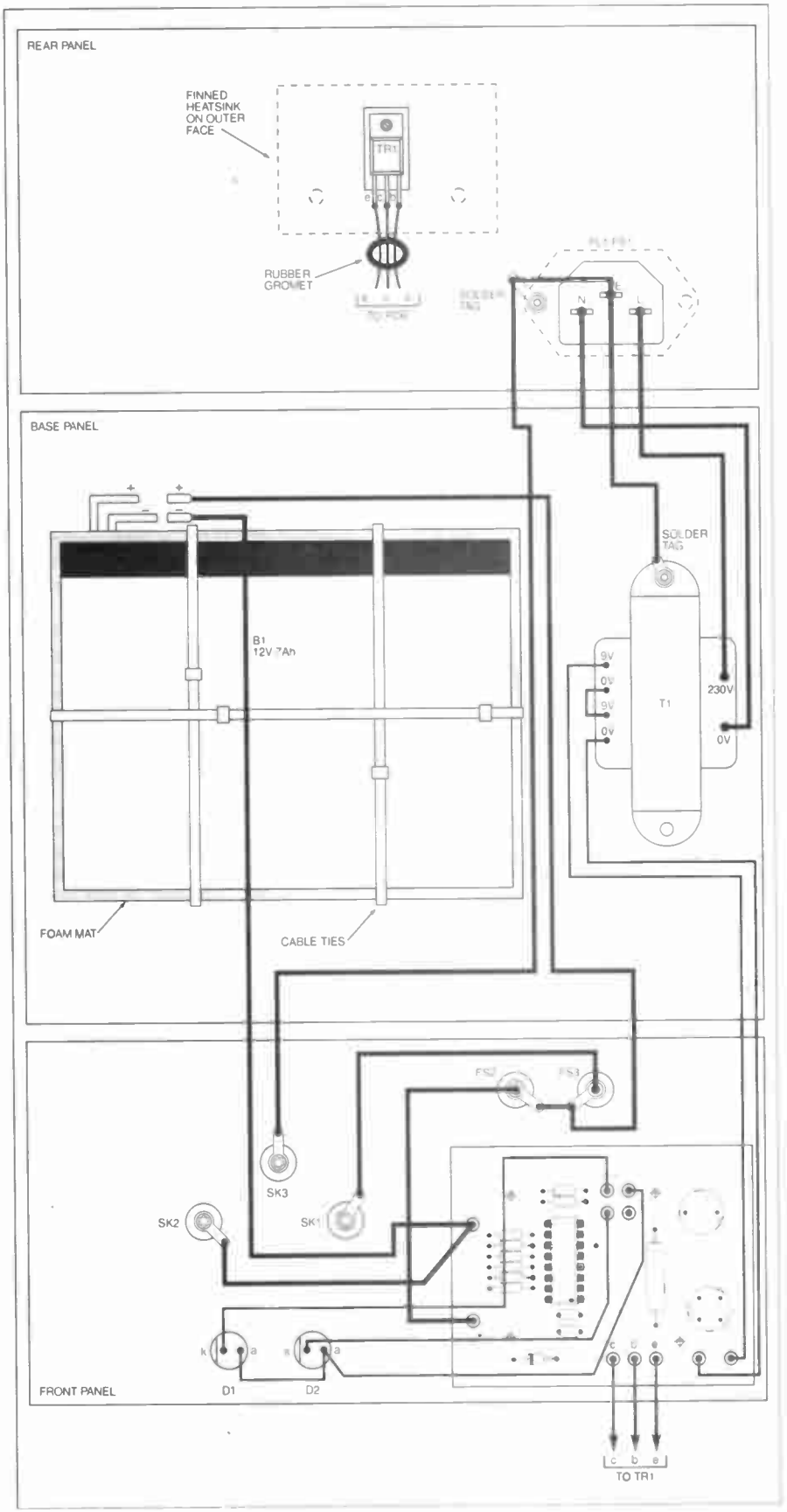


Fig.4. General layout of component and interwiring used in the model. Note, for clarity, TR1 is viewed from front, as if it is bolted on the outside rear panel.

COMPONENTS

Resistors

R1	0Ω22 3W wirewound (value to give 0·25V at charge current)	
R2, R3, R4	1k5 (3 off)	See SHOP TALK Page
R5	68k	
R6. R9	20k (2 off)	
R7	360k	
R8	100k	

All 0·25W 1% metal film, except R1

Capacitors

C1	2200μ radial elect. 35V (2000μ per amp of charge current – see text)
C2	220n ceramic
C3	100n ceramic

Semiconductors

REC1	W005 bridge rectifier (uprate for high current versions)
D1	5mm l.e.d. red
D2	5mm l.e.d. yellow
D3	1N4001 50V 1A rect. diode (uprate for high current versions)
TR1	TIP147 *pnp* power Darlington transistor on heatsink (uprate for high current versions)
IC1	Unitrode UC3906

Miscellaneous

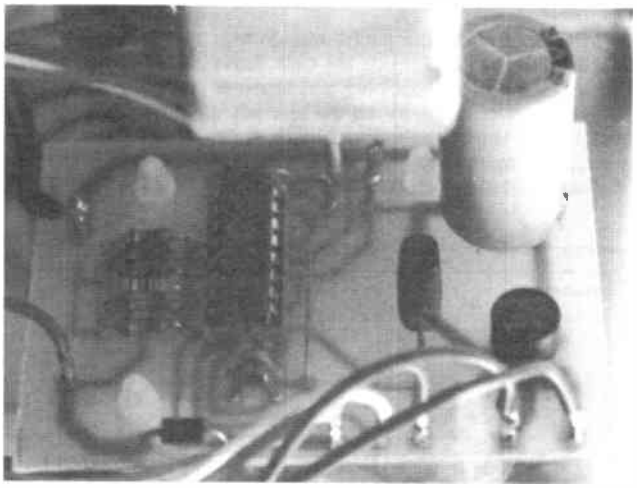
B1	12V 7Ah sealed lead-acid (gell-cell) battery (Yuasa NP7-12 or similar)
PL1/FS1	Mains input chassis mounting plug, incorporating fuseholder and 0·5A fuse
FS2	20mm chassis mounting fuseholder, with 1·6A fuse
FS3	20mm chassis mounting fuseholder, safety fuse selected for output-current (keep rating as low as possible to protect powered equipment)
SK1 to SK3	4mm screw terminal post: red, black and green
T1	230V mains transformer, 18V secondary (2 x 9V windings) 50VA

Printed circuit board available from *EPE PCB Service*, code 173; vinyl covered aluminium case, size to choice; plastic handle for case; 16-pin d.i.l. socket; finned heatsink, 3°C/W; mica insulating washer and heatsink thermal compound for TR1; single-sided solder pins (11 off); solder tags; crimp-on spade terminals for battery connections; *multistrand connecting wire; optional ammeter, rated for charge current; self-adhesive p.c.b. pillars (4 off); cable "tywraps" to secure battery and wiring looms; solder etc.

**Note higher rated heavy-duty wires will be needed for the battery to output sockets if the battery is expected to supply high current outputs. Rest will be standard hook-up wire*

Approx Cost Guidance Only £39 excluding battery

Compact layout of components inside metal case.



Components on completed p.c.b. Power resistor R1 should stand proud of board.

ASSEMBLY

In the prototype the battery is held in place with a set of tywraps that go through holes in the bottom of the case and around the battery. Between the bottom of the battery and the metalwork is a thin piece of foam rubber that prevents damage to the battery's plastic case should it move in the tywraps. The transformer sits next to the battery balancing its weight.

The p.c.b. is mounted on a set of self-adhesive stand-offs that stick it to the rear of the front panel, towards the top left-hand corner, whilst the heatsink and input plug fit into the rear panel. Since the battery has push-on terminals and it is rather difficult to make some of the solder connections with the battery in place it is easiest to leave fitting the battery until last.

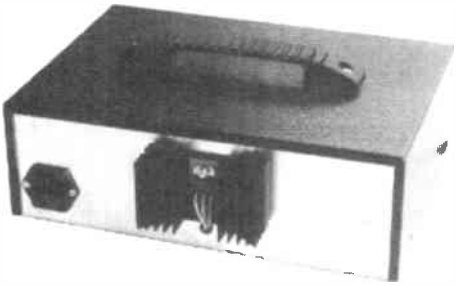
Drill and cut the rear of the case for the mains input chassis plug and the mounting screws for heatsink, adding a hole for the wires to the transistor below the heatsink. There are two holes for the l.e.d. indicators, two holes for the fuses and three holes for the 4mm output screw terminal connectors on the front panel. The bottom of the case has holes for the mains transformer mounting screws and, if required, four holes for the battery tywraps.

Fit the output connectors and the fused mains connector. Take the power transistor and solder three long insulated wires to the pinout leads so that connections to the p.c.b. can be made later. Push heatshrink sleeving over the transistor connections and heat it so that it contracts down.

Attach the transistor to the heatsink with an insulating washer and plenty of heatsink thermal compound. Then attach the heatsink to the prepared rear panel taking the wires through the hole provided, making sure that you include a rubber grommet to protect the wires. Stick the p.c.b. onto one of the panels using the nylon self-adhesive p.c.b. pillars.

The mains input, chassis mounting, connector PL1/FS1 has its own internal fuse, so take wires from the Live and Neutral terminals to the transformer primary windings. A connection from the Earth terminal should go to the ground connector solder tags under one of the transformer mounting nuts and the mains input plug fixings. This ensures a safety connection to the metal case of the supply. Remember the only other connection to this earth is the green 4mm output terminal SK3 on front panel.

Connect the transformer secondary winding(s) 18V a.c. output leads to the p.c.b. as shown in Fig. 4. This may require the linking of a centre tap connection on the transformer. Wire up the two l.e.d.s to their relevant solder pins on the p.c.b. Then connect the long transistor wires prepared earlier to their pins on the p.c.b. Be careful with the polarity of the l.e.d.s and the transistor.



Power transistor and heatsink on rear panel.

The negative output solder terminal on the p.c.b. should have a black lead terminated with a push-on, spade type, connector for the battery and another black lead to the black 4mm output terminal SK2. The connection from the positive p.c.b. pin is more complicated. The output passes first to fuse FS2 then to the battery. An output wire from the battery passes through fuse FS3 then to the red output 4mm terminal SK1, see Fig. 4. **You must be careful to rate the wires from the battery to the output terminals for the expected output current.**

The neatness of the layout can be enhanced by routing the cables through stick down pads and tywraps.

The same order of construction applies to the charger unit with an external battery.

HIGH CHARGE VERSION

If the high current version is preferred, where the battery is kept separately, the unit can be constructed containing just the transformer, heatsink and p.c.b., with the same 4mm output terminals for the battery. The gel-cell battery has push-on flat terminals so if we retain the 4mm output plugs then charging adapters can be made.

With higher power batteries you can accept the 1A charge, although a 24AH car battery will take about a day to charge after a deep discharge, or calculate the values for a higher charging current as discussed earlier.

An almost identical layout for the battery-less unit can be adopted. Additional input pin holes are provided on the printed circuit board, next to resistor R1 and between capacitor C1 and bridge rectifier REC1 for a high current d.c. input as discussed earlier. Capacitor C1, REC1 and the high wattage resistor R1 become off-board components.

Do NOT be tempted to try to leave out the fuses FS1 or FS2, with an external battery FS3 becomes an in-line fuse in the battery adaptor cable. It is possible for the adaptor's spade terminals to touch and cause an accident. A friend succeeded in having a fire in a battery pack because he left the fuse out. ***YOU HAVE BEEN WARNED***

An ammeter can be fitted between the fuse from the power transistor and the output 4mm terminal to monitor the charging rate. The fuse in this case also protects the ammeter from damage. The battery alone delivers 12V by 7A, i.e. 84 watts and it can keep this up for one hour.

TESTING

There is very little to test on the circuit after construction and a careful check of the wiring. When powered up there should be approximately 24V across the p.c.b. negative output solder pin and either of the l.e.d. anode p.c.b. pins. If this voltage is above 5V then the Power On l.e.d. D1 should be on.

Check across the output terminals as that is equivalent to a battery voltage test. If this is above 10V and the Overcharge l.e.d. D2 is *off*, there should be a voltage of either 250mV or zero across resistor R1 as the supply is either in the "bulk charge" or "trickle" charge modes. If D2 is *on* then there should be between 250mV and 25mV across R1 as the circuit is in the Overcharge mode.

Such is the versatility of the UC3906 that it can charge battery packs up to 36V and at currents that are controlled by the external components. The limitation of the circuit is your ideas.

You can contact the author of this project by E-mail: **david.silvester@xtra.co.nz** □

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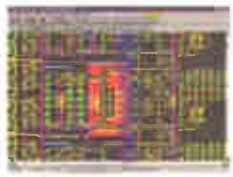

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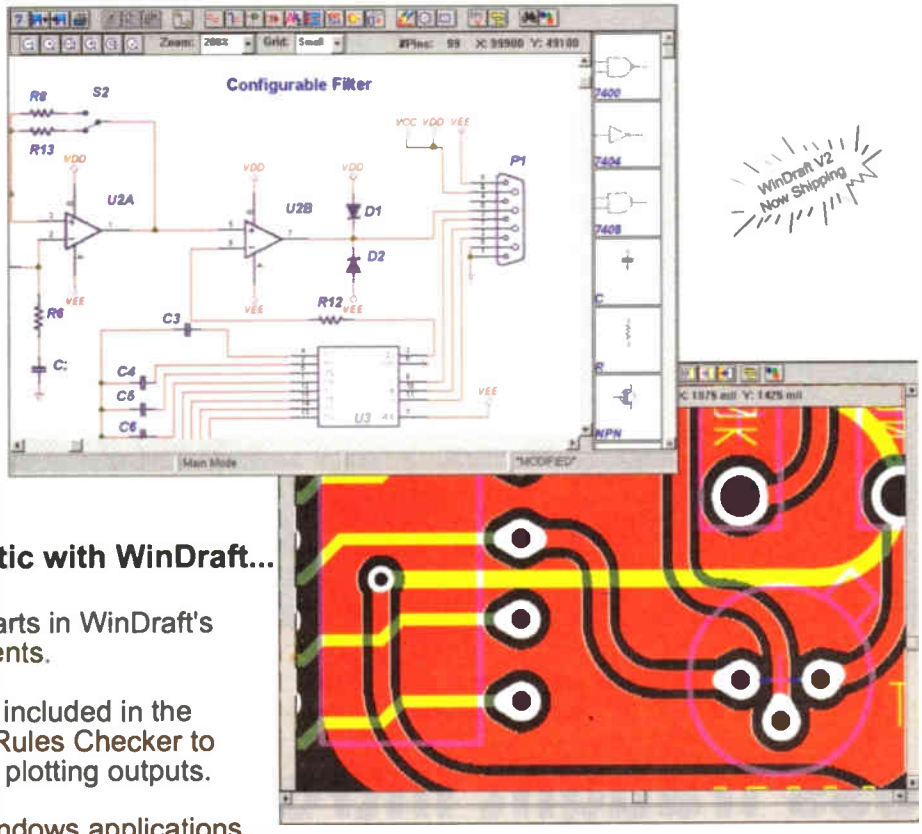

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Innovations

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

BERLIN INTERNATIONAL RADIO SHOW

Barry Fox reports on the latest consumer electronics equipment on display at Berlin's *IFA '97* exhibition.

THE *Internationale Funk Ausstellung* '97 exhibition drew 812 exhibitors and 41 TV and radio networks from 33 countries to Berlin in early September. The show grounds now straggle over 130,000 square metres – the size of a small town.

There is still no trade day and the 26 halls and grounds are soon so packed that it is impossible to move between appointments; and the show still belies the "Internationale" in its name. Company speeches and statements centre on German sales figures and many companies still supply written information only in German.

Telecommunications was promoted as the "key subject" of the show, but the press room could provide only a few phone lines with only one working socket which allowed a standard modem jack to plug into the decidedly non-standard German phone sockets.

DIGITAL VIDEO

DVD, the Digital Video or Versatile Disc, dominated the show, with all major manufacturers now promising a pan-European launch in Spring 1998 – traditionally the worst time of the year to launch a new home viewing product. The promises followed a last minute deal, brokered by Warner and Philips, to make MPEG-2 the standard for multichannel sound in PAL countries instead of Dolby Digital AC-3 as used elsewhere in the world. Making MPEG-2 the standard reinforces the Regional Coding system which seeks to stop people in Europe playing American discs.

But the deal may not be as firm as it looks. Within hours, Ray Dolby of Dolby Labs was saying that he was "convinced and confident" that the Dolby Digital AC-3 system would eventually become the *de facto* standard for PAL, as well as NTSC. Dolby's engineers were soon reminding that the PAL disc could carry two sound tracks, one in MPEG-2 and one in AC-3.

Philips, Panasonic and Sony have all promised players which can decode either sound system.

Just ahead of the Berlin show, news broke that Sony and Philips, backed by computer company Hewlett Packard, had broken away from the agreed standard for DVD-RAM (a recordable/erasable version of DVD). Neither Philips nor Sony has yet issued the promised statement on why they object to the standard which they agreed to earlier this year, after 14 months of negotiation.

This has spurred other members of the DVD Forum to push ahead with the launch of DVD-RAM systems which conform to the standard. At IFA Hitachi, the company who chaired the DVD-RAM standards committee, was showing a PC fitted with DVD-RAM drive and playing back recordings of MPEG-1 and MPEG-2 video.

Hitachi sees DVD-RAM primarily as a carrier for PC data, or MPEG-1 video which has a fixed data rate of a under 1·5 Mbit/second; it can store 200 minutes of MPEG-1 per side. For MPEG-2 recording, with higher and variable bit rates, Hitachi recommends the new D-VHS format which has a data capacity of 40 Gigabytes per tape. Most of the companies which currently sell VHS recorders were also showing D-VHS models or prototypes at IFA.

Panasonic's first Notebook with DVD-RAM player.

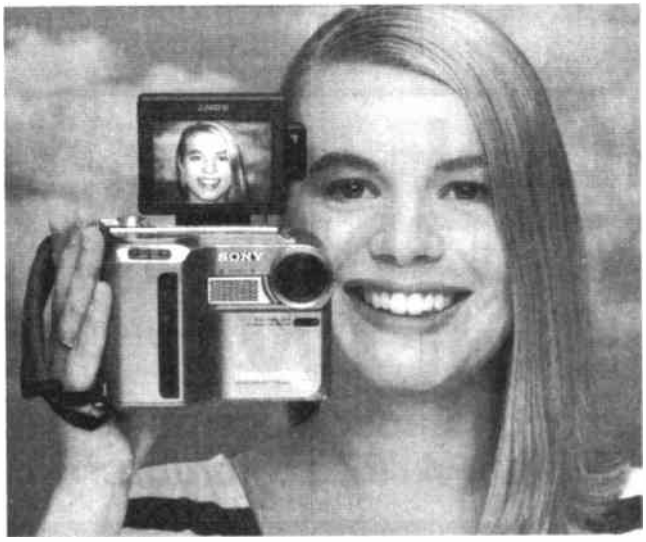
MINI DISC WAR

Five years after the DCC-versus-Mini Disc battle to set a new standard for home audio recording, Philips and Sony are again at war. Sony still pins faith on Mini Disc; Philips has long since abandoned DCC and is now promoting recordable CD.

Kei Kodera, President of Sony's Consumer Group in Europe, says he expects to sell one million MD recorders and players in Europe this year. In October Philips will launch a CD recorder for under £500. Blank 74 minute write-once discs, which will play back on any of the 500 million CD players already sold around the world, will cost only £3 – little more than a blank tape. Re-writeable (erasable) discs will cost £18 and play back only on a CD recorder or new generation CD player.

Philips acknowledges that MD erasable blanks cost only around £7 but reminds that they are wholly incompatible with CDs. "This year another 175 million CD audio and ROM drives will be sold," says Jan Oosterveldt, Philips'

Senior Director for Corporate Strategy. "By the year 2000 they will be selling at a rate of 250 million a year, of which 25 million will be DVD drives which are capable of playing CDs."



Sony's DCR-SC100E DV camcorder, equipped with 180,000 dots, 3-inch precision l.c.d. monitor, also enables infrared transmission of both video and audio.

DIGITAL PHOTOGRAPHY

Digital photography was as ubiquitous as DVD. Virtually every manufacturer now offers a camera which records still pictures in a solid state memory, either fixed inside the camera or on a removable card. The only real novelty was Sony's *Mavica* which sidesteps the high cost of memory chips by recording the digits onto a PC standard floppy disc.

This builds on Sony's original *Mavica* of ten years ago, which recorded analogue still onto non-standard disc and was a commercial flop. The advantage is lower cost storage and easy transfer to a PC; the disadvantage is a larger camera body and slower access to stored pictures.

DIGITAL AUDIO BROADCASTING

IFA 97 had for two years been targeted as the consumer launch for DAB. A DAB display platformed all receivers available from a wide range of manufacturers. "DAB has really arrived" said David Witherow, President of the World DAB Forum, at a reception called to celebrate the consumer launch of DAB and "mark a moment in broadcasting history".

"It's a great day", said Glyn Jones, the BBC's DAB Project Director.

But most of the fifteen DAB radios gathered together by the DAB Forum turned out to be prototypes, with the car units built in two boxes, like CD changers, connected to small dashboard control units. Panasonic had a table top receiver, but no price or delivery date; likewise for two-box car units. Technisat promises a PC card and Sharp and B&O have prototype rack systems. Bosch was showing a single box unit for dashboard mounting – albeit in a large slot.

"Where and when can I buy one, and for how much?" I asked several Bosch personnel, but got only very evasive replies.

Julie Unsworth Coordinator of the World DAB Forum is a whole lot more realistic than the Forum figureheads. "Bosch promised to be ready for IFA, and now promise October. We hoped for a price of 1000DM. Now they talk about 1700DM, and that probably means 2000DM."

Unsworth agrees that mixed signals are coming out of the manufacturers. It even depends on who you talk to inside a company. "Some are overly positive – some unduly negative", she admits. "Someone from Bosch may tell you they are ready tomorrow, while someone from Philips will tell you never. Talk to someone else from the same company and they will say the opposite. What we at the Forum want is a clear message."

DAB was a lot less noticeable on individual manufacturers' stands, with company spokesmen cagey over plans for the high street. Sony could give no price. Next year, said Philips. Others thought *IFA 1999* might be the real launchpad for the mass market. "DAB has got a bit lost in the noise over DVD" admitted a member of the DAB Forum.

The message is muddled because some manufacturers and marketing managers see DAB as a risk to sales of RDS, which offers self-tuning and traffic-announcement on analogue radios and now puts only around $3 on the manufacturing cost of a car radio; others see RDS as a feature which no longer commands a worthwhile price premium, like teletext on a TV set, and is ripe for replacement.

Whatever the reasons, the fact remains that two years after the BBC's clumsy "launch" of a DAB service, there are still no DAB radios for consumers to buy.

HIGH SPEED TV

Every IFA has its oddity. This year German broadcasters revealed that they had made an important discovery. The digital TV system for Europe, called DVB because its was developed by the Digital Video Broadcasting Group, was designed to give very reliable reception even on a very simple set-top aerial made of bent wire.

Because the signal is so robust it can be received on the move by a mobile TV set. German engineers first put a receiver in a van and drove it round the city. The pictures came through loud and clear. So one enterprising boffin tried it in a sports car. There are no speed limits on German motorways and he was still getting clear pictures at the car's top speed of 220 km/hour. Just before the show opened a colleague borrowed a Bugatti and clocked 320 km/hour while the passenger watched TV. This, the Germans claim, is a world record.

It may or may not be coincidence that German taxi drivers now have laptop computers bolted to the dashboard, to display a route map and log fare charges.

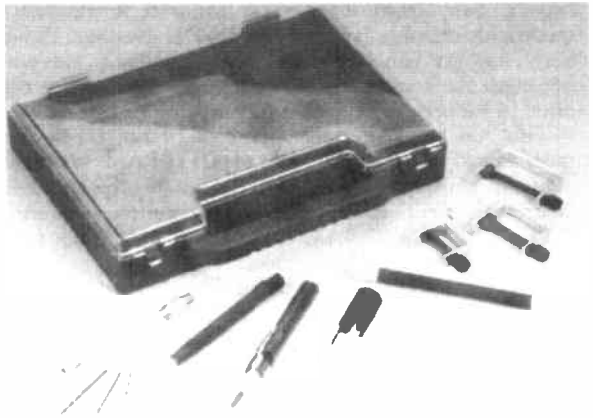
HAND TOOL KIT

MINICRAFT has introduced a new 8-piece hand tool set, order code MH811. Each tool has been selected to give maximum use when doing precision work such as model making, craftwork, electronic project construction and other small DIY tasks. The kit comprises:

* Three mini clamps with grip sizes up to 20mm, 30mm and 40mm
* Optical tweezer for holding and viewing small components
* Abrasive pencil for fast cleaning of metal and plastic, having a glass fibre tip with propelling action
* Softy knife for more control and extra comfort when cutting; uses quick-release blades
* Precision lubricator
* 4-jaw mini holder – equivalent to four individual pin vices

The kit also includes eight accessories and comes in a tough plastic case. It has a recommended retail price of £24·99.

For more information, plus a free catalogue and list of stockists, contact Minicraft, Macford Products Ltd., 1 & 2 Enterprise City, Meadowfield Avenue, Spennymoor, Co Durham DL16 6JF. Tel: 01388 420535. Fax: 01388 817182.



NEW LOOK KITS

NEW packaging for Maplin's range of electronic project kits has been introduced. The packaging has been designed to reflect the quality and diversity of the projects and "ready to integrate" modules in Maplin's range. It has been developed to make the products more eye-catching and easier to find in the 40 Maplin and three Mondo stores throughout the country.

"Our packaging must help us communicate that modern technology and components make it possible for hobbyists to construct projects which were technologically impossible a few years ago," explained Rob Ball, Maplin product group manager for projects and modules. "We've made it more colourful and informative in a bid to explain that our project range can open up a whole new world for electronics enthusiasts."

By the way, Maplin are about to introduce some *EPE* projects into their range of kits.

The new edition of the bi-annual Maplin MPS catalogue is now available. To get your hands on it, pop into your local Maplin store or Mondo Maplin Superstore, WH Smith or John Menzies. Alternatively, you can order your copy by phone: 01702 554002.

Incidentally, did you know that Maplin celebrates its 25th anniversary in October?

Maplin Joins AFDEC

MAPLIN has become the first mail order and retail based electronics company to be accepted as a member of AFDEC, the Association of Franchised Distributors of Electronics Components.

As the industry's trade organisation, AFDEC represents the business interests of franchised component distribution in the UK. The association aims to promote the benefits of quality products, high standards of service and best business practices to customers through a franchised distribution network.

Acceptance to AFDEC means professional recognition in the component sector. Customers can continue to be assured of receiving the high level of service together with competitively priced, good quality product ranges that they have come to expect from Maplin.

Pineapple PICS Basic

ARIZONA Microchip's range of PIC microcontrollers offers many facilities and great value, but for the inexperienced programmer, or constructor working on a one-off project, the task of writing and debugging many lines of assembly language can be daunting.

MicroEngineering Labs' PicBasic Compiler could well provide such readers with an alternative solution – to write the PIC code in Basic! Many readers will be familiar with Basic in its various dialects, and now it's possible to program a wide range of PIC chips in this straightforward and easily understood language.

After writing the code using simple "English-type" commands on any text processor (such as *Notepad* in Windows, or *Edit* in DOS), the compiler produces machine code ready for programming into any of the standard PIC chips, including the PIC16C84.

The MEL PicBasic Compiler is a DOS command line application (it also runs under Windows 95 and 3.1) and runs on a PC compatible computer. It includes a comprehensive printed manual and costs £69·95 (plus £2·50 handling charge per order. It is distributed in the UK by Pineapple Presentations, 30 Breckhill Road, Woodthorpe, Notts NG5 4GP. Tel: 0115 903 1851. Fax: 0115 903 2172. MEL's website is at: http://www.melabs.com/mel/pbc.htm.

AMS '97 SHOW

THE AMS '97 Computer and Electronics Show takes place on Saturday 8 November 1997 at Bingley Hall, Staffordshire Showground, Weston Road, Stafford. Doors open 10am to 4pm, entrance £3, concessions available. Masses of stands, free parking, licensed refreshments, meals and cafeteria.

For more information, contact Sharon Alward, tel: 01473 741533. Fax: 01473 741361.

Hand-Held Scope

OVER the years, oscilloscopes have become smaller and lighter. The latest development in the field, OsziFox, has just become available from Pico Technology. It is an astonishingly small digital storage scope in a housing scarcely longer than a pencil, and about as thick as a thumb.

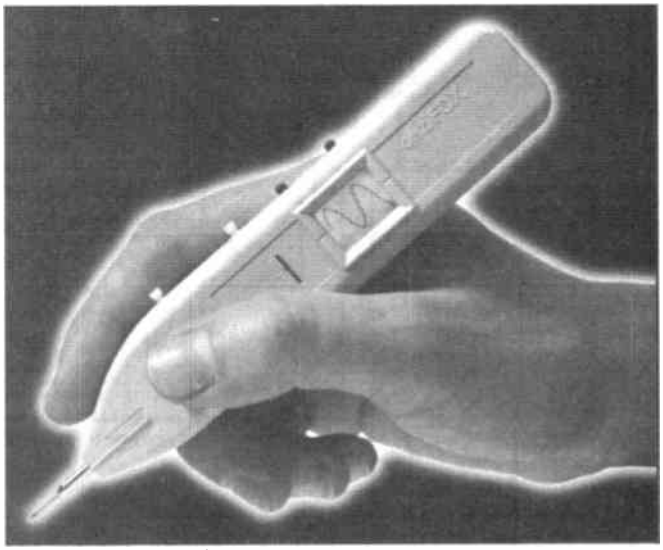
Based on the latest "scope on a chip" technology, OsziFox has features that rival those of a benchtop scope. Its sample rate of 20MS/s means that even microprocessor signals can be viewed on its back-lit display. A press of a button converts the display into meter mode allowing a.c. and d.c. voltages to be easily measured.

As well as its stand-alone use, OsziFox can also be connected to a PC using the supplied serial cable. This allows signals to be simultaneously viewed on a PC screen. For documentation, waveforms can also be saved to disk or printed.

OsziFox is available direct from Pico priced at £80 plus VAT, including cables and software. This low cost, together with the unit's small size, makes it ideal for any electronics technician who needs the ultimate in portability.

A demo version of the software (both Windows and DOS versions are supplied) can be downloaded free of charge from Pico's website.

For more information, contact Pico Technology Ltd., Dept *EPE*, Broadway House, 149-151 St Neots Road, Hardwick, Cambs CB3 7QJ. Tel: 01954 211716. Fax: 01954 211880. E-mail: post@ picotech.co.uk. Web: http://www.picotech.com.



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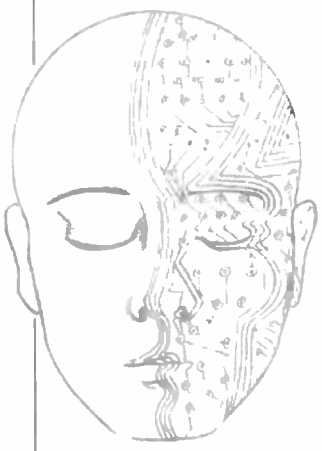
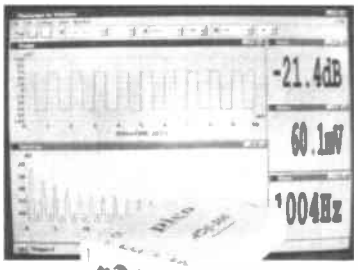


Our regular round-up of readers' own circuits. We pay between £10 and £50 for all material published, depending on length and technical merit. We're looking for novel applications and circuit tips, not simply mechanical or electrical ideas. Ideas *must be the reader's own work* and **not have been submitted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

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



WIN A PICO PC BASED OSCILLOSCOPE

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

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

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

A.C. Resistance Bridge –

DEPICTED in Fig. 1 is a bridge circuit which utilises a miniature "transistor driver" transformer to allow the measurement of input and output impedances of amplifiers, where it is not possible to take the measurements directly with a multimeter because there is no d.c. path. The circuit was used to measure the resistance of moving coil meters without wrapping the meter's needle around the end-stop!

To use the circuit, an audio source is connected to socket SK4. The source can be a sinewave oscillator or even a speech or music signal. A crystal earpiece is connected to SK3 and acts as a detector. VR1 is a logarithmic potentiometer which is adjusted until the signal heard in the earpiece is at a minimum. The value of the "unknown" resistance may then be read by a multimeter across the External and Screen terminals.

The transformer arms balance within at least 1% accuracy, even when cheap transformers are used. In order to measure very low resistances, VR1 is set to maximum value and a 100 ohm or 1 kilohm potentiometer placed in parallel with it.

Walter Gray, Farnborough, Hants.

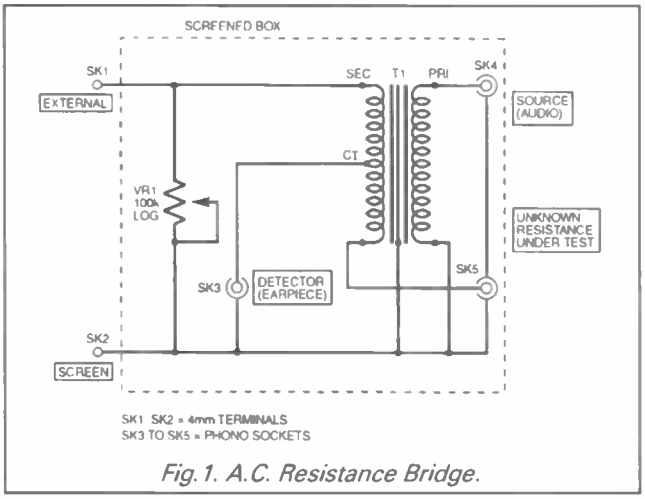


Fig. 1. A.C. Resistance Bridge.

ESP Conjuring Trick –

THIS clever magic trick circuit (see Fig. 2) will delight and astound! Here's how it works: the conjurer shows the audience a mysterious black box, which contains a triangular-shaped receptacle within. The receptacle may hold one of three coloured triangles – red, green or blue.

A member of the audience is invited to secretly select a triangle of the desired colour, insert it into the box and close the lid. Then through special extra-sensory powers, the conjurer reveals the contents of the box!

In fact, the box's contents are revealed by means of an l.e.d., which sends a code as follows: 1. l.e.d. off – box empty. 2. l.e.d. on – red triangle. 3. l.e.d. quickly pulsating – yellow triangle. 4. l.e.d. slowly pulsating – blue triangle.

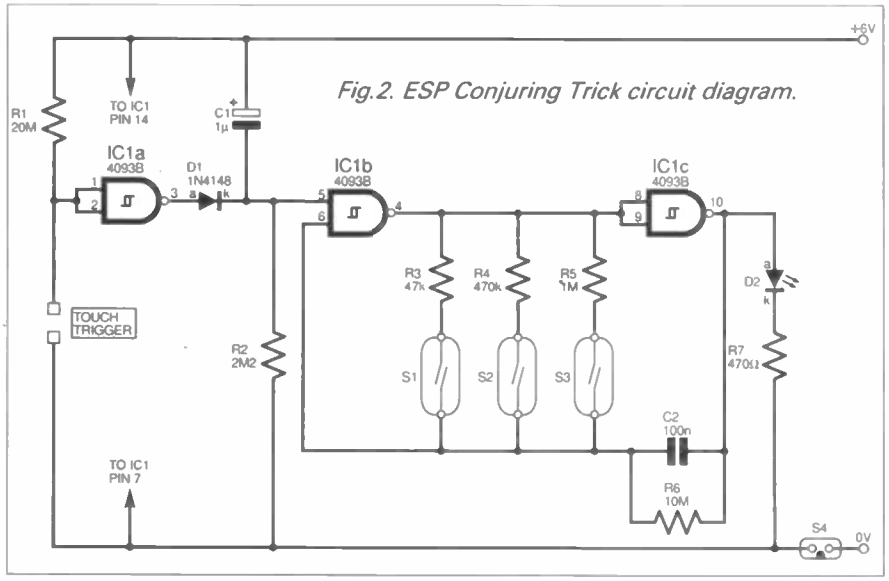


Fig.2. ESP Conjuring Trick circuit diagram.

The l.e.d. is unlikely to be detected by the audience because it is triggered only briefly when the conjurer touches two strategic points on the box, and it also shines through the tiniest of holes, smaller than a pinhole. Each of the triangles hides within it a small magnet located at a different corner for each triangle.

For the trick to work, the triangles must be isosceles-shaped so they can only fit one way into the box. Each magnet closes a different reed switch when placed in the receptacle.

In Fig. 2, when power is applied, capacitor C1 is charged through resistor R2. When the two "trigger" touch pads connected to the Schmitt NAND gate IC1a are touched, IC1a goes high which discharges C1 and starts the timer based around C1/R1. This enables the flasher circuit built around IC1b/IC1c for one to two seconds.

The frequency of the flasher is determined by resistors R3 to R5, which are selected by S1 to S3, a series of strategically-placed magnetically-operated glass reed switches. The l.e.d, D2 will therefore flash a code which is determined by whichever reed switch is closed by the hidden magnet.

Since no power switch should be visible, power is only applied when the tilt-operated switch S4 is closed. Two CR2032 lithium cells were used and the circuit is powered off when the box is laid on its back. The original box was square (10cc) with the three reeds hidden under the triangular impression. The two "trigger" points may be made from two pins sticking through the sides of the box.

Rev. Thomas A. Scarborough, South Africa.

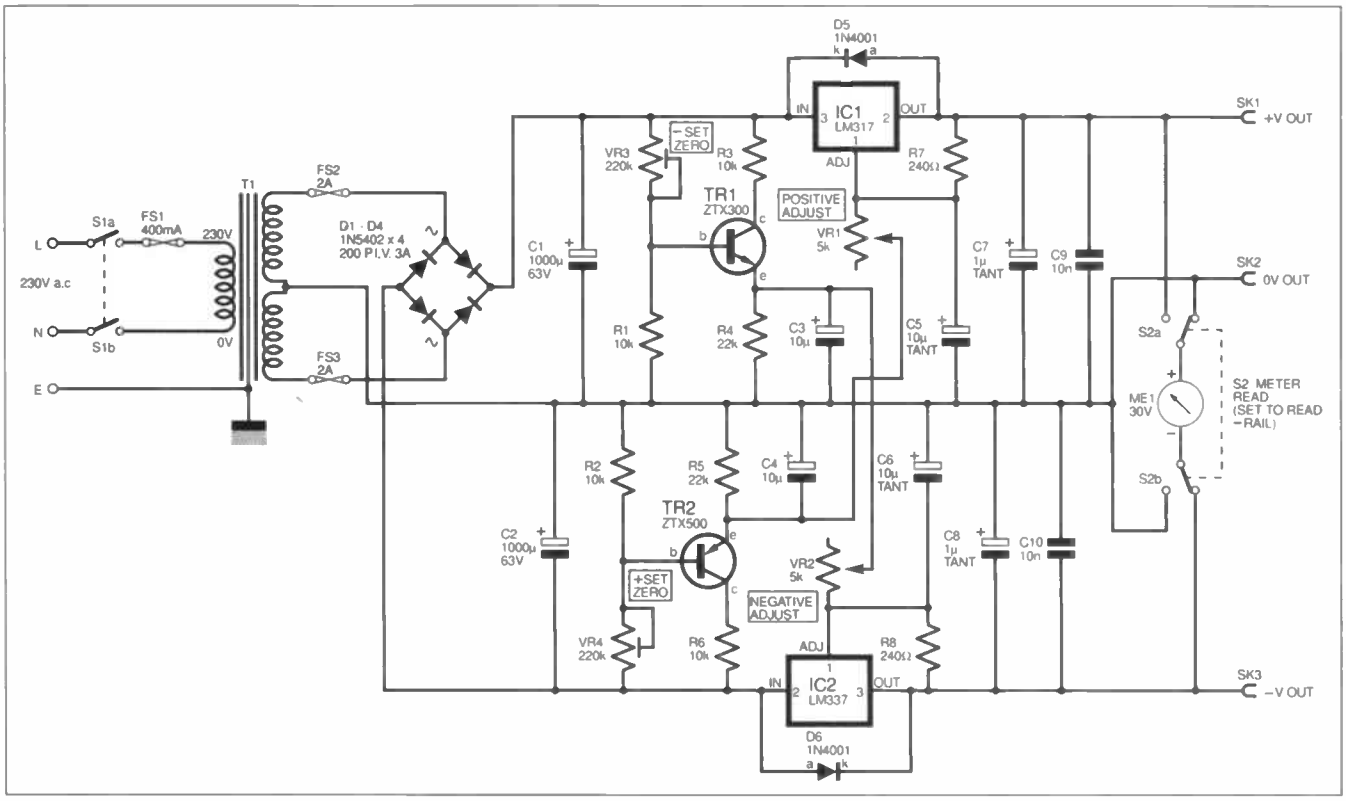


Fig.5. Circuit diagram for the 30V Split Power Supply.

30V Split Power Supply –

CIRCUIT diagram Fig. 5 illustrates a complementary-output power supply which offers ±30V d.c. at up to 1·5A. It is based around a pair of three-terminal voltage regulators (IC1 and IC2), type LM317 and LM337 which offer positive and negative voltage regulation respectively.

Normally, the minimum output of such types is 1·2V d.c. but by suitably biasing the "adjustment" pin it is possible to obtain a full sweep from 0V. This is achieved by taking a negative voltage from transistor TR2 to bias IC1, an LM317 positive regulator, and a positive bias voltage from transistor TR1 to the adjustment pin of IC2, an LM337. The controls VR1 and VR2 set the output voltages.

The switch S2 is a break-before-make changeover type which allows a single voltmeter ME1 to display the output voltage of either rail. If it is expected to use the power supply at higher currents, then the current ratings of mains transformer T1 and the bridge rectifier D1-D4 should be uprated to allow for this. It is advisable to mount the regulators IC1 and IC2 on generous external heatsinks, otherwise they will thermally-shut down at higher outputs. They will automatically current limit at approximately 1·5A maximum, depending on their junction temperatures.

Dave Stringwell,
Scunthorpe, North Lincolnshire.

INGENUITY UNLIMITED

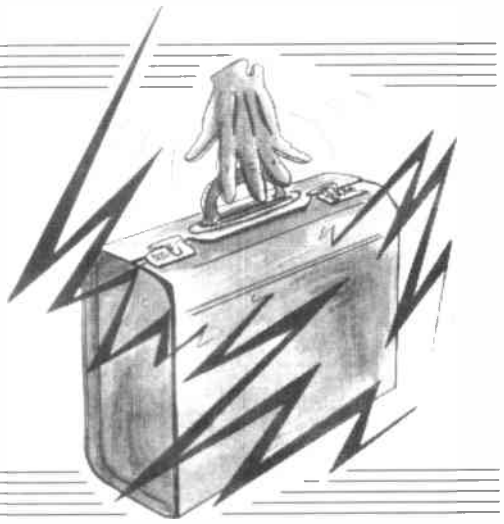
BE INTERACTIVE

IU is *your* forum where you can offer other readers the benefit of your Ingenuity.

Share those ideas and earn some cash and a prize!

Constructional Project

CASE ALARM



ROBERT PENFOLD

Protect your valuables with this low-budget, self-contained "trembler" alarm.

THIS low-budget project is a small and completely self-contained alarm which is activated by movement. Its main role is as an alarm for use in a case or bag that contains camera equipment, cash, or other valuables.

The basic idea is for the alarm to be switched on whenever the case is left at rest for more than a few moments. The alarm is immediately activated if anyone tries to make off with the case, and a loud frequency modulated alarm signal is produced. The alarm would probably be triggered by someone rummaging around inside the bag, but it is definitely not a good idea to leave a bag open so that valuables can be quickly and easily removed.

Alarms of the "tremble" type do have other applications, and they are used with practically any expensive piece of electronic equipment. This includes such things as computers, video equipment, and hi-fi gear.

Obviously, a burglar might decide to make-off with the equipment, complete with the activated alarm. In reality though, most thieves will lose their nerve in a situation of this type, and leave empty handed.

The unit incorporates a simple timing circuit which prevents it from being accidentally triggered at switch-on, or while it is being tucked away inside the bag. The stand-by current consumption is very low, enabling the unit to run continuously for months from a humble PP3 size battery.

VIBRATION DETECTION

Mercury switches are the most common choice for applications where movement must be detected. However, ordinary mercury switches are less than ideal for an application of this nature.

A normal mercury switch consists of a small container made from a non-conductive material. Two electrodes are fitted inside the container, which is partially filled with mercury. At certain orientations the mercury bridges the electrodes and closes the switch, while at other orientations it only touches one electrode and the switch is open.

Although usable in this application, a normal mercury switch is awkward to use as the alarm must have a suitable orientation if the alarm is to have good sensitivity. False alarms or poor sensitivity are likely to result if the orientation is slightly wrong.

There is an alternative type of mercury switch that has a more complex electrode arrangement and a smaller amount of mercury. It is designed so that the mercury never quite bridges two electrodes when the switch is static, whatever orientation it is given. Movement spreads the mercury slightly, and momentarily bridges the two electrodes.

The orientation of this type of switch is unimportant, making it much easier to use in the present application.

SYSTEM OPERATION

A block diagram for the Case Alarm is shown in Fig.1. The vibration switch can not be used to control the alarm generator directly, as it only provides intermittent contact. Also, once the movement has ceased, it does not even provide intermittent contact.

The vibration switch is therefore used to trigger a bistable, or "latch" as this type of circuit is also known. The output of the latch is set high at switch-on by a simple *C-R* timing circuit.

Apart from ensuring that the output of the latch starts at the right state, this circuit also provides a hold-off for a few seconds so that the unit will not be triggered if it is moved slightly as it is switched on. Once this hold-off has ended, activating the vibration switch sets the output of the bistable low, and it then remains in that state, whether the vibration switch is open or closed.

The bistable controls a low frequency oscillator (l.f.o.) and a voltage controlled oscillator (v.c.o.), and these are both switched on when its output goes low. The l.f.o. has an operating frequency of about two or three Hertz.

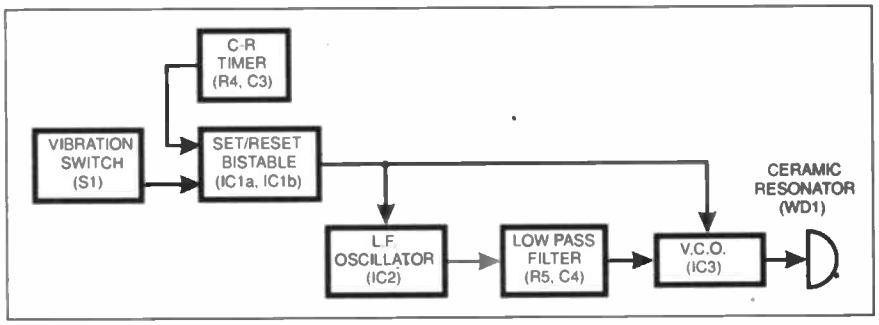


Fig.1. Block diagram for the Case Alarm

A squarewave output signal from the l.f.o. feeds the control input of the v.c.o. via a lowpass filter. The filter removes the higher frequency harmonics from the squarewave signal to produce a roughly triangular waveform. This gives smooth variations in the output frequency of the v.c.o., and a good frequency modulated alarm sound.

CIRCUIT OPERATION

The full circuit diagram for the Case Alarm appears in Fig.2. It is important that the circuit has a low standby current consumption so that it can be powered for hours at a time without significantly running down a small 9V battery.

This low current consumption is achieved by basing the circuit on CMOS logic devices. These consume minute supply when static, making it easy to produce a suitably low standby current drain.

A basic Set/Reset bistable circuit is formed by two of the 2-input NOR gates in IC1. The other two gates are unused, but have their inputs connected to the positive supply line in order to prevent spurious operations.

The output of a NOR gate is *low* (0) if either or both of its inputs are high, but is *high* (1) if both inputs are low. Under standby conditions, one input of IC1b is taken low by resistor R3. The other input is fed from the output of IC1a.

Capacitor C2 and resistor R1 produce a positive pulse of several seconds in duration at switch-on, which means that one input of IC1a is high initially, and its output is low. With both inputs of IC1b low, its output is high, and the alarm generator is switched off.

CONTROLLED ALARM

If vibration switch S1 closes during the switch-on delay period, the output of IC1b will go low and activate the alarm. However, the alarm will only be activated during the very brief periods when S1 is closed. With one input of IC1a high, its output must be low, and this ensures that the output of IC1b goes high and switches off the alarm when S1 is not closed.

The situation is very different once capacitor C2 has charged up, and pin 2 of IC1a has gone low. The coupling from the output of IC1b to the other input of IC1a (pin 1) ensures that one input of IC1a is high, and that its output remains low.

If S1 closes, the output of IC1b goes low, taking one input of IC1a low in the process. This sends the output of IC1a (and one input of IC1b) high.

If S1 now opens again, the output of IC1b will remain low, because the output of IC1a is still holding one of its inputs high. Thus, once the output of IC1b has been set low it remains in that state.

The alarm uses two CMOS 4046BE "micro-power" phase-locked loops (IC2 and IC3). In this circuit only the voltage controlled oscillator (v.c.o.) of each device is used, and no connections are made to the other stages, other than to earth the inputs of the phase comparators.

The output of IC1b controls the inhibit inputs (pin 5) of IC2 and IC3. These inputs shut down the v.c.o.s when taken high, and permit normal operation when taken low.

COMPONENTS

Resistors

R1	1M
R2	10k
R3	4k7
R4	1M8
R5	100k
R6	220k
R7	330k
R8	180k

All 0·25W 5% carbon film

See SHOP TALK Page

Semiconductors

IC1	4001BE quad 2-input NOR gate
IC2, IC3	4046BE phase-locked loop (2 off)

Capacitors

C1	1µ radial elect. 50V
C2	10µ radial elect. 25V
C3	470n polyester (5mm lead spacing)
C4	4µ7 radial elect. 50V
C5	1n polyester (5mm lead spacing)

Miscellaneous

S1	trembler switch (see text)
S2	s.p.s.t. min. toggle switch
WD1	cased ceramic resonator
B1	9V battery (PP3 size), with clips

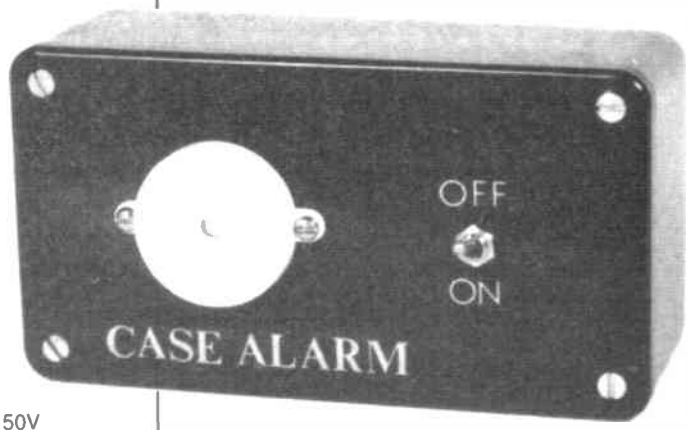
Small plastic case (approx. 119mm x 65mm x 40mm); 0·1 inch matrix stripboard, having 38 holes by 21 copper strips; 14-pin d.i.l. holder; 16-pin d.i.l. holder (2 off); multistrand connecting wire; solder, etc.

Approx Cost Guidance Only £15

OSCILLATORS

The l.f.o. is formed by IC2, it has resistor R4 and capacitor C3 as its timing components. These have quite high values which give the required low output frequency of around two hertz or so. The control input at pin 9 is simply connected to the positive supply rail, so that IC2 acts as a simple squarewave oscillator.

The tone generator is based on IC3, and the control input of this device is fed with the output signal of IC2, via a simple lowpass filter arrangement. The filter is a single stage type comprised of resistor R5 and capacitor C4. Resistors R6 and R7 provide a bias voltage to the control input of IC3, and together with timing components C5 and R8 this sets a suitable centre frequency.



The output frequency range of IC3 is around one to five kilohertz. It is at these relatively high audio frequencies that ceramic resonator WD1 achieves peak efficiency.

Although the drive current to sounder WD1 is strictly limited, its high efficiency ensures that a loud alarm sound is produced. A frequency modulated alarm sound is very effective because a wide range of output frequencies are produced, giving a sound that is attention grabbing and not easily masked by other noises.

Note that the output current from IC3 is too low to drive an ordinary loudspeaker, and using a moving coil loudspeaker in this circuit could result in damage to IC3.

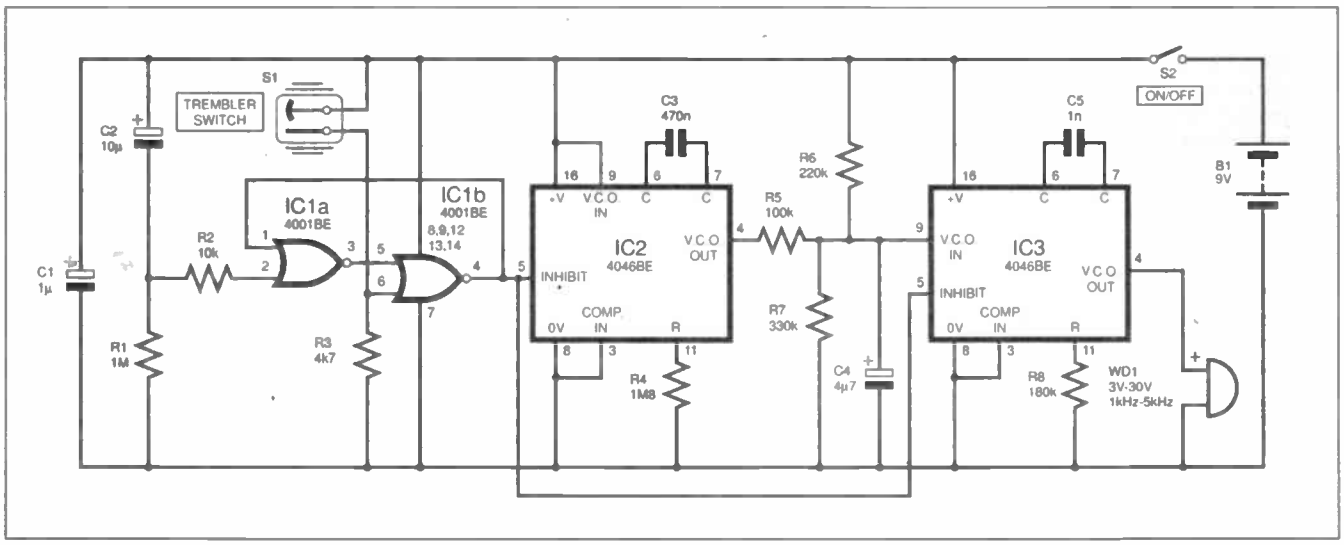
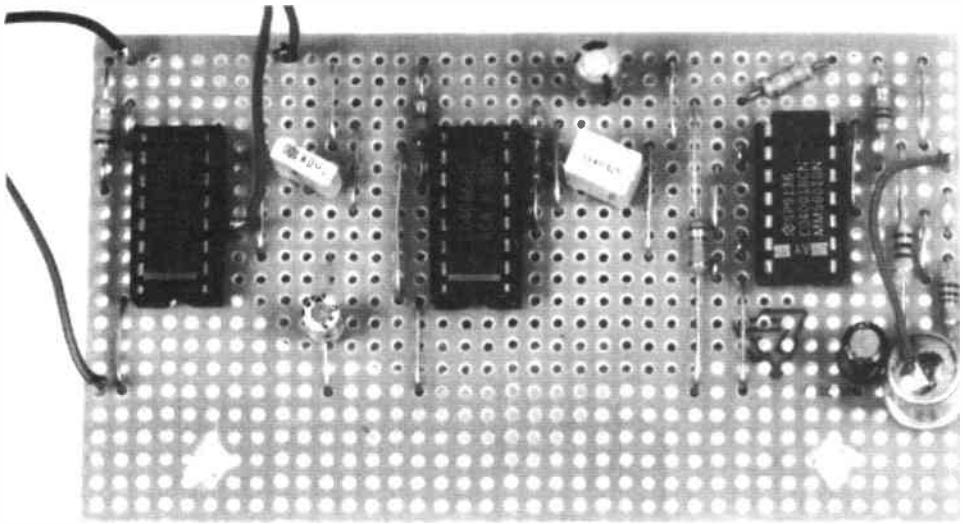


Fig.2. Complete circuit for the low-cost Case Alarm.



Completed Case Alarm circuit board showing layout of components.

The two CMOS NOR gates within IC1 have a totally insignificant current consumption under standby conditions, but IC2 and IC3 do consume some power when deactivated. There is also a small current flow through resistors R6 and R7. The total quiescent current consumption of the circuit is still only about 130µA though. This should give at least 3000 hours of continuous operation from each battery, even if cheap batteries are used.

CONSTRUCTION

Details of the component layout for the stripboard circuit panel, underside breaks in the copper strips and the small amount of hard wiring are shown in Fig.3. The board measures 38 holes by 21 copper strips, which is not one of the standard sizes in which stripboard is sold.

A larger piece must therefore be trimmed to size using a hacksaw. Stripboard is quite brittle, so cut carefully along rows of holes, and then file flat any rough edges that are produced. The two 3·2mm diameter mounting holes are then drilled in the board, and the five rows of breaks are cut in the underside copper strips.

Make the breaks using either the special cutting tool or a twist drill bit of about five millimetres in diameter. Obviously the strips must be severed across their full width, but try not to cut too deeply as this could seriously weaken the board.

All three integrated circuits are vulnerable to static charges, and require the standard handling precautions. The most important of these is that they should be fitted in holders, and not soldered direct to the circuit board.

Do not fit the integrated circuits in their holders until the board and wiring have been completed, and do not touch the pins any more than is absolutely necessary. Be careful to fit all three devices round the right way, as a very high supply current flows if a CMOS device is fitted with the wrong orientation.

VIBRATION SWITCH

There only seems to be one readily available vibration switch, and this is the one sold by Maplin – see *Shoptalk* page. It has an unusual switch contact arrangement in that it has a single pin for one contact and its casing acts as the other.

The pin is soldered directly on to the stripboard in the usual way. The other connection is made via an insulated lead which connects the appropriate point on the circuit board to the case top, see Fig.3. There should be no difficulty in making this connection to S1, but tin both the end of the lead and the case top before making the connection.

Capacitors C3 and C5 must be miniature printed circuit mounting types having 5mm (0·2 inch) lead spacing. Other types are unlikely to fit into the small amount of space available on the circuit board.

Construction of the board is perfectly straightforward in all other respects, and should follow the usual procedure of starting with the smallest working up to the largest component. Start with the 19 link wires and check their positions before soldering in place.

FINAL ASSEMBLY

Virtually any small plastic case will accommodate this project. Alarm sounder WD1 and switch S2 are mounted on the removable lid, which then effectively becomes the front panel.

On the face of it, S2 should be a key-operated switch so that a thief activating the unit cannot easily switch off the alarm. However, your attention will presumably be grabbed as soon as the alarm is activated, making it pointless for the would-be thief to try to turn it off.

If the unit is used as something other than a case alarm it might be preferable to use a key switch for S2, but due to the high cost of these components a key switch should only be used if it is really necessary.

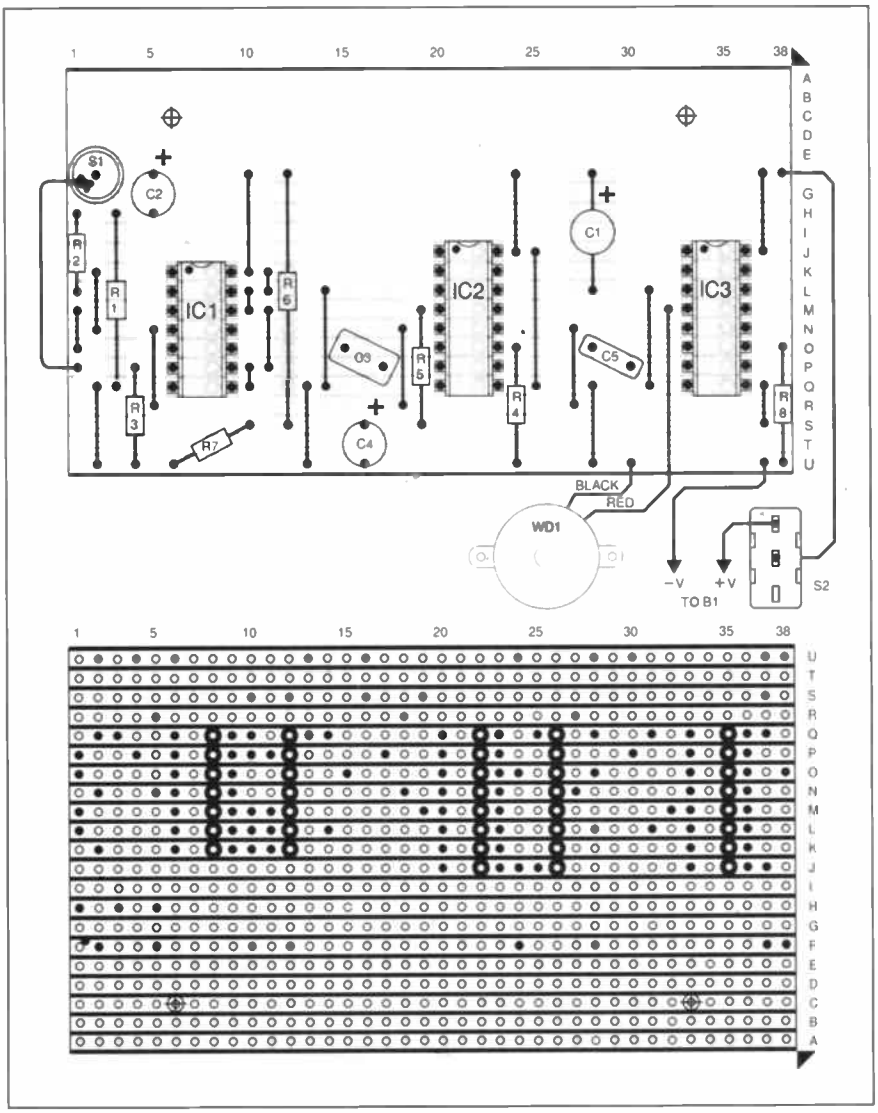


Fig.3. Stripboard component layout, wiring and underside details of breaks required in the copper tracks. Sockets must be used to mount the i.c.s on the board.

Alarm transducer WD1 can be mounted on the rear surface of the panel, but it then requires a large hole into which its body fits. It is easier to mount WD1 directly on the outside surface of the front panel, as it then only requires three small mounting holes. Two of these are for the 8BA mounting screws, and the third is for the two flying leads to the circuit board. All three holes are 2·5mm in diameter.

The transducer WD1 itself makes a good template when marking the positions of these holes. Most ceramic resonators have one red lead and one black lead, but these are not polarised components, and WD1 can be connected either way round.

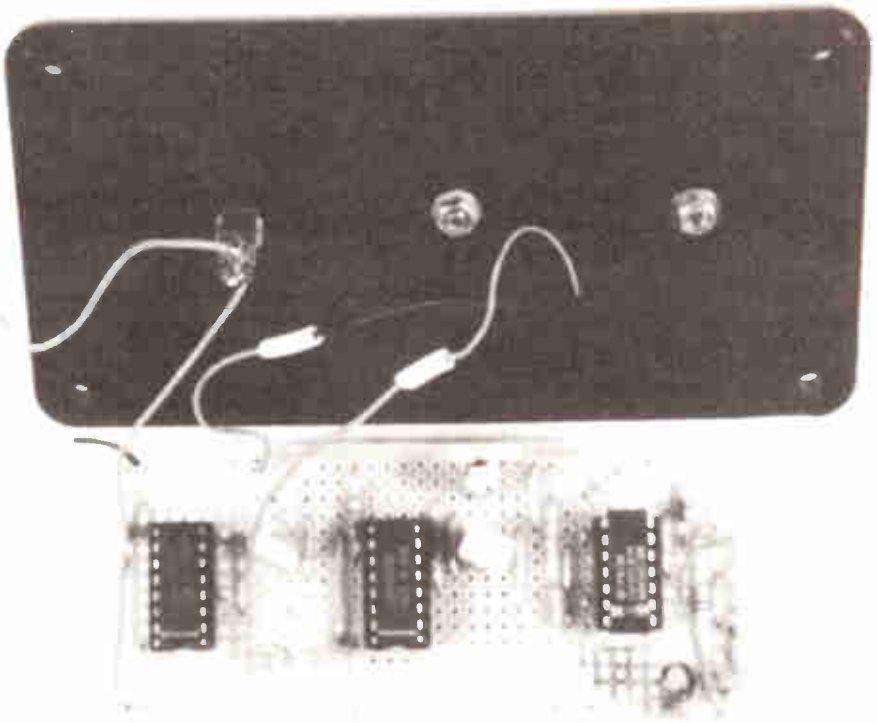
It might be necessary to fit insulated extension leads onto WD1. If so, insulate the soldered connections with p.v.c. sleeving so that there is no risk of accidental short circuits.

TESTING, TESTING

To complete the unit, add the battery connector and the lead from toggle switch S2 to the circuit board. After a final check of the wiring the unit is ready for testing.

At switch-on the alarm should not sound, except perhaps for a few minor "squeaks" if the unit is moved. Wait about ten seconds after switching on, and then move the alarm.

If all is well this should produce a loud frequency modulated alarm sound. The alarm is reset by switching off, waiting a few seconds, and then switching on again.



Wiring to the lid-mounted components. Note the two insulating sleeves over the sounder extension lead solder joints.

If the alarm does not operate, switch off at once and recheck the wiring once again. If no fault can be found, try replacing capacitor C2. This must be a good quality low-leakage component, or the hold-off at switch-on will last indefinitely.

READOUT

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

PIC DISK SIZE

Dear EPE,

I am an avid reader of *EPE* but sigh each time a PIC project is published. I know I can buy the PICs pre-programmed, but I would derive no pleasure from this and would like the fun of programming my own.

However, although I am reasonably computer literate, my computer is an Amstrad 1640 which has a 5·25-inch floppy disk drive, whereas you only provide the TASM software and PIC files on a 3·5-inch disk. I find my old Amstrad more than adequate for most purposes and do not wish to buy a more modern machine.

I am sure that there must be other people in a similar situation to myself who would appreciate you providing the necessary programs on a 5·25-inch disk – is this possible?

Incidentally, I am writing on an Amstrad PCW8256 which uses yet another obsolescent disk size – 3-inch floppy!

Dr Michael Sharp
Rubgy, Warks

It was only about 18 months ago that I replaced my Amstrad 1640 by a Pentium machine. The Amstrad had given good service for around ten years and is still perfectly usable. However, the need for greater memory and hard disk capacity, faster speed, Windows 95, CD-ROM etc., eventually became too great to ignore. But I sympathise with your preference to keep the Amstrad.

Whilst we do not wish to keep stocks of 5·25-inch disks, if any reader would care to send us a blank 5·25-inch disk, formatted as single-sided, single-density (plus the usual handling charge as shown on the EPE PCB Service *page) I will be pleased to personally copy all our PIC files onto it.*

Hopefully, Dr Michael, you are now putting to good use the complimentary 5·25-inch copy I sent you. **JB**

USA BOOSTS SALES

Dear EPE,

Rarely in the past have we been successful selling our software into the USA. However, since *EPE* is now distributed there, sales have improved significantly; more in the past few weeks than over the past four years.

Recently I spoke to a customer in New York and he is really impressed with *EPE*. It would appear that they don't have anything like it over there. Encouraging words!

Clive Humphries
E.P.T. Educational Software
Witham, Essex

We are very interested by your comments and are pleased that our efforts in the USA are bearing fruit. **JB**

BATTERY CLIP

Dear EPE,

In the *Ironing Safety Device* project of Sept. '97, it is stated that a clip for its 12V battery is not available. In fact, the Maplin GU65V clip can be used, soldered straight to the p.c.b. However, the battery then must be insulated from the clip by heat-shrink film or insulating tape.

Libor Pokorny, via the Net.

Thanks for the useful information. **JB**

MURPHY'S NO JOKE

Dear EPE,

I am a regular subscriber, I like *EPE* and realise there must be a good spread of articles. But – there's always a "but", you can see it coming – *Murphy's Law* can be summed up by Sod's Law, i.e. that "Murphy was an optimist". Did we really need three pages of it? I think the adventures of Piddles the Cat were fairly juvenile, but at least they only took half a page!

Lest you think me humourless, I sent 21 limericks to the WIs competition this year, most of them clever/funny. The local radio club newsletters are printing a Christmas Entertainment I wrote for my previous club. It lasted 20 minutes or so and was mostly original material. I could go on . . .

Ant Astley GWOAJA, via the Net.

Beauty, they say, lies in the eyes of the beholder. Similarly, one believes, appreciation of humour is just as personal and, indeed, idiosyncratic. It would be a strange old world if we all had equal likes and dislikes, and how boring!

We do not expect all readers to find humorous such offerings as Murphy's Law, Ohm Sweet Ohm *and* Chromo-Floristics *(an "April 1st" – 1996). But we do know that there are enough readers who do find them entertaining to make it worthwhile publishing them from time-to-time. Personally, I found some of the statements made in* Murphy's Law *to be very chuckle-worthy, but then I tend to find thought-worthy observations on life far more humorous than slap-stick comedy and other situations where the humour is foreseen and expected, the punch-line being spotted a mile off.*

To this observer, part of the humour of life is that we do all have different outlooks and concepts, and it seems that we should all allow others the right to express themselves in the manner best suited to their view of the world. It may not be our view, but then they may not relate to what we regard as valid, nor should we expect them to. One man's meat is another man's poison, says the old adage. Equally, one man's humour is another man's stupidity.

Long live diversity of view point – including that of those who find Murphy no joke! **JB**

UHF CONTROL

Dear EPE,

I am currently developing a project that requires multi-channel UHF control. I have had little experience in this area and am looking for any available circuit diagrams or advice that is available. The intention is to integrate the remote control with a microcontroller project that I am developing. Can you help?

Dave Hughes, via the Net

Unfortunately, such home-built equipment cannot be licensed in the UK so we have not published any designs. However, you might be interested to read the 418MHz Remote Control *article we published in the April '97 issue – it uses approved commercial modules.* **JB**

GW-BASIC

Dear EPE,

I have seen a few past projects which interest me but require the use of GW-Basic. Initially, I obtained a copy of GW-Basic but experienced problems with saving and exiting the program. Where would I be able to obtain a copy of the user's manual for GW-Basic?

Tony Hiener, via the Net

Our basic *advice is to forget about GW-Basic now. It was an excellent product for its time, but the later QBasic (also known as Quick-Basic) is a far superior product. Generally speaking, anything written in GW-Basic can be run under QBasic, although there are some routines which may not translate directly.*

We do not know where you would obtain a GW-Basic manual. Perhaps one of our readers might be able to tell us? You could also try advertising for one via our Classified Ads *page.*

To answer your other queries, to save a program, press function key F4, whereupon the statement SAVE" will appear. Type in the name of the program to be saved and press Enter. That's all there is to it. Note, though, that GW-Basic does not check if it is overwriting another program of the same name, so be cautious!

To exit to DOS from GW-Basic, simple type SYSTEM (in upper or lower case letters) and press Enter. Be wary here too, since GW-Basic does not check if the program currently loaded has been saved following any corrections you may have made. **JB**

OZ NOT IGNORED

Dear EPE,

I read on your website that *EPE* is available in the UK and USA but it didn't mention Australia. Although I was offended that you ignored us (something to do with the Ashes no doubt), I'd like to order a back issue. Can you let me know if I can still do so via your back issues order form, and is the overseas airmail postage still the same?

Geoff Watts, via the Net

For many years we have sold EPE *in Australia (probably our best export market). The reason we have been pushing the USA is that we have only recently managed to get* EPE *into the USA in quantity. To console you, we don't plug the other 60-odd countries we sell into either! Yes, you can order at the price indicated on the form.* **JB**

NET PINS

In answer to Brian Buckby's query (*Readout* June '97), the following semiconductor manufacturer's websites have been found to be helpful for chip pinout details:

National, **http://www.natsemi.com**
Dallas Semiconductors,
http://www.dalsemi.com
Fujitsu, **http://www.fujitsu.com**
Harris, **http://www.semi.harris.com**
Philips, **http://www.semiconductors.philips/semiconductors.com**

Tony Heiner, via the Net (again!)

Thanks, Tony. **JB**

TENS UNIT QUERY

Dear EPE,

Thank you for Andy Flind's TENS unit you published in March '97 issue. I am a registered physiotherapist from Cyprus with a great interest in electrotherapy.

I have the opinion that you can never apply the same intensity to two different body areas, consequently, you should construct two output circuits. Also, I am wondering why I can't see the output waveforms with the Velleman PC Oscilloscope. I have checked other TENS unit's waveforms and they are identical as specified.

Solomon, via the Net.

Andy Flind offers the following reply:

The dual output of my design was intended simply to improve the flexibility for the user when treating wide areas etc. For total control you would need two output stages, and possibly a degree of isolation between them as well, but this would be beyond the scope of a simple home-constructed unit such as this.

I am not familiar with the Velleman PC Scope, but if it interfaces with a PC then it probably uses a sampling technique followed by A-D conversion which may not respond well to the narrow output pulses of my TENS. It's very difficult to view them even on a normal analogue scope. I would be interested to know what other TENS waveforms you have seen, as all the ones I've seen to date have been narrow pulsed variety. I take it that your unit is working properly, in that you can feel a strong tingling sensation when in contact from the output. **Andy Flind**

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- Parallel connection
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- Data logger

The ADC-100 offers both a high sampling rate and a high resolution. It is ideal as a general purpose test instrument either in the lab or in the field. Flexible input ranges enable the unit to connect directly to a wide range of signals.

ADC-200/20
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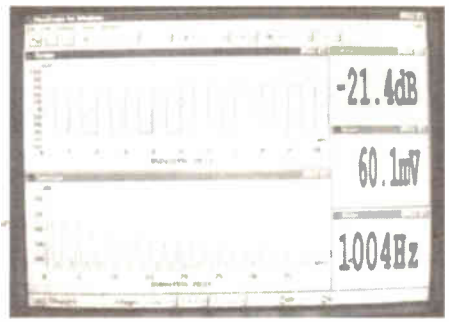
- 20MHz sampling – single and dual channel (suggested usable analogue bandwidth 10MHz)
- 10MHz spectrum analyser
- AC voltage and frequency meters
- 9 input ranges
- AC/DC coupling
- Parallel connection
- 8K per channel memory

The ADC-200 is a high speed virtual instrument offering a 20MSPS dual-channel digital storage oscilloscope (DSO), a spectrum analyser, voltmeter and frequency meter. The external trigger connector also doubles up as a simple signal generator. Reviewed in *EPE* May 97 issue.

Both units are guaranteed for 2 years

Specification

Pico ADC units	ADC-100	ADC-200/20
Resolution	12-bit	8-bit
Channels	2	2
Input Range(s), software selectable	±50mV to ±20V (9 ranges)	±50mV to ±20V (9 ranges)
Max Sampling Rate (33MHz 386/486)	100kHz	20MHz
Accuracy	1%	voltage ±3%, time ±100ppm
Over Voltage Protection	±50V	±100V
Input Impedance	1MΩ	1MΩ
Input Connector	BNC	BNC
Output Connector (D25 male)	parallel port	parallel port



PC requirements
IBM PC or AT compatible running MS DOS V3.1 (or above), or WIN 3.1 or 95. CGA, EGA, VGA or Hercules compatible display. Printers supported are Epson FX and LQ series, HP laserjet and deskjet (additional printer, plotter and graphics drivers available separately). All software supplied on 3·5 inch disk.

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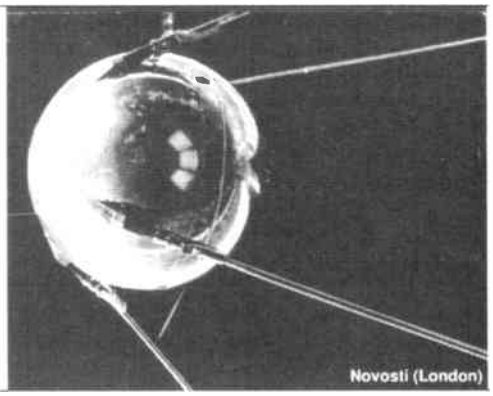


BARRY FOX

It is now 40 years since the earth-shattering bleeps from a "football" circulating the Earth announced the first thrusts of the communications space race. Since that momentous event there are now about 200 "birds" hovering above this planet reports Barry Fox.

Is it really forty years since the Space Age, and space race began? Yes, it was in October 1957 that we first heard bleeps over the radio, relayed from the *Sputnik* satellite which the Russians had launched.

Sputnik (shown above right) was orbiting the Earth once every hour and half in an egg shaped path. It carried only a radio beacon.

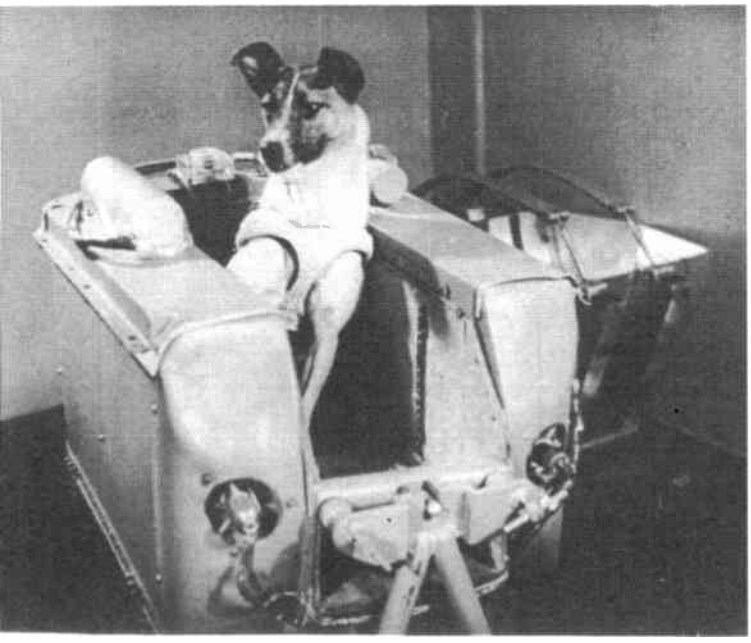
A month later the USSR launched a second *Sputnik* which carried a living passenger. It was a dog, called Laika. In all the excitement few people asked how the dog would get back. It couldn't of course. We were assured that the unfortunate animal was poisoned after seven days before it ran out of oxygen and suffocated.

Clarke Orbit

When we think of satellites today, we usually think of broadcasting birds which hang, as if stationary, in geostationary orbit. The idea behind this was published more than ten years before *Sputnik*.

Television signals normally come from a tall transmitter tower. The signals cannot reach past the horizon, so reception distance is limited to a few tens of miles. But if a transmitter could hover in space it could broadcast to a whole Continent.

It was science fiction writer Arthur C. Clarke who told how this could be done. In October 1945 he wrote an article for *Wireless World* magazine predicting that rockets, based on the Germans' V2, could lift a satellite with a radio transmitter into space.



Laika, the first living creature to be launched into space on the Russian Sputnik II satellite. (Novosti (London))

He used maths to prove that if the transmitter orbits the Earth, over the Equator at a height of 36,000km or 22,500 miles, it will move at exactly the same speed as the Earth is rotating. So it will appear to hover stationary above a fixed spot, and behave like a very tall transmitter aerial – without a mast.

This is now known as a geostationary satellite, in the "Clarke orbit". One satellite can "see" almost half the surface of the earth. So three satellites can relay a signal anywhere in the world, except the polar ice caps.

Wrote Clarke: "Many may consider the solution proposed in this discussion too far-fetched to be taken very seriously. Such an attitude is unreasonable as everything envisaged here is a logical extension of developments in the last ten years – in particular the perfection of the long-range rocket of which V2 was the prototype. While this article was being written, it was announced that the Germans were considering a similar project, which they believed possible within 50 to 100 years".

Wireless World paid Clarke £15 for the article and that is all he ever earned from his idea.

Blast-Off

In 1957, the super-powers were building rockets to deliver nuclear bombs but they were still not sufficiently powerful to carry a satellite up to the geostationary orbit. The size of a beachball, *Sputnik* swooped between heights of 230 and 900 kilometres. It made 1,400 revolutions in 92 days. It failed after a few days, but the space age – and space race – had begun.

In 1962 Bell Labs, the American equivalent of BT and inventor of the transistor, built and launched *Telstar* – immortalised by the Shadows song. *Telstar* was a one metre sphere which looped the globe every three hours. In theory it could relay up to 600 telephone calls or one TV programme between receiving stations on each side of the Atlantic. In practice it was not much use because it was only within range of the two earth stations for around half an hour.

Britons got their first taste of satellite broadcasting in July that year, when British Telecom's satellite tracking station at Goonhilly Downs in Cornwall picked up live TV signals bounced off *Telstar* from Andover, Maine. The experiment did not go smoothly. An engineer had connected some wires the wrong way round. It took 20 minutes to correct the fault while broadcaster Raymond Baxter tried to remain calm. By then they only had a few minutes left before the satellite disappeared over the horizon.

"Here we are, here we are. There's a bar. That's a man's face. There it is. There it is. That's the picture. You see it for yourself. There it is. It's a man. There it is. There's the unmistakable image. There is the first live television picture across the Atlantic".

Telstar had only a 2W transmitter, similar to a walkie talkie radio. BT had to use a dish that was 26 metres in diameter and weighed over 1,000 tonnes. The dish had to move to follow the satellite with an accuracy of one 60th of a degree while it raced at 19,000km/hour from horizon to horizon.

The first geostationary satellite was America's *Syncom*, made by Howard Hughes' company in California and launched in 1964. It was used to broadcast live TV from the Olympic Games in Japan. Hughes remains a world leader in the satellite business.

Today's Satellites

Modern satellites can carry tens of thousands of phone calls or a score of TV channels. They are the size of a garden shed, hang stationary in Clarke orbit and use 50W or 60W transmitters. So we can use a fixed dish of around 60cm diameter to watch TV programmes like Sky.

Each broadcast satellite has a radio receiver which picks up a narrow beam of radio signals from a "ground station" on Earth, and a transmitter which beams the signals back down over a wide area. There is no mains power in space, so satellites get their energy from the sun. Large solar panels, like wings, are coated with chemicals that convert light into electricity. The satellite also has batteries to keep the electronics working while the sun is eclipsed.

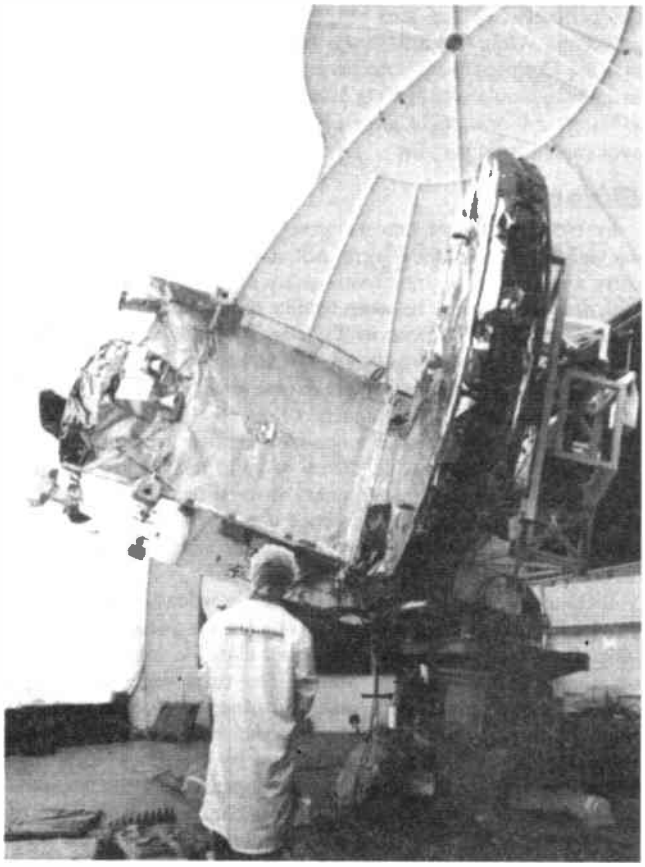
Eutelsat's latest satellite, *Hot Bird 3*, weighs 3 tonnes, should last for 15 years and has a 6kW solar power supply. It has two fixed dish aerials, 2·3m across and one 50cm unit which can be steered from the ground.

Collision Course

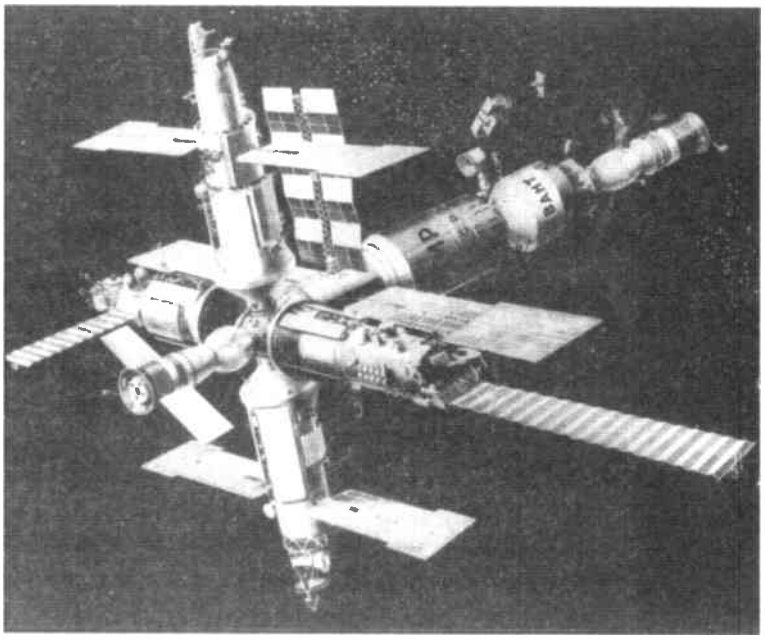
Satellites tend to wander out of orbit and would crash into each other or drift off into space, unless they are continually steered. This is done by venting small puffs of gas from jets in the side, under the control of the ground station.

The satellite must also be be kept steady, by on-board computers, so that the solar panels always face the sun. If they don't get sunlight the satellite has no electricity. This is what has been going wrong with space station *MIR*.

Colliding with even a small piece of space junk can destroy a satellite, so it is vital to clear dead satellites out of the working orbit. When the gas for the steering jets runs out, the satellite goes



Preparing the Eurosat Hot Bird 3 TV satellite for its space launch. (Matra Marconi Space)



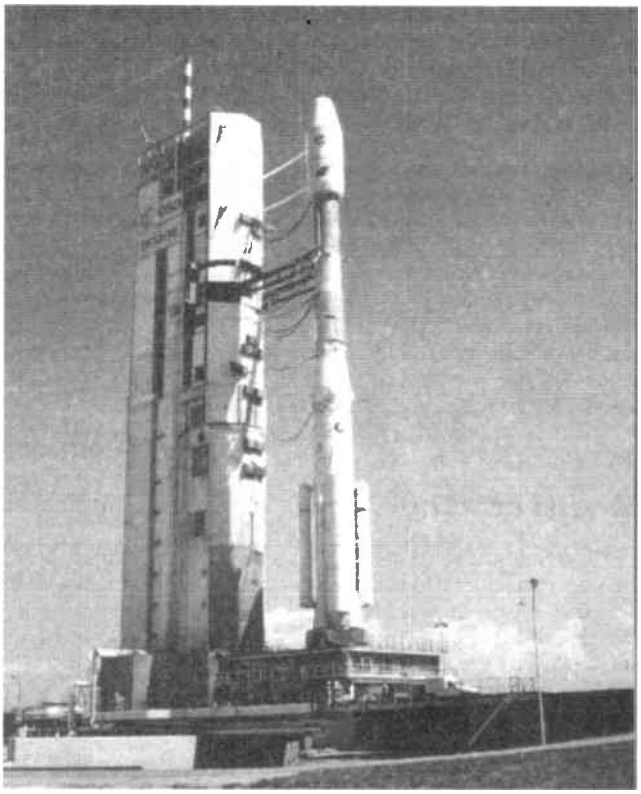
Artists impression of the Russian MIR space station that has been in the news lately. (Novosti (London))

out of control. This is never allowed to happen. The last dregs of gas are used to puff the satellite safely out of the Clarke orbit, and into graveyard orbits where they do no harm and may remain until the end of time.

But nothing can protect a satellite from meteors, the scraps of dust and rock which travel through space at high speed and eventually fall to earth as shooting stars. Usually the chances of a collision are very small but three or four times a century pure chance takes the Earth right through the tail of a comet, which is full of space rubble.

This creates a meteor "storm" and the number of shooting stars rises to hundreds of thousands an hour, for several hours. The odds on one colliding with a satellite shorten dramatically. The last storm was in 1966, when there were very few satellites. The next one is now expected in 1998 or 1999.

A satellite costs up to £100 million and as much again to blast



Launch of Hot Bird 3 by an Ariane V99 space rocket. (Arianespace)

There are around two hundred working satellites in the Clarke orbit. Some are owned by the military and secret. Here are a few of the best known commercial birds:

Astra, at 19° East, is not just one satellite, but a cluster of six owned by a Luxembourg company, of which four (known as *Astra A-D*) serve Europe with TV (including Sky), direct to home dishes. Astra says it will launch another series into orbit at 28 East, which will let Sky deliver several hundred new digital services. *Kopernikus* at 28° East, uses different frequencies to let German TV stations share programmes.

GALS is a Russian satellite at 74° East, which brings TV to the depths of Siberia.

Turksat, at 42° East, blankets Turkey with entertainment.

Statsionar at 40° East, is used by Russian TV stations to share news. Two more *Statsionars*, at 11° and 14° West, spray Russian news across the old Soviet Union.

***Eutelsat** I-F5*, at 21° East, and Eutelsat *I-F4* at 25° East, cover horse racing for betting shops.

Eutelsat *II-F3*, at 16° East, broadcasts TV signals mainly round Europe, especially Algeria and Croatia.

Eutelsat's three *Hot Birds*, at 13° East, deliver TV to Italy, Poland and the Middle East. They also carry free English language channels EBN and Europspot.

Eutelsat *II-F2*, at 10° East, serves TV to Europe, including Turkey.

Eutelsat *II-F4*, at 7° East, is used by the European Broadcasting Union to distribute TV programmes – including Noel's House Party – between European TV stations.

Telecom 2C, at 3° East, delivers movies and sports to French viewers. Two more *Telecoms*, at 5° West and 8° West, carry more French programmes into France and Belgium; one channel is devoted to green issues.

Thor, at 1° West, delivers entertainment to Scandinavia. The satellite started life as *Marcopolo*, the satellite owned by Britain's ill-fated BSB service. When BSB folded the satellite was sold and physically moved in orbit (by puffing its gas jets) from BSB's old position, at 31° West, to *Thor*'s slot.

Intelsat, an international consortium of telephone companies, has satellites at 18°, 21°, 28° and 34° West. They carry the BBC's programmes for European viewers, Reuters news footage for TV stations, Islamic programming and Italian politics, along with more video for bookmakers. They also relay news from America for use by European TV stations.

Hispasat at 30° West, serves Spanish viewers.

ACROSS THE WORLD

Anik Canadian satellites are at various positions including 108° West. They are used for telephones and television.

APMT, Asia Pacific Mobile Communications, at 95° East and 125° East. Provides telephone services for China.

Apstar, at 112° and 121° East, does the same for Hong Kong.

DirecTV, at 100° West, serves the USA with a direct-to-home digital TV service. Hughes built the satellite and helps run the service.

Inmarsat, the International Maritime organisation, has satellites at 15° and 64° West, and 5° and 178° East, to let ships navigate and talk to the shore. Inmarsat also provides a satellite phone service, but the equipment is much larger than an ordinary cellphone.

JC-Sat, at 150° East, and ***BS*** at 110° East, broadcast television programmes, including widescreen high definition pictures, direct into Japanese homes.

The UK's allocated slot for direct broadcasting at 31° West, vacated by BSB, is now up for grabs again. Any takers?

into space by rocket. Repairing satellites is only possible when they are in low orbit, a few hundred miles up, where astronauts can make a space walk. If a satellite in geostationary orbit goes wrong, it is a write-off. Otherwise they now last at least ten years.

Fall-Out

Satellites must be carefully spaced apart in orbit. This is not just to avoid collisions. When a dish aerial is pointed at one satellite it should not receive signals of the same frequency from its neighbours, or the viewer will see interference on the screen.

The allocated positions or "slots" in orbit are a few degrees apart. But operators now put more than one satellite in the same position, spaced apart by around 75km. They are so far away from Earth that as far as the receiving dish is concerned, they behave like one big satellite with many transmitters. Luxembourg company Astra pioneered this trick and now has several satellites at the same position (19 East), broadcasting Sky and other services.

The International Telecommunications Union in Geneva controls the allocation of orbital slots and frequencies, to avoid collisions and interfernence. No-one owns or controls space and there is no way of policing it. So the scheme has so far worked like a "gentlemens' club".

The first sign of a split is a dispute between Astra, who want to put up new satellites at 28° East to carry Sky's promised digital TV services, and Eutelsat, the Paris-based consortium of European telephone companies, who claim earlier rights to the same frequencies at the same position.

Bird Watching

In addition to the geostationary satellites in the Clarke orbit, many more circle the Earth in lower Sputnik-like orbits. Some of these low orbiters are used for surveillance. They take pictures as they fly over a target area and transmit them to a receiving station on the ground. The military use them, and so do governments to map the land.

The latest weather satellites, such as *Meteosat 7*, use cameras in geostationary orbit to take picures of the earth using visible and infra-red light. Resolution is 2·5km on the ground, from a distance of 36,000km. The satellite takes one picture every half hour, by oscillating up and down to give the frame scan while spinning at 100r.p.m. for line scan. The image is stored on the satellite and then transmitted to earth. It is not hard to see how military satellites, orbiting at low altitude, can resolve detail of individual people.

Other low satellites send out signals which let a radio receiver on the ground, in a ship or on a plane, know exactly where they are. Cruise missiles rely on these GPS, or Global Positioning System, signals, so do yachtsmen and hikers. The navigation systems which manufacturers are now fitting to more expensive cars use GPS signals, too.

The latest batch of low orbiting satellites will be used for cellphone systems which promise business travellers the chance to make and take calls anywhere in the world, whether deep in the rain forest, out in the desert or on top of a mountain. □

TEACH-IN '98

An Introduction to DIGITAL ELECTRONICS

Ian Bell, Rob Miles, Dr. Tony Wilkinson, Alan Winstanley

TEACH-IN is designed to support candidates following the City and Guilds (C&G) syllabuses, see facing panel, but includes further material as well. It is aimed initially at the complete novice or apprentice technician, and therefore commences with the most fundamental theoretical and practical aspects of electronics. The series then progresses straight into digital electronics, dealing with basic logical systems before moving on to more advanced levels.

Even if you are not undertaking the City and Guilds syllabus, there is much to be learned from following *Teach-In*, whether you are a GCSE or "A" Level student, hobbyist or you simply want to discover how to do things digitally.

Lab Work

Throughout *Teach-In*, attempts are made to involve the student with practical "Lab Work" experiments and demonstrations, and complex mathematics and physics will be avoided unless really necessary – and even then, plenty of help is to hand! We make a point of identifying practical components in special sections of *Teach-In*, so that you will learn to recognise parts, even if you don't necessarily use them yourself just yet.

We also take a light-hearted view of things from time to time, because electronics really is *fun* to learn, so we'll sometimes "have a laugh" at the same time!

Reader Support

We encourage you to contact us with your queries and feedback, either by writing to the *Teach-In* Team c/o the Editorial address, or by E-mail: **Teach_In98@epemag.demon.co.uk.** So help is never very far away. Please do not use any other E-mail address at all, for *Teach-In* queries, nor use it for anything other than questions related to the series. We hope you will find this series instrumental in stimulating your interest in electronics. I.M.B., R.S.M., A.J.W., A.R.W.

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Teach-In is a ten part series which aims to support students undertaking *City & Guilds 726 Information Technology*, with reference to the following specific syllabuses:

- **7261/ 301** ***Introductory Digital Electronics***
- **726/ 321** ***Elementary Digital Electronics***
- **726/ 341** ***Intermediate Digital Electronics***

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Teach-In has been co-written for *Everyday Practical Electronics* by Rob Miles, Ian Bell and Dr. Tony Wilkinson who are lecturers in the Department of Electronic Engineering at the *University of Hull*, England. Regular readers will know Alan Winstanley, of course, as the author of several columns in *EPE*: Alan has written for this magazine for over twenty years and is known internationally for his efforts to promote an understanding and interest in electronics. Alan has co-ordinated the series.

Part One: ELECTRICITY, CURRENT AND VOLTAGE

Charge Carriers and Potential Bargains

WHAT is electricity? This is a fundamental and profound question which can be answered at many levels, from "the stuff which comes out of batteries" to "a movement of charge carriers through a conductor".

It is very useful to think of *charge carriers* as tiny charged particles which flow through an electrical circuit. These charge carriers are pushed along by an *electric field* (the voltage) and the number of carriers which are moving past a fixed point determines the *current flowing*.

It is important that you understand the difference between *current* and *voltage*, and how this all relates to power. Perhaps an analogy might be fun: often at this stage, you'll see analogies based around simple water and hydraulic circuits. We think that's a bit boring – instead, let's go bargain hunting!

Consider the January Sale. At the start of the sale a huge number of shoppers (charge card carriers!) are queuing outside a shop, eagerly eyeing all the bargains within the store. They are driven into the shop by the amount of money they can save on all those bargains.

In electrical terms, we have an *electric field* which is driving our "carriers" in a particular direction. If there are no bargains to be had, then there is no electrical field, so the carriers don't move at all. The stronger the electric field, the more inclined the charge carriers will be to try to move. Also, the stronger the electric field, the more energy we get from our carriers when they move over it, in the same way that our shoppers will spend more if the bargains are more enticing.

Taking the analogy further, a railway station "produces" the shoppers, and once they have bought their goods they will return to it, as in Fig. 1.1a.

Once the shop doors are thrown open, the shoppers start to flow through the corridors towards their bargains. The *width* of the corridor determines how many shoppers can travel along it at any given time.

If the owners of the shop were interested in how shoppers move through the store, they could set up "people counters" to find out how many people jostle past a particular point. In electrical terms we are measuring ***current*** here. The greater the number of charge carriers which go down an electrical conductor at any one time, the greater the electrical current which flows. If the management make their corridors wider, they will be able to pack more shoppers through the store. In the same way, we can drive more current through a thicker wire – one with a larger cross-sectional diameter – than we can through a thinner one.

joined together. One single 1·5V "AA" battery is really one *cell* rather than a battery. A 12V car battery consists of six individual cells (which, on older batteries, need topping up with distilled water).

The simplest switch (shop door) is also shown in Fig. 1.1b: a very basic on-off switch. The type illustrated is a *single-pole, single-throw* (s.p.s.t.) switch. Check the separate explanation of switch terminology and practical examples. We will discuss many types of component like this during *Teach-In*, using separate "Check Out" topic boxes – so that you at least know what the parts look like, even if you do not necessarily use them right away (if ever).

Back to our shopping mall. We described how the number of shoppers going down a given corridor equates to the current flowing, and the savings which they can see is equivalent to

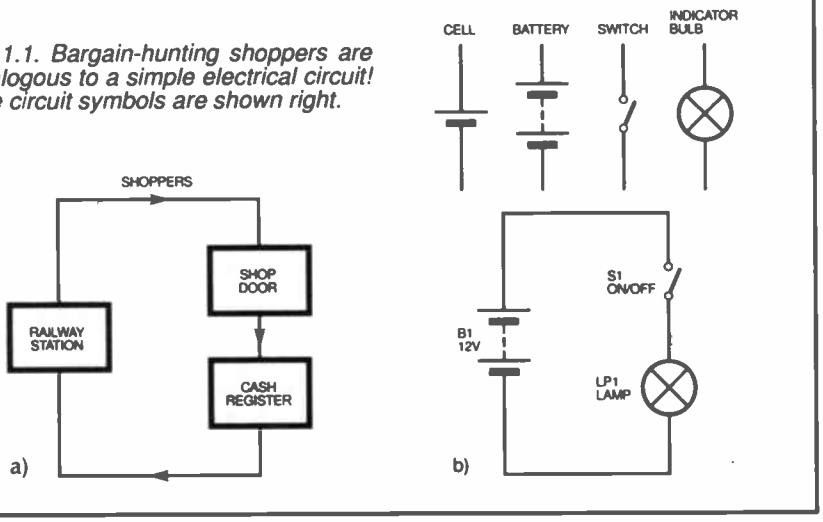


Fig.1.1. Bargain-hunting shoppers are analogous to a simple electrical circuit! The circuit symbols are shown right.

Note something interesting here: the number of shoppers pouring out of the railway station is actually finite. This means that if the management installs extra tills, doorways and corridors, more stock and more bargains, then it will experience a greater flood of customers, but this will mean that it "uses up" all those shoppers more quickly.

The same thing happens with electricity. The greater the current which is taken out of the battery, the faster the battery will become exhausted and go flat. The current flowing in an electrical circuit is expressed in *Amperes* (A), or amps for short. The symbol for current is actually I, for the French term *Intensité*. You may see "milliamp" (mA) used when talking about current; 1mA = 0·001Amp (one thousandth of an ampere).

Circuit Diagram

In Fig. 1.1b, our "bargain hunting" analogy has been converted into a *circuit diagram* – a very simple one using a battery, bulb and switch. The circuit symbols for these newly-introduced parts are shown separately. In fact, a battery (railway station) is made up of a number of individual *cells*, the electric field which is driving them. Let's develop this further.

The smallest saving a customer could make is a penny. In electrical terms there is also a lowest charge value too, which is equal to the charge carried on a single ***electron*** (this should give you a strong clue as to what a charge carrier actually is!). The electrical field driving a charge carrier is expressed in *volts* (V) as the *potential difference* (p.d.) between two terminals. You will occasionally hear of voltage being described as electromotive force (e.m.f.).

Once our shoppers arrive at the cash register with their bargains, they spend their money (illuminate the bulb) and go back to the station. In electrical terms, what we are talking about here is *power*. (You should not be surprised to learn that money is power!).

The same amount of money can be saved by a large number of shoppers each saving a small amount (a large current and small voltage), or by a small number of shoppers each saving a large amount (a small current and large voltage). Power (P) is measured in units of ***Watts*** (W) and we can write an equation which will let us work out the power if we know the voltage and the current:

$$P = I \times V$$

There is an alternative formula which can be used (see later), depending on what other circuit values you know.

Irresistible Bargains

We have already seen that, in shopping terms, wide corridors are a good idea because we can get more people through them in a given time. An inquisitive store manager could perhaps come up with a measure of how a corridor "resists" the movement of people.

Some shopping corridors can be pretty unappealing: they may be cramped, or they might have an escalator which is currently out of order. So you have to do *work* – clambering up stairs and jostling through crowded passageways to get to your bargains! Instead of doing work, you choose an easier route.

We do exactly the same with ***resistance*** (R) in electrical circuits. In general, current follows the path of least resistance: the greater the resistance of a component, the more difficult it will be for charge carriers to move through it. Resistance is expressed in *Ohms* (symbol Ω) and we can express what is going on in the form of a simple equation:

$$\text{Current} = \text{Voltage}/\text{Resistance}$$

or

$$I = V/R$$

This is derived from "Ohm's Law". If you keep track of what is going on you shouldn't have a problem. Bear in mind that the bigger the resistance (the narrower the corridor), the more difficulty our charge carriers have getting down it; the bigger the voltage (the more enticing the bargains) then the harder the charge carriers will try. As a quick test, see if you can work out which of the following is wrong:

- If I double the resistance, I will double the current
- If I double the voltage, I will double the current.
- If I halve the resistance, I will double the current.

If we want to have some more fun, we can use algebra to play with Ohm's Law:

$V = I \times R$ (now we can figure out the voltage if we know the current and resistance)

$R = V/I$ (now we can figure out the resistance if we know the voltage and current)

Ohm's Law states very simply that for many types of material, provided that ambient conditions are stable, then V/I is a *constant figure* (namely, its resistance). However, it's common practice – much to the chagrin of physicists – to state Ohm's Law by using the formula *derived from* his actual physical Law. So $I = V/R$ is often described as "Ohm's Law" though we should remember that it's really an equation derived from the original Law.

If you want to avoid the maths, there is the time-honoured *cover up trick* which uses a triangle. Draw Ohm's Law as follows:

We can see the calculation we need to do by covering up the element we want to calculate, e.g. cover up R to reveal the answer of V/I.

In the diagram of Fig. 1.2 we have again drawn the battery using its standard circuit symbol. It is convenient to think of our charge carriers travelling in a particular direction around our circuit, just as our shoppers will set out from the railway station with empty bags and full wallets, and return with full bags and empty wallets! For this reason we think of the carriers travelling from the "positive pole" of our battery and returning to the battery at the negative pole.

(A special note for readers with a background in chemistry: you will know that real-life electrons, having a negative charge, are attracted towards the most positively-charged pole. This is true ***electron flow***. However, for historical reasons of convenience, the pioneers in electricity thought that current actually flowed from positive to negative. This is called ***conventional current*** and it is still with us today – in the world of electronics, it is always assumed "by convention" that current flows from positive to negative.)

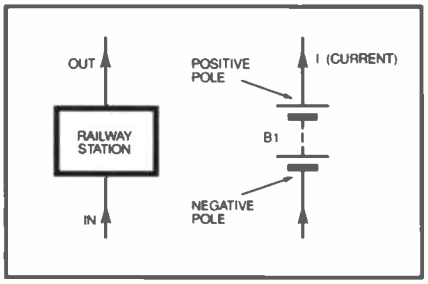


Fig.1.2. A railway station which "delivers" shoppers can be likened to a battery.

In Fig. 1.2, as far as the battery is concerned, we think of its connections as having a particular *polarity*. A simple device such as a lamp doesn't care about the polarity of the connections made to it (i.e. which connection to the lamp is to the positive end and which is to the negative) – the lamp will work fine whichever way round it's connected to the battery. Later on in the series we will discover some electronic components which care rather a lot!

Insulators, Conductors and Resistance

We now have an idea of what a ***resistor*** is, and soon we'll actually demonstrate their action. Resistors impede the flow of our charge carriers. The higher the resistance, the more difficult it is for them to pass through, and so the lower the current which flows. As we mentioned earlier, electrical resistance is expressed in Ohms, Ω. Whenever you see a value followed by this symbol, we are talking about resistance.

Resistance can sometimes be of such a large value that it becomes clumsy to deal with single ohms as a unit, so we use "multipliers" as a shorthand. One kilohm (kΩ) is 1,000 ohms, whilst a megohm (MΩ) is one million ohms. So a value written as 1kΩ is 1 kilohm or 1,000 ohms. 10MΩ is ten million ohms, for example. Also, the ohms or multiplier symbol can be used (preferred by *EPE*) in place of a decimal point on circuit diagrams, i.e. 1Ω1 = 1·1 ohms and 1k1Ω = 1·1 kilohms (1,100 ohms).

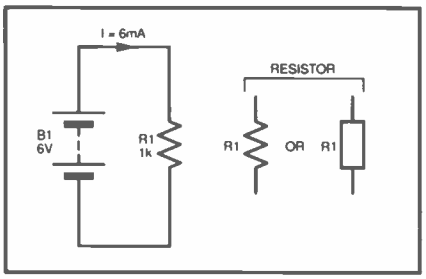


Fig.1.3. Circuit incorporating a fixed resistor across a 6V battery. In EPE *we always use the "zig-zag" symbol for a resistor.*

All components have a resistance of some kind: even those parts which you think are perfect conductors will actually have an electrical resistance, albeit an extremely small one. In the case of electrical wire, the resistance is as low as we can possibly manage, so that power is not wasted in the cabling.

Such waste is generated as heat, but again this may be of such a low level that you won't notice any temperature rise at all. In simple terms, heat is the same as power, or "work done". In the case of a switch, we want it to have a very high resistance when it is switched off, and a very low resistance when switched on.

In fact, it's possible to classify a whole range of materials by how good they are at carrying electric current. Materials including glass, ceramic, fibre glass, wood and most plastics, are very poor at conducting current, because they have very few charge carriers or "free electrons" available to transport charge. These materials are classed as ***insulators***.

At the other extreme, materials including gold, steel, copper and water have plenty of free electrons inside, and so these materials excel at carrying current – they are ***conductors*** of current. You will certainly have noticed how ordinary mains cable, a power cord, consists of copper conductors in its "core" surrounded by p.v.c. insulation to protect it and prevent a "short circuit" – or, indeed, injury to yourself!

Resistors and Current

When we start building circuits with resistors, interesting things happen. As a primer to performing your first practical experiments (described later in the section called "Lab Work"), consider the simple circuit diagram of Fig. 1.3. The circuit shows a single 1k resistor connected across a 6V battery. Note that in this magazine, we always use a "zig-zag" for resistors, but elsewhere you may see the equally-correct rectangle symbol (the difference being due to different international technical Standards in operation.)

Remember that the *power* which is consumed by our resistor depends on the current flowing through it. It dissipates I × V watts in the form of heat, though the power may be so small that you won't notice it. (An electric fire "bar" is a good example of a "wirewound" resistor which is designed to get really hot – red hot, in fact!)

Resistors themselves are given a *power dissipation* rating. You'll see this shown in catalogues. "Vanilla-flavour" resistors for most transistor or digital circuits are usually rated at 0·25W (a quarter of a watt). You can usually "guesstimate" the power rating of a resistor by its size; this comes with experience. Exceeding this value will damage the resistor and "let the smoke out"! Lab 1.6 (later) shows you how power is proportional to the square of the voltage: e.g. doubling the voltage will quadruple the power dissipated.

If you know the current flowing through a resistor, together with the voltage across it, multiply them together (P = I × V). Thus in Fig. 1.3, a 1kΩ resistor across 6V draws 6mA (0·006A) current and therefore dissipates 0·036W – i.e. 36 milliwatts (a "milli" of anything is one thousandth). A 24 ohm resistor with 6V across it would draw 250mA and dissipate 1·5 watts.

If you only know the resistance value plus the current or voltage, then two alternative formulae for Power are:

$$P = I^2R$$

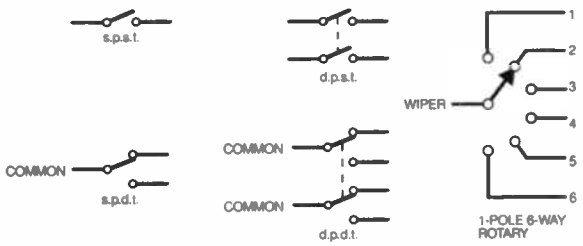
and

$$P = V^2/R$$

Run the circuit values of Fig. 1.3 through these formulae and prove that they are equally correct. You may sometimes hear designers talking about "I^2R heating" – power dissipation created when a current flows through any form of electrical resistance. In the next part, you'll learn how resistors are used as current limiters to protect devices such as light-emitting diodes and Zener diodes from damage. Now check the separate boxes on **Resistor Facts** and **Equations**.

In electronics you will also hear people talking about *voltage* sources and *current* sources. A voltage source is one which can provide a voltage, but where the current is severely limited (in effect there is a current limiter somewhere in the source). A current source is one which has the ability to provide current to do some work, for example light a lamp or drive a motor. We often have to use amplifiers to take a voltage source and then use it to provide a current source which will do useful work.

Check Out: Switches



A switch's configuration is determined by the number of "poles" and "ways". A double-pole (d.p.) switch can control two independent circuits. A double-throw (d.t.) switch enables you to switch between two states. Dotted lines show the switches are "ganged" together.

Switches are determined by the number of poles and the number of *throws*. A single-pole single-throw (s.p.s.t.) switch is a simple on-off switch. However a single-pole double-throw (s.p.d.t.) enables you to change over from one "way" to another "way", whilst a double-pole double-throw (d.p.d.t.) type enables you to switch over two completely separate circuits at the same time. See the "Check Out" circuit symbols above.

Switches are produced in a wide variety of styles – choose from toggle, slide, rotary, rocker, lever, push, key-operated and more besides. A good catalogue will show you typical types. Some switches may be "biased" – spring-loaded – so that they return to their original position when you release them.

Be sure to observe the switch ratings – some may not be suitable for mains voltages, but they will usually quote the maximum voltage and current rating allowed. Also be sure to specify the required number of poles and "ways". Many are panel mounting through standard-diameter holes but some need more elaborate panel-working to fit them correctly.

Equations

You might know a little about equations already. We represent particular quantities by symbols (e.g. resistance as R, power as P, etc.) and then express how they are related. The confusing thing about some electrical equations is that the letters used are not entirely obvious. The most striking example is the use of the letter *I* to mean *current*. Unfortunately you will just have to get used to this! The useful thing about equations is that you can "plug in" values to find out things, for example:

Imagine designing a headlamp bulb for a car. Lighting research says that we will need 60 watts of lighting power to let the driver see properly. We have a 12 volt battery on the car. The first question is, "What should be the current (*I*) which flows?". OK, let's plug some values in:

$P = I \times V$, so

$60 = I \times 12$

A quick calculation and we come up with the answer 5 for current *I*, so we need 5A (Amps) to flow. We now want to calculate the resistance of our bulb (ignoring things physicists know about, namely, the funny characteristics of a tungsten filament). We can now fire up the other equation:

$I = V/R$, so

$5 = 12/R$

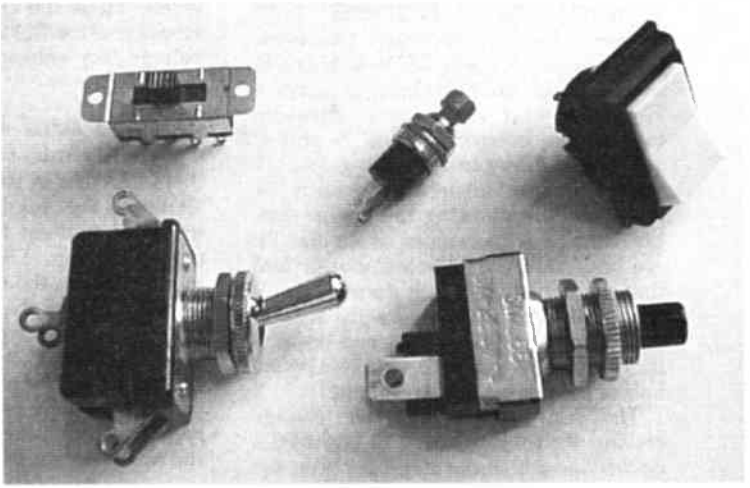
What is R? Algebra is simple, and boils down to one rule really; you can do what you like with one side of the "equals" sign, as long as you do the same thing to the other side too. So, multiply both sides of the equation by R:

$5 \times R = 12$

Now divide both sides by 5 to get:

$R = 2{\cdot}4$ ohms

Lastly, the formula $P = I^2R$ means "Power = the current squared, times the resistance." Multiply the 5 Amps current by itself (squaring), then multiply by the 2·4 ohm resistance: hence $P = 25 \times 2{\cdot}4 = 60$ Watts.



Just a small selection of the various types of switches available.

RESISTOR FACTS

- The value of an ordinary resistor is depicted by a series of coloured bands. If you stick with the simple four-band types (used for E12 and E24 5% resistors) you should manage without any problems.

  The colour code for a simple four band type is shown below: you will need this to get started with *Lab Work*. Which way round do you read the bands? The last band will usually be gold or silver, to indicate the tolerance – so the other three stripes indicate the resistance value. Practice will make perfect!

- Resistors are sold in "E12" or "E24" *preferred values* plus their multipliers. The twelve E12 values are: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68 and 82. So you can buy 10 ohm, 100 ohm, 1k, 10k, 100k, 1M resistors, and so on. The E24 values have further numerical values: E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75 and 91, making a total of 24 E24 values.

- If you work in industry you may also come across E48 or even E96 values, but they're overkill for many applications that you will encounter.

- Resistors also have a *tolerance* on their accuracy, which is expressed as a percentage. This is usually ±5% or ±2% indicating a "tighter" tolerance. So a 1k 5% resistor could really be anywhere between 0·95k to 1·05k in practice (950 to 1,050 ohms). E48 and E96 resistors have a closer tolerance because their ranges have to cover a wider number of values.

- Check for *power dissipation ratings*; higher power resistors may be *wirewound* types, but you will usually use general-purpose *carbon film* resistors.

  Have a look through some catalogues to see what's on sale. Ordinarily, the types used in *Teach-In* are 0·25W types.

Black	0	0	1	-
Brown	1	1	10	-
Red	2	2	100	-
Orange	3	3	1k	-
Yellow	4	4	10k	-
Green	5	5	100k	-
Blue	6	6	1M	-
Violet	7	7	10M	-
Grey	8	8	-	-
White	9	9	-	-
Gold	-	-	-	5%
Silver	-	-	-	10%

Four-band Resistor Code. Example: Yellow-Violet-Orange-Gold = 47,000 ohms (47k) 5%.

Resistors in Series

Circuit Fig. 1.4a illustrates two resistors, labelled Ra and Rb, which are in *series* configuration, connected across a 12V supply. If we were to measure the voltage between points A and C we would observe something like 12 volts – hardly surprising because we are actually measuring the power supply voltage! If the values of Ra and Rb are both 1kΩ (1,000Ω), we would find that the voltage between point A (positive) and B would be exactly half of 12V, and the voltage between point B (positive) and point C would also be half of the power supply voltage.

The fun starts when we change resistor Rb to, say, 100Ω. In electronics circles, we talk about a resistor *dropping* a certain voltage. What this means is simply that it has a certain voltage "across it". By measuring the voltage across A and B we can find the voltage dropped by Ra. By measuring the voltage between B and C we can find the voltage dropped by Rb.

The total resistance that the battery actually sees is the sum of Ra+Rb, which is 1·1kΩ (1,100Ω). Of this 1,000Ω is Ra and Rb is now 100Ω. We would expect to see a greater voltage across Ra than Rb, because it has the higher resistance. In fact, if we do a bit of maths we can predict the voltages we should see:

Ra contributes 1kΩ to the total 1.1kΩ of the resistance in the circuit, so by proportion we would expect there to be 1,000/1,100×12 volts across it, which we work out to around 10·9 volts.

Rb contributes 100Ω so we would expect it to have 100/1,100×12 volts across it, which we calculate to be about 1·1 volts.

Hence, 10·9V+1·1V=12V. Note that the sum of the voltages across each resistor must add up to the total voltage in the circuit. Voltage can't just "vanish" and it must all be accounted for.

The resistor circuit of Fig. 1.4a is called a *potential divider*, in that we can reduce (divide) a voltage by a known factor, simply by selecting a particular pair of resistor values. You will use this all the time, for instance when you adjust the sound volume of your radio you are changing the values of a pair of resistors to pick a particular voltage level off an incoming signal. The component you use to do this is a variable resistor or a ***potentiometer*** (*po-ten-she-ometer*) – VR1 (variable resistor 1) in Fig. 1.4b.

Potential dividers are used to divide voltages and generate an output voltage (V_o) which can be calculated as follows (refer to Fig. 1.4c):

$$V_o = \frac{Rb}{(Ra + Rb)} \times V_s$$

where V_o is the output voltage (seen across resistor Rb) and V_s is the supply voltage. Try with values for Ra and Rb in Fig. 1.4a.

Series and Parallel

If we have two resistors, we can wire them together in two different ways, as shown in Fig. 1.5. If we wire one resistor after another, this is called a *series connection*, Fig. 1.5a. The actual resistance between the two terminals A and B depends on the values of the two resistors. If the two are in series the effect "adds up", as you would expect. Because the charge carriers have to go through each resistor in sequence the resistance must be equal to the sum of the two resistance values:

$$R_{total} = Ra + Rb \text{ (ohms)}$$

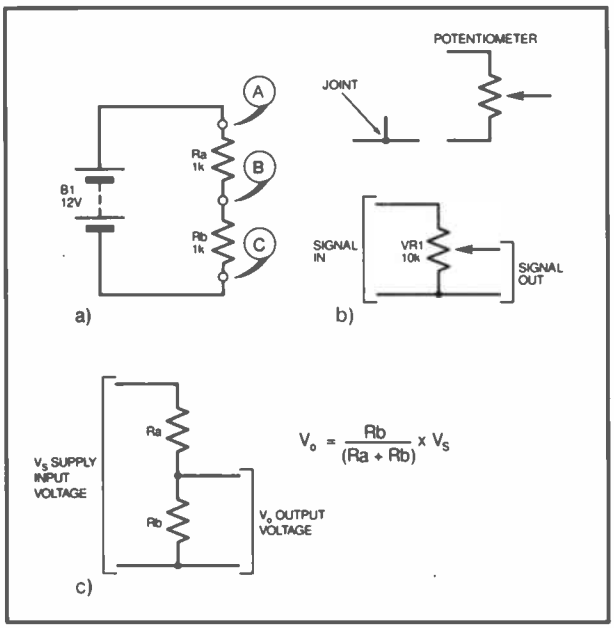


Fig.1.4. (a) Resistors in series forming a potential divider; (b) Potentiometer (variable resistor); (c) Potential divider formula.

Thus, two 15k resistors placed in series equate to a total of 30k. (Notice that it's common to drop the Ω symbol for brevity.) It's like the shopper's corridor narrowing in several places along the way, adding to the resistance value.

If we connect one resistor across the other, this is called a ***parallel*** circuit, see Fig. 1.5b. If the resistors are in parallel, something different happens. When the charge carriers arrive at the "fork"

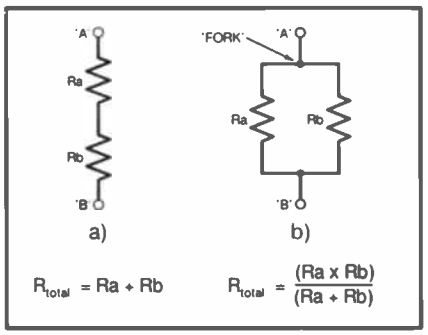


Fig.1.5. (a) Resistors in series; (b) Resistors connected in parallel.

in the circuit, some of them will go through Ra, and some of them will go through Rb. This means that the total resistance in the circuit will be **lower** than the resistance of either Ra or Rb. It is in fact calculated by the following equation for two resistors in parallel:

$$R_{total} = (Ra \times Rb)/(Ra + Rb) \text{ (ohms)}$$

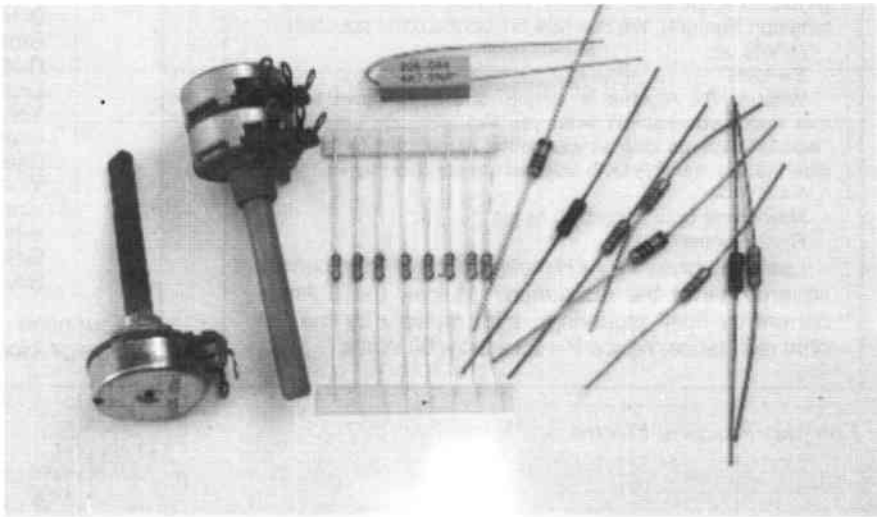
By placing Rb in parallel with Ra, you are in effect "bypassing" or short-circuiting Ra with the second resistor, so you reduce the overall resistance seen by the circuit – a bit like helping to move the crowd along by opening a second corridor as another route for those jostling shoppers! Two 15k resistors placed in parallel, equal 7·5k overall. A further formula can be used for computing the overall resistance of *any number* of parallel resistors:

$$\frac{1}{R_{total}} = \frac{1}{Ra} + \frac{1}{Rb} + \frac{1}{Rc} + \ldots etc$$

A scientific calculator helps! Three 15k resistors placed in parallel are equal to one 5k resistance. And so on. Remember not to confuse the units of resistance – use ohms throughout, or kilohms, but don't mix the two together in the equations because this will create errors in the calculations.

Now go to the **Lab Work** section for some practical demonstrations and experiments covering the material we have introduced in Part One. In *Teach-In* Part Two, we introduce further fundamental components used in electronics – the ***capacitor*** and the ***inductor***.

A small sample of resistive components. A single and dual potentiometer are shown on the left.



Using Your Multimeter

"Multimeters" are so-called because they can measure several things, including current, voltage and resistance. They are available in two types: *analogue* which uses a fragile moving-coil meter movement, and *digital* which is much easier to read and generally more precise.

Some can also measure additional parameters including frequency or capacitance or even test transistors. We suggest that a modest Digital Multimeter costing well under £20 will be enough to get you started.

Voltage Readings

When set to read voltage, your multimeter becomes a "Voltmeter". These measure potential differences **across** components such as resistors.

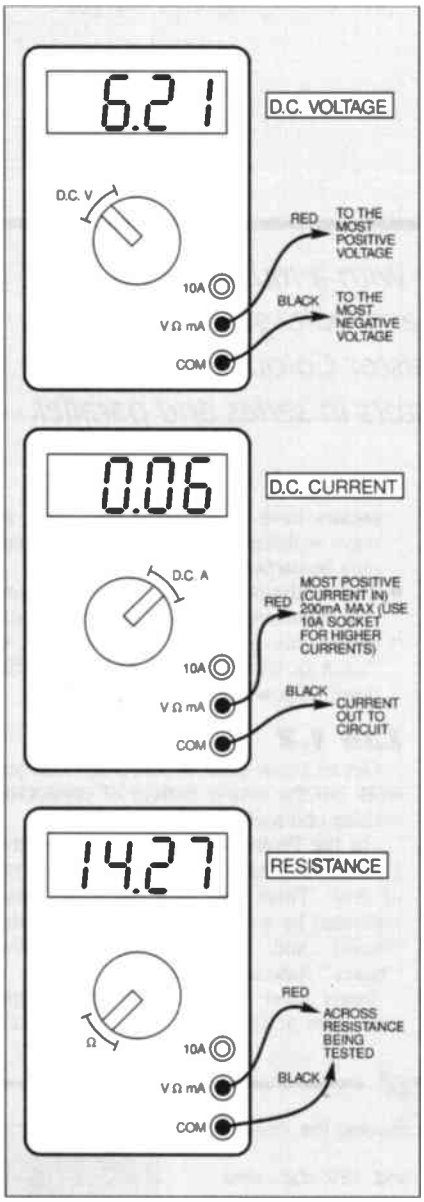
Digital meters have a very high resistance themselves, which doesn't "load" the circuit under test. The budget type we recommend requires that you set a suitable range using the control knob – select a d.c. V range (direct current Voltage) unless told otherwise.

Try to always connect the right way round – positive (red lead) to the highest voltage, "COM" (black) to the lowest. Reversed voltages are indicated by a minus sign in the l.c.d. (liquid crystal display). The same sockets in the suggested meter are also used for resistance and current (200mA maximum). You should **not** attempt any mains voltage readings unless under supervision.

Current Measurements

Your multimeter becomes an "Ammeter" (amp-meter) when measuring current. Current flows "into" the meter from the most positive potential, and then out from the meter COM (common) socket to the rest of the circuit.

Remove power first before inserting the ammeter. Start with a high current range, so that you avoid damaging the meter by overloading it. You can always switch to a lower range afterwards – disconnect the power from the circuit before switching ranges.



Select a d.c. A range (direct current Amps) unless otherwise stated. A separate 10A d.c. socket is available on the suggested meter. Use this for currents exceeding 200mA, but be aware that this range has no internal fuse so the meter is unprotected: maximum, 10 amps.

An ammeter "looks like" a virtual short-circuit between its terminals. **Never** put an ammeter across a battery or power supply to see what happens, because a high short-circuit current will flow (many amps, in the case of an alkaline battery) which may destroy your meter or the battery, or in extreme cases, even start an electrical fire.

Resistance

A multimeter set to read resistance becomes an "Ohmmeter". It uses its internal battery in this function to supply power to the part being tested. Hence you must always ensure that the circuit under test is fully de-energised, or damage or errors may result. Select a suitable range with the switch – you can measure up to 2MΩ with our suggested meter.

Other Functions

The meter we use for *Teach-In* also measures the gain (h_{FE}) of bipolar transistors (emitter, base, collector pins are connected to the test socket) and also tests diodes as a bonus.

Fairy Lights and Sudden Death

Once you understand how the voltage drop in a circuit is related to the resistance of it, you can start to think about other things. People have died because they misunderstood the way that this works. Consider "fairy lights" on Christmas trees:

The usual arrangement for Christmas tree lights is a number of low voltage bulbs, placed in series across the 230/240 volt mains, for example twenty bulbs each of which is rated at 12 volts. When we do the sums for the voltage drop across each bulb in the set, we get a 12 volt drop, and so each light is working off its proper voltage and all is well.

The problem comes if you think; "Aha, this is only a 12V bulb and 12 volts won't hurt me". Let's look at what's going on: say each bulb is a 3W, 12V bulb. OK, now for some maths:

P (power) = I (current) × V (voltage)
so the current is a quarter of an amp (0·25A).

Using Ohm's Law, or the "cover up trick":
R (resistance) = V (voltage)/I (current)
R = 12/0·25 = 48Ω

Each bulb in the circuit has a resistance of 48 ohms. This makes for a total resistance of 0·96kΩ (960Ω) wired across the mains. Suppose that a human being has a resistance of around 50kΩ and that it somehow becomes connected in series with the fairy lights.

We know that the voltage across each resistor is proportional to the resistance in series with it. What we have is a resistance of 50kΩ (the person) in series with a resistance of 0·96kΩ (the lights), across a voltage of 240 volts. This means that only around one fiftieth of the voltage will be dropped across the fairy lights, and the rest across the person, leading to a fatal electric shock of over 230 volts!

Up to a voltage of around 25 volts the resistance of our skin is such that no dangerous currents can flow. Above that voltage you must be **extremely** careful, and certainly any voltage over 50V or so should be treated with respect.

Note that all our experiments and circuit designs will keep well within safe voltage limits. Some devices, for example touch switches, make use of the fact that human bodies can conduct a tiny amount of electricity.

TEACH-IN '98

LAB WORK

Objectives: becoming familiar with a multimeter's basic functions. Observing current and voltage in series and parallel circuits. Using the Resistor Colour Code, then checking the function of resistors in series and parallel. Testing potentiometers.

Lab 1.1

YOUR multimeter is your best friend! Remember you measure voltages across two points. As a first test, set the meter to what you know will be a "safe" higher voltage range (e.g. 20V d.c.) and use the probes to measure the output voltages of your mains adaptor (see below), by placing the probes across the low-voltage output plug. (A blob of Blu-Tack might help hold the plug to the work top.) Note the polarity carefully. Which is positive and which is negative? Using a modest multimeter, our own readings were as follows (in brackets): 1·5V (1·74V), 3·0V (3·36V), 4·5V (4·72V), 6·0V (6·37V), 7·5V (7·77V), 9·0V (9·39V) and 12V (12·54V).

- Digital multimeters can usually cope with reverse voltages, by displaying a minus sign. Older "moving coil" meters have a needle which can't always withstand wrong connections, and may be damaged.
- The readings were taken with nothing else connected to the adaptor. We examine this further in the next part of *Teach-In* when we talk about "regulation" of power supplies.

Lab 1.2

Get to know your breadboard! Can you work out the matrix pattern of connectors with an ohmmeter?

On the Protobloc 2, sockets (numbered 1 to 64) are inter-connected to form rows of five. There are 128 strips of these, separated by a gap for handling integrated circuits, and also eight longer power "buses" indicated by coloured lines.

Insert short lengths of stripped single-core wire at each row end, and measure the resistance with your multimeter set to a low ohms range (e.g. 200 ohms). A short circuit will have near zero ohms. Work out and confirm the pattern of conductors for yourself, so you see how your breadboard works.

- Lab 1.2 uses an ohmmeter to check for "continuity" – a good, low-resistance connection between two points. Poor continuity is indicated by a high resistance, or sometimes by an unstable meter reading which won't settle down. This generally points to a problem – a loose or "noisy" connection, maybe.
- Solderless breadboards are only used for low-voltage circuits. They must **never** be used for mains voltage experiments.

Lab 1.3

Circuit diagram Fig. 1.6 shows two 6V 0·06A MES bulbs LP1 and LP2 **in series** across 12 volts, derived from the mains adaptor. Build this using wire and the two lamp bulbs, connected to the adaptor set for 12V. Set your meter to 20V d.c. and measure the voltage across each bulb. Is this what you would expect? We measured 6·9V and 5·59V, the difference being due to the tolerances of the bulbs.

Measure the voltage across the power supply when the bulbs are alight (12·49V in our case). Note that the power supply voltage may now be very slightly lower than the value you saw in Lab 1.1 – 12·54V in our case – we lost 50mV (0·05V) due to the "regulation" of the mains adaptor.

Measure the current flowing in the circuit. To do this you will need to interrupt the circuit, set your multimeter to read 200mA and insert it in *series* with the bulbs, the right way round. You could even use the ammeter's test probes to link the circuit back together again and read the current at the same time!

You Will Need

To start off with, to perform experiments and develop the *Teach-In* demonstration circuits you'll need:

- *A power supply capable of producing 6V and 12V d.c., and around half an amp (0·5A) of current.*

  We suggest a "regulated" *short-circuit proof* plug-in mains adaptor capable of providing at least 6V, 9V and 12V d.c. at up to 500mA (0·5A) or more. You could improvise with test leads (e.g. crocodile clip leads) to hook up between the mains adaptor, low voltage, d.c. output leads and the demo circuits.

  Some readers may be able to solder together a suitable adapter lead, enabling you to use red and black insulated crocodile clips as "flying leads". We made such a lead by soldering a pair of wires to an in-line socket that matched one of the mains adaptor's d.c. output plugs.
- *A modest digital multimeter* (DMM) capable of measuring d.c. voltages, d.c. current (perhaps with a 10 Amp socket), and resistance up to 2MΩ or more, will be fine, e.g. Monacor DMT-1010, in a purposeful shade of yellow, complete with leads, costing around £15. Check out the box "How to use your multimeter" before starting your lab work.
- Initially, in order to avoid soldering, a *solderless plug-in "breadboard"* is used. This means that low-power, low-voltage circuits can quickly be built and modified. E.G. a "Protobloc 2" which has two banks of 64 rows, plus supply strips. These interlock with other Protoblocs for larger projects. See Lab 1.2.
- A set of *modest hand tools*: electronics wire cutters/insulation strippers, pointed-nose pliers, flat-blade screwdriver to get you started.
- A number of 0·25W carbon film resistors of varying values, including a 100Ω and two 1kΩ for this month's Lab Work and random values for you to decode and measure. Also, a 10 kilohm potentiometer to test.

- Two 6V 0·06A "MES" screw base bulbs, in suitable holders.
- Some wire (obviously). Single-core "bell" wire is best here because it is easiest to push into the breadboard. Consider buying a few metres of different colours so that you can colour code the various connections to help with checking. Even surplus telephone wire is fine.

Shoptalk in this issue gives some information on buying these items.

When considering your lab work, it is worth bearing a few things in mind. Later on you'll discover that many components are fussy about their polarity (i.e. which connection is *positive* and which is *negative*). Incorrect connection can therefore have potentially messy (and expensive) results. Do NOT adjust your circuit with the power *switched on*; assemble everything first, check it and then apply the power.

We read 57·2mA, which is very close to the 60mA rating shown on the bulbs. Unscrew either one of the bulbs, note what happens. Are you surprised?

- Note that we are successfully using two low voltage bulbs on a *higher* voltage by putting them in series. This is not a million miles away from how fairy lights work – see the separate panel *Fairy Lights and Sudden Death*.

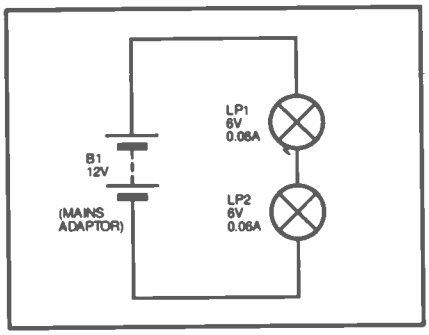


*Fig.1.6. Connect two bulbs in **series** and apply across a 12V supply derived from the Mains Adaptor.*

Lab 1.4

Change the adaptor voltage setting to 6 volts, and change the wiring so that both of your bulbs are now **in parallel**. See Fig. 1.7 – note that a "blob" where lines touch, indicates an electrical join. Interrupt the circuit and place your ammeter (200mA) in series with the supply wire.

Measure the current flowing in the entire circuit as shown (going into the "fork"). We read 112·8mA. Unscrew one of the bulbs and note what happens to the other one (if anything). Put the bulb back in place.

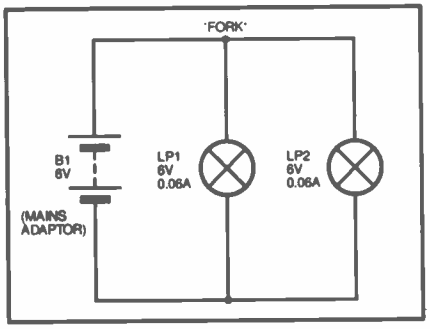


*Fig.1.7. Two 6V bulbs connected in **parallel**. Ensure the mains adaptor is set to **6V!***

Now measure the current flowing into each bulb. You should then see that the sum of the currents flowing into each bulb equals the total current delivered by the power supply.

- Increasing the power supply to, say, 12V would obviously damage both bulbs in this parallel circuit.

Lab 1.5

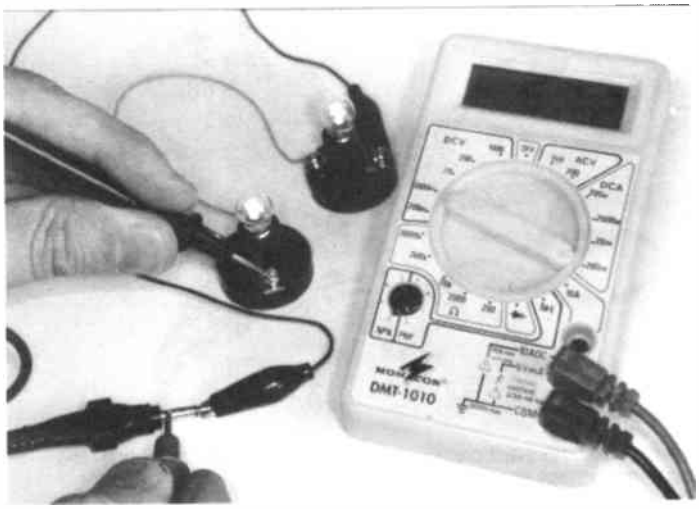
Use the Resistor Colour Code (see the topic *Resistor Facts*) to decipher the values of a variety of fixed resistors. Then use your ohmmeter set to a suitable resistance range, to see if you are right. Remember each resistor has a tolerance, so don't expect complete accuracy.

- The maximum power dissipation of a particular resistor will be shown in the manufacturer's data or supplier's catalogue.

Lab 1.6

Insert one 1k resistor into your solderless breadboard, making sure you pick appropriate sockets on the Protobloc so that you're not accidentally shorting it out! Connect it to the 6V supply from the mains adaptor, improvising with suitable test leads. See Fig. 1.8. Confirm the voltage across the resistor by using your multimeter.

Using the digital multimeter, set to 200mA range, to read the current through the bulbs. The reading shown here is 57·2mA.



Use I = V/R to calculate the likely current and then check this with your multimeter set to a current range (we measured 6·1mA). Use $P = V^2/R$ to calculate the theoretical power dissipation – 36mW. Now repeat by increasing the voltage to 12V and calculate the theoretical power dissipation in the 1k resistor – 144mW, closer to the resistor's limit.

- Notice how simply **doubling** the voltage across the resistor has **quadrupled** its power dissipation. *Power dissipation is proportional to the square of the voltage.*

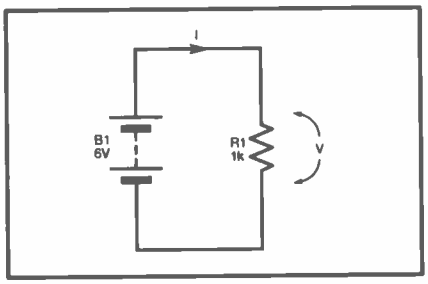
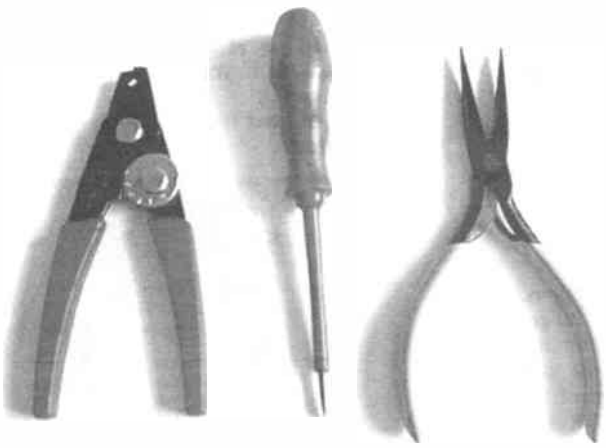


Fig.1.8. Measure the voltage across resistor R1, and the current I. Calculate the power dissipated by R1.

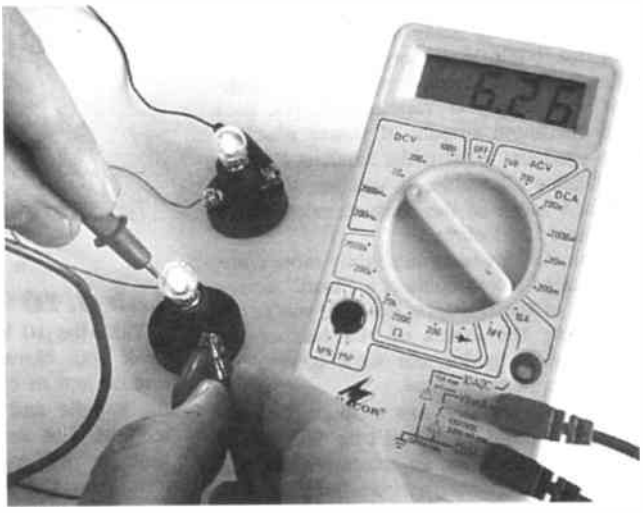
Lab 1.7

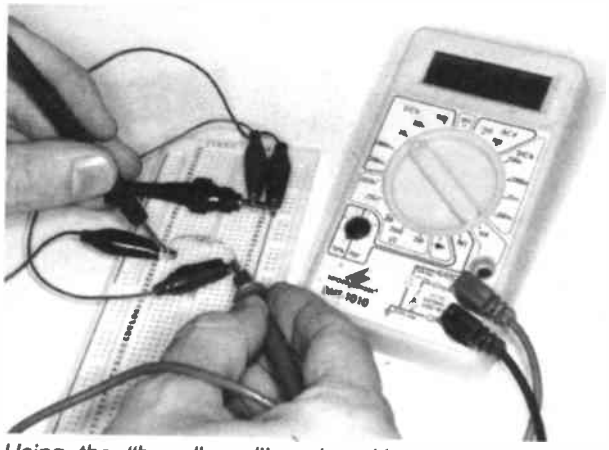
We are now going to replace the bulbs of Lab 1.3 with resistors. Check that your power supply is set to 12 volts and build a **potential divider** by connecting two 1k

Basic tools to get you started: insulation stripper/wire cutter; flat-bladed screwdriver and long-nosed pliers.

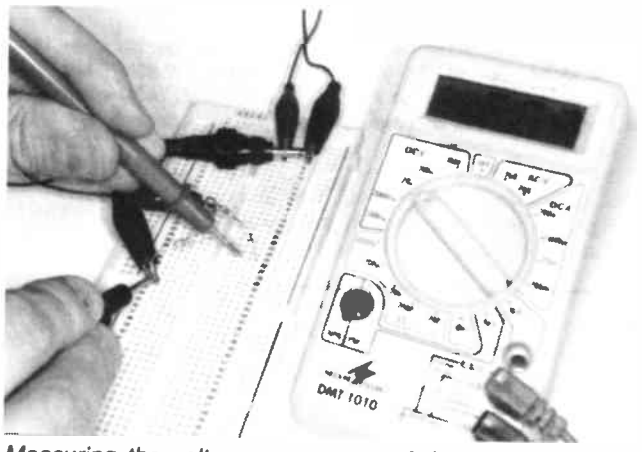


Using your digital multimeter to measure the voltage across one of the bulbs. The reading here is 6·26V.





Using the "breadboard" and multimeter to measure the voltage across the resistor.



Measuring the voltage across one of the potential divider resistors.

resistors in series across it (Fig. 1.9). Do this by inserting two resistors in your Protobloc so that one socket strip connects one lead from each resistor together.

Using Ohm's Law, what do you think the voltage across each resistor will be? Check to make sure you are right! (We read 6·28V and 6·26V). This equates to the supply voltage measured of 12·54V. What is the total resistance seen by the power supply? (2k assuming ideal resistances!)

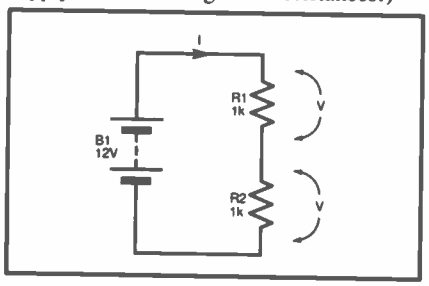


Fig.1.9. Construct the potential divider, resistors R1 and R2, across a 12V power supply. Measure both voltages and the current I.

You now know the voltages and the resistance in Lab 1.7. Use $I = V/R$ to calculate what current would flow in this circuit. Connect your multimeter in series and measure the total current flowing (6·1mA) and prove you are right once again! If your answer was wrong, remember that we have two 1k resistors in **series**. Note that the current flowing through either resistor in this circuit is of course the same.

Now use $P = V^2/R$ to work out how much power is being dissipated by each resistor (0·036 Watts, or 36mW). Find out the maximum current which your adaptor will supply at various voltages, plus the maximum amount of power which it can produce. What is the smallest "load" resistance allowable, if you use the 12V 595mA range of the recommended mains adaptor? (20·1 ohms.)

- Calculations become slightly more complicated if you connect a "load" across one of the resistors, because you're affecting the values of one half of the potential divider, but we'll ignore that for our purposes here.
- The suggested mains adaptor is short-circuit proof so it won't be damaged if you try to draw an excessive current. *Not all adaptors are protected this way.*

Lab 1.8

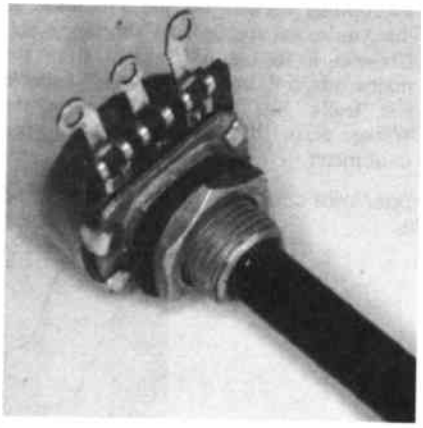
Replace one 1k resistor in Lab 1.7 with a 100Ω resistor and repeat the measurements for voltages and current. Calculate the power dissipated in both resistors, and the total resistance value (1k1).

Lab 1.9

Construct the circuit shown in Fig.1.10, which places two 1k resistors in parallel across 12 volts. Use $I = V/R$ to calculate the current through each resistor. Then using your multimeter set to 200mA, measure the total current flowing out of the supply (we read 24·5mA), and also through each resistor.

What does this tell you about the overall resistance of the resistor pair, compared to Lab 1.7? (It's equivalent to 500 ohms in total.) Confirm this by using your meter set to measure the combined resistance; be **careful that you disconnect the resistors from the power supply when measuring resistance**. Use $P = V^2/R$ to calculate the power dissipation of each resistor.

- Never measure resistances using a multimeter if *voltages* are present in a circuit.



Typical example of a potentiometer.

Lab 1.10

Take the 10 kilohm potentiometer and hook your ohmmeter (20k range) to the middle and to one other terminal. Rotate the spindle and observe the changes in reading. Test the resistance of the potentiometer by measuring the outer two terminals. The middle connection is the moving "wiper" of the potentiometer; the outermost terminals connect to either end of the resistance "track". Prise it open to see if you like!

- "Preset" potentiometers (or "trimmers") work the same way, only they are smaller. They're designed for soldering to circuit boards rather than being fitted to control panels. Adjust preset potentiometers with an insulated trimming tool.

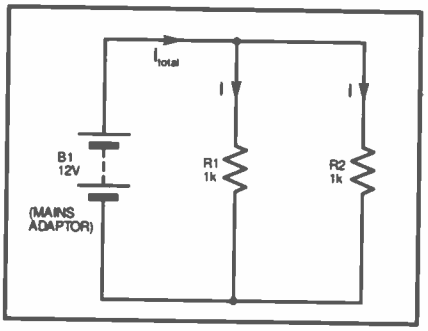


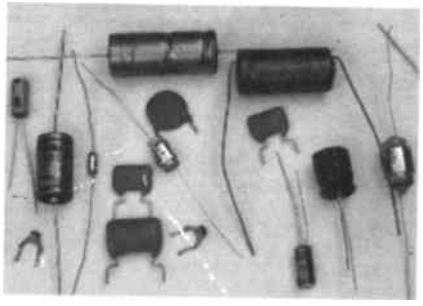
Fig.1.10. Connect both resistors in parallel across a 12V supply, measure the total current and the current through each resistor.

End of Lab 1 Tasks

You should now be familiar with the functions of your multimeter and mains adaptor, how your breadboard is interconnected, how to "read" resistors, how potentiometers function, and the effects which series and parallel connections have on the voltages and currents observed. Also, making resistance and power dissipation calculations.

Don't forget that you can write to us or E-mail us at **Teach_In98@epemag.demon.co.uk** if you have any queries or comments.

One of next month's subjects is the **capacitor.**



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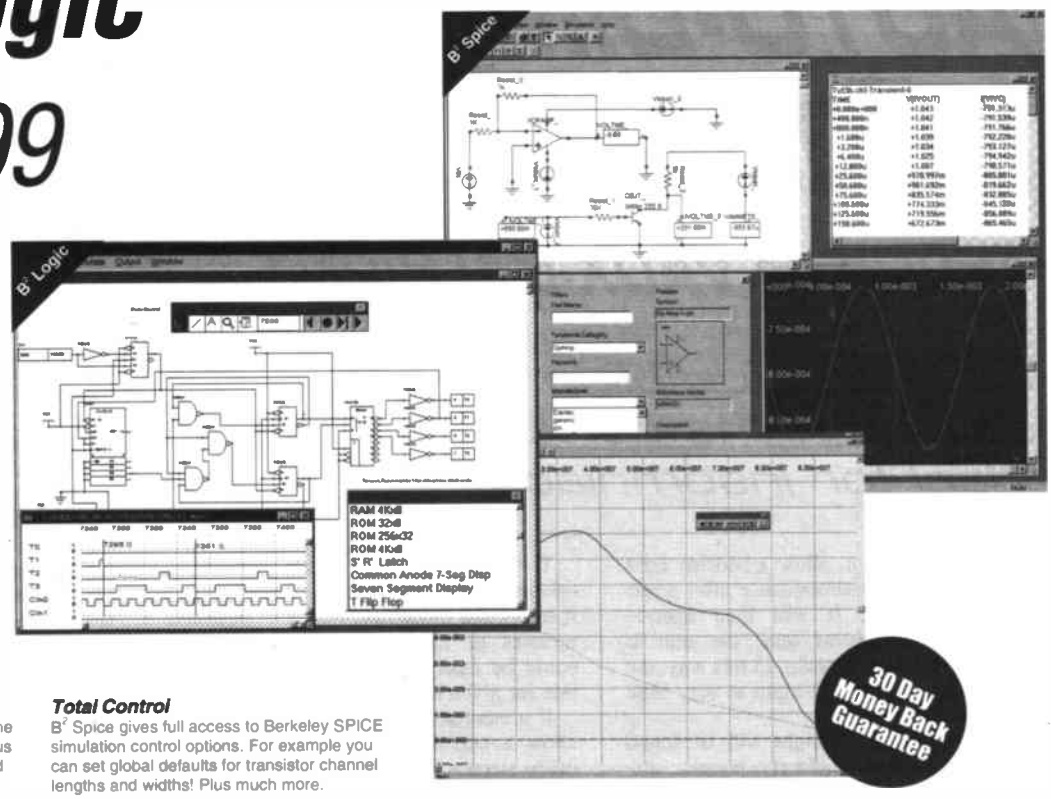

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AUTO-DIM BEDLIGHT

TERRY de VAUX-BALBIRNIE

No more fumbling for the switch in the dark. Ideal for insomniacs!

THIS circuit will allow a bedside light to go dim automatically after some preset time. It will then operate at reduced brightness until the unit is switched off then on again. In this way, the light may be left on all night at very little cost.

The Auto-Dim Bedlight will be found useful for children, elderly people, disabled people or anyone who does not sleep very well.

GENTLE GLOW

The degree of dimming is freely adjustable from virtually full brightness, to completely off. When set to operate with a gentle glow, it will be sufficient to comfort a child who is afraid of the dark.

Set a little brighter, it will allow the user to get out of bed and see his or her way to the door and back again. This avoids having to fumble for the light switch in the dark or, worse, not bothering and possibly falling over the furniture.

The time during which the lamp operates at full brightness – that is, before it enters *dim* mode may be preset from five minutes to 1½ hours approximately. It could be easily increased and details for this are given later.

If it were set for, say, one hour it would allow a person to read a book and nod off to sleep without having to worry about switching off the light. Not only will this save money but the reduced light is less likely to wake the user in the middle of the night.

Some people find that after having switched off the light, they can no longer go to sleep. This auto-dim circuit hopes to avoid this problem.

The dimmer the setting and the shorter the time taken to enter dim mode, the smaller the overall energy requirement will be. Coupled with the use of a low-wattage (say, 60W) bulb, the running costs will be negligible. Even a 15W bulb might be sufficient to comfort a child. Note that although the bulb may be of any mains *tungsten filament* type having a rating up to 150W, ***it must NOT be a fluorescent (including low "energy") type.***

The Auto-Dim Bedlight circuit is housed in a small metal box with an on-off switch on the front panel. There is a mains input lead and a similar output lead having a line socket to which an existing table-type lamp or overhead light is connected (see photograph). The switch on the unit will now be used to control the lamp so any existing switch could be left *on*.

HOW IT WORKS

The full circuit diagram for the Auto-Dim Bedlight is shown in Fig.1. When activated using switch S1, the lamp LP1 comes on at full brightness. However, for it to do this a fairly complex series of actions has to take place.

Transformer T1 has a 230V primary winding and a 12V secondary winding. With S1 on, the primary receives a mains supply through fuse FS1 and a low-voltage a.c. output is obtained at the secondary winding. This is rectified (converted into d.c.) using bridge rectifier REC1 and the result smoothed by capacitor C1.

The capacitor charges to the peak of the a.c. waveform (about 17V) but there is

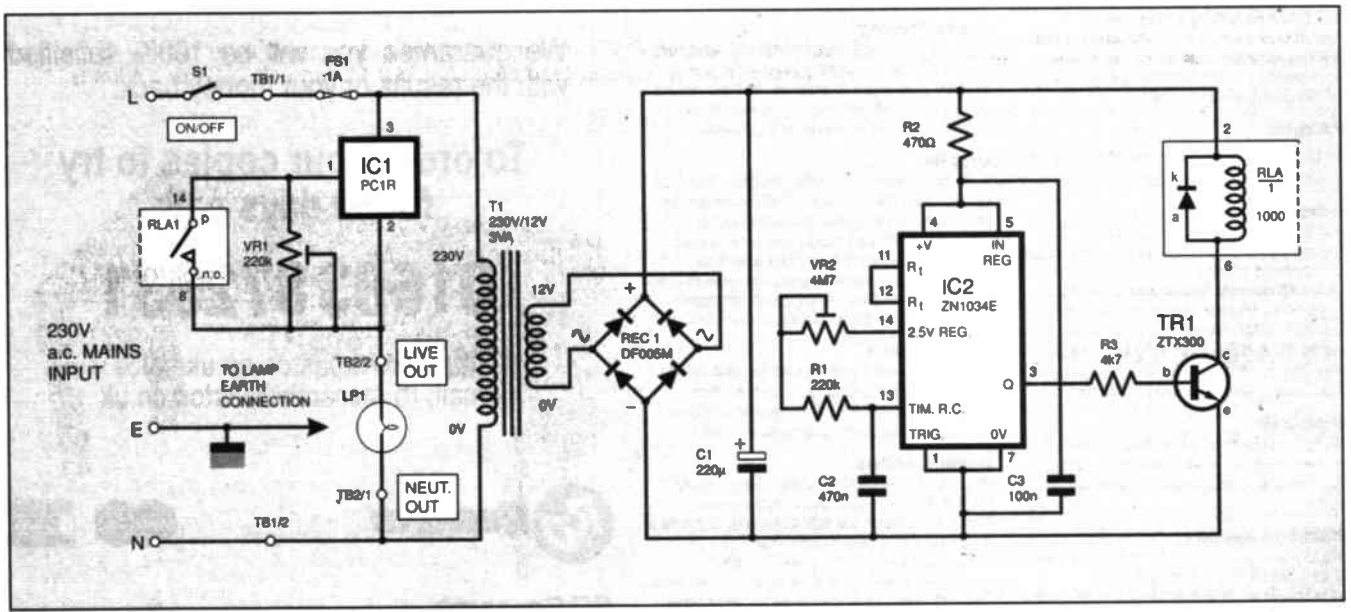


Fig.1. Complete circuit diagram for the Auto-Dim Bedlight. The relay RLA is a d.i.l. reed type and incorporates its own protection diode.

then a loss of 1·4V approximately due to the bridge rectifier. The result is a supply of about 15V d.c.

The specified transformer provides a 12V output on full load so the actual supply is higher (because this circuit requires much less current than "full load"). In the prototype, this was about 19V. This is not very important because any voltage between 12V and 20V will be suitable to operate the circuit.

Current flows to integrated circuit timer IC2 via resistor R2. This resistor is needed because IC2 requires a 5V supply which is obtained using an on-chip voltage regulator. The resistor operates in conjunction with the regulator and the difference between the 5V needed and that of the supply appears across it (about 10V to 14V).

Pin 1 and pin 7 of IC2 are connected together and taken to the 0V rail. This configures it in "self-triggering mode" and it will begin a timing cycle as soon as it receives a supply. Pin 3 will then go immediately high. Decoupling capacitor C3 is needed for stable operation of the i.c.

TIMING ADJUSTMENT

After a certain time, IC2 will time out and pin 3 will revert to low. The length of time during which it remains high is dependent on the values of fixed resistor R1, preset potentiometer VR2 (connected as a variable resistor) and capacitor C2.

With the values specified, the timing may be adjusted between five minutes (with VR1 set to zero) and more than 1½ hours (with VR1 at maximum). The timing could be increased by raising the value of C2 in proportion.

Integrated circuit IC2 is an interesting device because it provides long timings with relatively small component values. It does this in the following way: Capacitor C2 charges through R1 and VR1 and logic "1" is registered by an on-chip counter. The capacitor is discharged and begins a further cycle.

The counter continues to register the total number of charge/discharge cycles. When it reaches 4059, the device times out and pin 3 goes high (which is actually +4V approximately).

This allows current to enter the base (b) of transistor TR1 through current-limiting resistor R3. This turns it on and allows current to flow from the nominal +15V supply line through the coil of reed relay RLA1.

Note that there is no external diode connected in parallel with the coil because one is already built inside the relay. This is needed to remove the effect of the high-voltage pulse which occurs when the magnetic field in the core collapses. This happens when the coil current is switched off.

POWER CONTROL

With current flowing through the relay coil, its normally-open contacts close and short-circuit IC1 pins 1 and 2. This component is a *power controller* i.c. and its purpose is to adjust the average current flowing from pin 3 to pin 2 and hence through lamp LP1, according to the resistance (VR1) connected between pins 1 and 2. Thus, with zero resistance existing here, maximum current flows – almost as if pin 2 were connected *direct* to the mains Live supply line.

There will be a small voltage (1V to 1·5V approximately) between IC1 pins 2 and 3. This will be effectively "lost" as far as the bulb is concerned but is too small to have any significant effect. It will, however, lead to some power dissipation and, with a 60W bulb connected, the device will become warm in operation.

At any time, switch S1 may be switched off to cancel operation. When switched on again, the timing will start from zero.

Assuming the circuit is left switched on, lamp LP1 will remain operating at full power until IC2 times out. Pin 3 will then go low, transistor TR1 will switch off and the relay coil will lose its drive current. The relay normally-open contacts RLA1 will open and the short-circuit between IC1 pin 1 and pin 2 will be removed.

Preset potentiometer VR1 now provides a certain resistance between these points. Its setting therefore determines the power transferred to the bulb.

Thus, with VR1 set to zero, the lamp will continue to operate at maximum brightness (of course, there is no point in doing this). If VR1 were adjusted to *maximum*, the lamp would effectively go out (although a small current would still be flowing through its filament). In practice, VR1 will be set to some position between the two extremes so that the lamp operates with the required degree of brightness.

ON YOUR CYCLE

Power controller IC1 works by varying the position on the a.c. cycle when it triggers and allows current to flow. The device then switches off again when the wave passes through zero. On the next half-cycle it will be re-triggered and the whole process repeat indefinitely.

Looking at the a.c. waveform shown in Fig.2(a), with zero resistance between IC1 pin 1 and pin 2, the device triggers soon after the wave passes through zero (the triggering points are labelled "t"). Most of the wave then passes before it switches off at the next zero-crossing (shown by the shaded areas). Soon afterwards, it will be re-triggered so the lamp operates at virtually full power.

SAFETY WARNING

Since mains connections need to be made in the course of construction, it is essential that the constructor is able to do this work safely. If in any doubt, seek the assistance of a qualified person.

This project must be built into an Earthed METAL case and only used under dry indoor conditions.

If it is to be used in a child's bedroom, the unit and lamp itself must not be capable of being reached by the child.

With a high resistance connected between IC1 pin 1 and pin 2, triggering is delayed so that it occurs later in the cycle – see Fig 2(b). Most of the wave will therefore be unused.

This results in only a small proportion of the available power passing through the bulb. The lamp will therefore operate more dimly. Note that only the section of a.c. wave which is allowed to flow is paid for – the rest is unused, not wasted.

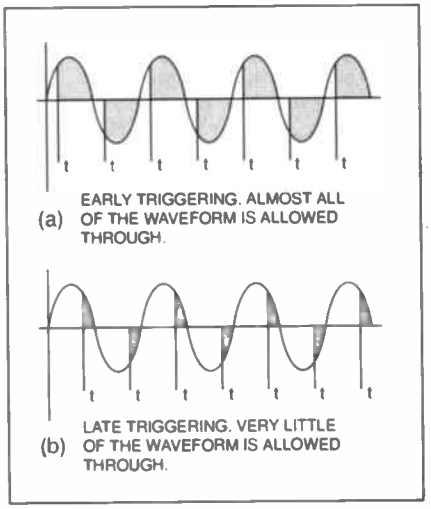
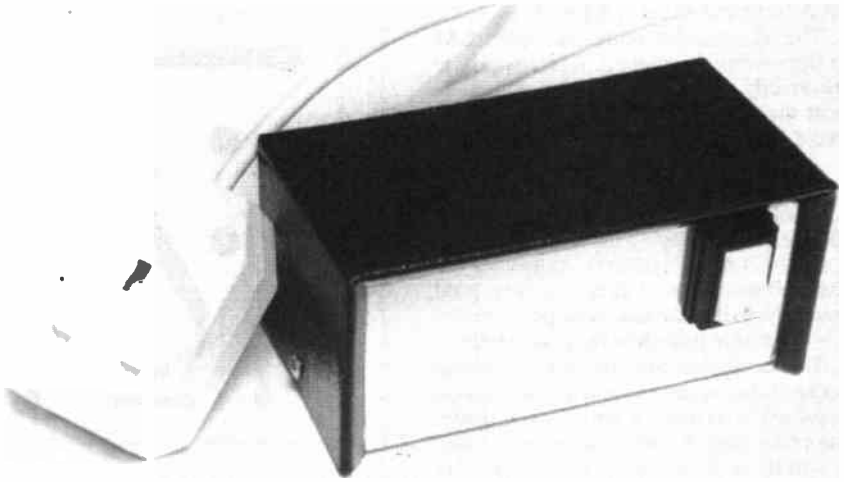


Fig.2. Effects of early and late triggering of a.c. waveform. Shaded areas show the part allowed to pass through IC1.

Completed Auto-Dim Bedlight with the mains output cable terminated in a three-pin line socket. The mains input lead plug should be fused with a 2A or 3A fuse.



COMPONENTS

Approx Cost Guidance Only £20
excluding case & mains cable

See SHOP TALK Page

Resistors:

R1	220k	
R2	470Ω	
R3	4k7	
All 0·6W 1% metal film		

Potentiometers

VR1	220k min. enclosed preset, vert.
VR2	4M7 min. enclosed preset, vert.

Capacitors

C1	220µ p.c.b. mounting radial elec. 25V
C2	470n min. metallised polyester - 5mm pin spacing
C3	100n min. metallised polyester - 5mm pin spacing

Semiconductors

REC1	DF005M 50V 1A bridge rectifier, d.i.l. package
TR1	ZTX300 *npn* silicon transistor
IC1	PC1R 1A power controller (see *Shoptalk*)
IC2	ZN1034E precision timer

Miscellaneous

T1	mains transformer – p.c.b. mounting. 230V or 240V primary and single 12V secondary (or twin 6V secondary windings) rated at 3VA
RLA	reed d.i.l. relay with mains-rated contacts, a 12V 1000Ω coil, and an inbuilt diode across coil
FS1	1A ceramic mains-type fuse with 20mm chassis fuseholder and protective cover
S1	s.p.s.t. rocker switch with 1A mains-rated contacts

Printed circuit board available from *EPE PCB Service*, code 172; vinyl-effect aluminium case, size 127mm x 63mm x 57mm; 6-pin d.i.l. socket (for REC1 if required - see text); 14-pin d.i.l. socket; 2-way, 10mm spacing, screw terminal block (2 off); mains trailing socket; mains 3-core cable, solder tag; stand-off insulators (6 off); small nylon nuts and bolts fixings (6 off); spade receptacles or heat-shrinkable sleeving; self-adhesive plastic feet (4 off); solder, etc.

CONSTRUCTION

The d.i.l. relay must be of the correct *reed* type as specified. That is, it must have contacts rated for ***mains*** use and it *must* contain the inbuilt protection diode, mentioned previously, connected in parallel with the coil.

The direction in which the coil is connected to the p.c.b. ensures that the diode will be the correct way round in the circuit.

CIRCUIT BOARD

Almost all of the components for the Auto-Dim Bedlight are mounted on a single-sided printed circuit board (p.c.b.). The exceptions are the mains On/Off rocker switch and the mains Earth leads "earthing" solder tag – see photograph.

The topside p.c.b. component layout and full size copper foil master pattern are shown in Fig.3. This board is available from the *EPE PCB Service*, code 172.

Begin construction by soldering the mains transformer in position. The specified component has twin 6V secondaries and the inter-connected copper pads at the output side place these in series to give the nominal 12V supply. The transformer is generously rated (3VA) and this ensures that it remains cool during long periods of use.

Because it is heavy, it needs adequate support. The unconnected tags help to provide anchorage and the p.c.b. mounting fixing holes are positioned so that the circuit panel is not strained any more than necessary.

Solder the two sections of screw terminal blocks (TB1 and TB2) to the p.c.b. then add fuseholder FS1. Follow with the i.c. socket (for IC2) and the reed relay RLA (soldered *direct* to the p.c.b.).

The off-set nature of the relay pins make it impossible to connect this component incorrectly. When soldering it, no more heat than is necessary to make good soldered joints should be applied.

Add the d.i.l. bridge rectifier REC1. It would be better if it were mounted in an i.c. socket rather than soldering it *direct* to the p.c.b.. However, in the absence of such a socket, it is acceptable to do this but use the minimum amount of heat to give good joints. Note that the side with pins labelled "~" (a.c.) are nearest to the transformer.

This device has four pins but a matching socket is not readily available. The easiest approach is to use a 6-pin unit and ignore the centre ones in each row. In some cases, it will be easier to use an 8-pin socket cut to size.

Follow with all resistors and capacitors including presets VR1 and VR2. Take care

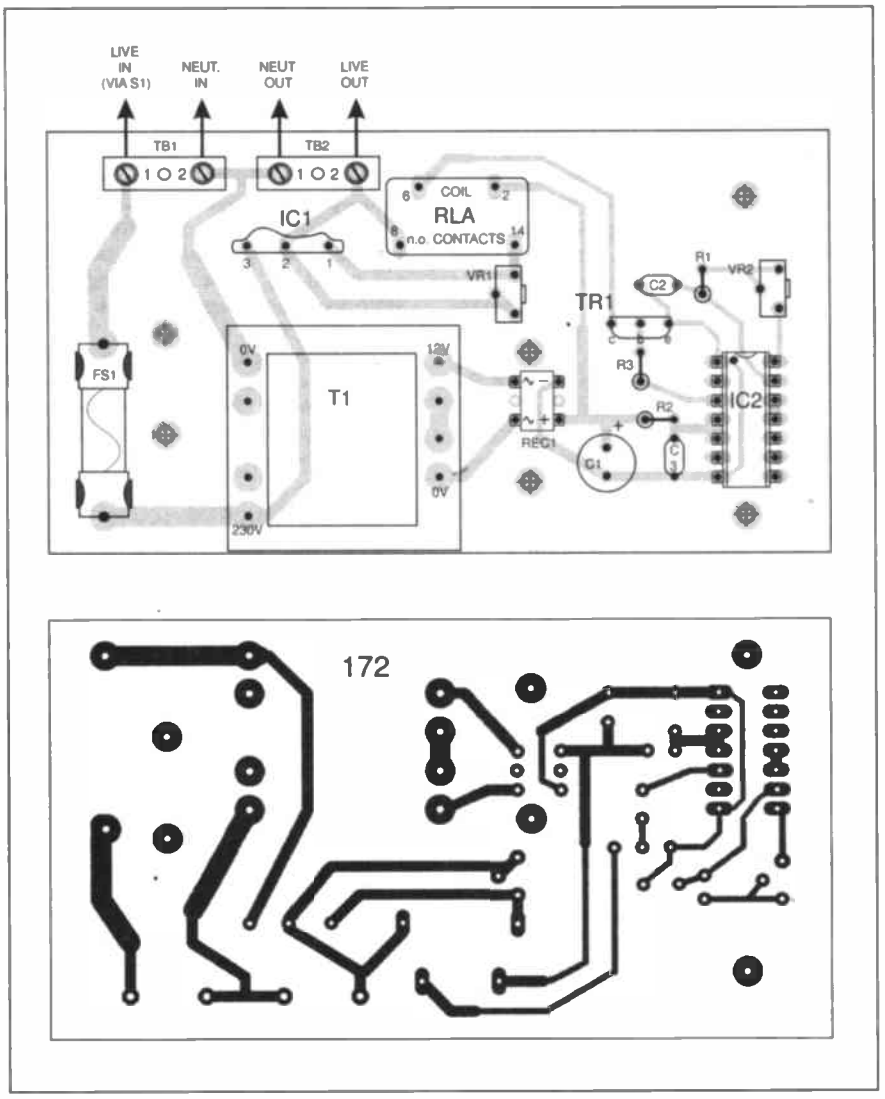


Fig.3. Printed circuit board component layout and full size underside copper foil master for the Auto-Dim Bedlight.

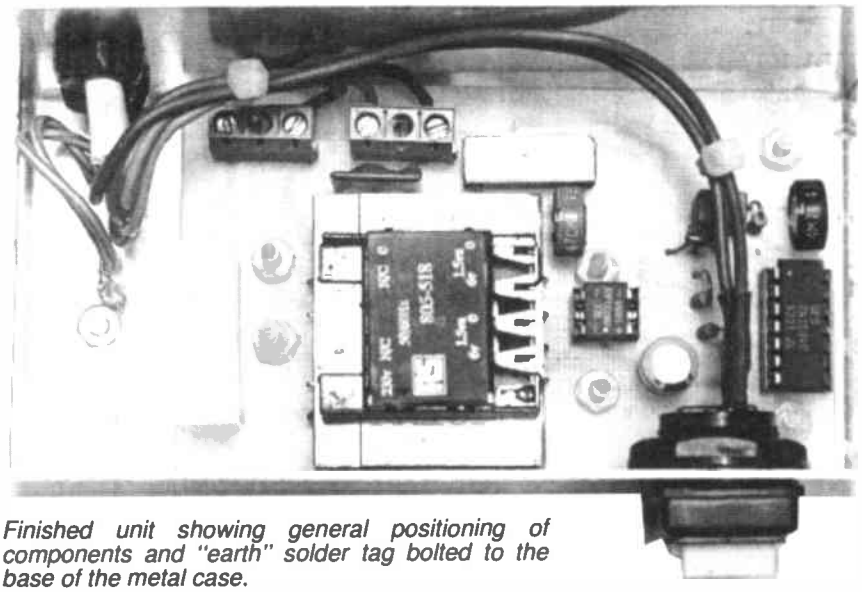
over the polarity of electrolytic capacitor C1 which is clearly marked on the body.

Solder the transistor in position followed by the power controller IC1. Take care over the latter component's orientation – the face with the raised centre is closest to the top edge of the p.c.b. (there is also a "1" on the flat face denoting pin 1). Note that the "flat" of the transistor faces the upper edge of the p.c.b.

FINAL ASSEMBLY

Make the holes in the rear of the chosen metal case for the two strain relief bushes which will be used on the mains input and output leads. Mark out and drill the hole for the switch in the front panel. Drill the small hole in the base for the solder tag (see photograph).

Hold the circuit panel in position temporarily and mark the base of the box directly below the fixing holes. Remove the p.c.b. again and drill these through.



Finished unit showing general positioning of components and "earth" solder tag bolted to the base of the metal case.

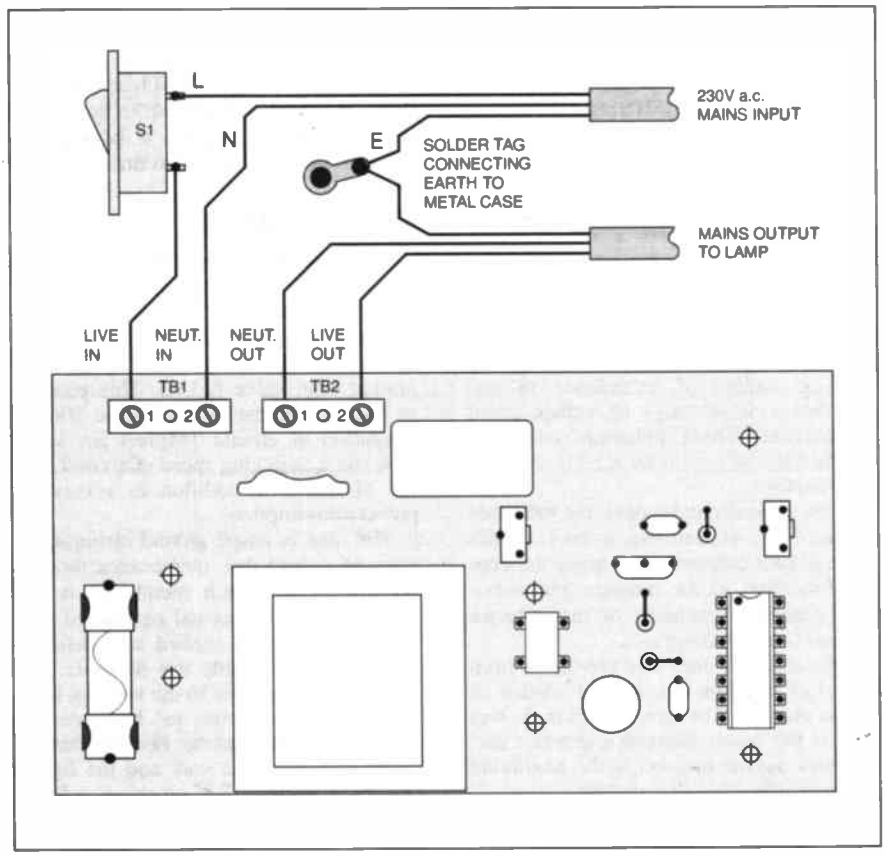


Fig.4. Interwiring from the p.c.b. mounted terminals to mains switch, the input and output mains cables and the "earth" solder tag.

Mount the p.c.b. on 12mm (½ in.) *plastic* stand-off insulators. It is essential to use nylon nuts and bolts to avoid any possibility of causing short-circuits. *For safety reasons, it is essential that the copper tracks and all connections on the underside of the circuit panel remain 10mm minimum from the base of the box.*

Insert IC2 into its socket taking care over the orientation. Since this is a CMOS component, it would be wise to touch something which is earthed before handling the pins to avoid possible damage due to any static charge which might exist on the body.

Insert the bridge rectifier into its socket (if it has not been soldered directly on the p.c.b.) again, taking care over the orientation. Insert a 1A *ceramic mains-type* fuse (not a glass one) in the fuseholder and fit the plastic cover.

Mount the mains On/Off switch in position on the front panel. Make up a mains input lead consisting of 3A minimum mains type 3-core wire of sufficient length, and fit a plug on one end. If the standard UK pattern is used, insert a 2A or a 3A fuse in the plug. Pass the other, free, end of the wire through one of the holes in the box and secure it using the strain relief bush.

Make and fit a similar lead for the output lead and, this time, fit the line ("trailing") socket to the free end. Leave sufficient slack inside the case so that the wires cannot be pulled free.

Refer to Fig. 4 and complete the internal wiring. ***Mains type wire of 3A rating minimum must be used throughout.*** Use proper insulated spade receptacles or heat shrinkable sleeving on the switch tags so that they are completely insulated.

Twist together the ends of the earth wires of the input and output leads. Pass them through the hole in the solder tag and solder them securely in place. ***Check this work very carefully since safety depends on this connection being sound.***

Adjust preset VR2 fully anti-clockwise (as viewed from the right-hand edge of the p.c.b). This will provide minimum timing for testing purposes. Adjust preset VR1 to approximately mid-track position (for a medium degree of dimming).

Clockwise rotation of VR1 increases the brightness of the lamp and clockwise rotation of VR2 increases the time before the lamp enters "dim mode" (both as viewed from the right-hand edge of the circuit board). Fit self-adhesive plastic feet to the base of the case.

Note that, for safety reasons, whenever the unit is connected to the mains, the lid of the case must remain in place. Adjustments to the presets must be made in a series of small steps with the unit unplugged from the mains each time before removing the lid.

IN USE

Plug the lamp into the line socket. Connect the unit to the mains and switch on. The bulb should come on at full brightness. After about five minutes (this is very approximate so if it is longer be patient) the lamp will enter dim mode.

Over the next few days, the presets may be adjusted for the required effect. Note that when the device has been operating for prolonged periods of time, it is normal for the case to become warm.

When a bulb fails, there is a chance that the fuse on the p.c.b. will blow. It would therefore be wise to carry a spare. It *must not be up-rated* since, in the event of a fault, this could result in excessive current passing through the power controller IC1 and it could be damaged.

It is thought that the bulb will have a very long life because, most of the time, it will be operating on reduced power. This will multiply its "normal" life by several times. When replacing the fuse, *do not forget to unplug the unit from the mains before removing the lid.*

Good Night! □

New Technology Update

Micro-electro-mechanical systems are to the forefront this month as Ian Poole investigates their latest developments.

MICRO-ELECTRO-MECHANICAL systems (MEMs) have appeared in the electronics technology news quite frequently over the past year or so. Originally shown as an interesting technique, some real applications are beginning to appear. In view of their revolutionary nature, it is only now that more applications are appearing and it may not be too long before products which use them come to the market place.

Variable inductors

In one development the possibility of manufacturing minute variable inductors is being investigated. This is creating considerable interest because it will enable higher levels of integration to be achieved in the field of r.f. and microwave radio systems.

In recent years a considerable amount of research has been put into improving the *Q* of inductors fabricated onto silicon chips as part of monolithic microwave integrated circuits (m.m.i.c). This has been achieved in a number of ways, including increasing the thickness of the isolation layer between the substrate and the metallisation used for the inductor, using several layers of metallisation to decrease the resistance of the inductor, and even removing silicon under the inductor to minimise substrate loss.

With these improvements available to the chip designer it is possible to make inductors with sufficiently high *Q*s. However, until now it has only been possible to make them variable or programmable by placing f.e.t. switches across sections of the inductor. This solution suffers from a number of disadvantages including a high on resistance of the f.e.t.s, leakage currents, large levels of parasitic capacitance, and crosstalk between the control and r.f. circuits.

The use of MEM technology has enabled these problems to be overcome. Instead of using an electronic switch, a small micro relay is used, and this gives far more satisfactory results.

Both electrostatic and thermal principles are used to operate the relay, as shown in Fig. 1. The first uses the electrostatic attraction between the cantilever arm and the silicon substrate. The second uses a thermal effect to achieve relay operation.

This uses the same ideas as a bi-metallic strip where a strip bends as the temperature changes due to differing coefficients of expansion. By passing only a very small current through the cantilever enough heat is generated to move the arm sufficiently to act as a switch. Gold contacts at the end of the cantilever ensure a low on resistance.

On-Cue

In the first experimental system a total of four inductors were used, each having differing values of inductance to ensure that a wide range of values could be obtained. These inductors could be switched out of circuit by a relay shorting the inductor.

In the experimental model, the inductors consisted of a sixteen-turn spiral coil with an underpass connection to bring the centre connection to the outside. The maximum external dimension of the inductor was just over 2000 microns.

The cantilever itself was fabricated from a layer of tantalum silicide and another of silicon dioxide. The tantalum dioxide was used as the heater element and when current was passed through it the cantilever bent upwards.

Fabricating the cantilever required that space be made under the cantilever. This was achieved by first fabricating the coil. After this a layer of aluminium was set down. Small gold contacts were placed in position where they were required later.

This was followed by setting down layers of silicon dioxide and then tantalum dioxide. Finally, an etch window was created and the aluminium under the cantilever was etched away to leave the cantilever as shown in Fig.1 and Fig.2.

The performance of even the first experimental models was very encouraging. Only 8mW and an electrostatic voltage pulse of 20V was required to give a closure time of just under 15μs; a very fast time for a relay. In addition to this, the on resistance was measured at between 0·6 and 0·8 ohms; far less than that of an f.e.t. switch.

MEM displays

Micro-machines also find use in a new type of display which, it is claimed, gives improved resolution, speed and contrast over existing technologies. The display is based around a technology known as a grating light valve (g.l.v.). This promises to offer a contrast ratio of up to 200:1, a resolution of around 1Mpixel per square inch and a switching speed of around 20ns. All of this is in addition to a very low power consumption.

The idea is based around changing the state of deformable membranes mounted on a substrate. Each membrane is bath tub shaped in its normal or relaxed state. When a voltage is applied it is deformed and attracted towards the substrate. This changes its properties to the incident light.

For a dark point to be seen, the membranes adjacent to one another are aligned in the same way and the light is simply reflected. By blocking reflected light using optical techniques a dark spot is seen.

For a light point to be seen, adjacent membranes are arranged in opposite states, i.e. one down and the next one up – every other pixel is addressed. In this way the light is diffracted and appears as a visible point of light.

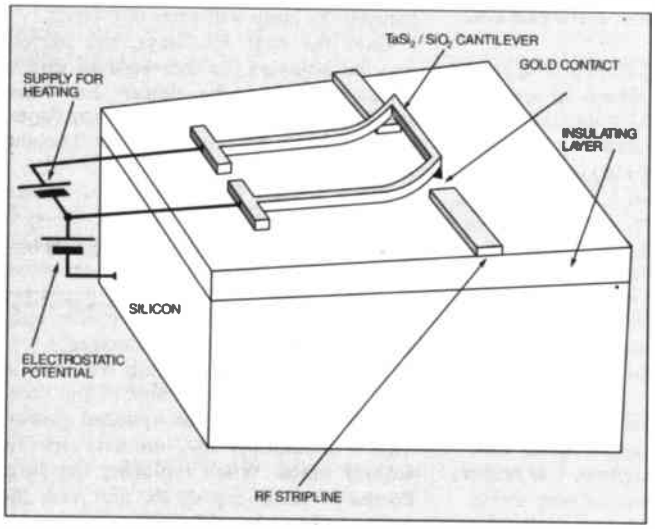


Fig.1. A micro-machine RF relay.

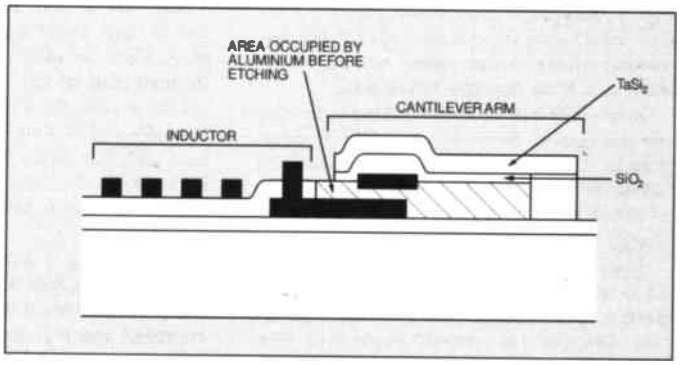


Fig.2. Side view of the micro-relay.

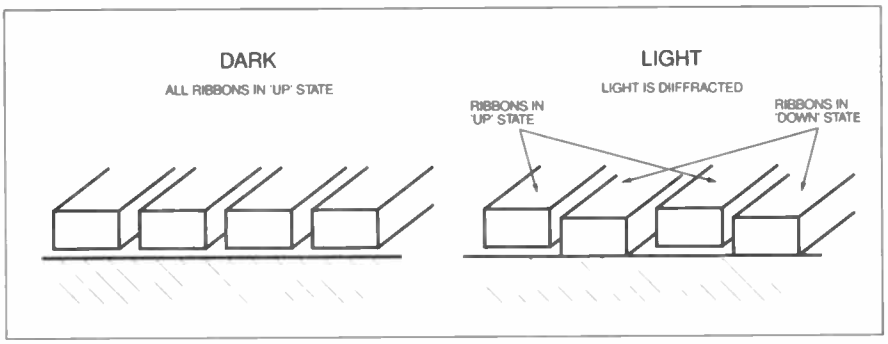


Fig.3. A micro-electro-mechanical display.

Controlling the display is relatively straightforward. The ribbons (six for each pixel) normally adopt the up or dark state, see Fig.3. To change their state a voltage is applied to an electrode beneath them. To pull them into the "light" state a voltage is applied.

As the mechanical properties of the ribbon mean that they snap into their new state the initial voltage is higher than the hold-in voltage. This enables the power consumption of the whole unit to be minimised.

In view of the requirements for driving the pixels it is possible to use a matrix system. Unlike some other technologies a transistor driver is not required for each pixel. This enormously simplifies the display and means that their eventual cost is likely to be much less than many of its competitors.

A further advantage is that the display is relatively easy to manufacture. It only requires a total of seven mask steps, making it a simple process by comparison with many other silicon devices in everyday use. However, the most critical step is that where the gap is between the moving and fixed ribbons.

Both of these technologies represent very interesting possibilities for the future, and they show that although micro-electro-mechanical systems might have just seemed like no more than an interesting technique, they are likely to bring some real advantages in the future.

SHOP TALK
with David Barrington

EPE Time Machine

Many of the special items needed for the *EPE Time Machine* project are going to be difficult to find in the usual local component outlets, so it will be a case of mail ordering.

Starting with probably the most expensive part, the EM2 MSF Rugby Time Signal Receiver module was purchased from **Maplin** for around £17. The 60kHz ferrite rod aerial also came from the same source, when ordering quote codes MK68Y (Rec. Mod.) and MK72P (MSF Ant.).

Working down the "Comp List", for those readers who do not have the facilities to program PIC chips, a ready-programmed PIC 16C84 microcontroller is available from **Magenta Electronics** (☎ ***01283 565435***) for the sum of £15 inclusive. However, if you wish to do your own programming, the software listing (TASM) is available on a 3·5in disk from the Editorial Offices – see *PCB Service* page for details. If you are an Internet user, it is available *Free* from our FTP site: **ftp//ftp.epemag.wimborne.co.uk/pub/PICS/timemachine**.

The 3·2768MHz crystal is available from our component advertisers. The 2-line 16-character intelligent l.c.d. module is another part that seems to be fairly widely available. When purchasing the display, it is recommended that the pinouts are checked against the printed circuit board for correct orientation. Our display came from Magenta and cost £10 inclusive, quote code Hitachi LM032L.

The right-angled "male" p.c.b. mounting headers should be widely stocked by advertisers. Try **ESR Electronic Components** (☎ ***0191 251 4363***), who carry large stocks of connectors. These male headers can easily be cut to the required number of pins, or you can, of course, use stiff wires as mentioned in the article.

Next in line is the 3×4 matrix membrane keypad. This comes with an attached "female" connector to mate with the p.c.b. header. The keypad is an RS part and ordered from **Electromail** (☎ ***01356 204555***) code 130-397, their mail order outlet. Our case was also purchased from the same source, code 507-668.

The *EPE Time Machine* printed circuit board is available from the *EPE PCB Service*, code 171 (see page 803).

Case Alarm

Not too many problems should arise when collecting together components for the *Case Alarm* project. However, there seems to be only one source for the mercury vibration switch, and this is sold by **Maplin**, code UK57M.

In view of the dangerous nature of mercury, readers may care to investigate the possibilities of their non-mercury version, code DP50E. This device has two leads, but lead identification is obvious from their physical appearance.

The warning sounder is a miniature, low-profile, piezoelectric type, and should be available from most of our advertisers.

Portable 12V PSU/Charger

Apart from the warnings about the current ratings for some of the wiring and the use of fuses, component sourcing for the *Portable 12V PSU/Charger* should be relatively trouble free.

Having said that, the only listing found for the sealed lead-acid battery charger controller chip type UC3906N is from **Farnell Components** (***0113 263 6311***), quote type number when ordering.

Ranging from several amp/hours to over 30Ah, the prices for the non-spill lead-acid batteries range from £10 up to about £80 plus. However, looking through the **Bull Electrical** (☎ ***01273 03500***) and **J&N Factors** (☎ ***01444 881965***) advertisements, we see they are offering Yuasa non-spill batteries at "special discounts" and are certainly worth further investigation.

The printed circuit board is available from the *EPE PCB Service*, code 173.

Auto-Dim Bedlight

A few pointers are needed when shopping for components for the *Auto-Dim Bedlight* project. The power controller PC1R is available from **Maplin**, code QY37 and **Electromail** (☎ ***01536 204555***), code 656-748. The mains transformer also came from the latter source, code 805-518.

The DF005M 50V 1A bridge rectifier should be a d.i.l. package type to fit the p.c.b. and was ordered from the above source, code 183-4028. The ever popular W005 could be used, but you will have to "fiddle" the leads to mount it on the p.c.b.

The only source we have found for the reed relay has been Electromail, code 348-576. This reed relay **must** have contacts rated for 230V a.c. mains and **must** have an in-built protection diode connected in parallel with the coil.

The printed circuit board is obtainable from the *EPE PCB Service*, code 172. The wiring must be rated at 3A minimum.

Teach-In '98

A few components are called for in *Teach-In 98* Part 1 and you will also need a digital multimeter, a power supply and a breadboard as recommended in the text. A couple of companies have indicated that they will be making these items available to readers, so a phone call or two should prevent you chasing round various suppliers.

Greenweld are putting together a pack of all the recommended items including the multimeter and p.s.u. These will be offered at a special price, post free if you spend over £10. Contact them on ***01703 236363***, fax ***01703 236307*** or by writing to them at 27D Park Road, Southampton, SO15 3UQ. The Greenweld 1998 catalogue is free in this issue.

Maplin can also supply all the items. Their order code for these is HB99 and they will include a *free* copy of their new catalogue. Hobbyists will find the catalogue an invaluable source of components, tools, test gear etc., as well as information. The catalogue is available from W. H. Smiths or see the Maplin advert on our back cover.

Squires have told us that they can supply a set of tools for those following *Teach-In*, they are at The Old Corn Store, Chessels Farm, Hoe Lane, Bognor Regis, West Sussex, PO22 8NW. ***Tel/Fax 01243 587009***. By the way, their 1998 catalogue is now available and it's free, yes free – you don't even pay the postage – just ring or write and request a copy.

PLEASE TAKE NOTE

Soldering Iron Controller (Sept '97)

Resistor R10 in Fig. 4 should have been shown as 10k, although any value between 10k and about 220k will probably be satisfactory.

FREE

NEXT MONTH

GIANT DATA CHART

Measuring over 850mm x 550mm (34in x 22in) this impressive wall chart provides the formulae you will need for electronics from Ohm's Law to Thevenin's and Norton's theorems etc. Brighten up your workroom, bedroom, classroom, lab, etc.

SAFE AND SOUND

Passive Infra Red (PIR) security lights are now a common feature of many homes, offices, factories etc. These are aimed at deterring would-be thieves by illuminating the area when anyone approaches. However, most people now realise that this is all they do and so much of the deterrent value is lost. This simple project produces an audible bleep when a security light is triggered, thus giving the impression that it is part of a more complex security system and restoring the deterrent value.

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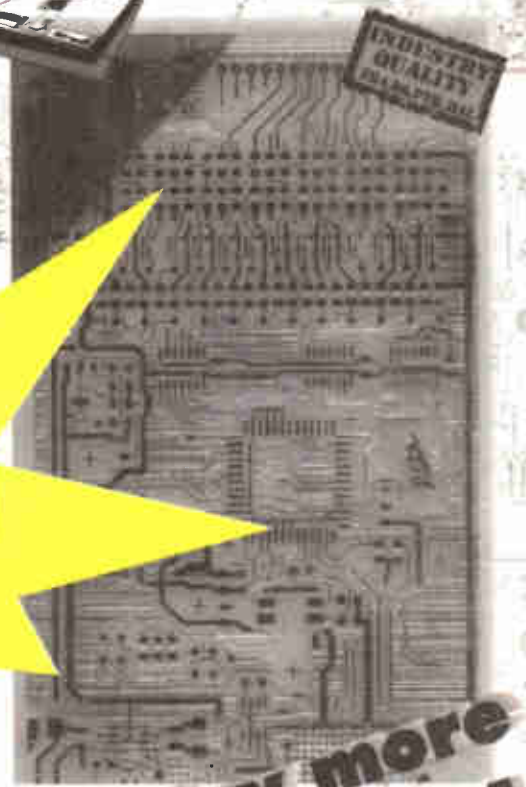

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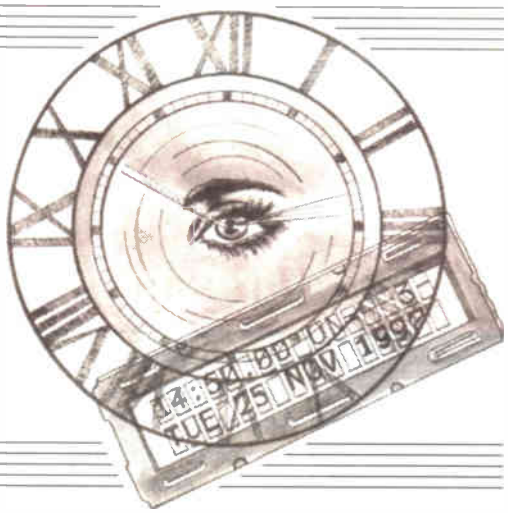


JOHN BECKER

Radio controlled time and timers, a Millennium countdown and a perpetual calendar – yet more proof of PIC power!

THE MILLENNIUM, at the moment that this sentence is being typed, is 74,218,393 seconds away! It will be a bit closer by the time you have read about how you too can have your own Time Machine that informs you of such incredibly important (?) information.

Some say that this is the last major countdown for all of time, predicting that ... well, you know what they predict. This author, though, holds no credence for prophets of doom (except those who insist your computer *must* be Millennium Compliant if it is to have a smooth roll-over to year 2000 (Y2K).

A TURN-ON

Whatever you believe about Y2K, though, we think you've still got time to also make use of the other facilities that our Time Machine offers. It's not just a pretty digital clockface – it's got *functions* to really turn you on!

Or, rather, it's got functions to turn on and off practically any four items of electrical equipment that you care to mention. Two items can each be switched on and off for two separate periods, repeatedly each day, every day, nearly *ad infinitum*. The other two can be even more versatilely controlled – they can have different twin-periods selected to match each of the seven days of the week, Sunday through Saturday.

So, that's two times two, plus two times two times seven – yes, 32 different periods that can be programmed in, not forgetting another "times two" because each has an On and Off setting – an astonishing 64 times that can be set via keypad switches.

Furthermore, the Time Machine is under control courtesy of two of the world's most remarkable items of electronic sophistication, the National Physical Laboratory's highly accurate caesium clock, and an on-board PIC microcontroller.

Of course, there's a bit of glue-logic involved as well, but what it amounts to is that NPL's coded time data is broadcast by a transmitter at Rugby and the Time Machine receives and decodes it, ensuring that the correct time is always displayed, and that your equipment will be switched on and off when it's meant to be – electricity generating boards and your payment of their bills permitting!

Power cuts, though, should never upset the timings you've programmed into the Time Machine. It uses a PIC16C84 microcontroller which permanently stores the data in its non-volatile memory. Even if power is lost, the data won't be. As soon as power is restored, that data is immediately available to be processed.

Not only that, even if the Rugby transmitter goes off the air, the Time Machine's own crystal controlled oscillator ensures that accurate tracking of the time is maintained, within a jiffy or two. When Rugby comes back on, its time signals bring any slight slippage of the clock back into line.

DATELINE

There is another benefit too. Because NPL transmits calendar data as well as the current time, the Time Machine will tell you the name of the weekday, day of the month, name of the month, and the year, all on the screen of an intelligent 2-line 16-character liquid crystal display. NPL even compensates for British Summer Time and Leap Years.

You need not worry, either, that once the new Millennium has dawned, the Time Machine will become a relic of a past era. Far from it, the author sees a great future for the Time Machine beyond Y2K.

He knows it's Millennium Compliant from his simulation of post-Y2K conditions via a computer. All major roll-over intersections of seconds, minutes, hours, days, weeks, months, years and centuries have been "ported" out as NPL codings to the circuit and the correctness of each transition checked.

But, down to mundanities: lets's examine the technical details.

BRIEFLY ROUND THE CIRCUIT

We'll only take a brief tour round the circuit since there's not much to say about the five blocks, which are largely self-contained modules. In Fig.1 is the circuit diagram for the receiver module; it picks up the radio time signals and converts them to "clean" pulses which are then sent to the PIC microcontroller, shown as IC3 in Fig.2.

As well as processing data from the receiver and a 12-switch keypad (Fig.3), the PIC outputs the decoded time and calendar data to the intelligent liquid crystal display X2.

It also sends control data to transistors TR1 to TR4, turning them on and off at the times that you set into its memory via the keypad. The transistors have open collectors, so you can connect them to things like bells, buzzers, motors, relays and the like.

What you can't see in the circuit diagrams, of course, is the controlling software. If you wish to, you can examine that on your computer once you've obtained our software disk, or downloaded it *free* from our Web site. It's notated where appropriate so you can read what's going on.

The components in the dotted box of Fig.2 are for those who wish to program their own PIC from the software.

A pre-programmed PIC is available for those who don't wish to program their own. This is used just like any other chip and you do not need to own a PC in order to build the Time Machine.

More on all these things will emerge as we progress. The tour now moves on to Teddington and Rugby.

RUGBY TRANSMISSIONS

The National Physical Laboratory (NPL) is at Teddington (a few miles south-west of London). It has equipment which monitors the very precise rate at which caesium atoms resonate – 9,192,631,770Hz. From this resonance, NPL derive an extremely accurate 60kHz

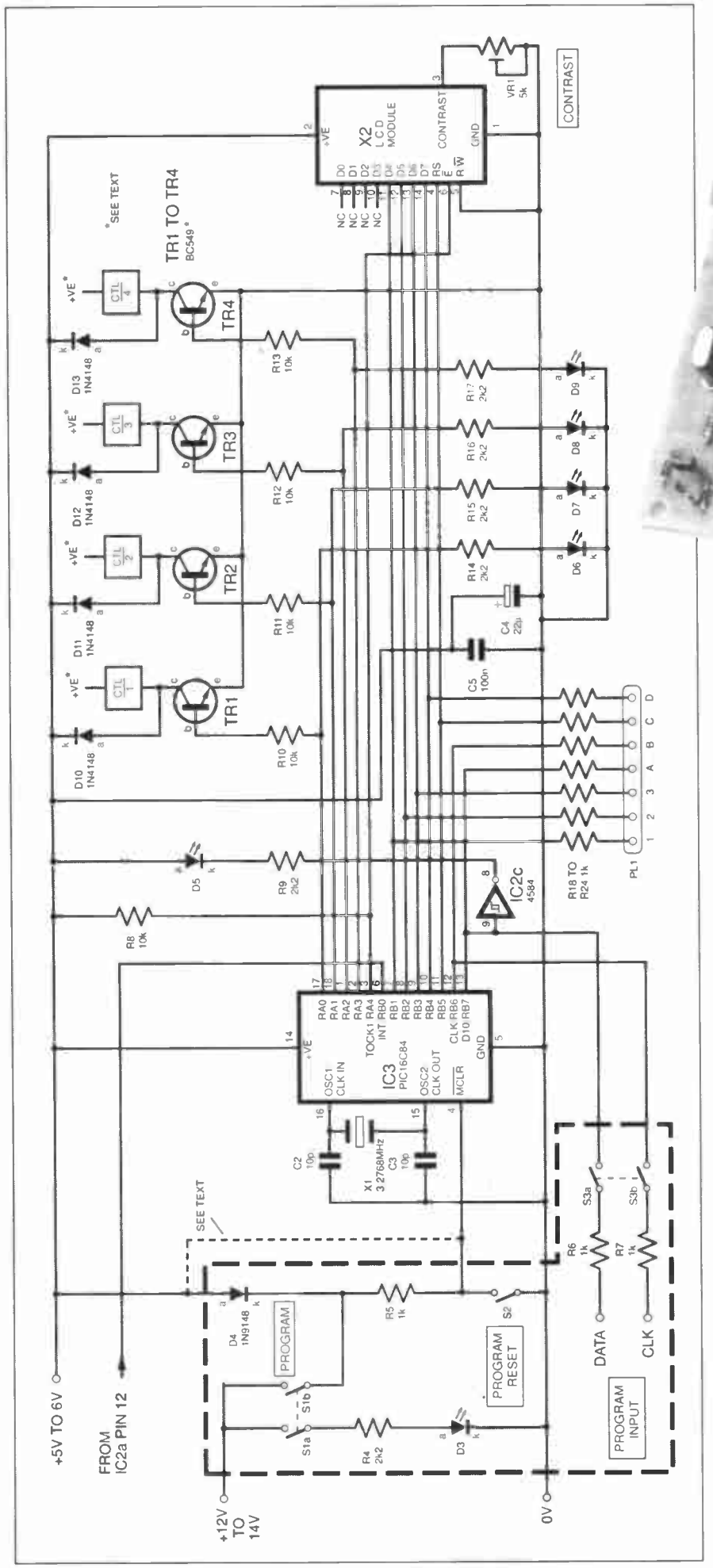
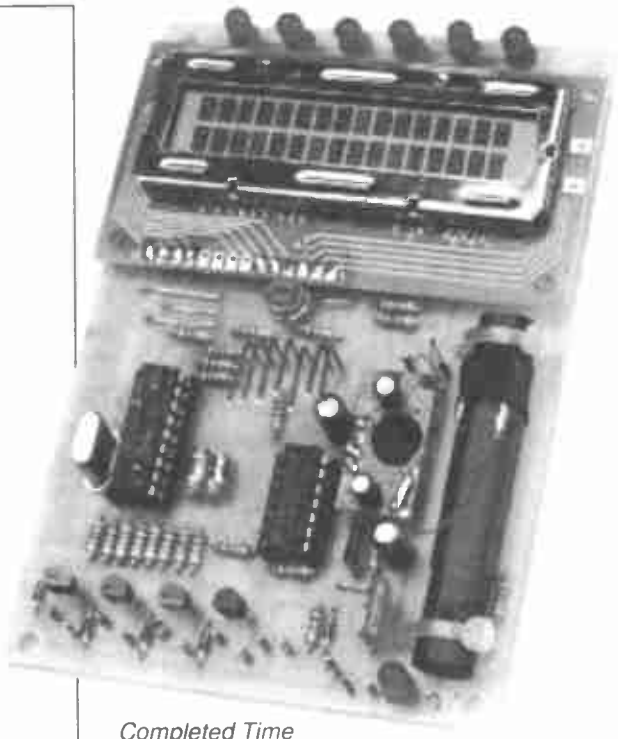


Fig.2. Circuit diagram for the PIC microcontroller and display module stages. The components within the dashed area are for those who wish to program their own PIC (see text).



Completed Time Machine circuit board.

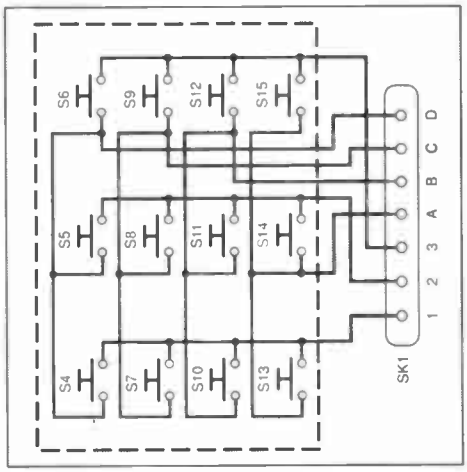


Fig.3. Keypad switch circuit and connections to D-connector SK1.

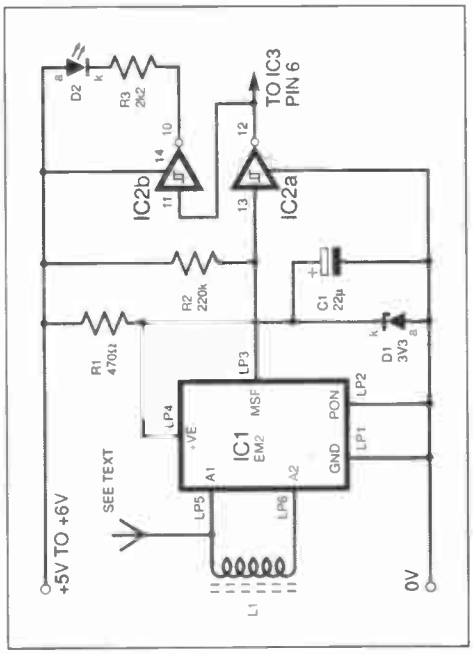


Fig.1 (above). Circuit diagram for the receiver module.

Keypad stuck to the top of the Time Machine transparent case.

frequency which is broadcast via the transmitter at Rugby (latitude 52° 22' N, longitude 1° 11' W – 80-ish miles north of London).

The estimated radiated power is 27kW which provides adequate field strength throughout the UK, and it can be widely received in northern and western Europe. It can even be satisfactorily received in Iceland, Finland and Gibraltar. The carrier frequency is maintained at 60kHz within two parts in 10^{12}.

Equipment at the NPL modulates the transmitted signal with the coded time and date data. The coding is in BCD (binary coded decimal) and takes the form of long and short pulses, each pulse turning the transmitted signal on and off. Long pulses represent logic 1, short pulses represent logic 0.

MAKE A DATE

A synchronising code is sent every 60 seconds. Then, during seconds 0 to 16, specialist data is transmitted, giving information about the difference between the atomic (caesium) time and astronomical time. Calendar and time data is then transmitted at a rate of one pulse per second. The data format is shown in Table 1.

Year data is transmitted first, as an 8-bit byte, starting on the 17th second. Only the tens and units of the year are transmitted (e.g. 97 instead of 1997), tens are in bits 7 to 4, units in bits 3 to 0. The BCD value for 97 is thus 10010111. The number is transmitted backwards (as are all numbers), bit 7, bit 6, etc., starting at the 17th second.

Starting at second 25, BCD month data is transmitted as a 5-bit byte. Month 1 is January, month 12 is December; the latter would be transmitted as 10010. The day of the month uses a 6-bit byte, thus 31 would be sent as 110001.

Since there are only seven days in a week (and the desirability of that is questionable!) only three bits are needed. Sunday is day 0, Saturday is day 6, being sent as 110.

Table 1. Rugby Code Format

BCD BIT		7	6	5	4	3	2	1	0
PERIOD	RANGE	NUMBERED SECONDS							
YEAR	00-99	17A	18A	19A	20A	21A	22A	23A	24A
MONTH	01-12				25A	26A	27A	28A	29A
MONTH-DAY	00-31			30A	31A	32A	33A	34A	35A
WEEKDAY	00-06						36A	37A	38A
HOUR	00-23			39A	40A	41A	42A	43A	44A
MINUTE	00-59		45A	46A	47A	48A	49A	50A	51A
SYNC		52A	53A	54A	55A	56A	57A	58A	59A
VALIDITY				54B	55B	56B	57B		

A 24-hour clock is used, so a 6-bit byte covers it, 23 being the maximum count and sent as 100011. Minutes need seven bits to cover up to 59 in BCD, which equals 1011001.

Seconds, of course, are their own marker. Their 8-bit synchronisation code, though, starts transmission at second 52. The sync code is the unique value of 01111110; no other transmitted Rugby time code can have this value. Following its receipt, the next second received is considered to be number zero.

Table 2. Rugby Coding Example

1997 = 97	=	10010111	= 5 bits high
Oct = month 10	=	10000	= 1 bit high
Day of month = 3	=	000011	= 2 bits high
Friday = day 5	=	101	= 2 bits high
15 hours	=	010101	= 3 bits high
32 minutes	=	0110010	= 3 bits high

Table 3. Validity Check for Table 2

Bit 54B (0) + 17A to 24A (5 high)	= 5 = odd
Bit 55B (0) + 25A to 35A (1 high + 2 high)	= 3 = odd
Bit 56B (1) + 36A to 38A (2 high)	= 3 = odd
Bit 57B (1) + 39A to 51A (3 high + 3 high)	= 7 = odd

VALID CODE

An ingenious, but basically very simple, method of transmitting the data is used by NPL. We have said that long and short pulses indicate logic values of 1 and 0. But, how short is short and how long is long? Ah, therein lies the ingenuity – and there are different lengths of long!

The pulses are created by turning the transmitted 60kHz signal on and off. A short pulse is an off-period of 100 milliseconds. A long pulse, though, can be an off-period of either 200ms or 300ms, and with good reason. Cleverly, another code is embedded in the sync code by the choice of long pulse length. That code is used to verify that the main code you have received is the same as that which you are *meant* to have received.

Any pulse whose length is 200ms or greater is taken as being logic 1 for the principal code. For the "validity" code, though, a pulse of 200ms is taken as a 0, and a 300ms pulse as a 1. In effect, then, the long bit can be considered as being two bits joined together. NPL term the first bit **A** and the second bit **B** and reference to the pulse for any given second is given the relevant suffix letter.

Look back at Table 1 and you will now understand why most numbered seconds have an **A** following them, representing the pulse period up to 200ms. The **B** suffix refers to the period between 200ms and 300ms.

The validity check examines certain combinations of bits, counts the number of 1s occurring, and adds the logic value of a specified B-bit; the correct answer has to be an odd number of 1s. Here's the logic:

- Bit 54B is taken with bits 17A to 24A (years)
- Bit 55B is taken with bits 25A to 35A (month and day of month)
- Bit 56B is taken with bits 36A to 38A (day of week)
- Bit 57B is taken with bits 39A to 51A (hours and minutes)

Bits 54B to 57B, you will notice, all occur within the fixed sync code (01111110) which commences at second 52 and ends at 59.

Let's take the time/date of 15:32 Friday 3rd October 1997 as an example as shown in Table 2.

Now regard the sync code as having its double-length bits represented by a 2, the sync code for this date and time would be: 01112210. If we relate this to numbered seconds, we get:

52 53 54 55 56 57 58 59
0 1 1 1 2 2 1 0

Thus two validity bits are low, 54B and 55B, and two are high, 56B and 57B.

To relate these bits to the main code, we get the data shown in Table 3.

As you see, the requirement for each combination to result in an odd number of 1s has been met. Had any combination resulted in an even number of 1s, then the received code should be regarded as incorrect and ignored.

In fact, of course, it is a system which can still result in an incorrectly received code being interpreted as valid since it is possible that several corrupt bits might result in an uneven number of 1s.

It may be of interest to know that bit 58B is used to indicate whether the times transmitted are GMT (0) or BST (1).

RUGBY RECEIVER

We return briefly to the Receiver circuit in Fig.1. The Receiver itself is a ready-built module type EM2. It comprises all the circuitry necessary to extract clean pulses from the 60kHz frequency and does not require any alignment. The ferrite aerial (L1) is also sold as a pre-wound unit tuned to 60kHz.

The EM2 module is designed for operation from a power supply of between 1·3V and 3·5V. For this circuit, 3·3V is used, and is derived from the +5V line via resistor R1 and Zener diode D1.

The negative-going output signal from the EM2 is buffered and inverted by the Schmitt trigger IC2a, from which it is fed to the PIC microcontroller. It is also fed into IC2b, which turns on l.e.d. D2 in response to each pulse received; a handy way of showing that Rugby reception is occurring.

PIC-TIME

From IC2a, the Rugby pulse is brought into the PIC at its RB0 pin.

We will not discuss PIC16C84 microcontrollers on this occasion – we've examined them several times recently. Besides, there is a wealth of such information in the *PIC Tutorials* that will soon be published *(scheduled for March '98 issue on sale February 6).*

Suffice to say that the PIC16C84 has to be specially programmed with the software that the author has written for the Time Machine (details about obtaining the software are given later).

The software detects the pulses from the receiver module, decodes them according to length and temporarily stores the basic logic value (0 or 1) of the A-bits in a 48-bit shift register (6 × 8-bit bytes). Simultaneously, it detects the status of the B-bits and stores them in another register for later use in code validity checking.

Each time the presence of the sync code 01111110 is found, the contents of the 48-bit shift register are separated into the respective bytes for the clock and calendar codes. These are then analysed against the validity code and, if the correct criteria have been met, each byte is transferred into the main time and calendar registers whose contents are output to the liquid crystal display.

In parallel with the Rugby time signal handling, an internal real-time clock is incremented. This is controlled by the external crystal X1. Generating a frequency of 3·2768MHz, the crystal sets the rate at which the PIC processes its software commands and at which the internal clock is incremented.

The software has been written so that internal pulses occur every 1/50th of a second. (The term "pulse" is used loosely, it is actually the logic of the register bits which is being changed). Using a counter set to divide by 25, further pulses are generated at half-second intervals. On each half second, the switch keypad is read to see if any key is pressed, taking action accordingly (more in a moment).

Also each half-second, a divide-by-two counter is incremented, from which are derived pulses at one second intervals. Now counters for seconds, minutes, hours, days of the week, days of the month, months, years and centuries are incremented as appropriate.

At relevant roll-over points between the various counters, look-up tables check how many days there are in the month being processed, and whether or not the year is a leap year, allowing February 29th to occur when it should!

These counters can stand alone without the intervention of the information from the NPL clock. However, their value at switch-on is zero, so the counting starts at (0) hours, (0) minutes, (0) seconds on Sunday 01 January 1900. The value of 19 for the century is programmed in as a default setting, otherwise we would go even further back in time to the year (0000)!

Once the Rugby sync marker has been received and the code validated, it is into these same stand-alone counters that the Rugby time and date values are copied. This usually occurs once every minute.

In the event that a valid set of Rugby data has not been received, all of the stand-alone counters continue to be updated from the values last produced from the Rugby data. Consequently, you will continue to have an accurately working clock and calendar. In theory, you never need another Rugby signal!

Of course, though, any clock needs periodic adjustment, even crystal controlled ones. Also, unless extreme measures are taken, loss of power to the Time Machine can occur. When mains power cuts occur, the Time Machine will restart quite happily when power is restored, but the time and calendar data will recommence from zero, as above. As soon as the next Rugby code is available, however, normal service is resumed!

Unless Rugby itself goes off the air (and it can), it should normally take less than two minutes from the moment of regaining power for Rugby data to be transferred into the clock counters.

The software looks for two parameters to be met simultaneously before accepting Rugby data: the occurrence of the sync signal and the validity of the error checking. Whilst the sync signal sets the seconds count to zero, the year data begins on second 17. Consequently, the entire block from second 17 to 59 must be received intact before Rugby data can meet validation requirements.

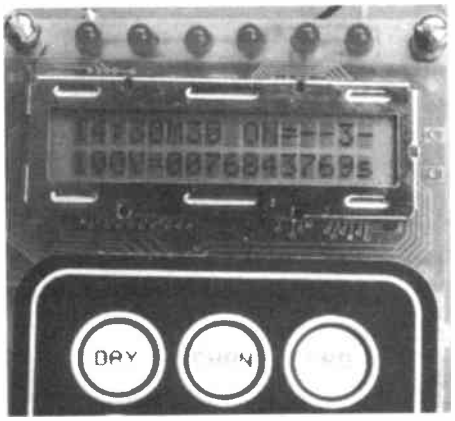
MILLENNIUM COUNTDOWN

The original concept of the Time Machine was that it should simply show a countdown of all the values of a clock/calendar until the year 2000: seconds, minutes, days, etc. Indeed its concept was inspired by a TV news item about a highly sophisticated and accurate piece of equipment having just been switched on somewhere to do just this.

In the course of editorial chattings, though, it was felt that, fascinating as such unrepeatable facts as these would be, the published project should be capable of doing more. It was decided, therefore, to also include time-switch controls.

Well, you've all read our article on *Murphy's Law*, haven't you (Oct '97)? It can't be proved, but we think something Murphy-ish has been lurking in our vicinity. The PIC program code required to receive, decode and validate Rugby data, plus that for a background clock, plus that for time-switch controlling, was too long to allow very much in the way of Millennium countdowns!

After much code scrimping and saving and rewriting and condensation and burning of midnight oils, enough PIC space was made available to just allow a seconds countdown routine to be inserted. The routine even takes into account the different lengths of the months and the existence of leap-years – with three bytes to spare!



Millenium countdown mode display.

When in normal clock display mode, pressing the YRS 00 button causes the Millennium seconds countdown to be displayed on line two. Releasing the button returns the display to normal mode. This button is inoperative when in time-setting mode.

It is a remarkable countdown to see occurring. It's even more remarkable to press the same key when the Time Machine has just been switched on and still thinks it's in the year 1900, a very high seconds count is shown, one hundred year's worth!

This size of figure, though, will become commonplace when we are actually beyond New Millennium's Eve and into the 21st century. We shall be looking at our Time Machines and remarking on the number of seconds until the year 2100. (There are even some children around now who will celebrate that New Year's Eve – at the time of writing, the oldest man in Britain is 116.)

TIME SWITCHES

There are 11 functions controlled by a multiplexed set of switches on a 3 × 4 matrix of pushbutton keypads.

To set the timing factors for any period, the sequence in which the switches are pressed is unimportant. Suppose that on Monday, for example, you want Channel 1 to come on for Period 1 at 6.15 a.m. and go off at 8.30 a.m. First you press DAY. The l.c.d. screen will change to the time-setting mode. At the top left of line 1 the current time continues to be shown.

At the right, any one of eight 3-lettered abbreviations will be seen. Seven are the abbreviations for the days of the week. The eighth (ALL) indicates the daily repeat mode. A cursor underlines the initial letter of the day abbreviation.

Pressing either UP or DOWN will cycle the Day display through its eight options at

two changes per second, forwards or backwards accordingly. When MON appears, press CHAN. The cursor will jump to underline the single numeral following *C* (for Channel) on the second line.

Pressing UP or DOWN now cycles the channel number through its two options, 1 and 2 (in this mode – 3 and 4 for the daily ALL mode). Stop when 1 shows. Press PRD for Period; the cursor now underlines the numeral following *P* (for Period) on line 2. The range is from 1 to 4, which can be changed by pressing UP or DOWN. Select period 1 (the first for the day).

Time setting mode display

Now press HOUR, moving the cursor under the units of hours value. Pressing UP or DOWN cycles you through the 00 to 23 values available; select 06. Press MINS and the cursor moves under the units of minutes value. There are four choices for minutes, in 15 minute increments: 00, 15, 30 and 45. Press UP or DOWN to select 15.

At the right of line 2, you will either see the word ON, or OFF. Press key ON/OFF to move the cursor below the *O*. Then press UP or DOWN to cycle to the setting you want, in this case, ON. As soon as you press one of the DAY, PRD, CHAN or SET keypads, the timing data just entered will automatically be stored in the EEPROM memory.

Whenever a change is made to any time setting or an on/off setting, a flag is set which ensures that new data will be automatically stored in the EEPROM at the correct moment during the setting mode.

However, if you just want to review the on/off settings and timings without making changes, you may simply press any of the keys DAY, CHAN and PRD without triggering the storage routine.

The position in EEPROM memory that data is stored is directly related to the day, channel and period selected (examine the software listing on the disk if you wish to know the storage order). Data is stored as a single byte in the selected memory cell. It is in a compressed format with hours in bits 7 to 3, minutes in bits 2 and 1, and the on/off flag in bit 0.

OFF TIME

Having set the On time, setting the Off time now takes fewer steps since you are already in the day and channel that you wish to be. Press PRD again, press UP so that P2 is shown (Period 2). Using HOURS and MINS as before, change the hours and minutes settings to 08 and 30, and then change ON to OFF.

Pressing SET now returns you to the normal screen display and automatically causes the fresh setting to be stored accordingly in its appropriate byte.

When you are simply reviewing settings, SET returns you to the main screen without triggering the storage routine.

If you prefer, you do not need to press SET at this moment. Should you wish to program the settings for other days, channels and periods, continue to do so in the manner just described. Each setting will, as said, be stored automatically at the appropriate moments without any intervention on your part.

For the same day and channel, you also have periods 3 and 4 to use if you wish. Set them in the same way as for P1 and P2.

You must ensure that timings for a particular day and channel must be in correct chronological order (each period must have a later time than any previous period for that day/channel).

If you want a channel On period to run from one day into the next, period 1 of the next day must be set to 00:00 hours ON.

Timings set when ALL is the "day" selected, will repeat daily. Always review any new settings to ensure that what you meant to be set *has* been set.

CHANNEL CONTROL

Every minute, the software jumps into its time checking routine to see if any channel output mode needs to be changed, depending on the current time and the times set into the EEPROM Memory.

It examines each of the EEPROM bytes in order and checks their decoded values against the current time, setting the output bits of PORTA accordingly, either high (on) or low (off).

Performing these checks every minute ensures that even if there is a power loss, the correct settings of the equipment being controlled will quickly be re-established once power is regained.

However, you should always remember that when power is re-established, the program resets its clock counters to zero. Therefore, the time against which the EEPROM timings are being checked will initially be 00:00 hours for a Sunday. The clock will continue to increment in the normal way from 00:00 until the Rugby time signal has been regained and fully accepted.

Consequently, it is recommended that no channel should be programmed to be turned on during the first 15 minutes of Sunday. Keeping all channels off for this duration will avoid any channel being incorrectly turned on following a power failure, assuming that the Rugby signal is available to be received within that period.

There are times when this may not be the case and for which no solution can be offered. NPL do not claim to keep a constantly running time signal transmission. Indeed, transmissions are intentionally turned off during monthly and annual maintenance.

The monthly maintenance period takes place on the first Tuesday from 10:00 to 14:00 hours GMT (11:00 to 15:00 BST in summer time). The annual maintenance period takes place over a two week period in the summer, with the signal being absent during the daytime but restored overnight (although NPL does not guarantee the overnight service).

Details of when the next annual maintenance will take place are available from NPL (in 1997 it was from 26 June to 10 July). At the time of writing, the 1998 period had not been scheduled.

It is also possible that short unscheduled breaks in transmission may occur. NPL provides a help-line (0181 943 6493) which gives information on whether the signal is on-air.

It is because of the possibility of transmission breaks that the Time Machine was designed with the crystal clock as the main time-keeper, using Rugby (in effect) only as a subsidiary and periodic source of data.

COMPONENTS

See SHOP TALK Page

Resistors

R1	470Ω
R2	220k
R3, R4, R9, R14 to R17	2k2 (7 off)
R5 to R7, R18 to R24	1k (10 off)
R8, R10 to R13	10k

All 0.25W 5% carbon film.

Potentiometer

VR1	5k min. horiz. round cermet preset

Capacitors

C1, C4	22µ radial elect.16V (2 off)
C2, C3	10p polystyrene (2 off)
C5	100n polyester

Semiconductors

D1	3V3 400mW Zener diode
D2, D3, D5 to D9	5mm red l.e.d. (7 off)
D4, D10 to D13	1N4148 signal diode (5 off)
TR1 to TR4	BC549 *npn* transistor (4 off)
IC1	EM2 MSF radio receiver module
IC2	4584 hex Schmitt inverter
IC3	pre-programmed PIC16C84 micro-controller (see text)

Miscellaneous

X1	3·2768MHz crystal
X2	2-line16-character intelligent l.c.d. module
L1	60kHz ferrite aerial rod
PL1	7-way p.c.b. header, right angle
S1, S3	d.p.d.t. min. toggle switch (see text) (2 off)
S2	s.p.s.t. min. toggle switch (see text)
S4 to S15	3 × 4 matrixed membrane keypad, self-adhesive

Printed circuit board, available from the *EPE PCB Service*, code 171; plastic case,190mm × 110mm × 90mm (l × w × h), transparent lid; 14-pin d.i.l. socket; 18-pin d.i.l. socket; 25-way D-type connector, male (see text); 2mm socket (see text); cable tie (2 off); nuts and bolts to suit; connecting wire; solder, etc.

Approx Cost Guidance Only £64 excl. programming parts

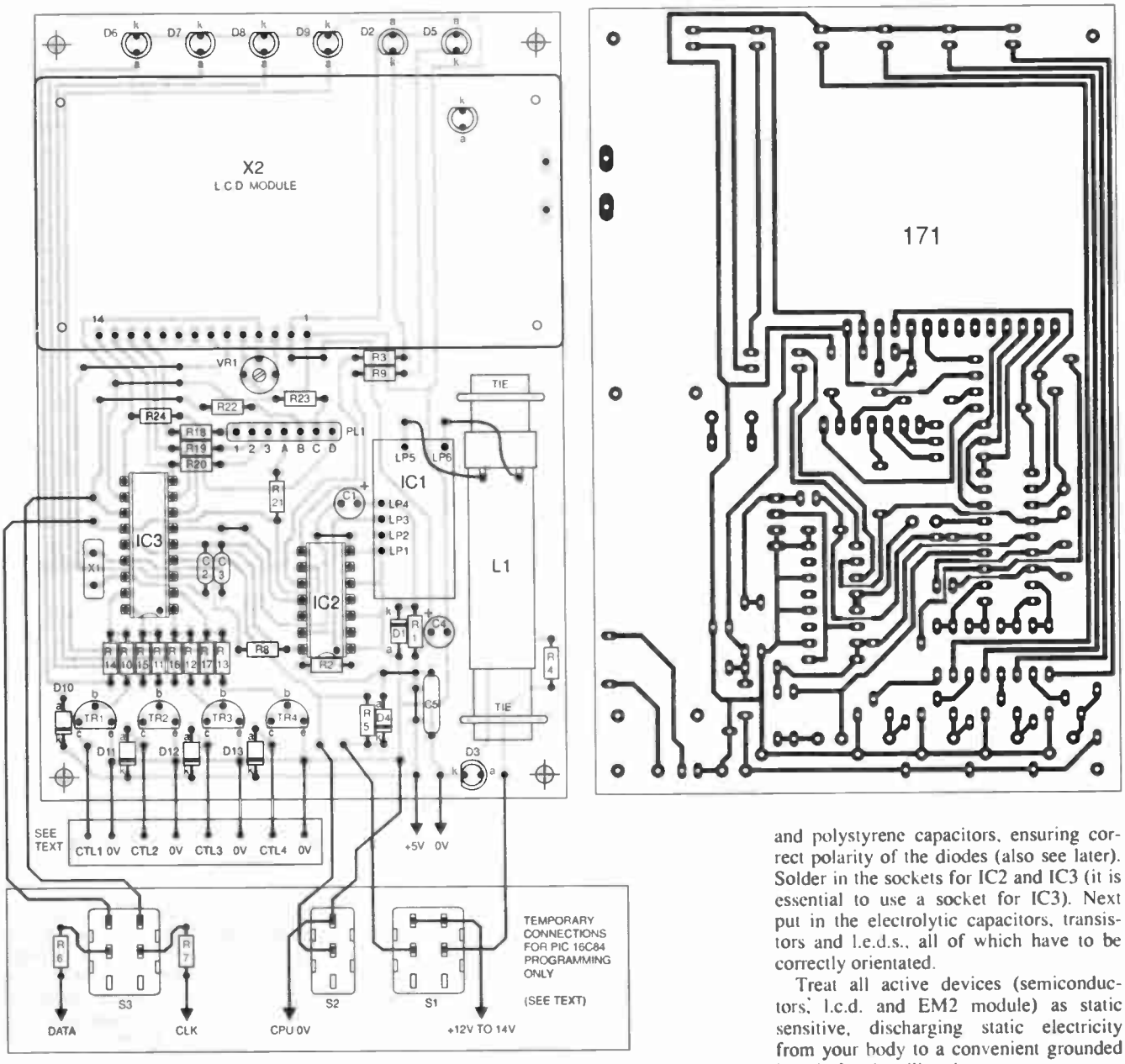


Fig.4. Printed circuit board component layout, interwiring and full-size copper foil master pattern (top right).

EEPROM RESET

A useful EEPROM Reset facility has been provided. It is principally of use when the Time Machine is first put into service. It is only available at the moment when power is switched on.

To use it, hold down the RST button before switching on, then, while still holding it down, turn on the power and wait for a couple of seconds. During this time, the software goes through its setting-up procedure, and when the RST button is pressed, the EEPROM reset routine is run. Release the button as soon as the normal screen is shown.

It is not a reset of the EEPROM bytes to zero which occurs, however. Instead, all 64 bytes are set to hold the code for 23:45 hours OFF. This is the latest Off time that can be given to any channel. There is no midnight setting at the end of the day. Rather, the 00:00 is taken as being the start of the next day.

Putting 23:45 OFF into all bytes saves you the trouble of having to program in final daily Off times unless you want to.

CONSTRUCTION

Details of the printed circuit board (p.c.b.) layout, master and interwiring are shown in Fig.4. This board is available from the *EPE PCB Service*, code 171.

First, insert all the on-board wire links, following them with the resistors, diodes and polystyrene capacitors, ensuring correct polarity of the diodes (also see later). Solder in the sockets for IC2 and IC3 (it is essential to use a socket for IC3). Next put in the electrolytic capacitors, transistors and l.e.d.s., all of which have to be correctly orientated.

Treat all active devices (semiconductors, l.c.d. and EM2 module) as static sensitive, discharging static electricity from your body to a convenient grounded item before handling them.

DISPLAY MODULE

Before assembling anything else, mount the l.c.d. (see also Fig.5). First, from the screen side of the module, pass short lengths (about 25mm) of 22 s.w.g. tinned copper wire through holes 1 to 6 and 11 to 14 (holes 7 to 10 are not used). Solder each on both sides of the module before inserting the next.

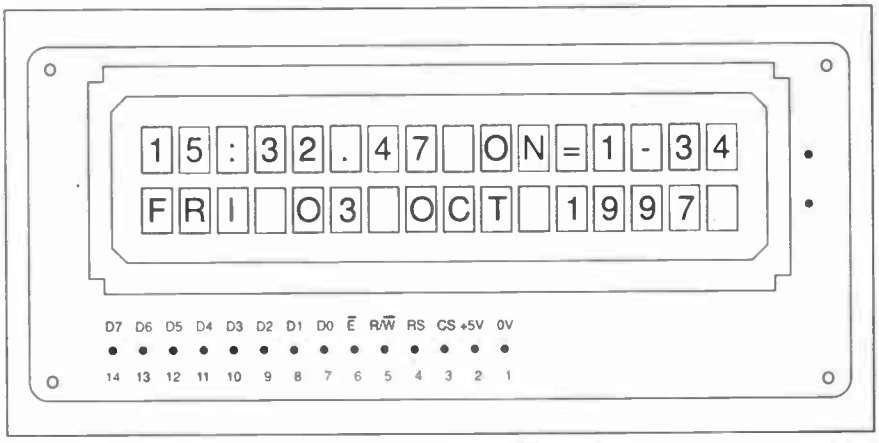


Fig.5. Pinout details for the l.c.d. module.

Cut off the top excess wire lengths, and cut all the lower lengths to be equal. With patience, and the use of a small screwdriver, persuade each wire to go through its respective hole in the top of the p.c.b.

When all are through, gently press down on the module to hold it flush with the p.c.b. Slightly bend some of the wires on the rear side of p.c.b. so that the module is temporarily held in position. Now solder each wire to the p.c.b. pads and trim off the excess lengths.

Perform a similar procedure with mounting the EM2 Receiver module. It requires six wires.

Now insert the preset potentiometer, crystal and polyester capacitor, after which insert terminal pins into all the remaining holes on the p.c.b., except for those in the middle which are marked for connector PL1. (You will probably need to drill the holes out to 1.00mm for the pins.)

In fact, PL1 is optional and, instead of using the right-angled connector (pin-header) stated in the components list, you can almost as conveniently do what the author did – use angled wires. The wires must be a bit thicker than 22 s.w.g. (the author used those from 0·5W metal oxide resistors) so that they fit snugly into the keypad socket.

Insert 25mm lengths of the wire through the top of the p.c.b. into the seven holes provided, soldering each on the underside of the p.c.b. Cut off the spare lengths on the underside. Using long nosed pliers, bend the upper lengths to right angles away from the l.c.d. Trim them equally so that the keypad connector can be pushed onto them.

AERIAL COIL

Finally, for this stage, secure the aerial coil to the p.c.b. using two cable ties passed through the holes provided (you will need to drill them to size to suit the tie widths – about 4mm).

Scrape the ends of the two aerial wires to remove their enamelled coating, and solder them to the pins as shown (it does not matter in which order). Keep them at the same length as supplied. Do not connect either wire of the coil to anything else – this receiver must not be grounded.

However, you may connect an external length of aerial wire to terminal LP5 of the module if you live in a poor reception area. The author allowed for this by adding a 2mm socket on the side of the case to which he connected a 25cm length of stranded wire. An additional length of aerial was not found to be required.

Thoroughly check all your soldering and correctness of component positions before going any further. Leave the assembly out of its case until testing has been completed. Current consumption is about 17mA with all l.e.d.s on; about 8mA with only l.e.d. D2 flashing.

CHECKING OUT

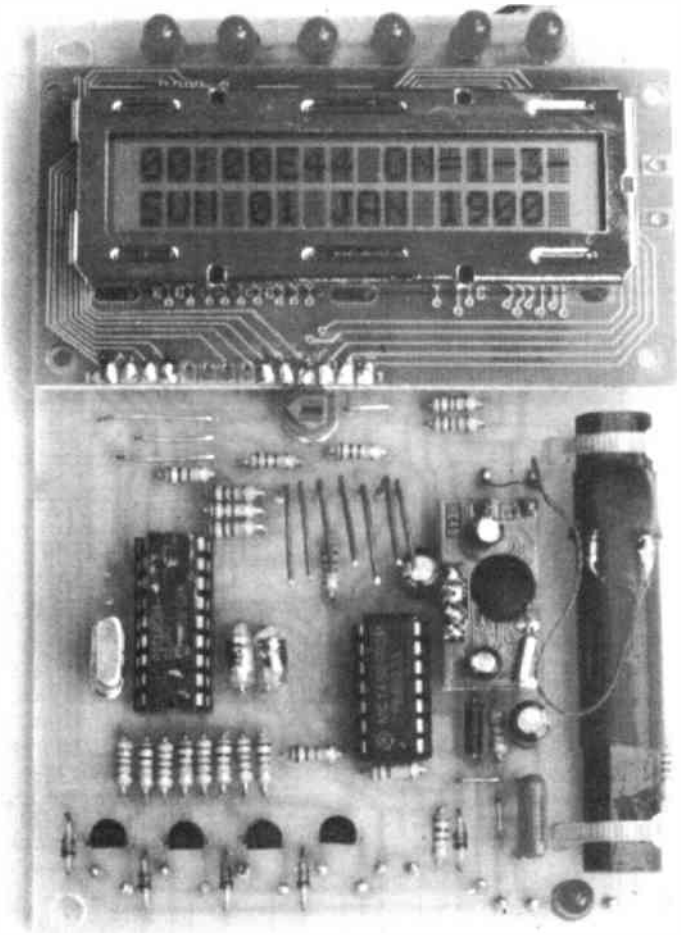
The unit should be powered by a regulated 5V to 6V d.c. power supply. It is recommended that the connections should be hard-wired. Plugged connections might be prone to removal!

Do not insert IC2 and IC3 yet. Push the keypad connector onto its pin-header or rigid wires, observing its orientation as marked.

Switch on the power supply and immediately check that the voltage on pin LP4 of the receiver module is at about 3·3V. It may be as low as 3V, but no less (if it is much less, Zener diode D1 may be back to front). Check that the power supply positive voltage is present at IC2's socket pin 14.

Assuming that IC3 has been programmed, you can insert it and IC2, and go straight for an operational check.

Switch on the power and observe the l.c.d. screen, adjusting preset VR1 until a reasonable contrast is obtained. In the top line at the left you should see the hours, minutes and seconds display. It will have started off at 00:00E00.



Layout of components on the finished printed circuit board. The seven angled wires in the centre are for the keypad connector.

The letter *E* in place of the decimal point indicates that the time being shown may be erroneous (it will be at this moment) since the Rugby signal has not been received and validated. The seconds count should be seen to be incrementing correctly (triggered by the internal clock).

The right-hand l.e.d. (D5) should be on – also indicating that an error *might* exist in the time shown. This l.e.d. also comes on at any time that the Rugby code has been found to be erroneous during the validity check, but that fact does not necessarily mean that the time shown is wrong.

At the right of the time will be the message ON=– – – –. The dashes are replaced by channel numbers when they are switched on. It is unlikely that any will be at this moment, depending on the current contents of the EEPROM data memory, which will probably be full of zeros – being interpreted as meaning all channels off since 00:00 hours.

On the second line, the information should read SUN 01 JAN 1900. This is the default display.

RECEPTION

Look at l.e.d. D2 (the second from the right). It should be flashing at the rate of the Rugby pulse, usually once per second, except during seconds 0 to 16 when other rates may be apparent. A flashing rate that appears somewhat erratic for longer than 16 seconds (or doesn't occur at all) indicates that the signal is not being received satisfactorily.

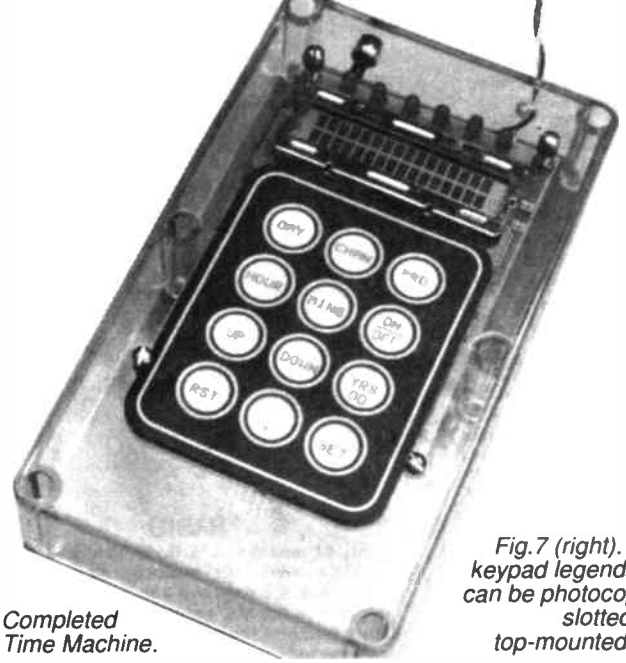
It may be necessary to rotate the unit in order to ensure that the aerial coil's length faces in the general direction of Rugby. It's not critical, although an end-on view of Rugby may not allow the signal to be picked up. The l.e.d. normally only flashes in response to the Rugby pulses (it has been found to flash erratically in response to another transmitter's signal when Rugby is off the air during maintenance).

It is also possible that the Time Machine might be shielded from the Rugby signal by something nearby. If so, move the unit to another part of the room. Keep it away from your computer (and, perhaps, the TV).

Once the Rugby signal has been acquired, you should soon have the current time and date being shown. The letter *E* before the seconds will be replaced by the decimal point at the moment of signal validation. Any time that the Rugby signal is lost, this letter will reappear. The same position is used for other "message" letters, as we shall see.

Now press button YRS 00, whereupon the seconds remaining until the Millennium will be seen on the second line, replacing the calendar data. The format is in the style of 100Y=00074218393s. The real-time clock and the status of the channels will remain displayed as before.

Releasing the button will return you to full calendar mode. Note, now, that the letter *M* is showing in the decimal point position, standing for Millennium. The decimal point will not reappear until the next correct validation has been received.



Completed Time Machine.

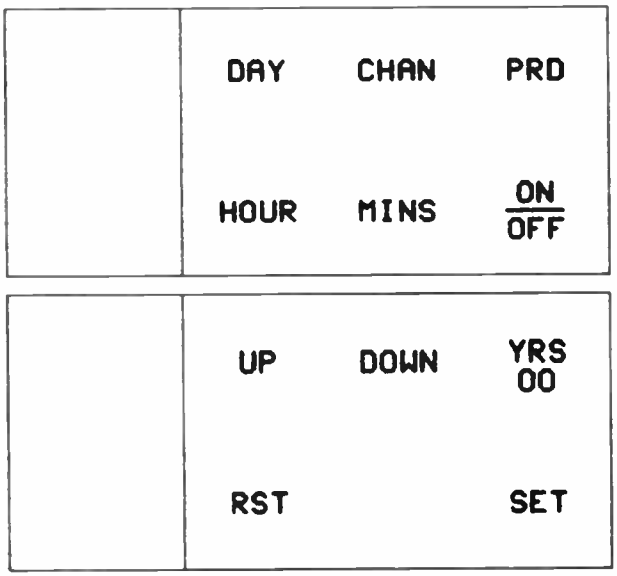


Fig.7 (right). Full size keypad legends. These can be photocopied and slotted into the top-mounted keypad.

This is because the registers used for Rugby data storage are used during the seconds countdown procedure. Therefore, a full set of register data has to be acquired and validated before the time is updated to match Rugby time. This, as they say, should be transparent to the user, apart from the *M*.

CHANNEL OUTPUTS

Now experiment with the channel on/off time settings.

Each time new channel data is stored into the EEPROM, confirmation of its storage is shown by the letter *Y* appearing in the decimal point position of the real-time display (meaning Yes, data has been stored!).

The four transistors, TR1 to TR4, are connected as open-collector output controls. Each can have a load, such as a relay for instance, connected to its collector terminal pin, and the other side of the relay to a separate 5V or 6V positive power supply line.

If the back-e.m.f. suppression diodes D10 to D13 are removed from the p.c.b. and placed directly across the relay's coil (with the correct polarity), voltages greater than 5V/6V may be connected across the coil; 12V, for example.

If a voltage greater than 6V is connected to the relay coil, failure to remove D10 to D13 from the p.c.b. will cause incorrect operation, the relay coil then effectively being connected across a supply of about 6V (12V into coil into 5V, less 0.7V diode drop).

The relay's contact switches should be chosen to suit the type of equipment you wish to control. Whilst it is possible to house the Time Machine and relays in the same box, it is recommended that they should be housed separately. This is especially true if the relays are to switch mains currents and voltages.

With the transistor types used, a relay coil (or other load) should allow no more than 100mA to flow through its controlling transistor when it is switched on.

When a channel is switched on, the corresponding l.e.d. (D6 to D9) also comes on.

It is recommended that bypass/override switches be used in conjunction with any controlled item.

PROGRAMMING THE PIC

On-board programming of the PIC16C84 can be done using the TASM software discussed in Derren Crome's *Simple PIC16C84 Programmer* (Feb '96) to which readers are referred for more information. The information is also to be repeated in the forthcoming PIC Tutorials.

Switch S1 turns on the 12V to 14V programming voltage (for which a suitable power supply must be available); l.e.d. D3 comes on when S1 is on. Switch S2 is the Reset switch. Switch S3 (not used in Derren's article) allows the computer connection to be switched on when the PIC is being programmed – otherwise keep it switched off.

Connections to the computer via a 25-pin D-connector are shown in Fig.6.

The configuration settings are XT, WDT off, POR off.

Having programmed the PIC according to Derren's instructions, and ensured that the Time Machine is working, switches S1 to S3 can be removed, as can resistors R6 and R7 (on S3). Resistor R4 and l.e.d. D3 may be left in place.

HOUSING THE UNIT

The author housed the Time Machine in a plastic case with a transparent lid. This allows the l.e.d.s and l.c.d. to be viewed without the need to cut apertures.

It is still necessary, though, to cut a slot through which the keypad ribbon cable and connector can pass. Position the keypad on the outer surface of the lid, and mark where the slot should be. Then drill out a length of holes and file down to the correct slot size.

The p.c.b. is secured to the inside of the lid, using bolts with additional nuts to act as stand-offs. Use the p.c.b. as a template, then mark and drill the holes.

There are two slots in the underside of the keypad. A photocopy of the legends in Fig.7 may be inserted into these slots before the keypad is mounted on the lid.

The keypad is self-adhesive – pass the cable through its slot and then remove the protective backing. *Very carefully* place the keypad in the *correct* position. Be warned that the adhesive is powerful and may not allow any repositioning to be done. Consequently, consider the use of double-sided adhesive tape (less powerful), leaving the keypad backing in place.

For the prototype, the base of the case was not used. To protect the parts mounted in the lid, a fibre-glass sheet was cut to size and secured to the lid. Make your own choice about whether or not you use the entire case.

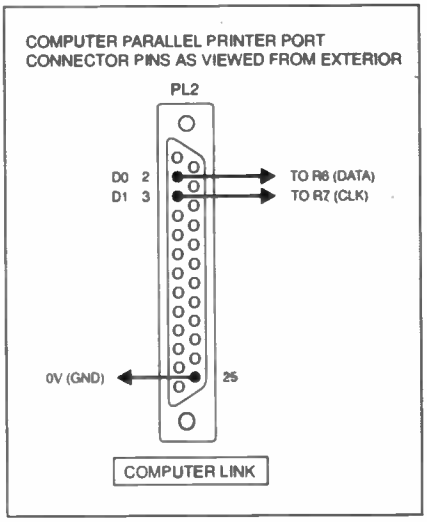


Fig.6. Computer link via 25-pin D-connector.

ON TIME!

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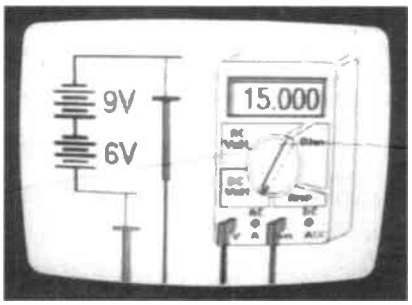

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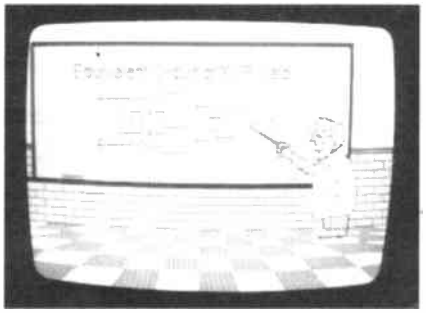

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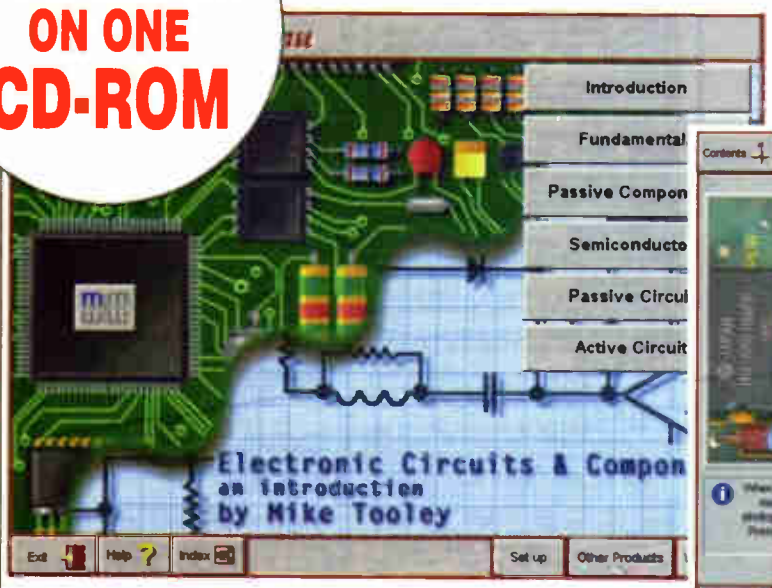

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Techniques

ACTUALLY DOING IT!

by Robert Penfold

ALTHOUGH stripboard seemed to fall out of favour with home constructors a few years ago, it has recently had something of a renaissance, and now seems to be used in a fair percentage of published projects. For the uninitiated it should perhaps be explained that stripboard is a form of proprietary printed circuit board. It consists of a thin board made from an insulating material which is drilled with one millimetre diameter holes in a 2·54mm (0·1 inch) matrix. Copper strips run along each row of holes on the underside.

Stripboard is used in standard printed circuit fashion, with the components fitted on the non-copper side of the board. The component leads are trimmed and soldered to the copper strips which then carry all the interconnections.

Stripboard is undoubtedly very versatile, and for many projects it represents the only viable alternative to a custom printed circuit board. In general, it probably represents a more economic method of construction than using custom boards, but it is not without a few drawbacks.

One of these is simply that projects tend to be relatively large when built on stripboard, and this method of construction does not permit anything like the degree of component density that is possible with a tailor made board. Obviously this is not of great importance in some applications, but it precludes its use in others.

The Hole Truth

Probably the main problem when using stripboard is that it is not as foolproof as a custom printed circuit board. With a custom board there is one hole per component lead, and there is little scope for making mistakes. You need to be careful that you do not get two resistors swapped over, or something of this nature, but otherwise mistakes are unlikely to occur.

Things are very different with stripboard, where it is quite normal to have something like 80 to 90 percent of the holes unoccupied. This makes it very easy to get one or two of the components in the wrong place. Stripboard is also unforgiving if you are a little careless when soldering components in place, and you have to keep your wits about you when using this method of construction

Occasionally a project may require a board that is one of the standard sizes in which stripboard is sold, but in most cases a larger board must be trimmed to the correct size.

There are several ways of cutting stripboard, but the safest method is to use a hacksaw to cut along rows of holes. There are quick alternatives which exploit the brittleness of this material, but these are all a little risky in that the board can easily shatter. It is even necessary to take due care when trimming stripboard using a hacksaw, as some makes of the board seem to be very brittle indeed.

Make sure that the board is securely held in place on the workbench, and make the cuts using minimal pressure. Do not try to cut between rows, as they are too close together and you are likely to end up with a board that is one set of holes short on both dimensions! Cutting along rows of holes inevitably produces some very rough edges, but it takes only a few seconds to file them to a smooth finish.

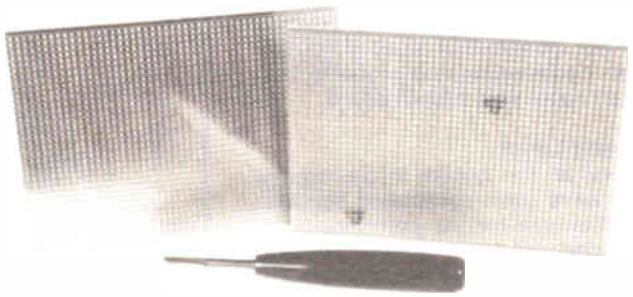
The next step is to drill the mounting holes which will permit the finished board to be bolted in place inside the project case. Most plastic stand-offs do not seem to work well with stripboard, with the component board tending to unclip as easily as it clips into place. Either 6BA or metric M2·5 bolts provide much more reliable results and, in either case, mounting holes of about three millimetres in diameter are suitable.

Due to the brittleness of the board it is essential that the mounting holes in the case are a good match for the board itself. Any discrepancy is likely to result in the board distorting and cracking when it is bolted in place. If necessary, use a miniature round file to elongate one or other of the sets of mounting holes so that the board can be bolted in place without putting it under stress.

Spaced Out

It is essential to use some form of spacer to keep the underside of the board clear of the case. This will be necessary anyway if a metal case is used, as the copper/solder connections on the underside of the board would otherwise be short-circuited through the case. With any form of circuit board it is good practice to use spacers whether or not a metal case is used.

Without the spacers the board tends to buckle slightly as the mounting nuts are tightened. This is due to the leadout wires and soldered joints protruding on the underside of the board, and preventing the board from fitting flush with the case.



Examples of stripboard showing copper tracks (left) on rear and plain topside (right). Also shown is a commercial track cutter.

Without spacers there is a risk of the board cracking as the areas of board around the mounting holes are forced down onto the case. All that is needed are a couple of extra nuts or spacers about 6mm long used on the mounting bolts, between the board and the case.

Making a Break

In order to produce reasonably compact layouts it is usually necessary to have some of the copper strips carry more than one set of connections. This is achieved by making breaks in the strips so that each section can be used for a separate set of connections.

The breaks can be made using a special "spot face cutter" tool which is available from most component retailers, but a handheld twist drill bit of about 5mm in diameter seems to do the job quite well. Whatever tool you use, make sure that the breaks are in the right places, and that the copper strips are cut across their full widths.

Do not get carried away and cut deeply into the board, or right the way through! Some projects require large numbers of cuts in the copper strips, and cutting deeply into a board could seriously weaken it. Err on the side of caution, but look carefully to check that each cut has properly severed the copper strip.

The diagrams for a stripboard project usually provide reasonably accurate representations of the top and bottom sides of the board,

making it clear where the breaks are made, where the components fit, etc. Fig. 1 shows a simple dummy layout diagram. Note the corner markers which are on the same corner of the board in the top and bottom views of the board.

If you should accidentally make a break in the wrong place it is not too difficult to repair it using a piece of wire. Soldering a tiny piece of wire in place is virtually impossible, so start with a piece about 50mm or more in length. "Tin" the broken ends of the copper strips with solder, and also "tin" a few millimetres at one end of the wire. It should then be very easy to solder the end of the wire across the gap, after which the excess wire can be trimmed away. If you get things badly wrong it is probably best to start again with a fresh board.

Missing Links

Once all the breaks in the copper strips have been completed successfully it is time for the components to be added. In the main this process follows along the normal lines for printed circuit construction.

One likely difference is that custom printed circuit boards have few (if any) link-wires, whereas most stripboard layouts make extensive use of them. In some cases they actually outnumber the components!

The board designer is rather hemmed-in by modern components that increasingly have rigid pin and lead spacing, rather than long leadout wires which give more scope with the positioning of components. Stripboard itself also imposes strict limitations on the way in which the interconnections can be implemented. Link-wires are therefore needed to wend connections around the board so that everything is connected together in the correct fashion.

Trimmings from resistor leadout wires are ideal for short links, but for the longer ones you will need some 22s.w.g. or 24s.w.g. (0·56mm or 0·71mm diameter) tinned copper wire. The thinner gauge is favoured, but either thickness will do the job well.

One way of adding the links is to carefully shape each piece of wire, drop it into place, trim the ends of the wire, and then solder it in place. This tends to be very time consuming if a large number of links are involved, and the following quick alternative can be used:

Cut off a piece of wire that is slightly over length, and solder one end in place on the board. Thread the other end through the appropriate hole in the board, and using pliers on the underside of the board pull the wire tight. Finally, trim away the excess wire and solder the wire in place. This method produces neat results provided the wire is pulled quite taut, but be careful as the wire will snap if you slightly overdo it.

Particularly with layouts that use large numbers of link-wires, make sure that none are omitted. Many

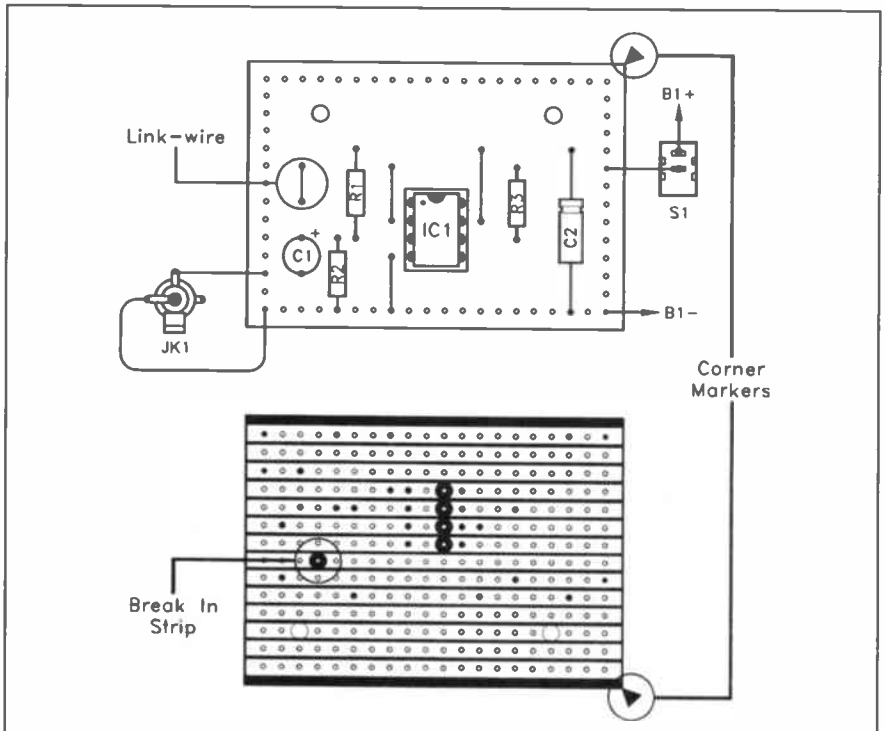


Fig. 1. A dummy stipboard layout showing link-wires, breaks in the strips, etc.

constructors find that it helps to tick-off each wire on the layout diagram as it is soldered into place.

When constructing practically any printed circuit board it is best to start with the links and small components, gradually working up to the largest components. Otherwise you tend to find that the large components get in the way, making it difficult to fit the smaller parts.

With stripboard it can be helpful to add the integrated circuit holders at an early stage as they then provide markers which help you to navigate your way around the board.

Some stripboard layout diagrams carry numbers and letters to identify the copper strips and columns of holes. Some constructors find it helpful to copy these onto the board itself, and this should greatly reduce the risk of making errors in component placement. A fibre-tipped pen which has a spirit based ink should mark stripboard quite well, and once dry the ink should not rub off too easily.

I do not generally bother to mark the boards in this way, but with larger boards it is well worthwhile placing marks at every five or ten holes along the board. This only takes a few seconds and makes finding the right positions for components much easier and quicker.

Mind the Gap

Undoubtedly, the main cause of problems with stripboard is accidental solder "bridges" across adjacent copper strips. With only 2·54mm between rows of holes, the gap between one copper strip and the next has to be minute. In fact there is a gap of only 0·5mm between each pair of strips.

It only takes a small amount of excess solder to produce a solder bridge between two strips. Consequently, solder bridges occur on practically every stripboard project. Fortunately, most of these solder bridges are very obvious, and will be spotted even before the solder has set. When a bridge occurs, remove all the solder from the offending joint or joints using a desoldering pump, or desoldering wick, and then resolder the connections.

From time to time there can be problems with solder bridges that are far from obvious. Either the amount of solder involved can be very small, or it can be hidden by excess flux in the solder. Routine checks of all completed stripboards for accidental short circuits prior to fitting them in the case are recommended.

It is always advisable to clean the copper side of the board first before undertaking any checking. Special cleaning fluids are available, but simply brushing the board vigorously with something like an old toothbrush thoroughly cleans the board.

Close Up

Even if you have keen eyesight, a fairly powerful magnifier greatly increases your chances of spotting any solder bridges. An 8x loupe (also sold as a "lupe") of the type sold by many photographic stores is ideal for this job. Pay particular attention to points on the board where there are a lot of joints packed together, and at the ends of copper strips.

Stripboard is not as easy to use as a custom printed circuit board, but it is not really that difficult to use either. Get everything in the right place and avoid solder bridges, and there is no reason why stripboard projects should not always work first time (well, nearly always).

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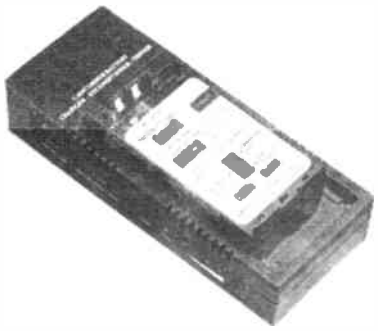

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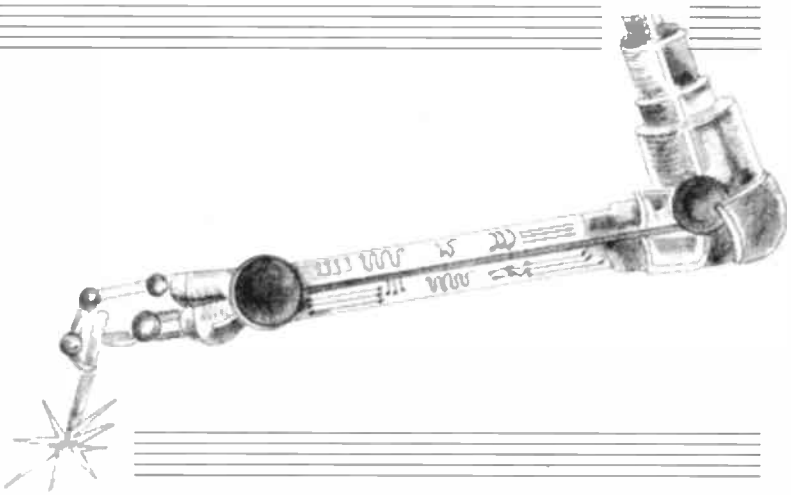

ALAN WINSTANLEY

Our monthly column of readers' questions and problems looks at silver solder, resistor power ratings and we get to grips with digital counters with a follow-up article by Ian Bell of the University of Hull.

As IF to coincide with Part One of our new *Teach-In '98* series, ***Tim Butcher*** of Cropston, Leicester asks for help identifying resistors.

Being an electronics student, I try to recycle old circuit boards as much as possible in order to re-use components. One problem concerns resistors – I can readily decode their values from the coloured bands, but what about the power dissipation ratings? Is there a way of telling this?

It's quite easy to make an educated guess as to the power rating of many resistors. You can't measure this with test equipment, and the answer is really just to try to identify the part and assess the physical size of the component. Most quarter-watt resistors are about the same size (I'm sure you've seen some) as are most half-watt types. It is safe to make an assumption about the power rating if you know that it's a carbon-film/metal film type: you can judge by the size and shape, more than anything.

It's more difficult to deal with unusual resistors, notably wirewound types. This comes with experience up to a point, but it can be quite misleading to judge from the dimensions. Sometimes, markings are included on the body (e.g. the maker's name, such as Welwyn), and this can then be cross-referred to a reputable catalogue. Harder still are those rectangular power resistors which could be anything from a few watts up to 20-30 watts or so.

With experience, you can soon judge the power rating just as you can read the resistor colour code, and you will soon start to recognise similar parts cropping up repeatedly. Checking through any current catalogue will be of help because they quote the dimensions. The useful book *Newnes Electronics Tool Kit* by Geoff Phillips (ISBN 0-7506-0929-X) gives several pages of resistor dimensions and manufacturers type numbers. Worth checking.

Schade Graphs

Thanks to Mr. David Reid of Livingston who followed up on the use of Schade's graphs for computing the values of a rectified and smoothed power supply (August issue). Mr. Reid comments:

Whilst Schade developed his reference work primarily when working with thermionic rectifiers (valves/vacuum tubes) it is never the less quite inaccurate when used with semiconductor rectifiers – and more so when dealing with high power types. A. Leiders has written a very thorough paper which deals with the theory of semiconductor-capacitor d.c. power supplies and also presents superb nomographs as a design aid. The paper is entitled Single-phase rectifier circuits with CR filters – Parts I & II, *published in* Electronic Components and Applications, Vol. 1 Nos. 3 & 4, *May and August 1979. I have found it exceedingly accurate and can thoroughly recommend it.*

Thanks. I believe I saw Schade's graphs being used in a p.s.u. design example of an old, rebadged National Semiconductor data book in the late seventies, though, and it clearly referenced semiconductor rectifiers. It's one area where rule of thumb design sometimes seems to prevail!

Cascading Counters

Let's now follow on from last month's general discussions about digital counter technology when we introduced some of the jargon describing counters. Ian Bell of the University of Hull, continues with our "counter intelligence" and helping out with a few queries from readers: thanks to ***Roger Dewhurst*** of Rotorua, New Zealand who asks:-

If I cascade 4017 counters to count pulses at millisecond intervals what interface do I require between the counters and the l.e.d. display? And is there a better way of counting pulses up to 99,999 in number?

Meantime, ***Mr. B. McClellan*** of Chester asks for help in cascading 4017 counters together to form a longer sequence. This problem isn't nearly as straightforward as you might think! Mr. McClellan says:

I'm trying to link two 4017 decade counters to form a simple sequencer which will drive a string of lamps sequentially. Unfortunately I could not get the second 4017 counter to continue the sequence. Could you help me with the wiring to get the second chip working properly?

In many applications it is necessary to use more than one counter device in order to be able to count a large enough number. For example you need five BCD counters – one for each digit – to count in decimal from 0 to 99,999. This is usually easy to do because many counters have special outputs for doing this, often called carry-out (CO), or ripple carry (RC) or terminal count (TC).

In some cases the "carry" is connected to the clock of the next counter, whilst in others it is connected to the count-enable input of the following stage. If the carry is connected to the clock of the next stage, this is known as *ripple-clocking*, whereas the latter use of a count enable input on fully synchronous counter provides a *fully synchronous* n-digit counter which is both faster and less prone to glitches. For this reason use the count-enable for cascading if possible when using counters which provide it.

The two-clock up/down counters such as the 74192 are slightly different in that they have two outputs – "carry out" to connect to the up-clock on the next stage,

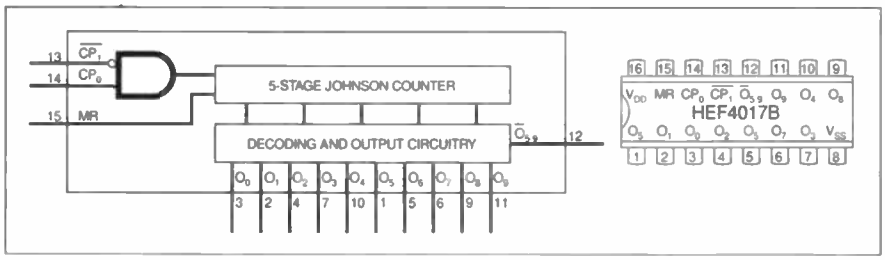

Fig. 1. 4017 functional diagram and pin-outs.

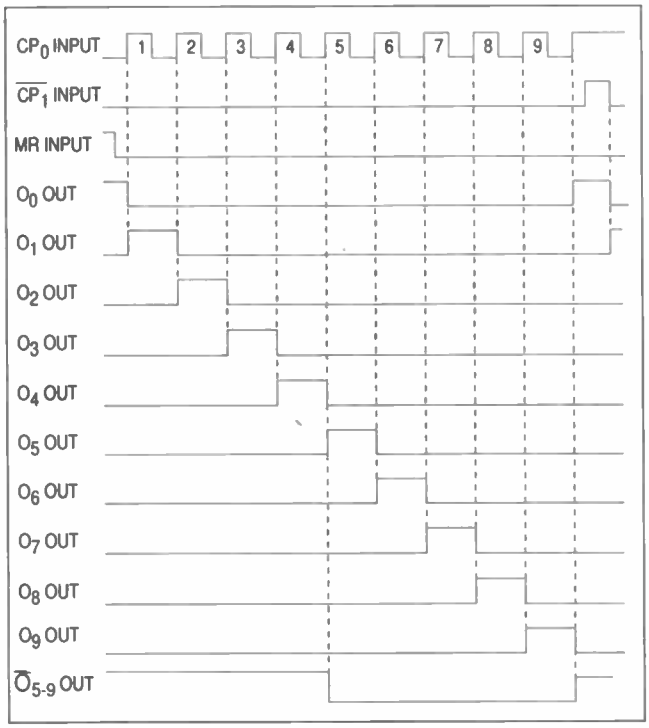

Fig.2. Output timing sequence of 4017.

and "borrow-out" to connect to the down-clock of the succeeding counter. The popular 4017 is a five-stage decade counter with a decoded decimal output, with pinouts shown in Fig. 1. Let's check out this device in more detail. It has two clock pins labelled CP_0 (pin 14) and $\overline{CP_1}$ (pin 13). Other data sources may label them differently: pin 14 may be the clock and pin 13 the clock inhibit. This counter is advanced either by a positive edge on CP_0 with low, or by a negative edge on $\overline{CP_1}$ with CP_0 high, see Fig. 2. A high on pin 15 (MR – master reset) clears the counter to read "zero" output (denoted by the O_0 output being a logic 1).

The 4017 can be cascaded to produce a multi-digit "1-of-10" coded decimal count by connecting the output of one stage to the clock of the next stage, with CP_0 held high, or by connecting O_9 of one stage to CP_0 of the next stage with $\overline{CP_1}$ low.

Cascading 4017 ring counters to produce sequences of more than 10 codes with only one output at a time is a little more complex, because unlike binary or BCD counting, only one stage should be counting at any one time. The circuit required to do this is shown in Fig. 3, which is actually a "classic" industry-standard method shown in several data books. Note that the sequence lengths are not 20 and 30 from 2 and 3 devices respectively, because of the way in which the O_0, and O_9 outputs are used to control the counting. Fig. 3 shows a circuit with a "first" and "last" stage, with any number of intermediate stages also represented. This circuit works as follows.

Assuming we start with the first stage at logic zero, then $O_0 = 1$ will cause all subsequent stages to reset. The reset ripples through from one stage to the next, with each stage $O_0 = 1$ driving the reset of the following stage. Note that O_0 is not used as a decoded output except from the first stage. At this point all the O_9 outputs are zero. This enables the counters (because $CP_1 = 0$), but disables the clock to the next stage by gating off with the AND gates shown. However, the first stage counting is not gated off so it will count. When it reaches $O_9 = 1$ it disables itself (because $CP_1 = 1$) so it stops with $O_9 = 1$. This gates the clock through to the next stage. This sequence continues, as each stage reaches $O_9 = 1$ it disables itself and gates the clock to the next stage. The last stage is slightly different, when it reaches $O_9 = 1$ it resets the first stage (and hence all the others) and the sequence starts over again. Cute!

Using three 4017s in this manner actually gives a "1-of-25" (i.e. 25 outputs pulsed in sequence). If you required other sequence lengths it is simply a matter of wiring the reset of the first stage to a different output of the final stage, so for example to get a "1-of-20" code sequence you would wire MR of stage 1 to O_4 of the 3rd stage.

Displaying Counter Outputs

BCD counter outputs can be connected directly to BCD to seven-segment display decoder driver chips such as the 7447 and 4511 (as used on the *Teach-In '93 Mini Lab*), which will directly drive a seven segment display and are easy to use. The 4511 offers 25mA output current per pin, and has display blank and lamp test features for further control of seven segment displays. Typically, use a 220 ohm resistor in series with each output connected to the l.e.d.

There are also displays with built-in decoders and drivers such as the TIL311 hexadecimal display with binary inputs and the HP 5082-7300 BCD numerical display with built-in decoders and on-board memory.

Converting binary to BCD or seven segment format is considerably more difficult. The 74185 did provide a binary to BCD conversion function, but these devices are probably no longer available. A single 74185 could convert a 6-bit binary number and multiple devices could be connected to cope with larger numbers (3 for 8-bit binary, 8 for 12-bit, and 16 for 16-bit).

A possible solution for advanced readers having access to an EPROM programmer is to set up an EPROM or two as a lookup table converting binary to BCD. For example 8 address lines and 12 data lines would be required to convert 8-bit binary to 3-digit BCD. The EPROM(s) contents are set up so that the binary number selects an address at which the BCD code for that number has been stored. If all you want is to display the binary then EPROM(s) could also convert directly to seven-segment codes. You would require more EPROMs (more data lines – 21 for 3 digits) but you would not need seven-segment decoders.

If you're looking for a decade counter to drive a seven-segment output, the 4026 and 4033 will both do this with low- power seven-segment displays. They're harder to find in the major catalogues (presumably due to lack of demand by industry) but are fun to play with. Housed in a 16-pin package, these chips will decode a clock pulse and advance a seven-segment display by 1. So simply clock the chip and the display will advance by 1.

Multi-digit displays are often time-multiplexed so that only one digit is on at a time – old l.e.d. calculators worked this way – but the switching between digits is so fast that it appears static to the human eye. This saves on wiring complexity and decoders as all the segment lines for each display can be wired together. For example a 5-digit separate display requires 35 segment lines plus 5 common lines and 5 decoders, whereas a multiplexed display only needs 7 segment lines plus 5 digit selectors and one decoder. Multidigit multiplexed displays are available as modules. The 4534 5-decade counter has tri-state BCD outputs which are multiplexed using an internal scanner and it can be cascaded easily.

Supplier update

Time to update you on a couple of suppliers. Without the services of mail order suppliers, it's a fact that many readers would find it utterly impossible to enjoy hobby or educational electronics. Not everyone, myself included, has a good electronics component store on their doorstep and mail order means that parts

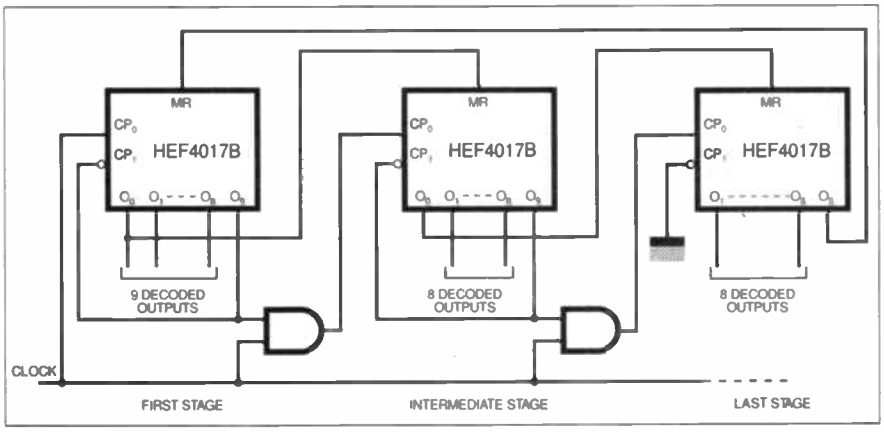

Fig.3. Method of cascading 4017 counters.

are just a letter-box or phone call away. The hoary old argument of minimum postage and packaging charges is one I don't have time for – one reader criticised me for using allegedly esoteric parts which weren't readily available from his local electronics shop. When I argued that mail-order postage & packing costs are likely to be far cheaper than using a car to visit a store anyway, so I didn't understand the problem, he argued that he bicycled to his store, and that costs nothing! Can't win.

ElectroValue

Many enthusiasts know of ElectroValue Ltd. and it's good to see their latest catalogue making an appearance. They are well known for their very large range of Siemens semiconductors, passive and electromechanical components, and they carry a good range of general components for both industry and hobbyist. The company moved into new, larger premises and have gained BSI certification to ISO9002. Their new mail order address is: ElectroValue Ltd., Unit 5, Beta Way, Thorpe Industrial Park, Egham, Surrey, TW20 8RE. Tel. 01784 433604. E-mail **evalue@compuserve.com**. The catalogue costs £2.50 including U.K. P&P.

Silver Solder

Jeff Spitza over in the USA E-mailed a query on silver solder which will interest Theremin and audio fans:

I've just ordered my first project kit (the PAIA music synthesiser) and was told to use silver solder – 62%-36%-2% to help prevent RF in the circuit. Will this be OK? Thanks for any info.!

Interesting. Multicore Solders sell this as "Smart Wire" silver loaded solder. It's very expensive and I'm personally unaware of any claims made regarding RF stability. It's advertised as being "non spitting" with good resistance to thermal fatigue and is designed for hand soldering of delicate surface-mounted components. Silver solder is also available with 5·5% and 10% silver which has a higher melting point than usual. The silver solder offers a lower resistance than usual which is said to be better for soldering e.g. hi-fi systems together. I guess silver solder can only result in an improved finish but I'm unsure of any supportive evidence which says you'd notice any difference. Audiophiles will soon correct me! Comments welcomed.

Next month: Ian Bell checks out switch debouncing and random number generation as we continue our mini-series on digital counting.

CIRCUIT THERAPY

Circuit Surgery is your column. If you have any queries or comments, please write to: Alan Winstanley, *Circuit Surgery*, Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset, BH21 1PF, United Kingdom. E-mail **alan@epemag.demon.co.uk.** Please indicate if your query is not for publication. A personal reply cannot always be guaranteed but we will try to publish representative answers in this column.

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This highly acclaimed *EPE Teach-In series, which included the construction and use of the Mini Lab* and *Micro Lab* test and development units, has been put together in book form. Additionally, EPT Educational Software have developed a GCSE Electronics software program to compliment the course and a **FREE DISK** covering the first two parts of the course is included with the book.

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Contains twenty projects from previous issues of *EE* each backed with a kit of components. The projects are: Seashell Sea Synthesizer, EE Treasure Hunter, Mini Strobe Digital Capacitance Meter, Three-Channel Sound to Light, BBC 16K sideways RAM, Simple Short Wave Radio, Insulation Tester, Stepper Motor Interface, Eprom Eraser, 200MHz Digital Frequency Meter, Infra Red Alarm, EE Equaliser, Ioniser, Bat Detector, Acoustic Probe, Mainstester and Fuse Finder, Light Rider – (Lapel Badge, Disco Lights, Chaser Light), Musical Doorbell, Function Generator, Tilt Alarm, 10W Audio Amplifier, EE Buccaneer Induction Balance Metal Detector, BBC Midi Interface, Variable Bench Power Supply, Pet Scarer, Audio Signal Generator.

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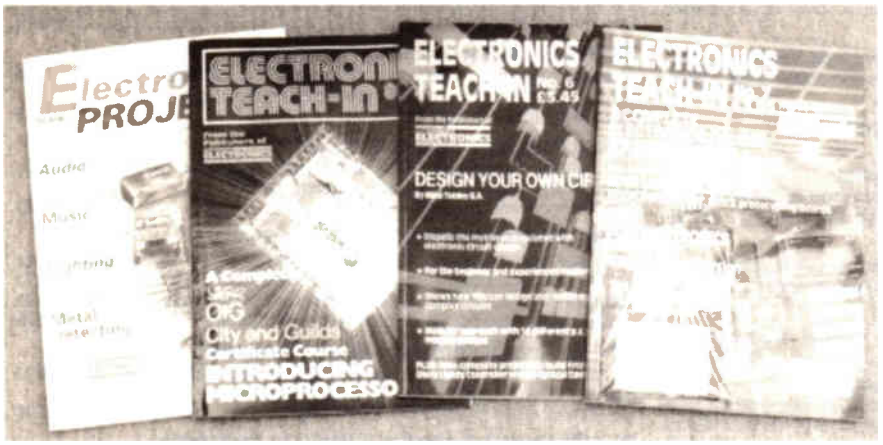

RADIO / TV / VIDEO

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R. A. Penfold
This book provides a number of practical designs for video accessories that will help you get the best results from your camcorder and VCR. All the projects use inexpensive components that are readily available, and they are easy to construct. Full construction details are provided, including stripboard layouts and wiring diagrams. Where appropriate, simple setting up procedures are described in detail; no test equipment is needed.

The projects covered in this book include: Four channel audio mixer, Four channel stereo mixer, Dynamic noise limiter (DNL), Automatic audio fader, Video faders, Video wipers, Video crispener, Mains power supply unit.

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I. D. Poole
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Topics covered include: The equipment that is needed; Setting up the shack; Which aerials to use; Methods of construction; Preparing for the licence.

An essential addition to the library of all those taking their first steps in amateur radio.

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EXPERIMENTAL ANTENNA TOPICS
H. C. Wright
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Much information is also given on shortwave bands, aerial directivity, time zones, dimensions etc.

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PROJECT CONSTRUCTION

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AF Generator, Capacitance Meter, Test Bench Amplifier, AF Frequency Meter, Audio Mullivoltmeter, Analogue Probe, High Resistance Voltmeter, CMOS Probe, Transistor Tester, TTL Probe.

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The preamplifier circuits include low noise microphone and RIAA types, a tape head preamplifier, a guitar preamplifier and various tone controls. The power amplifier designs range from low power battery operation to 100W MOSFET types and also include a 12 volt bridge amplifier capable of giving up to 18W output.

All the circuits are relatively easy to construct using the p.c.b. or stripboard designs given. Where necessary any setting-up procedures are described, but in most cases no setting-up or test gear is required in order to successfully complete the project.

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CIRCUITS AND DESIGN

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A. Flind
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Various circuits using inductors and capacitors are covered, with emphasis on stable low frequency generation. Some of these are amazingly simple, but are still very useful signal sources.

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The topics covered in this book include: the basic concepts of logic circuits; the functions of gates, inverters and other logic "building blocks"; CMOS logic i.c. characteristics, and their advantages in practical circuit design; oscillators and monostables (timers); flip/flops, binary dividers and binary counters; decade counters and display drivers.

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AUDIO AND MUSIC

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J. Chatwin
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Along with the electric guitar, sections are also included relating to acoustic instruments. The function of specialised piezoelectric pickups is explained and there are detailed instructions on how to make your own contact and bridge transducers. The projects range from simple preamps and tone boosters, to complete active controls and equaliser units.
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PROJECT TITLE	Order Code	Cost
Stereo "Cordless" Headphones **DEC '95**		
Transmitter	961	£8.04
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*EPE Met Office – Sensor/Rainfall/Vane	963/965	£11.33
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*EPE Met Office – **JAN '96**		
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Printer Sharer	973	£9.93
Analogue Frequency Meter **FEB '96**	957	£6.70
Vari-Speed Dice (Teach-In '96)	974	£5.69
Mains Signalling Unit – 2		
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*PIC-Electric Meter – Sensor/PSU–		
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Mind Machine Mk III – Sound and Lights	980	£7.39
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Mind Machine Mk III – Programmer **APR '96**	983	£7.36
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Countdown Timer (Teach-In '96)	993	£9.44
Sarah's Light **JUNE '96**	996	£7.17
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*PulStar	998	£6.60
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Twin-Beam Infra-Red Alarm –		
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*Games Compendium	104	£6.09
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– Receiver	154	£6.42
Pyrotechnic Controller	155	£6.93
*PIC Digilogue Clock	156	£7.39
Narrow Range Thermometer	158	£6.37
Micropower PIR Detector – 1 **JULY '97**	152	£6.69
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EPE SOFTWARE

Software programs for the *EPE* projects marked above with an asterisk (*) are available altogether on a *single* 3.5 inch PC-compatible disk, or as needed via our Internet site. The same disk also contains the following additional software: Simple PIC16C84 Programmer (Feb '96). The disk (order as "PIC-disk") is available from the *EPE PCB Service* at £2.75 (UK) to cover our admin costs (the software itself is *free*). Overseas £3.35 surface mail, £4.35 airmail. Alternatively, the files can be downloaded *free* from our Internet FTP site: **ftp://ftp.epemag.wimborne.co.uk.**

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SURFING THE INTERNET

NET WORK

ALAN WINSTANLEY

EPE NET WORK is our monthly column for those readers having access to the Internet. *EPE* operates a web site to support its readers at **http://www.epemag.wimborne.co.uk** and our additional FTP server is at **ftp://ftp.epemag.wimborne.co.uk** where we have a variety of files available related to our magazine and projects. This month's PIC project is at sub-directory **/TIMEMACHINE**.

Hopefully, by the time you read this, our new Secure Server will be on-line. I discussed the issues surrounding on-line ordering in *Net Work*, July 1997 issue. The new Secure Server allows subscriptions and Back Orders to be purchased with a credit card. Watch out for the **http://** address and the key logo (*Netscape*), or the padlock symbol (*Explorer*), in your browser window signifying that you are connected to a secure site.

Buying your first PC

Last month I grumbled about the High Street salesman who knew nothing about the digital camera that I wanted to buy; however, he tried to flog an extended warranty because "digital cameras are fragile and I could accidentally damage it", he said. A follow-up mailshot has duly arrived, offering more of the same. The deal is in fact now called a service agreement, and it does not cover "*product failure through negligence, abuse or misuse of the product*": so if I tried to see how high the camera bounced when I dropped it, I wouldn't have had a leg to stand on anyway.

If you're thinking of buying your first home computer in time for Christmas, especially if you are now intrigued by what the Internet has to offer, then now is the time to start looking. The object of this month's *Net Work* is to prevent those readers thinking of buying a new PC, from being ruthlessly strapped by a Salesman from Hell who would say anything to make a sale. Here's my quick guide for first-time home computer buyers:

Home computers come in two flavours: IBM is *the* name in personal computers (PCs), the mainstream alternative is Apple Macintosh ("Macs"); neither are directly compatible with the other. However, most PCs are now not built by IBM but are said to be "IBM compatible" – the so-called "IBM clone". As far as the mass market goes, the place is stuffed full of PC-compatible hardware and software, yet I have only ever found one or two AppleMacs on sale in provincial High Street retailers.

This does not reflect upon the capability of the AppleMac, more in the way it has been marketed (badly) over the years. There is nothing wrong with buying an AppleMac: their owners love them, and they will testify that they are easier to use and certainly easier to configure and set up than any IBM-compatible PC (but the gap has narrowed considerably). AppleMacs are heavily entrenched in the graphics industry (most web graphics are produced on them).

Historically, the IBM-compatible PC suited a more technically-receptive market. Adding any hardware was not to be undertaken lightly and often needed expert knowledge. However, PCs now have a much wider appeal and are easier to live with, cheap to upgrade, universally available and there are shed-loads of IBM-compatible hardware and software around, produced by a multitude of manufacturers. For these reasons, it makes more sense to buy an IBM-compatible PC for home use. (Anyway, you'd find it quite hard to buy anything else.)

If you like the comfort of buying a PC the same way you'd buy a fridge or TV, check the High Street or out of town store. The sales staff may have minimal knowledge (as my digicam experience showed), but you can see the thing, try it, and take it away with you. However, you may be paying more than is necessary, or it may not be bang up to date (and don't be seduced by its appearance, either). One alternative is to get a word-of-mouth recommendation from a friend about a well-established local independent computer shop who may assemble PCs themselves and be more competitive, though quality varies.

Old-hands at this game will tell you that you can't beat buying a PC "direct" – i.e. by mail-order, from an established manufacturer, but you need to be a "canny" buyer. Computer magazines are crammed full of advertisements, and in my personal view a good benchmark is Dell Computers (**www.dell.com/uk**), who claim to be the world's largest direct seller. They're a safe bet, aggressively priced, right up to date and assembled to a fine standard. Critically, unlike many, Dell's machines include excellent documentation to help you upgrade later on.

What to look for

Sadly, many direct suppliers' adverts offer a confusing array of options! For home use (games, Internet, accounts, fun graphics, word processing etc.), choose a reputable make such as Dell, Gateway, Viglen, Dan or Evesham (there are more besides), and price up a "multimedia" PC with a minimum spec. as follows:

Processor speed: 166MHz or higher, (Intel Pentium MMX=A9 processor or competing brand, e.g. AMD K6); *RAM* (random access memory) indicates how much "headroom" the PC has to do its sums, the more the merrier – 16MB minimum, 32MB EDO or SDRAM is better. *Hard disk size* – 2·1 Gigabytes or so should easily last you a year or more. CD-ROM – 12 speed or more; *graphics card* – a "3D" card might help with graphics and the latest games, ensure 2MB video memory or more. *Expansion slots:* later you may want to add a modem, perhaps a better sound card, TV or radio card, or flatbed scanner – so look for five or six rear "slots" to allow for growth.

Check for spare "bays" to hold an extra drive or two (e.g. tape or Zip drive, or second hard disk) later. Aim for a 15 inch (not 14 inch) *SVGA colour monitor* included, these days. If wanted, a *modem* – 33·6k internal "Plug & Play" type. Windows 95 pre-installed is *de rigeur* for the new home user; the original CD ROM disk should be supplied. A *software "bundle"* may include old or American versions - so don't be swayed; however, you may also get the latest Microsoft or Lotus software suites, again *with original disks included.* (Manuals probably won't be, though.) Help is often "on-line" meaning you use the computer's on-screen system when you get stuck. Or buy a text book! Check the warranty offers *one year on-site*, at the very minimum, and don't forget to budget for a *colour inkjet printer*. Be aware that whatever you buy, it will depreciate as technology moves on. It's unavoidable so don't worry about it; buy a future-proof machine and enjoy your new PC.

Latest Links

Keep those links coming! As always, there is a variety of electronics-related "Hot Links" for you to try, ready-made on the *Net Work* page of our web site. If you're looking for obsolete semiconductors, try Mushroom Components on **www.mushroom.co.uk**, where there's a search engine. PIC fans may like to know of the Microchip Enthusiasts' pages at **www.microchip2.com/enth.htm**. Peak Electronic Design Ltd. tell me that they manufacture a range of amateur and professional test equipment, see their attractive site at **www.peakelec.co.uk**. Thomas Kay advises that he's trying to form the UK Robotics Club – join him on **www.thomas-kay.demon.co.uk**. Thanks to David O'Shea for offering the Hardware Book at **www.blackdown.org/~hwb/hwb.html** which contains lots of useful connector pinouts and cable info. And finally – a superb *History of Computers* is now on-line – see **ro.com/~bebopbb/history/history_book.htm**.

My E-mail address is **alan@epemag.demon.co.uk**. My Home Page is **http://homepages.tcp.co.uk/~alanwin**. See you next month!

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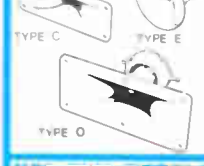
Join the Piezo revolution! The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if two are put in series. **FREE EXPLANATORY LEAFLETS ARE SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN1036A) 3" round with protective wire mesh. Ideal for bookshelf and medium sized Hi-Fi speakers. Price £4.90 - 50p P&P.
TYPE 'B' (KSN1005A) 3½" super horn for general purpose speakers, disco and P.A. systems etc. Price £5.99 - 50p P&P.
TYPE 'C' (KSN1016A) 2"x5" wide dispersion horn for quality Hi-Fi systems and quality discos etc. Price £6.99 - 50p P&P.
TYPE 'D' (KSN1025A) 2"x6" wide dispersion horn. Upper frequency response retained extending down to mid-range (2KHz). Suitable for high quality Hi-FI systems and quality discos. Price £9.99 - 50p P&P.
TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-FI monitor systems etc. Price £5.99 - 50p P&P.
LEVEL CONTROL Combines, on a recessed mounting plate, level control and cabinet input jack socket. 85x85mm. Price £4.10 - 50p P&P.

tbl FLIGHT CASED LOUDSPEAKERS

A new range of quality loudspeakers designed to take advantage of the latest speaker technology and enclosure designs. Both models utilize studio quality 12" 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

POWER RATINGS QUOTED IN WATTS RMS FOR EACH CABINET
FREQUENCY RESPONSE FULL RANGE 45Hz - 20KHz

***tbl* FC 12-100WATTS (100dB) PRICE £159.00 PER PAIR**
***tbl* FC 12-200WATTS (100dB) PRICE £175.00 PER PAIR**
SPECIALIST CARRIER DEL. £12.50 PER PAIR

OPTIONAL STANDS PRICE PER PAIR £49.00
Delivery £6.00 per pair

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PRICES: 150W £49.99 250W £99.99
400W £109.95 P&P £2.00 EACH

THREE SUPERB HIGH POWER CAR STEREO BOOSTER AMPLIFIERS
150 WATTS (75 - 75) Stereo, 150W Bridged Mono
250 WATTS (125 - 125) Stereo, 250W Bridged Mono
400 WATTS (200 - 200) Stereo, 400W Bridged Mono
ALL POWERS INTO 4 OHMS
Features:
★ Stereo, bridgable mono ★ Choice of high & low level inputs ★ L & R level controls ★ Remote on-off ★ Speaker & thermal protection.

OMP MOS-FET POWER AMPLIFIER MODULES SUPPLIED READY BUILT AND TESTED.

These modules now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models are available to suit the needs of the professional and hobby market i.e. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE that all models include toroidal power supply, integral heat sink, glass fibre P.C.B. and drive circuits to power a compatible Vu meter. All models are open and short circuit proof.

THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS

OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 45V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 123 x 60mm.
PRICE £40.85 - £3.50 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. -110 dB. Size 300 x 155 x 100mm.
PRICE £64.35 - £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. -110 dB. Size 330 x 175 x 100mm.
PRICE £81.75 - £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. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 385 x 210 x 105mm.
PRICE £132.85 - £5.00 P&P

OMP/MF 1000 Mos-Fet Output power 1000 watts R.M.S. into 2 ohms, 725 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 422 x 300 x 125mm.
PRICE £259.00 - £12.00 P&P

NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 500mV, BAND WIDTH 100KHz. PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BAND WIDTH 50KHz. ORDER STANDARD OR PEC.

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McKenzie and Fane Loudspeakers are also available.

EMINENCE:- INSTRUMENTS, P.A., DISCO ETC

ALL EMINENCE UNITS 8 OHMS IMPEDANCE

8" 100 WATT R.M.S. MEB-100 GEN. PURPOSE, LEAD GUITAR, EXCELLENT MID, DISCO.
RES. FREQ. 72Hz, FREQ. RESP. TO 4KHz, SENS 97dB. **PRICE £32.71 - £2.00 P&P**

10" 100 WATT R.M.S. ME10-100 GUITAR, VOCAL, KEYBOARD, DISCO, EXCELLENT MID.
RES. FREQ. 71Hz, FREQ. RESP. TO 7KHz, SENS97dB. **PRICE £33.74 - £2.50 P&P**

10" 200 WATT R.M.S. ME10-200 GUITAR, KEYB'D, DISCO, VOCAL, EXCELLENT HIGH POWER MID,
RES. FREQ. 65Hz, FREQ. RESP. TO 3.5KHz, SENS 99dB. **PRICE £43.47 - £2.50 P&P**

12" 100 WATT R.M.S. ME12-100LE GEN. PURPOSE, LEAD GUITAR, DISCO, STAGE MONITOR.
RES.FREQ. 49Hz, FREQ. RESP. TO 6KHz, SENS 100dB. **PRICE £35.64 - £3.50 P&P**

12" 100 WATT R.M.S. ME12-100LT (TWIN CONE) WIDE RESPONSE, P.A., VOCAL, STAGE MONITOR. RES. FREQ 42Hz, FREQ. RESP. TO 10KHz, SENS 98dB. **PRICE £36.67 - £3.50 P&P**

12" 200 WATT R.M.S. ME12-200 GEN. PURPOSE, GUITAR, DISCO, VOCAL, EXCELLENT MID.
RES. FREQ. 58Hz, FREQ. RESP. TO 6KHz, SENS 98dB. **PRICE £46.71 - £3.50 P&P**

12" 300 WATT R.M.S ME12-300GP HIGH POWER BASS, LEAD GUITAR, KEYBOARD, DISCO ETC.
RES. FREQ. 47Hz, FREQ. RESP. TO 5KHz, SENS 103dB. **PRICE £70.19 - £3.50 P&P**

15" 200 WATT R.M.S. ME15-200 GEN. PURPOSE BASS, INCLUDING BASS GUITAR.
RES. FREQ. 46Hz, FREQ. RESP. TO 5KHz, SENS 99dB. **PRICE £50.72 - £4.00 P&P**

15" 300 WATT R.M.S. ME15-300 HIGH POWER BASS, INCLUDING BASS GUITAR.
RES. FREQ. 39Hz, FREQ. RESP. TO 3KHz, SENS 103dB. **PRICE £73.34 - £4.00 P&P**

EARBENDERS:- HI-FI, STUDIO, IN-CAR, ETC

ALL EARBENDER UNITS 8 OHMS (Except EB8-50 & EB10-50 which are dual impedance tapped @ 4 & 8 ohm)
BASS, SINGLE CONE, HIGH COMPLIANCE, ROLLED SURROUND

8" 50watt EB8-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40Hz, FREQ. RESP. TO 7KHz SENS 97dB. **PRICE £8.90 - £2.00 P&P**

10" 50WATT EB10-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS. 99dB. **PRICE £13.65 - £2.50 P&P**

10" 100WATT EB10-100 BASS, HI-FI, STUDIO.
RES. FREQ. 35Hz, FREQ. RESP. TO 3KHz, SENS 96dB. **PRICE £30.39 - £3.50 P&P**

12" 100WATT EB12-100 BASS, STUDIO, HI-FI, EXCELLENT DISCO.
RES. FREQ. 26Hz, FREQ. RESP. TO 3 KHz. SENS 93dB. **PRICE £42.12 - £3.50 P&P**

FULL RANGE TWIN CONE, HIGH COMPLIANCE, ROLLED SURROUND

5¼" 60WATT EB5-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 63Hz, FREQ. RESP. TO 20KHz, SENS 92dB. **PRICE £9.99 - £1.50 P&P**

6½" 60WATT EB6-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 38Hz, FREQ. RESP. TO 20KHz, SENS 94dB. **PRICE £10.99 - 1.50 P&P**

8" 60WATT EB8-60TC (TWIN CONE) HI-FI, MILTI-ARRAY DISCO ETC.
RES. FREQ. 40Hz, FREQ. RESP. TO 18KHz, SENS 89dB. **PRICE £12.99 - £1.50 P&P**

10" 60WATT EB10-60TC (TWIN CONE) HI-FI, MULTI ARRAY DISCO ETC.
RES. FREQ. 35Hz, FREQ. RESP. TO 12KHz, SENS 98dB. **PRICE £16.49 - £2.00 P&P**

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PHOTO: 3W FM TRANSMITTER

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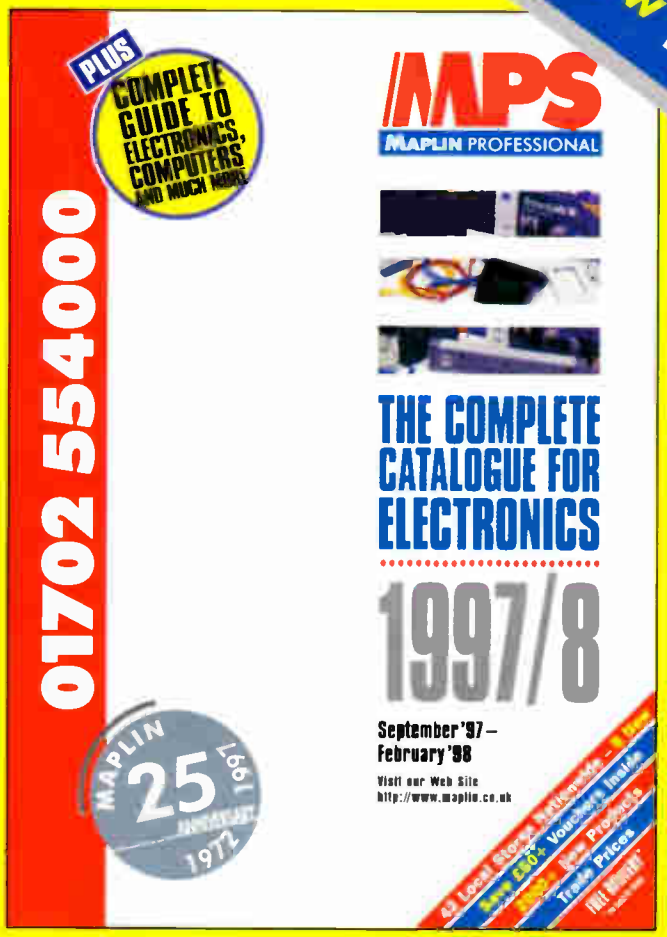

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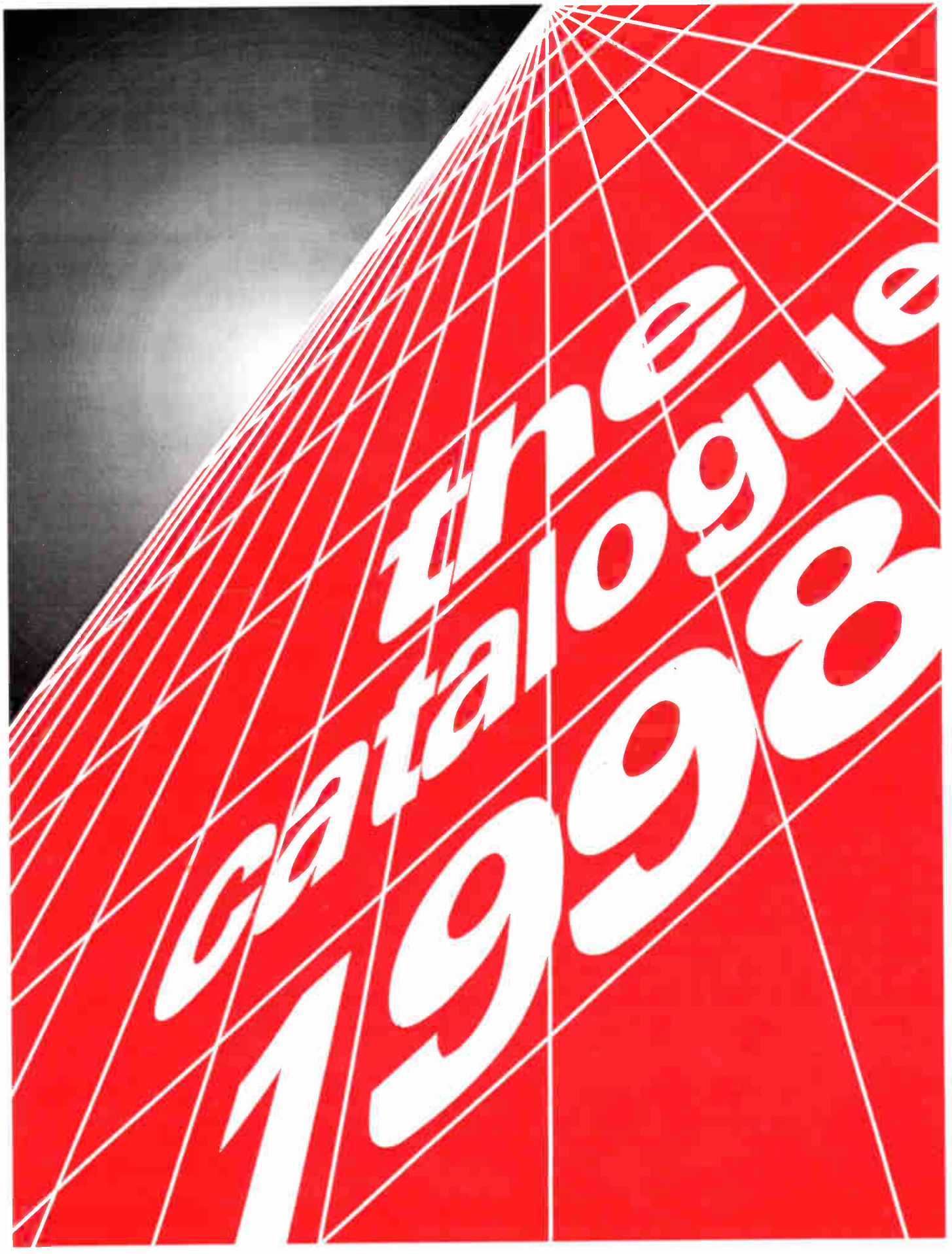

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To our 1998 Catalogue which is full of goodies especially selected for the general modeller and electronic enthusiast.

We mainly specialise in mail order, but we also have a shop counter with small display area, which you are more than welcome to visit. We are open from 8.00am to 5.30pm Monday to Saturday.

Greenweld was established in 1973 and since that time has grown from a few hundred square feet to 12,000 square feet in storage space. Apart from the main catalogue, we produce a Bargain List every month, crammed full of good value products that we purchase in job lots. So, if you would like a copy of our latest Bargain List, please don't hesitate in giving us a ring and we will put one in the post for you. Alternatively, just call into the shop.

Looking forward to hearing from you

Kevin Jarvis.

Kevin Jarvis
Managing Director

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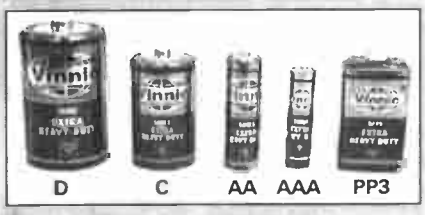
BATTERIES



Zinc Chloride Batteries

A range of zinc chloride, non rechargeable batteries.

Code	Type	Voltage	Price	50+	100+
BT2001	PP3	9V	0.60	0.50	0.33
BT2002	AAA	1.5V	0.30	0.20	0.17
BT2003	AA	1.5V	0.25	0.18	0.16
BT2004	C	1.5V	0.40	0.30	0.25
BT2005	D	1.5V	0.65	0.45	0.39

Rechargeable Ni-Cad Batteries

Code	Type	Rating	Price	20+	100+
BT2110	PP3	150mAH	£4.50	3.60	3.30
BT2120	AAA	150mAH	£1.46	0.93	0.79
BT2130	AA	550mAH	£1.20	0.81	0.65
BT2140	C	1.2AH	£2.60	1.79	1.44
BT2150	D	1.2AH	£2.60	1.79	1.44

Battery Checker

BT3010 A simple, hand held tester for checking the energy levels of alkaline, zinc carbon and zinc chloride batteries (not nickel cadmium). By employing a novel slide mechanism many batteries can be tested, including AAA, AA, C, D, PP3 and button cells. Three LEDs are used to indicate 'high', 'normal' and 'replace' energy levels. **£3.20; 10+ 2.10**

Alkaline Button Cells

A range of popular long life alkaline manganese button cells. Nominal voltage 1.5V. Used extensively in calculators, cameras, clocks, etc. Supplied in protective blister package.

Equivalents

Type	Old Code	Ever Ready	Ray-o-Vac	Maxell	Varta
L621	-	-	-	LR60	-
L726	AG2	196	-	LR69	-
L736	AG3	192	-	LR41	-
L754	-	193	-	LR48	-
L1121	AG8	191	-	LR1120	V86A
L936	-	-	-	LR936	-
L1131	AG10	189	RW89	LR1130	V10GA
L721	-	-	-	LR58	-
L1142	-	186	RW84	LR43	V12GA
L1154	AG13	A76	RW82	LR44	V13GA

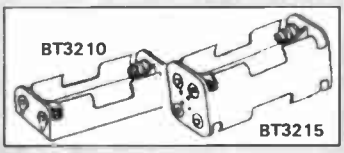
Code	Type	Dia	H	1+	10+	100+
BT2015	L621	6.8	2.1	0.45	0.30	0.14
BT2020	L726	7.9	2.6	0.45	0.30	0.14
BT2025	L736	7.9	3.6	0.45	0.30	0.14
BT2030	L754	7.9	5.4	0.45	0.30	0.14
BT2035	L1121	11.6	2.1	0.45	0.30	0.14
BT2045	L1131	11.6	3.1	0.45	0.30	0.14
BT2055	L1142	11.6	4.2	0.45	0.30	0.14
BT2060	L1154	11.6	5.4	0.45	0.30	0.14

Lithium Manganese Coin Cells

Technical Specification

Voltage	Capacity (mAh)	Height	Dia	Weight	Manuf Part No
3.0V	50	2.0	16.0	1.2g	CR1620
3.0V	75	1.6	20.0	1.7g	CR2016
3.0V	130	2.5	20.0	2.5g	CR2025
3.0V	200	3.2	20.0	3.0g	CR2032
3.0V	260	3.0	24.5	4.0g	CR2430

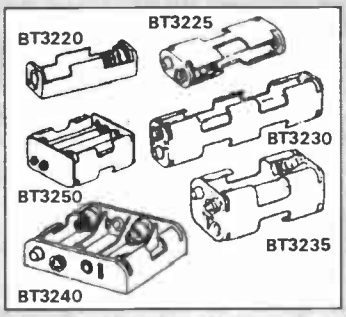
Code	Type	1+	10+	100+
BT2106	CR1620	£1.75	1.15	0.96
BT2107	CR2016	£1.00	0.66	0.55
BT2108	CR2025	£1.00	0.66	0.55
BT2109	CR2032	£1.00	0.66	0.55
BT2110A	CR2430	£1.00	0.66	0.60



Battery Holders

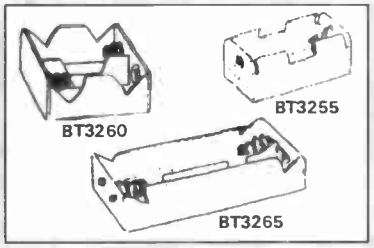
(a) AAA size (HP16 etc)

Code		1+	25+	100+
BT3210	Takes 2 AAA cells Solder terminals Dims 52x22x13mm	34p	0.19	0.16
BT3215	Takes 4 AAA cells Solder terminals Dims 52x26x25mm	42p	0.27	0.23



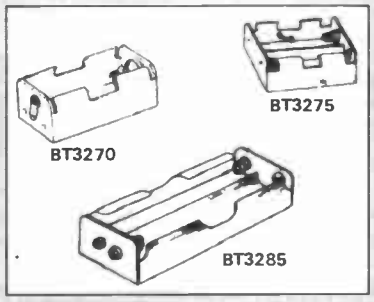
(b) AA size (HP7 etc)

Code		1+	25+	100+
BT3220	Takes single AA cell Dims 57x13x17mm	14p	0.10	0.08
BT3225	Takes 2 AA cells Dims 57x28x15mm	14p	0.10	0.08
BT3230	Takes 4 AA cells Dims 110x26x16mm	20p	0.12	0.09
BT3235	Takes 4 AA cells Dims 57x28x30mm	20p	0.12	0.09
BT3240	Takes 4 AA cells Dims 57x60x16mm	28p	0.17	0.14
BT3245	Takes 6 AA cells Dims 60x45x30mm	28p	0.17	0.14
BT3250	Takes 8 AA cells Dims 57x57x29mm	34p	0.21	0.16



(c) C size (HP11 etc)

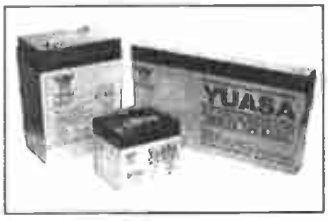
Code		1+	25+	100+
BT3255	Takes 1 (C) cell Solder terminals Dims 52x29x23mm	40p	0.23	0.17
BT3260	Takes 2 (C) cells Snap terminals Dims 54x54x23mm	25p	0.17	0.14
BT3265	Takes 4 (C) cells Snap terminals Dims 108x54x236	28p	0.19	0.16



(d) D size (HP2 etc)

Code		1+	25+	100+
BT3270	Takes 1 (D) cell Solder terminals Dims 68x36x30mm	43p	0.24	0.19
BT3275	Takes 2 (D) cells Snap terminals Dims 68x68x30mm	31p	0.17	0.15
BT3285	Takes 4 (D) cells Snap terminals Dims 144x66x30	40p	0.28	0.23

Rechargeable Lead Acid Batteries



Code	Capacity	Size (mm)	Weight	1+	10+
BT3139	6V, 1.0Ah	51x43x58	0.25kg	£11.48	7.34
BT3140	6V, 1.2Ah	97x25x58	0.34kg	£9.33	6.02
BT3141	6V, 2.8Ah	134x34x67	0.60kg	£12.88	8.25
BT3142	6V, 4.0Ah	70x47x109	0.90kg	£14.49	9.28
BT3143	6V, 7.0Ah	151x34x101	1.25kg	£19.54	12.51
BT3144	6V, 10.0Ah	151x50x101	2.0kg	£16.44	10.38
BT3145	6V, 12.0Ah	151x50x101	2.06kg	£21.80	13.95
BT3146	12V, 0.8Ah	96x25x62	0.35kg	£17.40	11.14
BT3147	12V 1.2Ah	97x48x58	0.60kg	£17.40	11.14
BT3148	12V, 2.0Ah	150x20x84	0.7kg	£20.08	12.85
BT3149	12V, 2.1Ah	178x34x67	0.90kg	£18.89	12.30
BT3150	12V, 2.3Ah	178x34x64	0.94kg	£22.56	14.44
BT3151	12V, 2.8Ah	134x67x67	1.15kg	£20.08	12.85
BT3152	12V, 6.0Ah	151x65x103	2.40kg	£24.27	15.54
BT3153	12V, 7.0Ah	151x65x98	3.0kg	£29.21	18.70
BT3154	12V, 12.0Ah	151x98x98	4.0kg	£49.41	31.62
BT3155	12V, 15.0Ah	181x76x167	5.9kg	£65.95	42.21
BT3156	12V, 24.0Ah	166x175x125	8.65kg	£75.51	48.33

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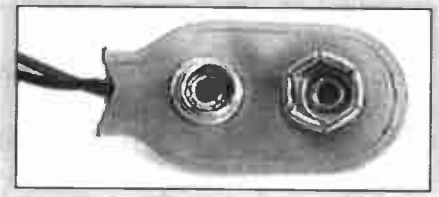


Battery Clips

BT3290 Twin battery snap to suit PP3 and PP6 type batteries. Lead length 150mm minimum. **10p each;** 25+ 0.05; 100+ 0.04

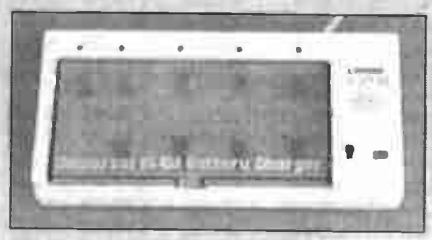
1 Amp Lead Acid Charger

Two free standing four stage chargers offered in 6 or 12V versions suited to charging a wide variety of sealed lead acid batteries. The four stage system employed by the chargers will enable the charging of batteries with low terminal voltages with maximum safety. This is achieved by detecting if the battery has a low terminal voltage and if so applying a low trickle current to raise the terminal voltage. If the terminal voltage exceeds 0.92 of the rated charger output a constant current is applied until the gassing voltage is reached. This is then held until the battery reaches 90% charge the a temperature compensated float voltage is applied maintaining the battery ready for use. Both chargers incorporate LED indication of charge state: red to indicate bulk, green for float and include short circuit and reverse polarity protection. The units are supplied with 1.5M of mains cable terminated to a 13A mains plug: outputs are 2 wire red/black cables 0.4M in length terminated with 6.3 x 0.8mm slide on terminals.

BT4325 6V 1A Charger **£79.95**
BT4345 12V 1A Charger. **£79.95**

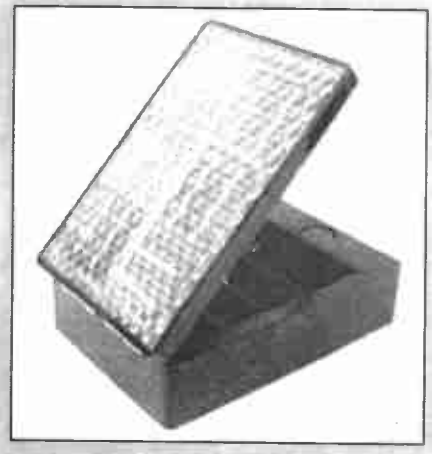
Technical Specification

	6V	12V
Battery voltage		
Battery capacity	4Ah to 12Ah	
Output current (max)	1A	
Output voltage		
Bulk charge	7.25V(nom)	14.5V (nom)
Float charge	6.9V ±1%	13.8V ±1%
Bulk to float transition current	100mA	
Float to bulk transition voltage	6.3V ±5%	12.6V ±5%
Supply voltage	240Vac ±10%	
Temperature range	-10°C to +45°C	
Weight	1.36Kg	
Dimensions	150 x 90 x 70mm	



Universal Battery Charger

BT4300 Neat attractive instrument will charge 5 different sizes of battery: AAA, AA, C, D and PP3 either singly or in any combination. Charge time 7-8 hours for AA, 14-16 hours for others. Test facility to check if battery needs charging. Size 210 x 100 x 50mm **£6.95; 10+ 4.12**



Solar Powered Ni-Cad Battery Charger

BT4315 Takes up to 4 AA cells and will charge 2 cells in 4-6 hours, 4 cells in 10-14 hours, depending on strength of sun. The solar panel is housed in the hinged lid, which can be angled towards the sun for optimum effect. **£6.50; 10+ 4.30**

CABLES

Single Core Equipment Wire on 100M Reels

1/0.6mm copper conductor. Overall diameter 1.2mm. Rating 1kV rms 1.8A at 70 deg C. Reel weight approx. 400g

Code	Colour	Price/M	Price/Reel
CB3300	Black	**0.05**	**3.25**
CB3305	Blue	**0.05**	**3.25**
CB3310	Brown	**0.05**	**3.25**
CB3315	Green	**0.05**	**3.25**
CB3320	Grey	**0.05**	**3.25**
CB3325	Orange	**0.05**	**3.25**
CB3330	Pink	**0.05**	**3.25**
CB3335	Red	**0.05**	**3.25**
CB3340	Violet	**0.05**	**3.25**
CB3345	White	**0.05**	**3.25**
CB3350	Yellow	**0.05**	**3.25**

CB3388 Pack containing 5m of each colour. Total 55m. **Price £2.30/pack**

Stranded Equipment Wire on 100M Reels

7/0.2mm copper conductor. Overall diameter 1.2mm. Rating 1kV rms 1.4A at 70 deg C. Reel approx weight 360g.

Code	Colour	Price/M	Price/Reel
CB3400	Black	**0.05**	**3.00**
CB3405	Blue	**0.05**	**3.00**
CB3410	Brown	**0.05**	**3.00**
CB3415	Green	**0.05**	**3.00**
CB3420	Grey	**0.05**	**3.00**
CB3425	Orange	**0.05**	**3.00**
CB3430	Pink	**0.05**	**3.00**
CB3435	Red	**0.05**	**3.00**
CB3440	Violet	**0.05**	**3.00**
CB3445	White	**0.05**	**3.00**
CB3450	Yellow	**0.05**	**3.00**

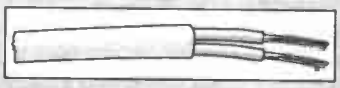
CB3499 Pack containing 5m of each colour. Total 55m. **Price £2.45/pack**

Extra Flexible Cable on 25M Reels

55/0.1mm copper conductor. Overall diameter 2.8mm. Max. current rating 6A. Supplied on 25M reels.

Code	Type	Price/m	Price/reel
CB3600	Red extra-flex	**0.14**	**2.60**
CB3605	Black extra-flex	**0.14**	**2.60**
CB3610	Blue extra-flex	**0.14**	**2.60**
CB3615	Green extra-flex	**0.14**	**2.60**
CB3620	Brown extra-flex	**0.14**	**2.60**
CB3625	White extra-flex	**0.14**	**2.60**
CB3630	Yellow extra-flex	**0.14**	**2.60**

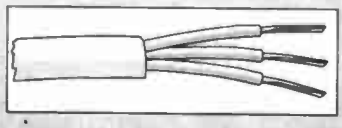
CB3677 Pack containing 5m of each colour total 35m. **Price £2.95/Pack**



3A Oval 2-Core Mains Cable

Two core mains cable rated at 3A at 300V. Two 16/0.2mm copper conductors sheathed overall in PVC. BS6500 table 15 fully BASEC approved. CMA ref. 2192Y. Dimensions 3.5x4.5mm. Supplied on 100m reels. 16/0.2mm(0.5mm²)

Code		Price/m	Price/reel
CB4810	100M 3A Black	**0.30**	**18.95**
CB4820	100M 3A White	**0.30**	**18.95**



3A Mains Equipment Cable

Three core mains cable rated at 3A at 300V. Three 16/0.2mm copper conductors sheathed overall in PVC in a variety of colours. BS6500 table 15 fully BASEC approved. CMA ref.2183Y. Overall diameter 5.6mm. Supplied on 100M reels. 16/0.2mm(0.5mm²)

Code		Price/m	Price/reel
CB4830	100M 3A Black	**0.50**	**31.95**
CB4840	100M 3A White	**0.50**	**31.95**

6A Mains Equipment Cable

Three core mains cable rated at 6A at 300V. Three 24/0.2mm copper conductors sheathed overall in PVC in a variety of colours. BS6500 table 16 fully BASEC approved. CMA ref. 3183Y. Overall diameter 6.9mm. Supplied on 100M reels. 24/0.2mm(0.75mm²)

Code		Price/m	Price/reel
CB4850	100M 6A Black	**0.65**	**38.95**
CB4860	100M 6A White	**0.65**	**38.95**

13A Mains Equipment Wire

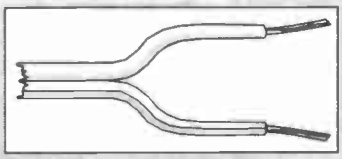
Three core mains equipment wire rated at 13A at 300V. The 40/0.2mm copper conductors sheathed overall in white or black PVC. BS6500 table 16 fully BASEC approved. CMA ref. 3183Y. Overall diameter 8.5mm. Supplied on 50M reels. 40/0.2mm(0.75mm²)

Code		Price/m	Price/reel
CB4870	50M 13A Black	**1.00**	**37.95**
CB4880	50M 13A White	**1.00**	**37.95**

Loudspeaker Cable

A heavy duty cable with a 'figure 8' profile offered in a variety of colours .Ideal for speaker connection. 13/0.2mm plain copper conductor. Rating 60V rms 2.5A. Overall size 3.8x1.9mm. supplied on 100M reels.

Code	Colour	Price/m	Price/reel
CB4900	White/black stripe	**0.13**	**6.75**
CB4910	Grey/black stripe	**0.13**	**6.75**
CB4920	Black/red stripe	**0.13**	**6.75**



Heavy Duty Loudspeaker Cable

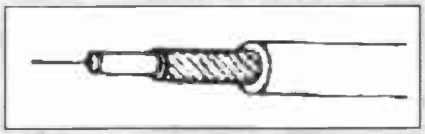
A very heavy duty twin cable with a 'figure 8' profile ideal for high power speaker connection suitable for power amplifiers up to 500W output. **CB4922** Figure 8 heavy duty 42/0.2. For high power audio systems Max current 15A. White sheath 6x3mm with black polarity line. **42p/Metre; £22.95/Reel**

CB4924 Figure 8 heavy duty 79/0.2. Professional quality. Max current 25A. Size 6x3mm. White sheath with black polarity line. **68p/Metre; £35.95/Reel**

Ribbon Cable

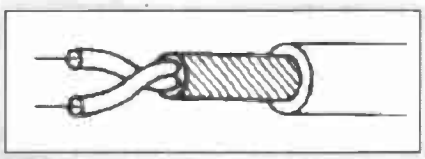
Parallel stranded conductors, easily split in any number of ways. 0.05 spacing. Red identification band on grey cable. 7/0.127. Conductors rate 1A 300V. Reel length 100ft.

Code	Colour	Type	Price/m	Price/reel
CB3210	Grey	10 way	**44p**	**5.17**
CB3216	Grey	16 way	**71p**	**8.36**
CB3220	Grey	20 way	**88p**	**10.35**
CB3226	Grey	26 way	**1.15**	**13.51**
CB3234	Grey	34 way	**1.50**	**17.62**
CB3240	Grey	40 way	**1.76**	**20.71**
CB3250	Grey	50 way	**2.21**	**25.99**
CB3260	Grey	60 way	**2.65**	**31.13**
CB3280	Rainbow	10 way	**80p**	**14.10**
CB3290	Rainbow	20 way	**1.38**	**24.38**



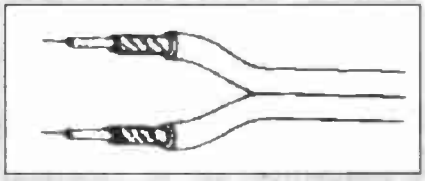
Screened Audio Single Core

CB4930 Single core, 7/0.1mm stranded conductors. Nominal conductor area: 0.05mm². Lap screened. O.D. 3mm. Black. 100M reel. **16p/Metre; £7.95/Reel**



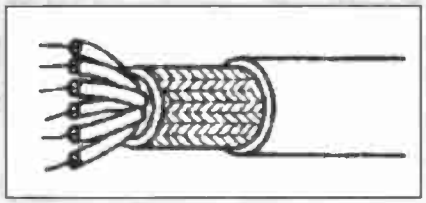
Microphone

CB4935 2-core microphone cable 2x 7/0.2mm stranded conductors. Nominal conductor area: 0.22m². Overall lap screen. Heavy duty outer sheath. O.D. 5mm. Black. 100m Reel. **29p/Metre; £15.95/Reel**



Screened Audio - Multicore

CB4940 2 core x 7/0.1mm stranded conductors. Nominal conductor area 0.05m². Lap screened. Dims 4.0 x 2.0mm. Black. 100m reel. **24p/Metre; £13.95/Reel**



Screened Multicore

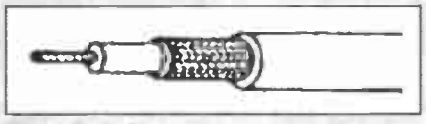
Screened multicore cable. All cores colour coded. Black outer sleeving. 100M reel.

CB4945 6 x 7/0.1mm. Nominal Conductor area: 0.05mm². Lap screen. O.D: 4mm. **40p/Metre; £20.95/Reel**

CB4950 10 x 7/0.13mm. Nominal conductor area: 0.09mm². Braided screen. O.D: 5.6mm. **46p/Metre; £24.95/Reel**

CB4960 15 x 7/0.13mm. Nominal conductor area: 0.09mm². Braided screen. O.D: 6mm. **64p/Metre; £34.95/Reel**

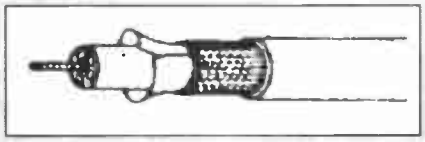
CB4965 25 x 7/0.13mm. Nominal conductor area: 0.05mm². Braided screen. O.D: 6mm. **76p/Metre; £39.95/Reel**



Coaxial

Low-loss UHF coaxial cable. 1/1.0mm conductor. Nominal conductor area: 0.78mm². 75Ω impedance. Braided screen. Semi-air spaced. O.D 6.5mm. 100m reel.

Code	Colour	Price/m	Price/Reel
CB4970	Brown	**36p**	**19.50**
CB4975	White	**36p**	**19.50**

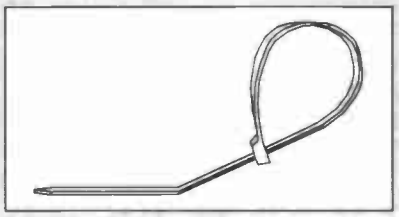


Satellite Cable

CB4980 RG6 cable suitable for use as a satellite down-lead. Single 1/1.0mm conductor. Nominal conductor area: 0.78mm². 75Ω. Impedance. Semi air-spaced. Copper and aluminium foil screens. O.D 6.5mm. 100m reel. Black. **44p/Metre; £21.95/Reel**

RF Cable

CB4990 RG58U coaxial cable, suitable to use as CB aerial lead. 7/0.3mm conductors. Nominal conductor area: 0.5mm². 50Ω impedance. Braided screen. Solid polyethylene insulator. O.D: 5mm. Black. 100m reel. **40p/Metre; £18.95/Reel**



Natural Cable Ties

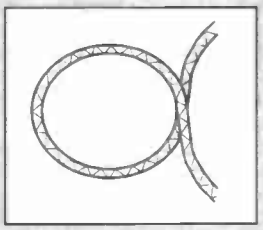
White nylon cable ties with a non-releasable ratchet lock action.

Code	Width	Type	Pack 20	Pack 100	1000+
CB3700	2.4	75mm	**N/A**	**0.56**	0.0028
CB3710	2.5	100mm	**N/A**	**0.60**	0.0030
CB3720	3.2	140mm	**0.50**	**1.50**	0.0075
CB3730	4.6	200mm	**0.83**	**2.50**	0.125
CB3740	3.6	300mm	**1.32**	**3.98**	0.199
CB3750	5.0	385mm	**3.03**	**9.12**	0.456

Cable Tie Bases

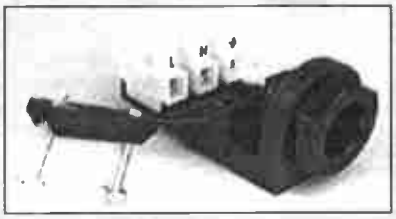
Self adhesive bases which will accept above cable ties. The base has a fixing hole of 5mm as an alternative.

Code	Size	Colour	Pk/20	Pk/100
CB2760	19x19mm	Natural	**0.97**	**£4.00**
CB2770	25x25mm	Natural	**1.57**	**£6.00**



Spiral Cable Wrapping

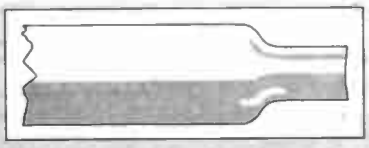
CB3780 Preformed binding which can be expanded by wrapping round cable forms. Natural colour. Supplied in 10m lengths. Diameter 6mm. Maximum diameter 50mm. **£1.86 per pack;** 10+ 1.05; 25+ 0.88



Conblock

CB2790 Versatile cable entry clamp, M20 but with 10A 3 way terminal block. **£1.25**

TEL: 01703 236363
FAX: 01703 236307
GREENWELD
27 Park Road · Southampton · SO15 3UQ



Heat Shrink Sleeving

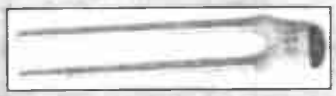
Highly flexible polyolefin tubing which will shrink in a ratio of 2:1 by heating above 120°C. Supplied in 1.2m lengths.

Code	Bore	Colour	1+	10+	25+
CB2500	1.6mm	Yellow	£1.01	0.57	0.44
CB2505	2.4mm	Yellow	£1.06	0.60	0.46
CB2510	3.2mm	Yellow	£1.15	0.65	0.50
CB2515	4.8mm	Yellow	£1.50	0.85	0.65
CB2520	6.4mm	Yellow	£1.82	1.03	0.79
CB2525	9.5mm	Yellow	£2.05	1.16	0.89
CB2530	12.7mm	Yellow	£2.42	1.37	1.05
CB2535	1.6mm	Black	£1.01	0.57	0.44
CB2540	2.4mm	Black	£1.06	0.60	0.46
CB2545	3.2mm	Black	£1.15	0.65	0.50
CB2550	4.8mm	Black	£1.50	0.85	0.65
CB2555	6.4mm	Black	£1.82	1.03	0.79
CB2560	9.5mm	Black	£2.05	1.16	0.89
CB2565	12.7mm	Black	£2.42	1.37	1.05

CB2580 Pack of 1 length of each size in Yellow, total 8.4m. **£7.50**

CB2590 Pack of 1 length of each size in Black, total 8.4mm. **£7.50**

CAPACITORS



Miniature Low K Ceramic Plate Capacitors

Code	Value	W	Ht	1+	100+	1000+
CP2A1PF8	1.8pf	3.6	5.0	6p	0.036	0.029
CP2A2PF2	2.2pf	3.6	5.0	6p	0.036	0.029
CP2A3PF3	3.3pf	3.6	5.0	6p	0.036	0.029
CP2A4PF7	4.7pf	3.6	5.0	6p	0.036	0.029
CP2A6PF8	6.8pf	3.6	5.0	6p	0.036	0.029
CP2A10PF	10pf	3.6	5.0	6p	0.036	0.029
CP2A12PF	12pf	3.6	5.0	6p	0.036	0.029
CP2A15PF	15pf	3.6	5.0	6p	0.036	0.029
CP2A18PF	18pf	3.6	5.0	6p	0.036	0.029
CP2A22PF	22pf	3.6	5.0	6p	0.036	0.029
CP2A27PF	27pf	3.6	5.0	6p	0.036	0.029
CP2A33PF	33pf	3.6	5.0	6p	0.036	0.029
CP2A39PF	39pf	3.9	5.0	6p	0.036	0.029
CP2A47PF	47pf	3.9	5.3	6p	0.036	0.029
CP2A56PF	56pf	4.5	5.0	7p	0.045	0.036
CP2A68PF	68pf	4.5	6.0	7p	0.045	0.036
CP2A82PF	82pf	5.1	6.6	10p	0.063	0.050

Ceramic Disc Capacitors

General purpose disc capacitors manufactured from high dielectric constant ceramics. Durez coated and high temperature wax impregnated.

Technical Specifications

Tolerance	±10% below 4n7 -20% to +80% for 4n7 and above
Working Voltage	50Vdc (100n 25Vdc)
Temperature Range	-25 to +80°C

Code	Value	Pitch	1+	100+	1k+
CP2B100PF	100pf	2.5	5p	0.016	8.75
CP2B120PF	120pf	2.5	5p	0.016	8.75
CP2B150PF	150pf	2.5	5p	0.016	8.75
CP2B180PF	180pf	2.5	5p	0.016	8.75
CP2B220PF	220pf	2.5	5p	0.016	8.75
CP2B270PF	270pf	2.5	5p	0.016	10.00
CP2B330PF	330pf	2.5	5p	0.016	10.00
CP2B390PF	390pf	2.5	5p	0.016	10.00
CP2B470PF	470pf	2.5	5p	0.016	10.00
CP2B560PF	560pf	2.5	5p	0.016	10.00
CP2B680PF	680pf	2.5	5p	0.016	11.25
CP2B820PF	820pf	2.5	5p	0.016	11.25
CP2B1N	1n	2.5	5p	0.016	8.75
CP2B1N5	1n5	2.5	5p	0.016	8.75
CP2B2N2	2n2	5	5p	0.016	11.25
CP2B3N3	3n3	5	5p	0.016	11.25
CP2B4N7	4n7	2.5	5p	0.016	11.25
CP2B6N8	6n8	2.5	5p	0.016	11.25
CP2B10N	10n	2.5	5p	0.016	11.25
CP2B10N	10n	5	5p	0.016	11.25
CP2B100N	100n	5	7p	0.03	22.50

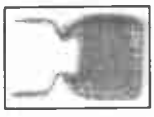
Miniature Polyester Capacitors

A cost effective range of miniature metallised polyester capacitors with a 5mm pitch. Self extinguishing plastic case and sealed with epoxy resin. An ideal decoupling capacitor where space is at a premium. All types are maximum 7.5mm wide.

Technical Specifications

Tolerance	±10%
Temperature coefficient	-5 to +5%
Working Voltage	100Vdc below 22n. 63Vdc 22n and above
Insulation resistance	Greater than 10^{3}Ω
Temperature Range	-55 to +85°C

Code	Value	Size	1+	100+	1k+
CP2C1N	1n	6.5x2.5	10p	0.054	0.036
CP2C2N2	2n2	6.5x2.5	10p	0.054	0.036
CP2C4N7	4n7	6.5x2.5	10p	0.054	0.036
CP2C10N	10n	6.5x2.5	10p	0.054	0.036
CP2C22N	22n	6.5x2.5	12p	0.066	0.040
CP2C47N	47n	6.5x2.5	12p	0.061	0.041
CP2C100N	100n	6.5x3	12p	0.066	0.044
CP2C220N	220n	8.3x3.5	22p	0.112	0.075
CP2C470N	470n	10x5	30p	0.152	0.101



Metallised Polyester Capacitors

Metallised polyester capacitors compatible to Mullard C280/352 series. Particularly suited to coupling and decoupling applications. Pitch is 10mm except 150n and 22n (15mm) and 330n and 470n which are 20mm.

Technical Specifications

Tolerance	±20% below 220n ±10% 220n and above
Tangent of loss angle	Less than 75x10^{-4} at 1kHz
Working Voltage	250V dc
Insulation Resistance	Greater than 10^{3}Ω
Temperature Range	-40 to +85°C

Code	Value	Size	1+	100+	1k+
CP2D10N	10n	12.5x9x4	10p	0.055	0.037
CP2D15N	15n	12.5x9x4	10p	0.055	0.037
CP2D22N	22n	12.5x9x4	10p	0.055	0.037
CP2D33N	33n	12.5x9x4	13p	0.067	0.045
CP2D47N	47n	12.5x9x4	13p	0.067	0.045
CP2D68N	68n	12.5x9x4	13p	0.067	0.045
CP2D100N	100n	12.5x11x6	14p	0.07	0.047
CP2D150N	150n	17.5x12x7	18p	0.09	0.06
CP2D220N	220n	17.5x12x7	20p	0.10	0.069
CP2D330N	330n	22.5x12.5x7	25p	0.123	0.082
CP2D470N	470n	22.5x12.5x7.5	30p	0.15	0.10

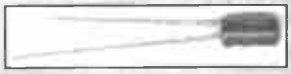
Mains Suppression Capacitors

A range of radial lead boxed metallised polypropylene mains suppression capacitors. Approved to VDE-0565 Class 2. Epoxy resin encapsulated in flame retardent plastic case with stand off feet. Iskra KNB1530/31. Class X2 capacitors.

Technical Specifications

Tolerance	±20%
Working Voltage	250Vac
Climatic category	25/085/21 DIN 40040
Temperature range	-25 to +85°C

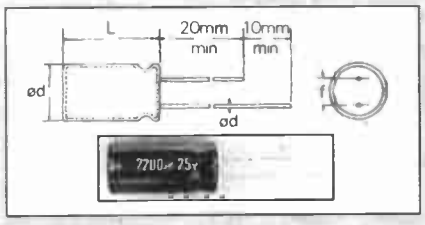
Code	Value	Size	1-99	100+
CP2E22N	22n	18x5.5x11	26p	0.133
CP2E47N	47n	18x5.5x11	29p	0.146
CP2E100N	100n	18x7x13	35p	0.173
CP2E220N	220n	27x7x16.5	53p	0.266
CP2E470N	470n	27x10.5x19	91p	0.452



Sub-Miniature Electrolytics

A range of radial leaded capacitors offering size, tolerance and leakage characteristics similar to tants, but a lower cost.

Code	Value	V	Size	1+	100+
CP2F47M-50	0.47µF	50	7x4	6p	0.03
CP2F1M-50	1µF	50	7x4	6p	0.03
CP2F2M2-50	2.2µF	50	7x5	6p	0.03
CP2F4M7-50	4.7µF	50	7x5	6p	0.03
CP2F10M-35	10µF	35	7x5	7p	0.033
CP2F22M-35	22µF	35	7x6.3	8p	0.038
CP2F10M-16	10µF	16	7x4	6p	0.03
CP2F22M-16	22µF	16	7x5	7p	0.033
CP2F47M-16	47µF	16	7x6.3	8p	0.038



Radial Electrolytic Capacitors

A comprehensive range of miniature radial lead aluminium electrolytic capacitors for mounting directly to PCBs manufactured to high technical and quality standards. All types are fully sleeved. Ripple current quoted at 85°C.

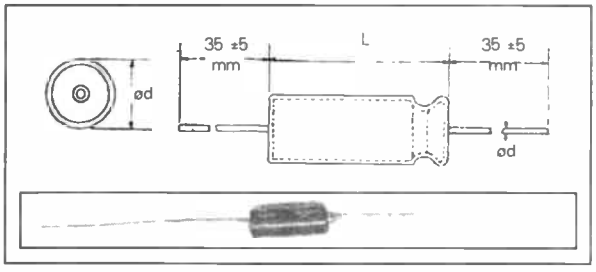
Case Code	L	D	f
A	11	5	2
B	11	6	2.5
C	12	8	3.5
D	12.5	10	5
E	17.5	10	5
F	18.5	13	5
G	20	13	5
H	25	13	5
I	26	26	7.5

Technical Specifications

Tolerance	±20%
Temperature Range	-40 to +85°C
Leakage Current	0.03CV or 4µA whichever is greater

PRICES IN BOLD INCLUDE VAT; QTY PRICES IN LIGHT DO NOT

Code	Value	Case	1+	100+	1k+
10V					
CP2GR10-47M	47	A	**6p**	0.0255	0.017
CP2GR10-100M	100	A	**6p**	0.027	0.018
CP2GR10-470M	470	D	**14p**	0.068	0.045
CP2GR10-1000M	1000	E	**18p**	0.088	0.059
CP2GR10-2200M	2200	H	**35p**	0.168	0.112
16V					
CP2GR16-47M	47	A	**6p**	0.029	0.019
CP2GR16-100M	100	B	**6p**	0.029	0.019
CP2GR16-220M	220	C	**8p**	0.048	0.032
CP2GR16-470M	480	E	**15p**	0.072	0.048
CP2GR16-1000M	1000	F	**20p**	0.096	0.064
CP2GR16-2200M	2200	I	**36p**	0.176	0.117
25V					
CP2GR25-10M	10	A	**6p**	0.019	0.013
CP2GR25-22M	22	A	**6p**	0.022	0.015
CP2GR25-47M	47	B	**7p**	0.031	0.021
CP2GR25-100M	100	C	**8p**	0.037	0.025
CP2GR25-220M	220	D	**12p**	0.056	0.037
CP2GR25-470M	470	E	**21p**	0.10	0.067
CP2GR25-1000M	1000	I	**30p**	0.147	0.098
CP2GR25-2200M	2200	I	**60p**	0.30	0.20
35V					
CP2GR35-22M	22	B	**7p**	0.030	0.020
CP2GR35-47M	47	C	**9p**	0.046	0.031
CP2GR35-100M	100	C	**12p**	0.059	0.039
CP2GR35-220M	220	E	**18p**	0.09	0.06
CP2GR35-470M	470	F	**30p**	0.156	0.104
63V					
CP2GR63-1	1	A	**6p**	0.024	0.016
CP2GR63-2M2	2.2	A	**6p**	0.024	0.016
CP2GR63-4M7	4.7	A	**6p**	0.027	0.018
CP2GR63-10M	10	A	**7p**	0.03	0.02
CP2GR63-22M	22	C	**9p**	0.043	0.029
CP2GR63-47M	47	D	**13p**	0.063	0.042
CP2GR63-100M	100	E	**21p**	0.103	0.069
CP2GR63-220M	220	G	**35p**	0.171	0.114
CP2GR63-470M	470	I	**68p**	0.339	0.226



Axial Electrolytic Capacitors

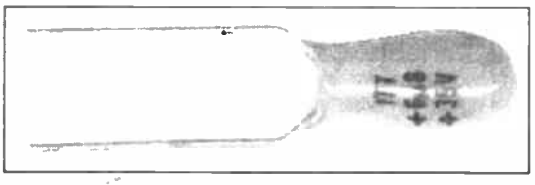
Miniature axial lead electrolytic capacitors manufactured to high technical and quality standards. All types are sleeved. Ripple current quoted is at 85°C

Case Code	L	D	d
A	12	5	0.5
B	12	6	0.5
C	13	8	0.6
D	17	8	0.6
E	18	10	0.6
F	21	10	0.6
G	21	13	0.6
H	26	13	0.6
I	27	16	0.8
J	33	16	0.8
K	37	18	0.8
L	43	20	1.0

Technical Specification

Tolerance	±20%
Temperature Range	-40 to +85°C
Climatic Category	40/085/56 (IEC68)
Shelf Life	Minimum 2 Yrs
Manufactured to Spec	IEC 384-4, DIN 41316

Code	Value	Ripple	Case	1+	100+	1k+
10V						
CP2HA10-47M	47	200	A	**14p**	0.071	0.047
CP2HA10-100M	100	290	B	**15p**	0.076	0.051
CP2HA10-1000M	1000	1000	E	**35p**	0.176	0.117
CP2HA10-2200M	2200	1560	G	**57p**	0.288	0.192
16V						
CP2HA16-47M	47	200	A	**15p**	0.076	0.051
CP2HA16-100M	100	330	C	**16p**	0.082	0.055
CP2HA16-220M	220	490	C	**22p**	0.114	0.076
CP2HA16-470M	470	740	E	**35p**	0.174	0.116
CP2HA16-1000M	1000	1130	G	**47p**	0.234	0.156
CP2HA16-2200M	2200	1750	I	**76p**	0.379	0.253
CP2HA16-4700M	4700	2220	J	**£1.40**	0.678	0.452
25V						
CP2HA25-10M	10	90	A	**13p**	0.066	0.044
CP2HA25-22M	22	160	A	**14p**	0.071	0.047
CP2HA25-47M	47	240	B	**16p**	0.078	0.052
CP2HA25-100M	100	360	C	**23p**	0.117	0.058
CP2HA25-220M	220	540	D	**26p**	0.127	0.085
CP2HA25-470M	470	810	F	**38p**	0.186	0.124
CP2HA25-1000M	1000	1130	H	**50p**	0.289	0.193
CP2HA25-2200M	2200	1870	I	**£1.08**	0.538	0.359
CP2HA25-4700M	4700	2690	K	**£1.80**	0.90	0.599
35V						
CP2HA35-10M	10	105	A	**13p**	0.063	0.044
CP2HA35-22M	22	180	A	**14p**	0.073	0.049
CP2HA35-47M	47	270	C	**21p**	0.106	0.071
CP2HA35-100M	100	400	E	**23p**	0.117	0.078
CP2HA35-220M	220	600	E	**37p**	0.187	0.125
CP2HA35-470M	470	920	G	**48p**	0.243	0.162
63V						
CP2HA63-1	1	35	A	**13p**	0.066	0.044
CP2HA63-2M2	2.2	45	A	**13p**	0.066	0.044
CP2HA63-4M7	4.7	80	A	**13p**	0.066	0.044
CP2HA63-10M	10	120	A	**15p**	0.078	0.052
CP2HA63-22M	22	210	C	**17p**	0.087	0.058
CP2HA63-47M	47	290	E	**23p**	0.114	0.076
CP2HA63-100M	100	450	E	**37p**	0.187	0.125



Tantalum Bead Capacitors

Tantalum bead capacitors, suitable for coupling and by-passing, filters, timing circuits and general applications. Very low cost, small size. 5mm lead spacing. In low impedence circuits care should be exercised to ensure that the surge voltage is not exceeded

Technical Specifications

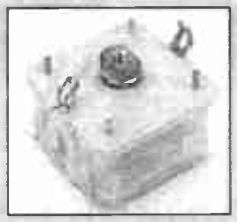
Tolerance	±20%
Tangent of loss angle	0.012max
Leakage current	0.04CV or 2µA whichever is greater.
Temperature range	-55 to +85°C

Code	Value	V	Size	1+	100+	1000+
CP2J35-0.1M	0.1	35	7x4	**12p**	0.087	0.058
CP2J35-0.22M	0.22	35	7x4	**12p**	0.087	0.058
CP2J35-0.33M	0.33	35	7x4	**12p**	0.087	0.058
CP2J35-0.47M	0.47	35	7x4	**12p**	0.087	0.058
CP2J35-1M	1	35	7x4	**12p**	0.087	0.058
CP2J25-2M2	2.2	25	7x4	**14p**	0.107	0.071
CP2J25-3M3	3.3	25	8.5x5.5	**20p**	0.144	0.096
CP2J25-4M7	4.7	25	8.5x5.5	**20p**	0.146	0.097
CP2J25-6M8	6.8	25	10x6	**22p**	0.165	0.11
CP2J25-10M	10	25	9x5.5	**27p**	0.154	0.137
CP2J16-15M	15	16	10x6	**35p**	0.264	0.176
CP2J16-22M	22	16	10x6	**30p**	0.229	0.163
CP2J16-33M	33	16	11x6.5	**61p**	0.459	0.306
CP2J06-47M	47	6	10x6	**29p**	0.219	0.146
CP2J16-47M	47	16	12x8	**80p**	0.588	0.392
CP2J06-68M	68	6	14x7	**96p**	0.72	0.48
CP2J10-100M	100	10	15x8	**£1.80**	1.29	0.86
CP2J16-100M	100	16	15x8	**£1.80**	1.29	0.86

TEL: 01703 236363
FAX: 01703 236307
GREENWELD
27 Park Road · Southampton · SO15 3UQ

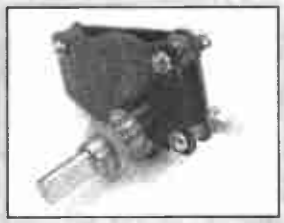
Miniature Trimmer Capacitors

Code	Type	1+	100+
CP2K10PF	2-10pf miniature film	50p	0.30
CP2K22PF	2-22pf miniature film	54p	0.36
CP2K65PF	5 5-65pf miniature film	60p	0.52



Miniature Tuning Capacitor

CP2K126PF A miniature tuning capacitor suitable for ZN414 circuits and crystal sets. Comprises AM sections of 126pF with trimmers and FM sections of 22pF with trimmers. Control shaft is a flatted 6mm diameter tapped with an M2.5 thread. Rotation 180°. Max voltage 100V. Dimensions 20 x 20 x 12.5mm. **£1.25**

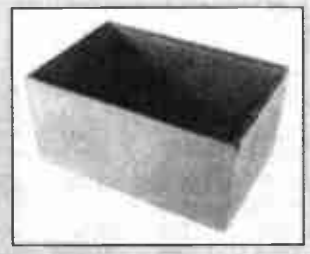


Jackson Variable Capacitors

CP2K300PF 300pf variable tuning capacitors manufactured by Jackson Bros.

Dilecon type. A compact solid dielectric variable capacitor. Tested at 750 volts. Suitable for panels from 1/16th to 1/4 inch. **£10.95**

CASES



Potting Boxes

A range of miniature potting boxes moulded in black ABS ideal for permanent encapsulation of small circuits

Code	L	W	H	Wall Thick	1+	25+	100+
CS3010	30	20	15	1.0	12p	0.076	0.061
CS3020	40	40	20	1.0	26p	0.169	0.135
CS3030	50	50	30	1.0	33p	0.214	0.171
CS3040	75	50	30	1.0	45p	0.289	0.21
CS3050	100	60	25	1.3	78p	0.50	0.40

Snap-In PCB Electrolytic Capacitors

The TSU range of snap-in electrolytic PCB mount capacitors offers extremely high volumetric efficiency. These capacitors are ideal for all applications requiring high CV values and high voltage operation including switched mode power supplies. Snap-in terminals on a 10mm pitch for direct mounting into 2mm holes.

Code	Value	Voltage	1+	25+	100+
CP21-16-4700M	4700µ	16V	£1.88	1.20	0.96
CP21-16-10000M	10000µ	16V	£2.68	1.72	1.38
CP21-35-4700M	4700µ	35V	£2.61	1.67	1.34
CP21-35-10000M	10000µ	35V	£4.61	2.95	2.36
CP21-63-1000M	1000µ	63V	£2.17	1.39	1.11
CP21-63-2200M	2200µ	63V	£2.56	1.64	1.31
CP21-63-4700M	4700µ	63V	£4.47	2.86	2.28
CP21-100-1000M	1000µ	100V	£2.93	1.88	1.50

ABS Boxes

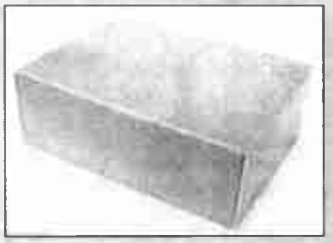
Professional quality, versatile boxes for use where both cost and finish are important. Moulded in high impact ABS, they are easily punched or drilled to produce a professional looking end product. The lids are retained by machined screws into brass inserts. Printed circuit board slots are provided (except CS4207 and CS4208 which use self tapping screws). Available in black.

Code	External Dimensions	1+	25+	100+
CS4207	75x51x25	81p	0.58	0.50
CS4208	111x57x22	£1.01	0.70	0.62
CS4210	79x61x40	£1.54	1.07	0.94
CS4213	100x76x41	£1.70	1.18	1.03
CS4216	118x98x45	£1.93	1.35	1.18
CS4215	150x80x50	£2.47	1.71	1.51
CS4217	150x100x60	£2.77	1.92	1.69
CS4220	177x120x83	£3.83	2.67	2.34
CS4218	216x130x85	£5.89	4.10	3.59
CS4219	220x150x64	£4.44	3.16	2.78

Power Supply Cases

CS4310 ABS box with 13A pins in-built for a variety of different supplies. Overall size 75 x 50 x 50mm. **£1.90;** 25+ 1.44; 100+ 1.20

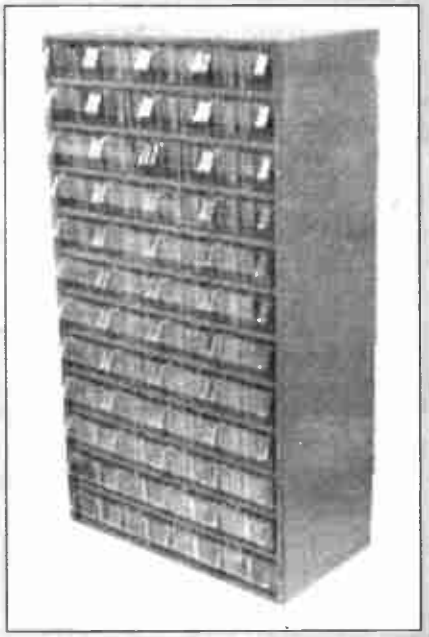
CS4330 Versatile case with built-in battery compartment. Case separates into two halves and front panel is removable. Ideal for DVM's or hand held equipment. Length 120mm, width 66mm, height 32mm. Battery compartment will take PP3. **£2.95;** 25+ 2.20; 100+ 1.70



Miniature Aluminium Boxes

A range of attractive aluminium boxes, finished in grey, for a wide range of applications requiring a sturdy enclosure. Two U sections are secured by four self-tapping screws. The box is covered in a protective plastic film.

Code	L	W	H	1+	10+	25+
CS3415	55	40	25	£1.79	1.27	1.02
CS3425	75	55	25	£2.50	1.78	1.43
CS3435	105	75	35	£3.99	2.83	2.27
CS3445	105	125	35	£4.89	3.47	2.78
CS3455	125	85	60	£6.78	4.81	3.70
CS3465	155	105	45	£7.24	5.14	3.96
CS3475	175	125	45	£7.95	5.85	4.68



Storage Cabinets

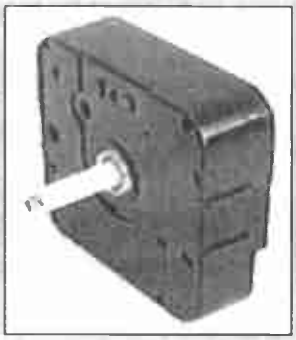
CS4440 Link Hanson type 501. This contains, within a steel case 540 x 300 x 160mm, 48 plastic drawers. Each drawer is divisible into a maximum of 6 compartments. Individual drawer size 155 x 70 x 37mm. **£37.95;** 4+ 28.04

CS2442 Dividers in packs of 10. **£1.40;** 100+ 0.10 each

CLOCKS

A new quartz clock movement with a range of hands, dials, chapter rings and accessories, all at extremely competitive prices.

Quartz Movement



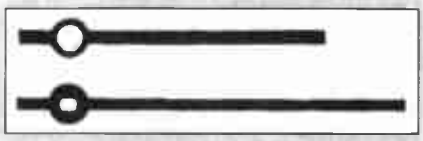
Kienzle Model W716. Facility for hour, minute and second hand. Takes single AA cell. Type current 80µA. Accuracy to within 1 sec/day. Size 58x50x16mm, weight without battery 26g. **£3.50**; 10+ 2.34, 25+ 1.87; 100+ 1.50

Code	Spindle Lengths H	M	S
CL3101	11.5	16.3	20.5
CL3202	6.0	11.5	15.5
CL3303	6.8	8.1	11.0

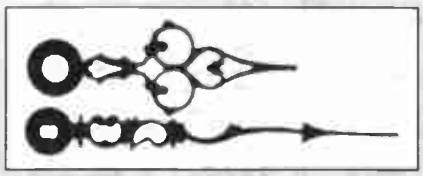
Hands

A selection of modern and traditional hands, all of which will fit either movement described. Measurements are from spindle centre to end.

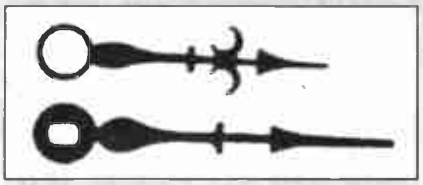
Code	Length H	M	Colour	1+	25+	100+
CL2410	28	42	Black	**38p**	0.25	0.19
CL2420	28	42	Brass	**42p**	0.28	0.21



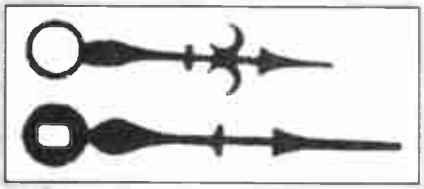
CL2430	60	80	Black	**48p**	0.31	0.24
CL2440	60	80	Brass	**52p**	0.34	0.26



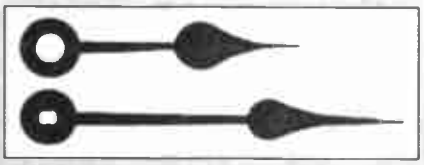
CL2450	47	68	Black	**48p**	0.31	0.24
CL2460	47	68	Brass	**52p**	0.34	0.26



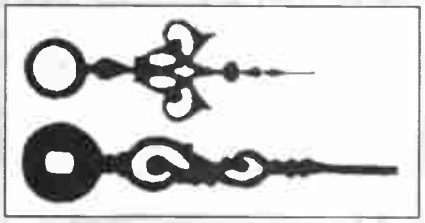
CL2470	34	46	Black	**36p**	0.23	0.18
CL2480	34	46	Brass	**40p**	0.26	0.20



CL2490	58	77	Black	**50p**	0.33	0.25
CL2500	58	77	Brass	**54p**	0.36	0.27



CL2510	53	75	Black	**48p**	0.31	0.24
CL2520	53	75	Brass	**52p**	0.34	0.26

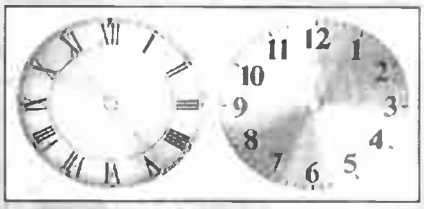


CL2530	35	44	Black	**46p**	0.30	0.23
CL2540	35	44	Brass	**50p**	0.33	0.25

Second Hands

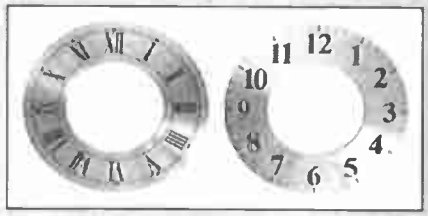
Code	Length	Colour	1+	25+	100+
CL2550	60	Red	**28p**	0.18	0.14
CL2560	60	White	**28p**	0.18	0.14

CL2570	80		Red	**28p**	0.18	0.14
CL2580	80		White	**28p**	0.18	0.14



Dials

Code	Col	Size	Num	1+	25+	100+
CL2605	White	4"	Arabic	**£1.75**	1.18	0.94
CL2610	Silver	4"	Arabic	**£1.75**	1.18	0.94
CL2615	Brass	4"	Arabic	**£1.75**	1.18	0.94
CL2620	White	4"	Roman	**£1.75**	1.18	0.94
CL2625	Silver	4"	Roman	**£1.75**	1.18	0.94
CL2630	Brass	4"	Roman	**£1.75**	1.18	0.94
CL2635	White	5"	Arabic	**£1.84**	1.25	1.00
CL2640	Silver	5"	Arabic	**£1.84**	1.25	1.00
CL2645	Brass	5"	Arabic	**£1.84**	1.25	1.00
CL2650	White	5"	Roman	**£1.84**	1.25	1.00
CL2655	Silver	5"	Roman	**£1.84**	1.25	1.00
CL2660	Brass	5"	Roman	**£1.84**	1.25	1.00
CL2665	White	6"	Arabic	**£1.96**	1.32	1.06
CL2670	Brass	6"	Arabic	**£1.96**	1.32	1.06
CL2675	White	6"	Roman	**£1.96**	1.32	1.06
CL2680	Silver	6"	Roman	**£1.96**	1.32	1.06

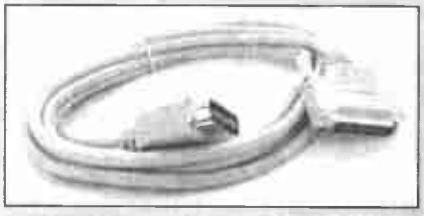


Chapter Rings

Code	Col	Size	Num	1+	25+	100+
CL2805	White	4"	Arabic	**£1.75**	1.18	0.94
CL2810	Silver	4"	Arabic	**£1.75**	1.18	0.94
CL2815	Brass	4"	Arabic	**£1.75**	1.18	0.94
CL2820	White	4"	Roman	**£1.75**	1.18	0.94
CL2825	Silver	4"	Roman	**£1.75**	1.18	0.94
CL2830	Brass	4"	Roman	**£1.75**	1.18	0.94
CL2835	White	5"	Arabic	**£1.84**	1.25	1.00
CL2840	Silver	5"	Arabic	**£1.84**	1.25	1.00
CL2845	Brass	5"	Arabic	**£1.84**	1.25	1.00
CL2850	White	5"	Roman	**£1.84**	1.25	1.00
CL2855	Silver	5"	Roman	**£1.84**	1.25	1.00
CL2860	Brass	5"	Roman	**£1.84**	1.25	1.00
CL2865	White	6"	Arabic	**£1.96**	1.32	1.06
CL2870	Brass	6"	Arabic	**£1.96**	1.32	1.06
CL2875	White	6"	Roman	**£1.96**	1.32	1.06
CL2880	Silver	6"	Roman	**£1.96**	1.32	1.06
CL2885	Brass	6"	Roman	**£1.96**	1.32	1.06

The White and Silver dials are made from aluminium.

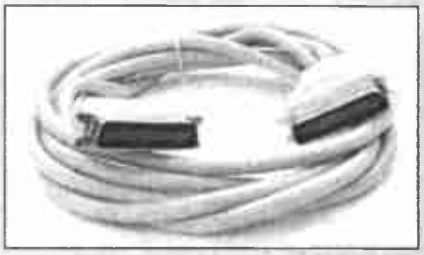
COMPUTER PRODUCTS



IBM Parallel Printer Cables

A completely screened Centronics type parallel cable for interfacing IBM and compatible computers to a printer comprising a 36 way male Centronics connected to a 25 way 'D' connector plug. Manufactured from 7/0.2 cable, sheathed in grey PVC with aluminium screen. Fully moulded construction.. Available in 2 lengths.

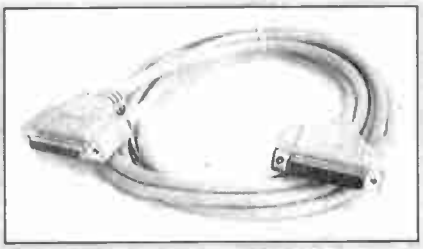
Code	Length	1+	10+
CM3102	3m	**£4.95**	2.75
CM3104	5m	**£5.95**	3.65



Parallel Extension Cables

CM3106 Completely screened Centronics type parallel cables for use to interface between printers, word processors, VDUs, etc. Manufactured from 7/0.2 cable, sheathed in grey PVC with aluminium screen to minimise crosstalk and provide protection against external noise. Fully moulded construction employing 36 way male Centronics connectors at each end. All lines connected. 3 metres. **£7.50**; 10+ 5.07

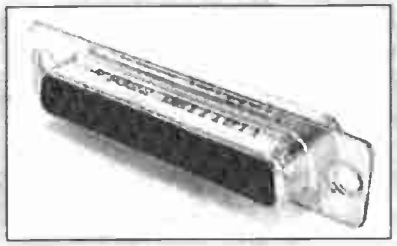
TEL: 01703 236363
FAX: 01703 236307
GREENWELD
27 Park Road · Southampton · SO15 3UQ



RS232 Extension Cables

RS232 data cables completely screened end to end with 25 way 'D' connectors at each end supplied in a variety of lengths in either male (plug) to male (plug) or male (plug) to female (socket) styles. Manufactured from 7/0.2 cable, sheathed in grey PVC with aluminium screen to minimise crosstalk and protect against external noise. Fully moulded construction with all 25 lines connected.

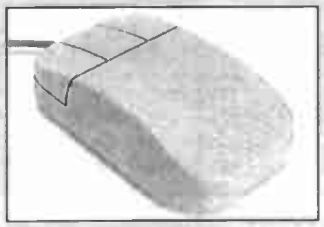
Code	Type	Length	1+	10+
CM3108	Male to Male	3m	£4.95	2.67
CM3110	Male to Female	3m	£4.95	2.67



Low Profile Gender Changers

Low profile space saving versions of the above. Overall length of connector is reduced to just 18mm. Male to male is fitted with male jackscrews, female to female with female screw receptacles.. All lines are wired pin to pin. Fully screened construction.

Code	Type	Price
CM2112	9 way male to male	£3.50
CM2114	9 way female to female	£3.50
CM2116	25 way male to male	£3.95
CM2118	25 way female to female	£3.95

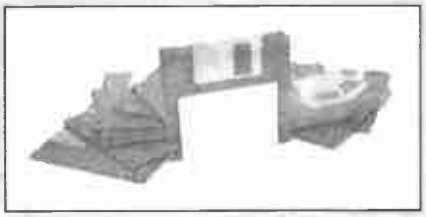


XT/AT Serial Mouse

CM3120 The Rapid M130 is a new low cost 3 button Serial mouse suitable for use with IBM XT/AT and compatible computers. The improved design is easy to use and fits neatly into the palm of the hand. The mouse driver software supports all applications such as AutoCAD, CasCAD, AutoSketch, Ventura, Publisher, and a host of other programs used on the IBM PC. The mouse is supplied complete with mouse driver software on 3½ inch disc and user manuals. The mouse is terminated with a 9-pin D female (socket). Fully compatible with the RM Nimbus 486 computer. £12.95; 5+ 8.43; 25+ 6.75

Technical Specifications

Mechanism	Optional encoder
Compatibility	Microsoft and MSC compatible
Dynamic Resolution	400DPI
Tracking Speed	500mm/second
Connector	RS232 9 way female
System Requirements	IBM PC XT/AT or compatible



3½ Inch Floppy Disks

A range of high quality 3½ inch diskettes available at a very competitive price. All disk are certified to be 100% error free and performance exceeds ANSI, ECMA and ISO standards. Every disk is 100% checked before leaving our factory. Supplied in packs of 10 disks complete with labels.

Code	Type	Price per box of 10 1+	10+	25+
CM3122	3½ DSDD	£4.22	3.33	3.12
CM3124	3½ DSHD	£7.43	5.32	5.00

Diskette Storage Boxes

A range of high quality lockable diskette storage boxes available to suit 3½ inch diskettes. The boxes incorporate lockable pivot action smoked transparent lids and rugged anti-static ABS base with convenient hand grip for easy transportation. Supplied complete with 2 keys, dividers and coloured identification labels.

Code	Type	1+	10+
CM4126	40x3½ diskette box	6.95	4.00
CM4128	80x3½ diskette box	7.95	4.95

CONNECTORS

AUDIO/VIDEO

Low Cost XLR Connectors

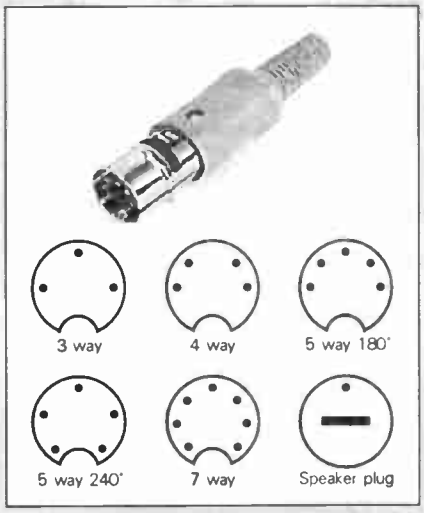
A range of low cost professional quality plugs and sockets moulded from tough nylon. Sockets may be mounted to front or rear of chassis. To facilitate soldering rear contacts pins are hollow. Cable plug and socket incorporate cable strain relief.

Code	Type	1+	25+	100+
CN2001	3 way cable skt	£2.34	1.35	1.20
CN2002	3 way cable plg	£2.11	1.22	1.10
CN2003	3 way chassis skt	£1.08	0.62	0.52
CN2004	3 way chassis plg	87p	0.50	0.45

Latching XLR Connectors

A range of XLR connectors which offer a high level of quality and ease of assembly. a single fixing screw retains the nickel plating housing which is easily removed for rapid assembly. Solder bucket terminations with integral cable strain relief. Will accept cables from 3 to 8mm in diameter.

Code	Type	1+	25+	100+
CN2006	3 way cable skt	£2.57	1.45	1.19
CN2007	3 way cable plg	£2.13	1.20	1.00
CN2008	3 way chassis skt	£2.66	1.50	1.30
CN2009	3 way chassis plg	£1.97	1.11	0.98



DIN Audio Connectors

A range of economical insulated DIN plugs. Will match with all DIN socket types detailed below. Black PVC body.

Code	Type	1+	25+	100+
CN2010	Speaker plug	19p	0.13	0.10
CN2011	3 way	34p	0.22	0.17
CN2012	4 way	38p	0.23	0.18
CN2013	5 way 180°	44p	0.25	0.19
CN2014	5 way 240°	38p	0.23	0.18
CN2015	6 way	53p	0.30	0.23
CN2016	7 way	53p	0.30	0.23
CN2017	8 way 270°	56p	0.32	0.24

DIN Chassis Sockets

Chassis mounting sockets suitable for insulated or screened DIN audio connectors. Panel cutout is 16mm. 2 pin type has plastic body.

Code	Type	1+	25+	100+
CN2020	Speaker Socket	19p	0.13	0.10
CN2021	3 way	34p	0.22	0.17
CN2022	4 way	41p	0.23	0.17
CN2023	5 way 180°	50p	0.28	0.21
CN2024	5 way 240°	50p	0.28	0.21
CN2025	6 way	50p	0.28	0.21
CN2026	7 way	50p	0.28	0.21
CN2027	8 way	56p	0.32	0.24

DIN Line Sockets

CN2029 An economical insulated DIN line socket to match DIN plugs Black PVC body 5 way 180°. **47p**; 25+ 0.27; 100+ 0.20

Miniature Jack Plugs

Miniature 2.5mm and 3.5mm insulated plugs with strong plastic barrels and integral cable protector sleeve Solder termination.

Code	Type	1+	25+	100+
CN2030	2.5mm ins. plug	28p	0.17	0.13
CN2031	3.5mm ins. plug	27p	0.17	0.13
CN2032	3.5mm stereo ins plg	36p	0.24	0.18

Screened Miniature Jack Plugs

Miniature screened 2.5mm and 3.5mm plugs with bright nickel plated bodies. All types incorporate knurled body finish to assist grip and inner cable protector. Solder termination.

Code	Type	1+	25+	100+
CN2033	2.5mm screened plug	41p	0.23	0.17
CN2034	3.5mm screened plug	66p	0.44	0.33
CN2035	3.5mm stereo plug	81p	0.46	0.35

Standard Jack Plugs

Standard insulated jack plugs of 0.25in nominal diameter. All types include strong black plastic barrels and integral cable protector sleeve. Solder termination.

Code	Type	1+	25+	100+
CN2036	Insulated plug	46p	0.30	0.24
CN2037	Stereo ins plug	63p	0.42	0.32

Standard Screened Jack Plugs

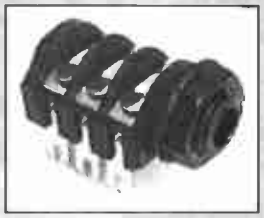
Standard screened jack plugs of 0.25in nominal diameter with bright nickel bodies. All types incorporate knurled body finish to assist grip and inner cable protector. Solder termination.

Code	Type	1+	25+	100+
CN2038	Screened plug	84p	0.49	0.37
CN2039	Screened stereo plg	£1.09	0.69	0.53

Miniature Jack Sockets

Miniature enclosed type jack sockets for 2.5 and 3.5mm jack plugs. Max panel thickness 2.5mm. Panel cutout 4.5mm for 2.5mm type; 6mm for 3.5mm type.

Code	Type	1+	25+	100+
CN2040	2.5mm	9p	0.055	0.045
CN2041	3.5mm	9p	0.055	0.045
CN2042	3.5mm stereo	13p	0.09	0.07



Standard Jack Sockets

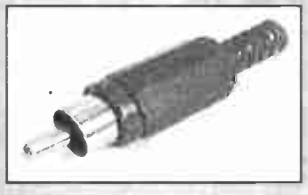
Chassis mounting jack sockets to suit jack plugs. Available with unswitched or switched contacts. Switched contact types have normally closed contacts which open upon insertion of the plug. Will accept a wide range of standard 0.25in plugs.

Code	Type	1+	25+	100+
CN2043	Mono unswitched	36p	0.24	0.20
CN2044	Mono switched	43p	0.28	0.24
CN2045	Stereo unswitched	48p	0.34	0.26
CN2046	Stereo switched	56p	0.40	0.32

Jack Line Sockets

A range of cable mounting jack line sockets. Black moulded body complete with cable clamp.

Code	Type	1+	25+	100+
CN2050	2.5mm	32p	0.20	0.15
CN2051	3.5mm	32p	0.20	0.15
CN2052	3.5mm stereo	37p	0.23	0.17
CN2053	Standard mono ¼"	43p	0.28	0.20
CN2054	Standard stereo ¼"	48p	0.30	0.22



Phono Plugs

Insulated phono plugs in red or black.

Code	Colour	1+	25+	100+
CN2060	Red	25p	0.15	0.11
CN2061	Black	25p	0.15	0.11

Screened Phono Plugs

CN2062 Screened metal bright nickel plated phono plug with knurled body. The plug also includes a spring cable strain relief. **41p**; 25+ 0.24; 100+ 0.19

Gold Plated Phono Plugs

Professional quality gold plated phono plugs incorporating coloured bands for easy identification. The plug is supplied with gold flashed cable strain relief and will accept cables up to 8mm diameter.

Code	Colour	1+	25+	100+
CN2063	Red	85p	0.54	0.43
CN2064	Black	85p	0.54	0.43

Single Phono Sockets

Chassis mounting phono sockets for use with above plugs. Socket is metal type with single hole fixing of 6mm. Colour coded insulators for easy identification.

Code	Colour	1+	25+	100+
CN2070	Black	42p	0.25	0.20
CN2071	Red	42p	0.25	0.20

Gold Plated Phono Sockets

Professional quality single nut fixing gold plated phono sockets. Sockets are supplied complete with insulating washers to facilitate isolation from panel. A colour coded ring in red or black assists in identification. Supplied with gold plated solder tag. Panel cutout 8mm (9.5mm with insulating washers).

Code	Colour	1+	25+	100+
CN2072	Red	£1.73	1.18	0.95
CN2073	Black	£1.73	1.18	0.95

Phono Line Sockets

Insulated cable mounting phono line sockets in red or black.

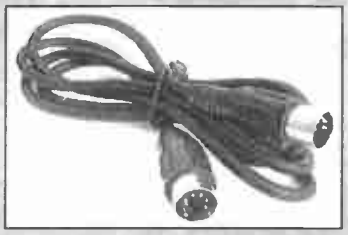
Code	Colour	1+	25+	100+
CN2074	Red	22p	0.12	0.093
CN2075	Black	22p	0.12	0.093

Screened Phono Line Sockets

CN2076 Screened cable mounting phono line socket. **40p;** 25+ 0.24: 100+ 19

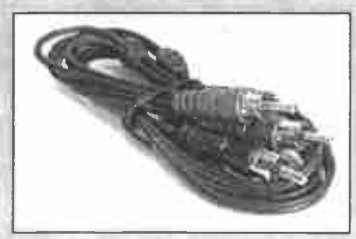
Audio Leads

A range of made up audio leads for general industrial and audio-visual applications.



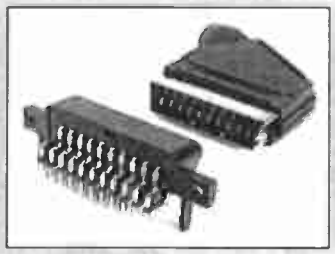
5 pin 180° DIN plug to 5 pin 180° DIN plug. Fully moulded construction employing four core screened cable. Overall length 1.5M, 3M or 5 metres.

Code	Type	Length	1+	50+
CN3101	DIN-DIN	1.5M	**£1.52**	0.94
CN3102	DIN-DIN	3M	**£2.30**	1.40
CN3103	DIN-DIN	5M	**£2.70**	1.60



Phono to phono. Two phono plugs to two phono plugs. Fully moulded construction employing twin screened cable. Overall length 1.5M, 3M or 5 metres.

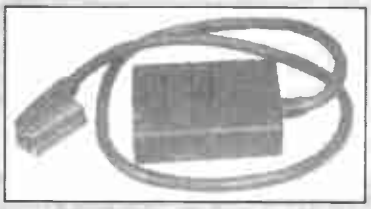
CN3105	Phono-Phono	1.5M	**£1.00**	0.60
CN3106	Phono-Phono	3M	**£1.36**	0.73
CN3107	Phono-Phono	5M	**£1.71**	0.90



Scart Connectors

Scart connectors are now commonly used for the interconnection of television receiver, video equipment, cameras and recorders. All inputs and outputs are via a 21 pin connector, the socket being PCB moulded. The cable mounting non-reversible plug is supplied as a fully loaded solder type complete with cable strain relief.

Code	Type	1+	25+	100+
CN2110	Scart cable plug	**75p**	0.46	0.41
CN2111	Scart PCB socket	**60p**	0.40	0.32

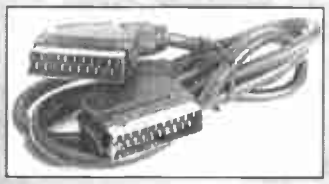


Scart Adaptor

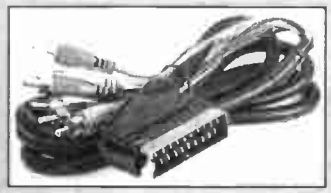
CN3112 A scart adaptor comprising a cable ended scart plug with one metre of fully screened cable terminated to a junction box comprising two scart sockets. Ideally suited to coupling up to three pieces of audio/visual equipment with scart sockets. **£7.99;** 10+ 4.50

Scart Cable Assemblies

A comprehensive range of Scart cable assemblies for use in the interconnection of TV and video systems employing television type cable.



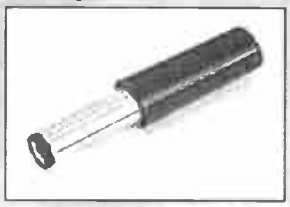
CN3113 Scart plug to Scart plug. Length 1.5M. **£3.50;** 10+ 2.18



CN3114 Scart plug to 6 Phono plugs (NICAM Stereo). Length 1.5M. **£3.75;** 10+ 2.30

CN3115 Scart plug to 2 BNC and 4 Phono plugs (NICAM Stereo). Length 1.5M. **£5.17;** 10+ 3.50

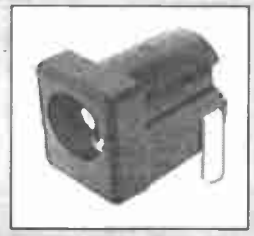
MAINS/POWER



DC Power Plugs

A range of miniature power inlet plugs to suit a range of appliances. 1.3mm diameter type suits Walkman-type cassette players. Standard plugs have 10mm shaft, long plugs have 14mm shafts.

Code	Type	1+	25+	100+
CN2120	1.3mm mini	**44p**	0.30	0.20
CN2121	2.1mm standard	**22p**	0.16	0.12
CN2122	2.1mm long	**34p**	0.20	0.16
CN2123	2.5mm standard	**22p**	0.15	0.12
CN2124	2.5mm long	**34p**	0.20	0.16



PCB DC Power Socket

PCB mounting DC power sockets manufactured in PBT available to suit 2.1 or 2.5mm DC power plugs. Both types may also be hand wired if required. Both incorporate a single pole switch. Contacts rated at 5A 12V DC.

Code	Type	1+	25+	100+
CN2130	2.1mm	**20p**	0.12	0.09
CN2131	2.5mm	**22p**	0.13	0.10

DC Power Sockets

Switched insulated flush mounting sockets to suit 2.1mm and 2.5m DC power plugs. Fixing centres 18mm.

Code	Type	1+	25+	100+
CN2132	2.1mm	**44p**	0.35	0.30
CN2133	2.5mm	**44p**	0.35	0.30

Cigar Lighter Plugs

CN2137 Cigar lighter line socket for cigar lighter plug. **£1.00;** 25+ 0.55; 100+ 0.45

CN2135 Quality cigar lighter plug. **40p;** 25+ 0.23; 100+ 0.18

IEC Chassis Plug

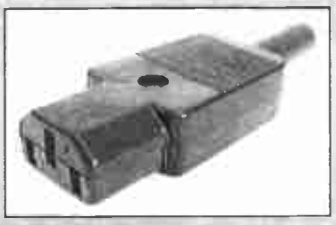
CN2140 A range of front or rear mounting inlet connectors approved IEC320 and CEE22. **90p;** 25+ 0.51; 100+ 0.38

IEC Chassis Socket

CN2141 Female version of chassis plug for power take-off applications. Terminated with 4.8mm fast-on connections. Contact rating 10A 250V AC. **87p;** 25+ 0.49; 100+ 0.37

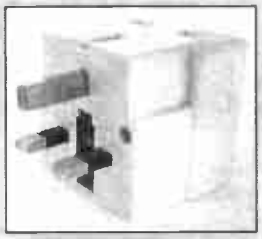
Rewireable Cable Plug

CN2143 A CEE22/IEC320 straight rewireable power take-off connector. Fitted with internal screw grip cable clamp and strain relief. Contact rating 10A 250V AC. **£2.30;** 25+ 1.46; 100+ 1.15



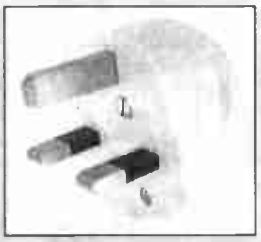
IEC Cable Socket

CN2142 A rewireable cable socket. Fitted with internal screw connections and cable strain relief. Contact rating 6A 250V AC **£1.50;** 25+ 1.01; 100+ 0.81



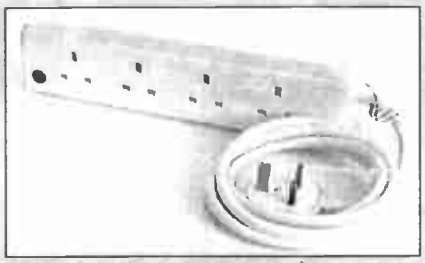
2 Way Mains Adaptor

CN2154 2 way adaptor. **£1.50;** 25+ 0.80



Bakelite 13A Mains Plugs

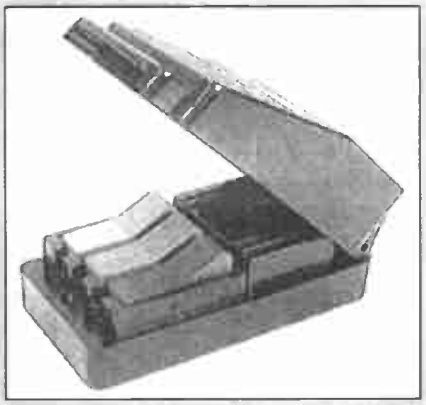
CN3150 13A plug fused at 13A. **68p;** 20+ 0.42; 100+ 0.36



Trailing Sockets

CN3151 4 way trailing skt with fuse. **£3.95;** 25+ 3.00; 100+ 2.50

CN3152 4 way trailing skt with 2m lead and plug. **£6.95;** 25+ 5.07; 100+ 3.90

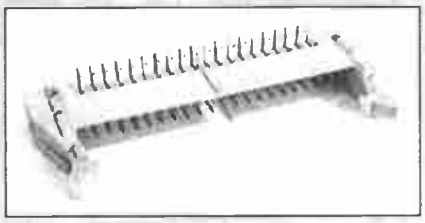


Quicktest - 13A Mains Connector

CN3155 The Quicktest is ideal for laboratories and service and test departments. With the lid open the wires of plugless lead are inserted into the insulated clips. When the lid is closed current passes to the equipment being demonstrated or tested. The lid has a spring latch to hold it open when the Quicktest is wall mounted. A neon light shows that the connector is live and ready to use. The 13A fuse is easily accessible for replacement. The insulated clips are colour coded for easy identification. **£14.95;** 10+ 10.00

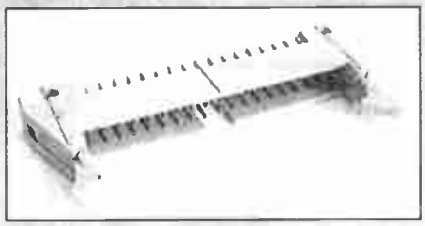
MULTIPOLE

IDC Connectors



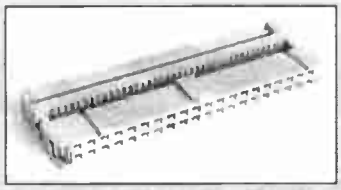
Right Angle PCB Plugs

Code	Type	1+	25+	100+
CN2200	10 pin	**58p**	0.33	0.25
CN2205	20 pin	**83p**	0.48	0.36
CN2210	26 pin	**£1.10**	0.64	0.48
CN2215	34 pin	**£1.45**	0.84	0.63
CN2220	40 pin	**£1.70**	0.98	0.74



Straight PCB Plugs

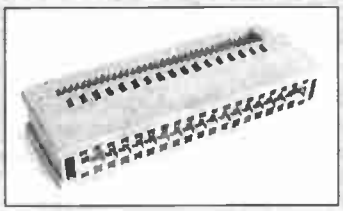
Code	Type	1+	25+	100+
CN2250	10 pin	**58p**	0.33	0.25
CN2255	20 pin	**71p**	0.41	0.31
CN2260	26 pin	**94p**	0.54	0.41
CN2265	34 pin	**£1.24**	0.72	0.54
CN2270	40 pin	**£1.63**	0.94	0.71



Cable Mounting Socket

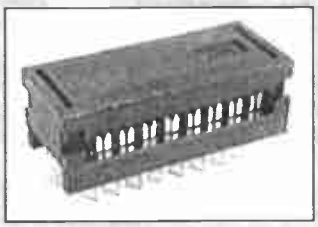
Cable mounting sockets which mate directly with the PCB mounting plugs. Complete with cable strain relief. Beryllium-copper contacts. Bump polarised.

Code	Type	1+	25+	100+
CN2300	10 way	**29p**	0.18	0.13
CN2305	20 way	**32p**	0.20	0.15
CN2310	26 way	**36p**	0.21	0.16
CN2315	34 way	**37p**	0.23	0.18
CN2320	40 way	**67p**	0.39	0.29



Edge Connectors

Code	Type	1+	25+	100+
CN2355	34 way	**75p**	0.60	0.50



IDC DIL Connectors

A range of low profile DIL plugs for direct termination to ribbon cable. Connectors offer a maximum height above PCB of just 7mm.

Code	Type	1+	25+	100+
CN2400	14 pin	**45p**	0.29	0.22
CN2410	16 pin	**49p**	0.32	0.24
CN2420	24 pin	**68p**	0.45	0.34
CN2430	40 pin	**80p**	0.49	0.37

'D' Type Connectors

A range of competitively price commercial specification 'D' connectors which meet the dimensional requirements of MIL-C-24308. White, flame retardent glass filled polyester insulators; gold plated stamped contacts housed in tinned and dimpled steel shells. Rated 5A 250V AC max.

Code	Type	1+	25+	100+
CN2450	9 pin solder lug plug	**35p**	0.19	0.13
CN2455	9 pin solder lug skt	**38p**	0.21	0.15
CN2460	15 pin solder lug plug	**45p**	0.26	0.18
CN2465	15 pin solder lug skt	**38p**	0.21	0.15
CN2470	25 pin solder lug plug	**51p**	0.30	0.21
CN2475	25 pin solder lug skt	**56p**	0.33	0.23

TEL: 01703 236363
FAX: 01703 236307
GREENWELD
27 Park Road · Southampton · SO15 3UQ

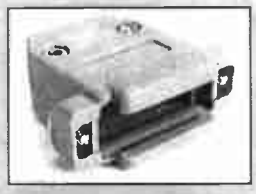
IDC 'D' Connectors

A range of IDC 'D' connector plugs and sockets for direct termination to ribbon cable. Gold over nickel-plated beryllium copper contacts housed in a tinned metal shell for extra reliability and EMI/ESD reduction. Complete with cable strain relief.

Code	Type	1+	25+	100+
CN2500	9 way IDC plug	£1.40	0.97	0.75
CN2505	15 way IDC plug	£1.45	1.01	0.78
CN2510	25 way IDC plug	£1.50	1.09	0.84
CN2515	9 way IDC skt	£1.40	0.97	0.75
CN2520	15 way IDC skt	£1.45	1.01	0.78
CN2525	25 way IDC skt	£1.50	1.09	0.84

'D' Connector Covers

A range of competitively priced two part 'D' connector covers moulded in grey ABS. Supplied complete with cable clamp and short jack screws. Top cable entry type.



Code	Type	1+	25+	100+
CN2550	9 pin	30p	0.17	0.13
CN2555	15 pin	32p	0.19	0.14
CN2560	25 pin	34p	0.20	0.15

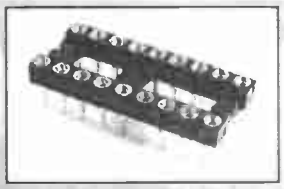
A range of ABS covers to fit all 'D' connectors listed. Features captive screw locks with long shanks (finger and screwdriver slots) and adjustable cable clamps. Can be fitted to connectors that have already been wired.

Code	Type	1+	25+	100+
CN2570	9 pin screwlock	76p	0.44	0.33
CN2575	15 pin screwlock	78p	0.45	0.34
CN2580	25 pin screwlock	80p	0.46	0.35

Low Profile Turned Pin SIL Sockets

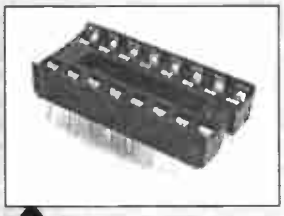
A low profile high-quality machined contact SIL socket. Moulded in black glass-filled flame retardant polyester. Supplied as a 20 or 32 way strip which may be broken down to the required number of ways. Temperature range -50 to +180°C.

Code	Type	1+	25+	100+
CN2605	20 pin connector	48p	0.29	0.22
CN2610	32 pin connector	92p	0.52	0.40



Low Profile Turned Pin DIL Sockets

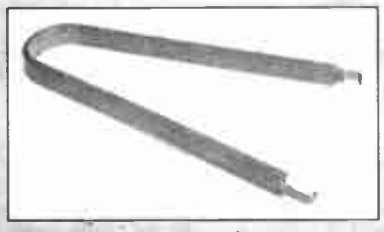
Code	Type	1+	Pk/10	100+	1k+
CN2615	8 pin	16p	£1.24	0.083	0.066
CN2620	14 pin	28p	£2.18	0.145	0.118
CN2625	16 pin	32p	£2.48	0.165	0.132
CN2630	18 pin	35p	£2.71	0.181	0.145
CN2635	20 pin	40p	£3.09	0.206	0.165
CN2640	22 pin	44p	£3.42	0.228	0.182
CN2645	24 pin	48p	£3.72	0.248	0.198
CN2650	28 pin	56p	£4.34	0.289	0.231
CN2655	40 pin	80p	£6.19	0.413	0.330



Low Profile DIL IC Sockets

Low cost sockets with side-wipe contacts.

Code	Type	1+	Pk/10	100+	1k+
CN2700	8 pin	10p	65p	0.029	0.015
CN2705	14 pin	12p	78p	0.052	0.026
CN2710	16 pin	13p	85p	0.059	0.030
CN2715	18 pin	16p	£1.04	0.066	0.034
CN2720	20 pin	18p	£1.17	0.074	0.039
CN2725	22 pin	21p	£1.36	0.081	0.045
CN2730	24 pin	23p	£1.49	0.088	0.046
CN2735	28 pin	25p	£1.62	0.103	0.055
CN2740	40 pin	34p	£2.21	0.148	0.078

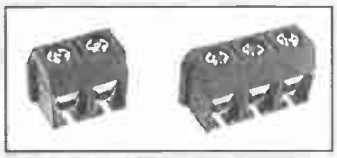


IC Extraction Tool

CN2760 Simple spring clip tool for easy extraction of integrated circuits. Suitable for use with ICs with up to 28 pins. Insulated handle. **80p**; 25+ 0.50

IC Extraction/Insertion Tool

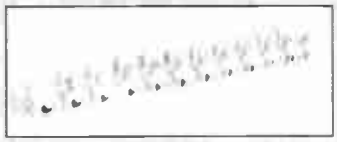
CN2770 A high quality spring loaded tool for use with 0.3in (8, 14, 16, 18 and 20 pin) devices. The tool may be for insertion or extraction of IC's. **£1.40**; 25+ 0.90



Terminal Blocks

PCB terminal blocks. Interlocking allows any number to be connected together on a 5mm pitch. Rated 16A Max wire size 2.5mm. 90° mounting.

Code	Type	1+	25+	100+
CN2800	2 pin 10mm long	16p	0.12	0.09
CN2805	3 pin 15mm long	24p	0.18	0.14
CN2810	4 pin 20mm long	40p	0.274	0.219
CN2815	6 pin 30mm long	58p	0.406	0.325
CN2820	12 pin 60mm long	£1.15	0.813	0.650



Polythene moulded 12 way connection block, easily cut into smaller sections if required. In four current ratings

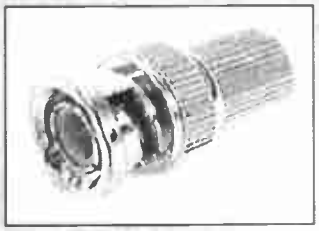
Code	Type	1+	25+	100+
CN2850	2A 95x16x13mm	50p	0.32	0.254
CN2855	5A 117x19x15mm	50p	0.32	0.254
CN2860	15A 133x25x18mm	88p	0.55	0.44
CN2865	30A 173x30x23mm	£1.72	1.07	0.86

RF/COAXIAL

BNC Connectors

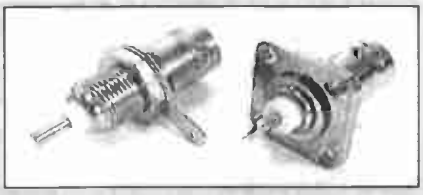
A range of quality constant impedance connectors with nickel plated bodies, PTFE insulator and silver plated brass contacts. Offered in either 50 ohm (accept RG58/U or Belden 9907 cable) or 75 ohm impedance (accepts RG59B/U cable).

Code	Type	1+	25+	100+
CN2870	50 Ohm clamp plug	97p	0.57	0.49
CN2871	75 Ohm clamp plug	97p	0.57	0.49



Solderless BNC Connector

CN2872 Constant impedance high quality connector. Connection is made via screw connection for the signal and by crimp connection to the outer screen which also acts as a cable clamp. A soft moulded PVC cover covers the completed connector. 50 ohm impedance. Suitable for use with RG58C/U cable. **£1.44**; 25+ 0.81; 100+ 0.61



BNC Bulkhead Sockets

BNC bulkhead sockets with bright nickel plated bodies available in single hole fixing or with square flange 17.5mm square. Max panel thickness for single hole fixing type 4mm. Supplied complete with mounting washers, nut and solder tug.

Code	Type	1+	25+	100+
CN2873	50 ohm bulkhead skt	**£1.38**	0.80	0.60
CN2874	75 ohm bulkhead skt	**£1.38**	0.80	0.60
CN2875	50 ohm panel skt	**81p**	0.55	0.42

BNC Adaptors

A range of adaptors suited to interconnection of a wide range of BNC sockets with nominal impedance of 50 ohms suited to many applications including Networked computer systems. Bright nickel plated bodies.

Code	Type	1+	25+	100+
CN2876	Socket to socket	**£1.20**	0.81	0.65
CN2877	T.skt/skt/plug	**£2.15**	1.47	1.18
CN2878	T.skt/skt/skt	**£1.79**	1.22	0.98

Oscilloscope Probes

A range of high quality oscilloscope probes for use between DC and 250 MHz. Available in either fixed 10:1 or switched 1:1,10:1, options. Compensation to match instruments of 12pF to 35pF input capacitance. Detachable 20cm ground lead. Spare accessories are available as separate items. Probes are supplied with comprehensive instructions.

Contents:
Test hook spring loaded
Test clip
Insulating tip
BNC adaptor
Compensation tool
20cm ground lead
Probe tip

Technical Specification

	CN2880	CN2881	
Position	x10	x1	x10
Bandwidth	DC to 250MHz	DC to 15MHz	DC to 250MHz
Rise time	1.4ns	25ns	1.4ns
Compensation range	12pF to 35pF	12pF to 35pF	12pF to 35pF
Input resistance	9MΩ 1%	1MΩ	9MΩ 1%
Input capacitance	14pF	65pF	14pF
Working Voltage	500V DC	200V DC	500V DC
Operating Temp	-25 to +70°C	-25 to +70°C	

Code	Type	1+	10+
CN2880	Fixed 10:1	**£20.95**	14.39
CN2881	Switched 1:1, 10:1	**£21.95**	15.42
CN2882	Pk of 3 test hooks	**£6.95**	4.72
CN2883	Pk of 5 screw in tips	**£4.50**	2.90

BNC Adaptor

CN2879 An adaptor comprising a BNC male plug terminated to a standard female phono socket assisting with interconnection of video equipment. Nominal impedance 50Ω. **75p;** 25+ 0.46; 100+ 0.38

F Series Coaxial Connectors

A range of quality constant impedance connectors for satellite TV cable installation and other high frequency applications. Bright nickel plated brass body with phosphor bronze contacts with polypropylene insulator. Nominal impedance 75 ohms.

'Twist-On' Plug

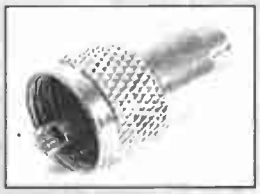
CN2885 A rapid assembly 'twist-on' plug for easy and fast termination to satellite TV cable type RG6/CT100. Bright nickel plated body. 75 ohm impedance. **22p;** 25+ 0.15; 100+ 0.12

F Panel Socket

CN2886 F series panel mounting socket for above. 75 ohm nominal impedance. Bright nickel plated brass body. Maximum panel thickness 4mm. **25p;** 25+ 0.18; 100+ 0.15

F Adaptor

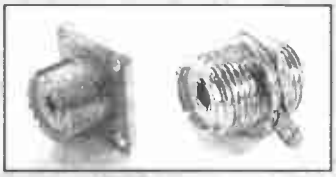
CN2887 An adaptor suited to mating two F plugs comprising two jacks back to back. Bright nickel plated brass body. 75 ohm nominal impedance. **25p;** 25+ 0.18; 100+ 0.15



UHF Connectors

A series of connectors for use up to 500V peak and 200MHz. Non constant impedance. Plug PL259 supplied less reducer. PL259 accepts Uniradio M67 cable.

Code	Type	1+	25+	100+
CN2890	PL259 plug	**97p**	0.65	0.52
CN2891	Small reducer	**24p**	0.16	0.13



UHF Sockets

UHF SO239 sockets available with square flange 18mm square or round for fixing to panels up to 4mm thick.

Code	Type	1+	25+	100+
CN2892	Square socket	**£1.09**	0.70	0.58
CN2893	Round socket	**97p**	0.65	0.52

Coax Plugs

CN2894 A high quality UK manufactured standard coax plug with aluminium body with knurled finish. **44p;** 25+ 0.30, 100+ 0.24

Flush Mounting Socket

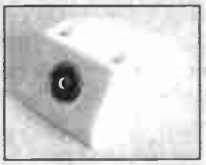
CN2895 Socket to suit above. Fits flush to chassis surface. Panel cut-out 13.2mm. Fixing centres 19mmx6BA. **28p;** 25+ 0.19; 100+ 0.15

Line Socket

CN2896 Free cable mounting socket to suit coax plug. Aluminium construction. Fully screened. **80p;** 25+ 0.55; 100+ 0.44

Line Connector

CN2897 Line connector for connecting two coax plugs together. **24p;** 25+ 0.16; 100+ 0.13



Coax Surface Sockets

CN2900 Surface mounting single coaxial socket. White ABS housing, internal cable clamp and supplied with mounting screws. Dimensions 27x51x59mm. **£1.32;** 25+ 0.90; 100+ 0.72

Coaxial Splitter

CN2901 A splitter suitable for dividing signals between receivers. Typical insertion loss 6dB. **£1.20**; 25+ 0.81; 100+ 0.65

TV Connector Lead

TV connector leads available in black or white comprising a coaxial plug to plug lead with moulded strain relief. Available in 2 metre or 4 metre cable lengths. Suitable for all channels.

Code	Type	1+	25+	100+
CN3902	2M black	**95p**	0.64	0.52
CN3903	2M white	**95p**	0.64	0.52
CN3904	4M white	**£1.35**	0.93	0.73

SINGLE POLE

2mm Stackable Plug

2mm gold plated plug with 2mm socket in the rear providing an in-line stacking facility. The lead wire is soldered into position at the bottom of the 2mm socket. Rated at 10A.

Code	Colour	1+	25+	100+
CN2910	Black	**64p**	0.43	0.33
CN2911	Blue	**64p**	0.43	0.33
CN2912	Green	**64p**	0.43	0.33
CN2913	Red	**64p**	0.43	0.33
CN2914	White	**64p**	0.43	0.33
CN2915	Yellow	**64p**	0.43	0.33

Insulated 2mm Sockets

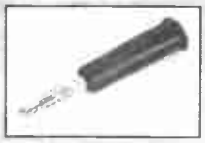
A range of insulated panel mounting 2mm sockets available in a wide range of colours. Nickel plated brass turned insert. Solder termination. Rated at 5A. Panel cutout 5.1mm.

Code	Colour	1+	25+	100+
CN2920	Black	**41p**	0.28	0.22
CN2921	Blue	**41p**	0.28	0.22
CN2922	Green	**41p**	0.28	0.22
CN2923	Red	**41p**	0.28	0.22
CN2924	White	**41p**	0.28	0.22
CN2925	Yellow	**41p**	0.28	0.22

Low Cost 4mm Plugs and Sockets

A range of very economically priced 4mm plugs and sockets. Available in red and black. Can be used in conjunction with our 4mm terminals. Solder connection.

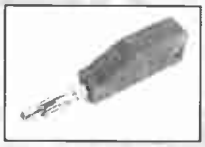
Code	Type	1+	25+	100+
CN2926	Red plug	**33p**	0.23	0.18
CN2927	Black plug	**33p**	0.23	0.18
CN2928	Red socket	**18p**	0.12	0.09
CN2929	Black socket	**18p**	0.12	0.09



4mm Plugs

A range of high quality 4mm non stackable plugs with stainless steel lantern spring to maintain contact pressure in 4mm sockets. A novel design feature of the plug enables assembly of the plug AFTER soldering. Rated at 16A.

Code	Colour	1+	25+	100+
CN2930	Black	**40p**	0.28	0.22
CN2931	Blue	**40p**	0.28	0.22
CN2932	Green	**40p**	0.28	0.22
CN2933	Red	**40p**	0.28	0.22
CN2934	White	**40p**	0.28	0.22
CN2935	Yellow	**40p**	0.28	0.22



In-Line Stackable 4mm Plugs

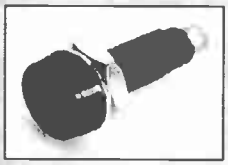
4mm plug with 4mm socket in the rear providing an in-line stacking facility. The lead wire is clamped in position by screw located at the bottom of the 4mm socket. Nickel plated brass insert with stainless steel plug spring. 10A rating.

Code	Colour	1+	25+	100+
CN2940	Black	**45p**	0.31	0.25
CN2941	Blue	**45p**	0.31	0.25
CN2942	Green	**45p**	0.31	0.25
CN2943	Red	**45p**	0.31	0.25
CN2944	White	**45p**	0.31	0.25
CN2945	Yellow	**45p**	0.31	0.25

4mm Terminals

High quality moulded terminals in acetal. All metal parts bright nickel plated. Rated at 10A. Will accept our low cost or standard 4mm plugs. Height above panel 24-32mm. 14mm diameter. Maximum panel thickness 12.7mm. Thread size 4BA clearance.

Code	Colour	1+	25+	100+
CN2950	Red	**75p**	0.50	0.40
CN2951	Green	**75p**	0.50	0.40
CN2952	Blue	**75p**	0.50	0.40
CN2953	Black	**75p**	0.50	0.40
CN2954	White	**75p**	0.50	0.40
CN2955	Yellow	**75p**	0.50	0.40



4mm Sockets

A range of very competitively priced 4mm panel mounting round sockets. The tin plated turned brass insert accepts a wide range of 4mm plugs. Moulded in acetal. Sockets have double flat along mounting bush to assist positive location in panels and are supplied complete with panel fixing nut. Solder termination.

Code	Colour	1+	25+	100+
CN2960	Black	**32p**	0.23	0.18
CN2961	Blue	**32p**	0.23	0.18
CN2962	Green	**32p**	0.23	0.18
CN2963	Red	**32p**	0.23	0.18
CN2964	White	**32p**	0.23	0.18
CN2965	Yellow	**32p**	0.23	0.18

Standard Crocodile Clips

CN2970 Standard crocodile clip. Nickel plated steel. Overall length 42mm. **10p**; 25+ 0.065; 100+ 0.05

Miniature Crocodile Clips

A range of miniature insulated crocodile clips supplied with covers. Solder termination complete with cable grip. Overall length 33mm.

Code	Colour	1+	25+	100+
CN2973	Black	**9p**	0.06	0.045
CN2974	Blue	**9p**	0.06	0.045
CN2975	Green	**9p**	0.06	0.045
CN2976	Red	**9p**	0.06	0.045
CN2977	White	**9p**	0.06	0.045
CN2978	Yellow	**9p**	0.06	0.045

Crocodile Lead Pack

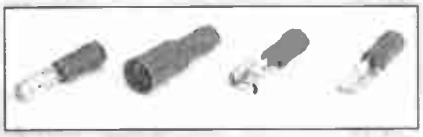
CN3980 A set of ten leads 18 inches long in five assorted colours, terminated at each end with a vinyl covered crocodile clip. Ideal for use as test clips. **£2.20**; 10+ 1.50; 50+ 1.30

Microminiature Probes

CN2982 Microminiature plunger action probes suited to making contact with components on high density PCB's including DIL packages. Solder connection. Gold flashed contacts. Max voltage 50V. Overall length 40mm. Available in pairs of 1 red and 1 black. **60p**; 25+ 0.42; 100+ 0.33

Multimeter Test Leads

CN3984 Multimeter test leads to suit our range of multimeters. Leads are of fully moulded construction and incorporate right angle 4mm plugs for ease of use. Overall length 1M. Supplied as a pair of leads: one red and one black. **£1.99;** 10+ 1.43; 50+ 1.25

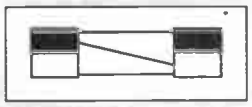


Crimp Connectors

Red sleeve (for cable up to 1.65mm dia), crimp connection supplied in packs of 10, 100, or 1000.

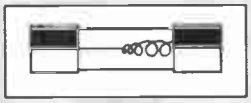
Code	Type	Pk of 10	100	1k
CN2990	Male bullet	**80p**	0.04	0.035
CN2991	Female bullet	**80p**	0.04	0.035
CN2992	Plain 0.25" blade	**80p**	0.04	0.035
CN2993	Insulated 0.25" receptacle	**80p**	0.04	0.035

FUSES



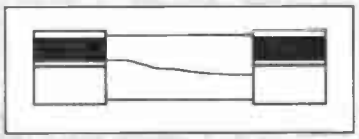
20mm Quickblow

Code	Type	1+	10+	100+
FS2A63MA	63mA	**18p**	0.12	0.07
FS2A100MA	100mA	**9p**	0.06	0.03
FS2A125MA	125mA	**9p**	0.06	0.03
FS2A160MA	160mA	**9p**	0.06	0.03
FS2A200MA	200mA	**9p**	0.06	0.03
FS2A250MA	250mA	**9p**	0.06	0.03
FS2A315MA	315mA	**9p**	0.06	0.03
FS2A400MA	400mA	**9p**	0.06	0.03
FS2A500MA	500mA	**9p**	0.06	0.03
FS2A600MA	600mA	**9p**	0.06	0.03
FS2A630MA	630mA	**9p**	0.06	0.03
FS2A800MA	800mA	**9p**	0.06	0.03
FS2A1A	1A	**9p**	0.06	0.03
FS2A1A25	1.25A	**9p**	0.06	0.03
FS2A1A5	1.5A	**9p**	0.06	0.03
FS2A1A6	1.6A	**9p**	0.06	0.03
FS2A2A	2A	**9p**	0.06	0.03
FS2A2A5	2.5A	**9p**	0.06	0.03
FS2A3A	3A	**9p**	0.06	0.03
FS2A3A15	3.15A	**9p**	0.06	0.03
FS2A3A5	3.5A	**9p**	0.06	0.03
FS2A4A	4A	**9p**	0.06	0.03
FS2A5A	5A	**9p**	0.06	0.03
FS2A6A3	6.3A	**9p**	0.06	0.03
FS2A7A5	7.5A	**9p**	0.06	0.03
FS2A10A	10A	**9p**	0.06	0.03
FS2A13A	13A	**9p**	0.06	0.03
FS2A15A	15A	**9p**	0.06	0.03
FS2A20A	20A	**9p**	0.06	0.03



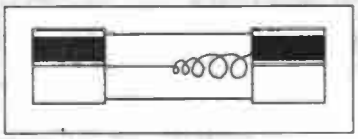
20mm Antisurge

Code	Type	1+	10+	100+
FS2B32MA	32mA	**60p**	0.45	0.30
FS2B63MA	63mA	**37p**	0.23	0.15
FS2B80MA	80mA	**37p**	0.23	0.15
FS2B100MA	100mA	**25p**	0.15	0.10
FS2B125MA	125mA	**25p**	0.15	0.10
FS2B160MA	160mA	**18p**	0.11	0.09
FS2B250MA	250mA	**18p**	0.11	0.09
FS2B315MA	315mA	**18p**	0.11	0.09
FS2B400MA	400mA	**18p**	0.11	0.09
FS2B500MA	500mA	**18p**	0.11	0.09
FS2B630MA	630mA	**18p**	0.11	0.09
FS2B800MA	800A	**18p**	0.11	0.09
FS2B1A	1A	**18p**	0.11	0.09
FS2B1A25	1.25A	**18p**	0.11	0.09
FS2B1A6	1.6A	**18p**	0.11	0.09
FS2B2A	2A	**18p**	0.11	0.09
FS2B2A5	2.5A	**18p**	0.11	0.09
FS2B3A15	3.15A	**18p**	0.11	0.09
FS2B4A	4A	**18p**	0.11	0.09
FS2B5A	5A	**18p**	0.11	0.09
FS2B6A3	6.3A	**18p**	0.11	0.09
FS2B7A5	7.5A	**18p**	0.11	0.09
FS2B10A	10A	**18p**	0.11	0.09



32mm Quickblow

Code	Type	1+	10+	100+
FS2C60MA	60mA	**18p**	0.12	0.07
FS2C100MA	100mA	**9p**	0.06	0.03
FS2C150MA	150mA	**9p**	0.06	0.03
FS2C200MA	200mA	**9p**	0.06	0.03
FS2C250MA	250mA	**9p**	0.06	0.03
FS2C350MA	350mA	**9p**	0.06	0.03
FS2C500MA	500mA	**9p**	0.06	0.03
FS2C600MA	600mA	**9p**	0.06	0.03
FS2C630MA	630mA	**9p**	0.06	0.03
FS2C750MA	750mA	**9p**	0.06	0.03
FS2C800MA	800mA	**9p**	0.06	0.03
FS2C1A	1A	**9p**	0.06	0.03
FS2C1A25	1.25A	**9p**	0.06	0.03
FS2C1A5	1.5A	**9p**	0.06	0.03
FS2C2A	2A	**9p**	0.06	0.03
FS2C2A5	2.5A	**9p**	0.06	0.03
FS2C3A	3A	**9p**	0.06	0.03
FS2C4A	4A	**9p**	0.06	0.03
FS2C5A	5A	**9p**	0.06	0.03
FS2C7A5	7.5A	**9p**	0.06	0.03
FS2C10A	10A	**9p**	0.06	0.03
FS2C13A	13A	**9p**	0.06	0.03
FS2C15A	15A	**9p**	0.06	0.03
FS2C20A	20A	**9p**	0.06	0.03



32mm Antisurge

Code	Type	1+	10+	100+
FS2D50MA	50mA	**40p**	0.30	0.20
FS2D100MA	100mA	**28p**	0.21	0.14
FS2D150MA	150mA	**28p**	0.21	0.14
FS2D200MA	200mA	**28p**	0.21	0.14
FS2D250MA	250mA	**28p**	0.21	0.14
FS2D350MA	350mA	**28p**	0.21	0.14
FS2D500MA	500mA	**28p**	0.21	0.14
FS2D600MA	600mA	**28p**	0.21	0.14
FS2D630MA	630mA	**28p**	0.21	0.14
FS2D750MA	750mA	**28p**	0.21	0.14
FS2D800MA	800mA	**28p**	0.21	0.14
FS2D1A	1A	**28p**	0.21	0.14
FS2D1A25	1.25A	**28p**	0.21	0.14
FS2D1A5	1.5A	**28p**	0.21	0.14
FS2D2A	2A	**28p**	0.21	0.14
FS2D2A5	2.5A	**28p**	0.21	0.14
FS2D3A	3A	**28p**	0.21	0.14
FS2D4A	4A	**28p**	0.21	0.14
FS2D5A	5A	**28p**	0.21	0.14
FS2D10A	10A	**28p**	0.21	0.14
FS2D13A	13A	**28p**	0.21	0.14

25mm (1") Plug Top

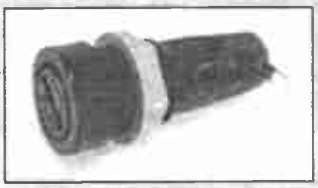
Code	Type	1+	10+	100+
FS2E2A	2A	**16p**	0.12	0.09
FS2E3A	3A	**16p**	0.12	0.09
FS2E5A	5A	**16p**	0.12	0.09
FS2E10A	10A	**16p**	0.12	0.09
FS2E13A	13A	**16p**	0.12	0.09

20mm PCB Fuse Clip

FS2010 Tin plated PCB mounting fuse clips for use with 20x5mm fuses. Each clip has two mounting legs to suit mounting on 0.1in pitch board. Clips are rated at 5A. **Price/pair 8p;** 25+ 0.05; 100+ 0.04

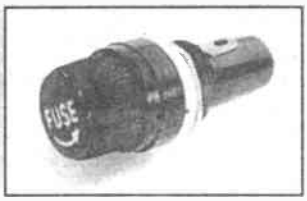
Finger Release 20mm Fuseholder

FS2020 Low cost panel mounting 20mm finger release fuseholder with knurled cap moulded in black self extinguishing polycarbonate. A screwdriver/coin slot is also incorporated in the fuse cap. Maximum fuse rating 6.3A 250V AC. **38p;** 25+ 0.29, 100+ 0.23



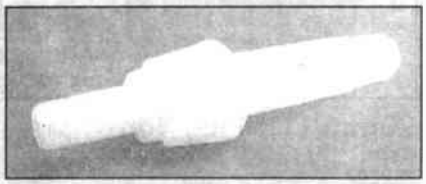
Low Profile 20mm Fuseholder

FS2030 A high quality low profile panel mounting 20mm screwdriver release fuseholder moulded in black self extinguishing polycarbonate rate at UL94V-1. Requires a flat blade screwdriver to open fuse cap. A 'D' shaped cutout prevents rotation. Maximum fuse rating 6.3A. **55p;** 25+ 0.45; 100+ 0.36



Finger Release 1¼x¼" Fuseholder

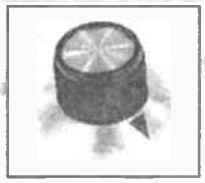
FS2040 A panel mounting 1¼x¼" finger release fuseholder moulded in phenolic resin. Maximum fuse rating 10A 250V AC. **55p**; 25+ 0.45; 100+ 0.36



Bayonet 1¼ In-line Fuseholder

FS2050 A nylon moulded bayonet action plug and socket style fuseholder suitable for 1¼ x ¼" fuses. Rated at 10A. Not recommended for use in circuits above 50V. Overall length 60mm. 15mm diameter. **20p**; 25+ 0.15; 100+ 0.12

HARDWARE



23mm Aluminium Inlay Control Knobs

Matched 23mm diameter black control knobs with spun aluminium skirt and inlay. Available calibrated 1 to 10 or with arrow indication. Depth 14mm. Grub screw for 0.25in diameter spindles.

Code	Type	1+	25+	100+
HW2101	Arrow	**55p**	0.39	0.32
HW2102	Calibrated	**55p**	0.39	0.32

30mm Aluminium Inlay Control Knobs

Matched 30mm diameter black control knobs with spun aluminium skirt and inlay. Available either calibrated 1 to 10 or with arrow indication. Depth 18mm. Grub screw for 0.25in spindles.

Code	Type	1+	25+	100+
HW2103	Arrow	**55p**	0.39	0.32
HW2104	Calibrated	**55p**	0.39	0.32

37mm Aluminium Inlay Control Knobs

Matched 37mm diameter black control knobs with spun aluminium skirt and inlay. Available either calibrated 1 to 10 or with arrow indication. Depth 15mm. Grub screw fixing for 0.25in spindles.

Code	Type	1+	25+	100+
HW2105	Arrow	**62p**	0.43	0.34
HW2106	Calibrated	**62p**	0.43	0.34

19mm Mixer Style Control Knobs

A range of 19mm skirt diameter black control knobs available with a wide variety of matching coloured caps with marker line which push fit in the knob. Knob bodies are available as push fit onto 6mm splined shafts or grub screw fixing for 6mm shafts. A stylish, modern, uncluttered control knob offering exceptional value.

Code	Type	1+	25+	100+
HW2220	Knob body (6mm push fit)	**19p**	0.13	0.10
HW2230	Knob body (6mm grub screw)	**65p**	0.45	0.36
HW2310	Red cap	**12p**	0.07	0.055
HW2320	Yellow cap	**12p**	0.07	0.055
HW2330	Green cap	**12p**	0.07	0.055
HW2340	Grey cap	**12p**	0.07	0.055
HW2350	Blue cap	**12p**	0.07	0.055
HW2360	Black cap	**12p**	0.07	0.055

Ribbed With Coloured Caps

Ribbed black plastic with coloured caps. Modern styling. Grooved pointer. Caps are interchangeable.

Diameter	13mm
Depth	15.5mm
Fitting	Grub screw
Spindle dia	6.35mm

Code	Type	1+	25+	100+
HW2410	Red cap	**30p**	0.20	0.17
HW2420	Yellow cap	**30p**	0.20	0.17
HW2430	Green cap	**30p**	0.20	0.17
HW2440	Blue cap	**30p**	0.20	0.17
HW2450	Black cap	**30p**	0.20	0.17

Black pointer Knob

HW2500 Black pointer knob with central indicator line in white. Made from phenolic plastic which is resistant to heat. Grub screw fixing for 0.25in spindles. **30p**; 25+ 0.20; 100+ 0.17

Nuts, Screws, Washers and Solder Tags all supplied in Packs of 100

Steel Nuts

Code	Type	Price
HW2680	2BA Steel Nuts	**£1.22**
HW2685	4BA Steel Nuts	**90p**
HW2690	6BA Steel Nuts	**82p**
HW2695	8BA Steel Nuts	**£1.04**

Steel Cheesehead Screws

Code	Type	Price
HW2605	2BA x 2"	**£3.20**
HW2610	2BA x 1"	**£2.80**
HW2615	2BA x ½"	**£2.20**
HW2620	2BA x ¾"	**£2.52**
HW2625	4BA x 1"	**£2.06**
HW2630	4BA x ½"	**£1.54**
HW2635	4BA x ¼"	**£1.36**
HW2640	6BA x 1"	**£1.90**
HW2645	6BA x ½"	**£1.18**
HW2650	6BA x ¼"	**£1.22**
HW2655	8BA x ½"	**£1.42**
HW2660	8BA x ¼"	**£1.24**

Steel Plain Washers

HW2700	2BA	**34p**
HW2705	4BA	**32p**
HW2710	6BA	**28p**
HW2715	8BA	**28p**

Hot Tinned Brass Solder Tags

HW2720	2BA	**£1.80**
HW2725	4BA	**£1.68**
HW2730	6BA	**£1.68**
HW2735	8BA	**£1.91**

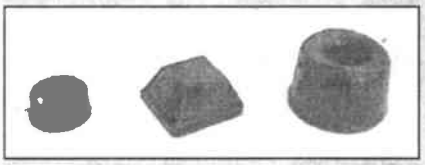
Hardware Packs

Each pack contains 20 **each** screws, nuts, washers and solder tags, **all** in **steel.**

HW2740	2BA x 1" screws etc	**£1.00**
HW2745	2BA x ½" screws etc	**90p**
HW2750	2BA x ¼" screws etc	**95p**
HW2755	4BA x 1" screws etc	**80p**
HW2760	4BA x ½" screws etc	**71p**
HW2765	4BA x ¼" screws etc	**68p**
HW2770	6BA x 1" screws etc	**75p**
HW2775	6BA x ½" screws etc	**62p**
HW2780	6BA x ¼" screws etc	**63p**
HW2785	8BA x ½" screws etc	**70p**
HW2790	8BA x ¼" screws etc	**64p**

Feet

A range of self-adhesive cabinet feet in black rubber.



Round Profile

Code	Dia	Height	Pk/10	100+	1k+
HW2800	10mm	4mm	**48p**	0.04	0.03
HW2810	13mm	3.6mm	**70p**	0.042	0.035

Square Profile

Code	Width	Height	Pk/10	100+	1k+
HW2820	10mm	5mm	**70p**	0.042	0.035
HW2830	12.5mm	5.7mm	**80p**	0.044	0.038
HW2840	20mm	8mm	**£1.25**	0.09	0.07

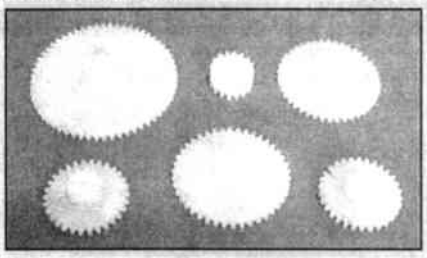
Screw On Feet

Moulded with a 3.5mm mounting hole. Black or grey finish, according to availability.

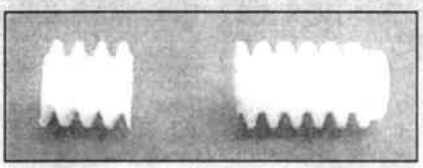
Code	Dia	Height	Pk/10	100+
HW2850	15.5mm	10mm	**£1.40**	0.10
HW2860	19mm	10mm	**£1.60**	0.11

Gears

A range of miniature gears to use with small motors. Available in individual sizes or mixed packs as shown. All have 1.9mm base for tight fit onto 2mm spindle.



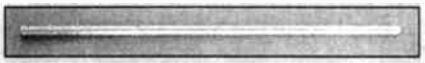
Code	OD Teeth	OD	ID	Pk of 10	100+	1k+
HW2900	16	9	-	28p	0.016	0.012
HW2910	30	16	6	37p	0.021	0.016
HW2920	42	22	6	48p	0.027	0.021
HW2930	60	31	6	67p	0.038	0.029
HW2940	30	16	5.5	37p	0.021	0.016
HW2950	42	22	5.5	48p	0.027	0.021



Miniature Worm Gears

Miniature worm gears for use with the above gears.

Code	Dia	Length	Pk/10	100+	1k+
HW2960	6	6	32p	0.018	0.014
HW2970	6	10	44p	0.025	0.019



Steel Shaft

HW2980 Steel shaft for use with above worms and gears. 2mm dia x 75mm long. **Pack of 10 23p;** 100+ 0.013; 1k+ 0.01

HW2985 Pack of 10 each of all listed items above. Total 90 items. **£2.95;** 10+ 1.90

DC Motors

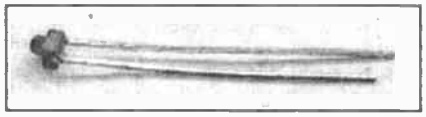
A range of 3 small motors operating on 1.5 to 4.5V with many applications including models, robotics and educational demonstrations.

HW2990 30mm long x 20mm dia with flats on both sides. Speed 14,000 RPM at 3V. 1=380mA. Stall torque 26g/cm. **40p;** 25+ 0.30; 100+ 0.20

HW2992 30mm long x 24mm dia. Higher torque than above. Speed 6,300 RPM at 3V. 1=110mA. Stall torque 44g/cm. **50p;** 25+ 0.35; 100+ 0.25

HW2994 34mm long x 24mm dia. High torque model. Speed 8,300 RPM at 3V. 1=170mA. Stall torque 56g/cm. **60p;** 25+ 0.44; 100+ 0.34

OPTOELECTRONICS



Miniature 1.8mm LED

A range of miniature diodes diffused package of 1.8mm diameter suited to through-panel applications. Cathode identified by shorter lead. Package style 2. Kingbright L-1060 series.

Technical Specification

	I_f max	V_f typ	V_f max	V_R max	Int at I_f mcd	View angle	Wave length
Red	20mA	2V	2.6V	5V	2.0 at 10mA	30°	660
Green	30mA	2.2V	2.6V	5V	5 at 10mA	30°	565
Amber	30mA	2V	2.6V	5V	12.5 at 10mA	30°	626
Yellow	30mA	2.1V	2.6V	5V	5.0 at 10mA	30°	590

Code	Type	1+	100+	1000+
OP2010	Red	13p	0.081	0.065
OP2020	Green	13p	0.089	0.077
OP2030	Amber	15p	0.098	0.078
OP2040	Yellow	15p	0.098	0.078

Miniature 3mm LED

A range of miniature 3mm round LEDs housed in a diffused coloured package. A wide range of colour options. Kingbright L934 series. Package style 7.

Technical Specification

	I_f max	V_f typ.	V_f max	V_R max	Int at I_f mcd	View angle	Wave length
Red	20mA	2V	2.6V	5V	5@10mA	60°	625
Bright red	30mA	2V	2.6V	5V	50@10mA	60°	625
Green	25mA	2.2V	2.6V	5V	32@10mA	60°	565
Yellow	30mA	2.1V	2.6V	5V	32@10mA	60°	590
Amber	30mA	2V	2.6V	5V	50@10mA	60°	625

Code	Type	1+	100+	1000+
OP2105	Red	10p	0.05	0.035
OP2110	Bright Red	10p	0.05	0.035
OP2115	Green	12p	0.06	0.05
OP2120	Yellow	12p	0.06	0.05
OP2125	Amber	12p	0.06	0.05

Standard 5mm LED

A range of 5mm LEDs suitable for PCB and panel mounting applications. A wide range of colour options available. Kingbright L-53 series. Packaged style 8. Cathode identified by flat on body.

Technical Specification

	I_f max	V_f typ.	V_f max	V_R max	Int at I_f mcd	View angle	Wave length
Red	20mA	1.7V	2V	5V	3.2@10mA	60°	625
Bright Red	25mA	2.0V	2.5V	5V	80@10mA	60°	626
Green	25mA	2.2V	2.5V	5V	32@10mA	60°	565
Yellow	30mA	2.1V	2.5V	5V	32@10mA	60°	590
Amber	30mA	2.0V	2.5V	5V	80@10mA	60°	625

Code	Type	1+	100+	1000+
OP2205	Red	10p	0.05	0.035
OP2210	Bright Red	10p	0.05	0.035
OP2215	Green	12p	0.06	0.05
OP2220	Yellow	12p	0.06	0.05
OP2225	Amber	12p	0.06	0.05

Bi-colour 5mm LED

OP2250 Miniature bi-colour 5mm LED comprising two LEDs (red/green) connected in inverse parallel housed in a milky white package. Applications include polarity indication, etc. Package style 8A. Kingbright L-57W series. **35p;** 25+ 0.23; 100+ 0.18

Technical Specification

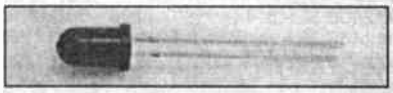
	I_f max	V_f typ.	V_f max	V_R max	Int at I_f mcd	View angle	Wave length
Red	30mA	2V	2.6V	5V	40@20mA	60°	625
Green	30MA	2.2V	2.6V	5V	40@20mA	60°	565

Tri-colour 5mm LED

OP2260 Miniature tri-colour 5mm LED housed in a milky package. Both diodes (red/green) are connected in a common cathode configuration and by connecting both together a third colour is obtained. Style 8b. Kingbright L-59W series. **36p;** 25+ 0.24; 100+ 0.19

Technical Specification

	I_f max	V_f typ.	V_f max	V_R max	Int at I_f mcd	View angle	Wave length
Red	30mA	2V	2.6V	5V	90@20mA	60°	625
Green	30mA	2.2V	2.6V	5V	70@20mA	60°	565



Flashing 5mm LED

A range of 5mm LEDS in a diffused package with an inbuilt IC to provide a continuous flash at a frequency of 3Hz. Supply voltage 9 to 12V - no series resistor required. Ideal for use in warning devices, alarms, etc. Kingbright L-56 series. Package style 8.

Technical Specification

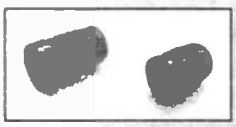
	I_f max	V_f typ.	V_f max	V_R max	Int at I_f mcd	View angle	Wave length
Red	50mA	9-12V	3.6V	0.5V	5@9V	120°	650
HE Red	50mA	9-12V	3.6V	0.5V	80@9V	120°	625
Green	50mA	9-12V	3.6V	0.5V	32@9V	120°	565
Yellow	50mA	9-12V	3.6V	0.5V	32@9V	120°	590

Code	Type	1+	25+	100+
OP2300	Red	50p	0.38	0.30
OP2305	HE Red	70p	0.50	0.40
OP2310	Green	55p	0.41	0.33
OP2315	Yellow	70p	0.50	0.40

3mm and 5mm Panel Clips

3mm one part and 5mm two part panel clips to suit above LEDs

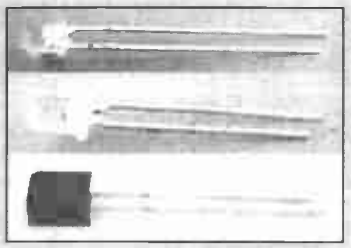
Code	Type	1+	100+	1000+
OP2350	3mm	5p	0.03	0.02
OP2360	5mm	5p	0.03	0.02



5mm Bezel Panel Clips

Attractive push fit panel clips for 5mm LEDs in black nylon offering professional appearance at low cost. Available in either recessed or prominent position styles. Mounting hole is 8mm.

Code	Type	1+	100+	1000+
OP2370	Prominent	16p	0.10	0.08
OP2380	Recessed	16p	0.10	0.08



High Power Infra-Red Source and Sensor

A range of spectrally matched near infra-red emitters and sensors. The infra-red emitters have very high power output and are housed in a standard 5mm clear package. The sensor is a high speed PIN photo diode with high sensitivity housed in a black infra-red transmissive epoxy moulding.

Technical specification

Emitter	Standard		High Power
Radiant output pwr	10mW		20mw
Wavelength	940nm		880nm
Forward V (max.)	1.6V		1.7V
Forward current (max)		100mA	
Power dissipation	100mW		120mW
Viewing angle		30°	
Temperature range		-30 to +80 deg C	
Sensor			
Breakdown (I_R =100µA)		32V min.	
Dark Current (V_R =10V)		2nA typ.	
Light Current (V_R =5V)		45µA typ.	

Code	Type	1+	25+	100+
OP2400	Standard emitter	**26p**	0.16	0.13
OP2405	High power emitter	**32p**	0.23	0.17
OP2410	Sensor	**72p**	0.46	0.36

Light Dependent Resistor ORP12

OP2450 A cadmium sulphide cell light dependent resistor in a sealed plastic case with clear end window. Resistance reduced as the light falling on the device increases **£1.04**; 25+ 0.70; 100+ 0.60

Technical specification

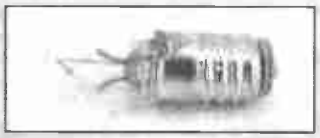
Dark resistance	1 Megohm
Resistance @ 1Ftc	9 Kilohms
@ 100Ftc	400 ohms
Max voltage	320V dc or ac peak
Max current	75mA

BULBS

Wire Ended Bulbs

Submin and miniature types in a variety of voltages.

Code	Type	1+	25+	100+
OP2500	6V 65mA clear 10x3.2 dia	**28p**	0.18	0.14
OP2505	12V 65mA clear 10x3.2 dia	**28p**	0.18	0.14
OP2510	12V 65mA red 8.2x3.2 dia	**28p**	0.18	0.14
OP2515	12V 65mA green 8.2x3.2 dia	**28p**	0.18	0.14
OP2520	12V 65mA blue 8.2x3.2 dia	**28p**	0.18	0.14
OP2525	12V 65mA yellow 8.2x3.2 dia	**28p**	0.18	0.14



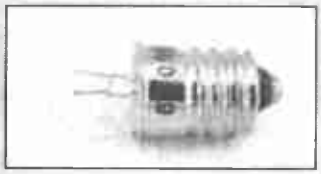
T1.5 LES Lamp

A range of miniature T1.5, LES (E5) lamps to suit our lampholders. Dimensions 16mm x 5mm diameter.

Technical specification

Voltage	Current	Watts	Nom lumens	Nom Hours
6V	60mA	0.36	1.0	1000
12V	80mA	0.96	2.0	10000
24V	40mA	0.96	3.8	5000

Code	Type	1+	25+	100+
OP2550	6V	**28p**	0.18	0.15
OP2560	12V	**28p**	0.18	0.15
OP2570	24V	**28p**	0.18	0.15



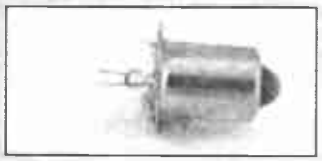
MES (E10) G3½ 11mm Lamps

A range of miniature MES lamps in a wide range of voltages. 11mm diameter, 23mm overall length.

Technical Specification

V	Current	W	Lumens	Nominal life (hrs)
1.5V	300mA	0.45	1.2	50
2.5V	200mA	0.5	3.8	100
3.5V	300mA	1.05	6.0	1000
6.0V	60mA	0.36	1.0	10000
12.0V	200mA	2.4	12.0	3000

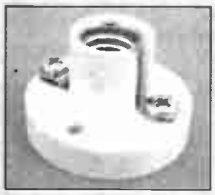
Code	Type	1+	25+	100+
OP2600	1.5V,300mA	**15p**	0.09	0.07
OP2610	2.5V,200mA	**15p**	0.09	0.07
OP2620	3.5V,300mA	**15p**	0.09	0.07
OP2630	6.0V,60mA	**18p**	0.11	0.08
OP2640	12.0V,200mA	**18p**	0.11	0.08



Pre-Focus

Range fitting 27mm x10mm diameter.

Code	Type	1+	25+	100+
OP2700	2.4V,500mA	**20p**	0.14	0.11
OP2710	3.6V,500mA	**20p**	0.14	0.11
OP2720	4.8V,500mA	**20p**	0.14	0.11
OP2730	6V,500mA	**20p**	0.14	0.11
OP2740	12v,500mA	**20p**	0.14	0.11



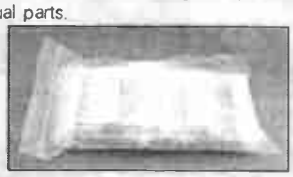
MES Lampholder

OP2800 MES battenholder. Spring loaded contact, cross head screw connections, white. Dimensions are 29mm diameter, fixing centres 22mm. **30p**; 25+ 0.19; 100+ 0.14

PACKS & KITS

Component Packs

These packs of brand new top quality components are designed to give the constructor a complete range of the right values to hand whenever required. They also give a substantial saving (40% or greater) over buying individual parts.



CR25 Carbon Film Resistor Kit

KT3010 A pack containing a total of 1,000 0.25W 5% carbon film resistors ranging in value from 4.7 ohms through to 10 Megohms. A total of 64 different values. Supplied in 8 packs. **£9.95**; 5+ 7.18, 25+ 5.75

Contents

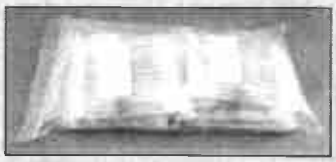
10x4R7	10x120R	30x1K	10x8K2	15x68K	10x560K
5x5R6	10x150R	15x1K2	30x10K	10x82K	10x680K
10x10R	10x180R	15x1K5	15x12K	30x100K	5x820K
10x15R	20x220R	10x1K8	15x15K	20x120K	20x1M
10x22R	20x270R	25x2K2	15x18K	15x150K	10x2M2
10x33R	20x330R	20x2K7	20x22K	15x180K	5x3M3
10x47R	10x390R	20x3K3	15x27K	20x220K	10x4M7
10x56R	30x470R	15x3K9	20x33K	15x270K	5x6M8
10x68R	20x560R	25x4K7	10x39K	15x330K	20x10M
10x82R	20x680R	20x5K6	30x47K	10x390K	
10x100R	10x820R	15x6K8	20x56K	25x470K	

CR50 Carbon Film Resistor Kit

KT3020 A pack containing a total of 1,000 0.5W 5% carbon film resistors ranging in value from 4.7 ohms through to 10 Megohms. A total of 64 different values. Supplied in 8 packs. **£12.95**; 5+ 7.37; 25+ 7.22

Contents

10x4R7	10x120R	30x1K	10x8K2	15x68K	10x560K
5x5R6	10x150R	15x1K2	30x10K	10x82K	10x680K
10x10R	10x180R	15x1K5	15x12K	30x100K	5x820K
10x15R	20x220R	10x1K8	15x15K	20x120K	20x1M
10x22R	20x270R	25x2K2	15x18K	15x150K	10x2M2
10x33R	20x330R	20x2K7	20x22K	15x180K	5x3M3
10x47R	10x390R	20x3K3	15x27K	20x220K	10x4M7
10x56R	30x470R	15x3K9	20x33K	15x270K	5x6M8
10x68R	20x560R	25x4K7	10x39K	15x330K	20x10M
10x82R	20x680R	20x5K6	30x47K	10x390K	
10x100R	10x820R	15x6K8	20x56K	25x470K	



MR25 Metal Film Resistor Kit

KT3030 A pack containing a total of 0.25W 1% 50ppm precision metal film resistors ranging in value from 10 ohms through to 10 Megohms. A total of 70 different values including many selected from the E24 range to provide a comprehensive spread of resistances. Supplied in 10 packs all clearly marked with contents. **£16.95**; 5+ 11.40; 25+ 9.12

Contents

10x 10R	10x150R	10x910R	15x5K6	15x33K	15x220K
10x15R	10x180R	20x1K	15x6K8	10x39K	10x240K
10x22R	20x220R	20x1K2	10x7K5	10x43k	10x270K
10x33R	20x270R	15x1K5	10x8K2	20x47K	20x330K
10x39R	30x330R	10x1K8	30x10K	15x56K	10x390K
15x47R	10x390R	10x2K	15x12k	10x68K	20x470K
10x56R	10x430R	20x2K2	15x15K	10x75K	10x560K
10x68R	20x470R	10x2K7	10x16K	10x82K	10x680K
10x75R	10x560R	15x3K3	10x18K	40x100K	10x820K
10x91R	10x620R	10x3K9	10x20K	15x120K	30x1m
30x100R	20x680R	25x4K7	20x22K	10x150K	
10x120R	10x820R	10x5K1	15x27K	10x180K	

PRICES IN BOLD INCLUDE VAT; QTY PRICES IN LIGHT DO NOT

Ceramic Capacitor Kit

KT3040 A pack containing a total of 240 50V ceramic disc and plate capacitors ranging in value from 22pF to 0.1µF. Each value is individually packed. A total of 26 different values. **£9.95;** 5+ 7.19; 25+ 5.75

Contents

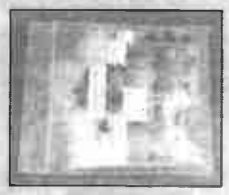
5x22p	5x82p	10x220p	10x560p	10x2n2
5x33p	20x100p	5x270p	5x680p	10x3n3
10x47p	5x120p	15x330p	5x820p	10x4n7
5x56p	10x150p	5x390p	20x1n	5x6n8
5x68p	5x180p	15x470p	10x1n5	20x10n
10x100n				

Miniature Polyester Capacitor Kit

KT3050 A pack containing total of 100 miniature 5mm pitch polyester capacitors. Each value individually packed. A total of 9 different values. **£7.95;** 5+ 5.31; 25+ 4.25

Contents

15x1n	10x4n7	10x22n	20x100n	5x470n
10x2n2	15x10n	10x47n	5x220n	



Metallised Polyester Capacitor Kit

KT3060 A pack containing a total of 110 250V metallised polyester capacitors ranging in value from 10n to 470n. Each value individually packed. A total of 11 different values. **£10.95;** 5+ 8.12; 25+ 6.50

Contents

20x10n	10x22n	15x47n	20x100n	10x22n	5x470n
5x15n	10x33n	5x68n	5x150n	5x330n	

Radial Electrolytic Capacitor Kit

KT3070 A package containing a total of 93 miniature radial lead electrolytic capacitors. Each value individually packed. A total of 12 different values. **£10.95;** 5+ 7.97; 25+ 6.38

Contents:

10x1µ 63V	15x10µ 25V	15x100µ 16V	3x100µ 16V
10x2µ2 63V	5x22µ 25V	5x220µ 16V	3x1000µ 25V
10x4µ7 63V	10x47µ 25V	6x470µ 16V	2x2220µ 16V

Preset Potentiometer Kit

KT3080 A pack containing a total of 110 miniature horizontal preset potentiometers. Each value individually packed. A total of 13 different values. **£9.95;** 5+ 6.17; 25+ 4.94

Contents

5x100R	10x1k	15x10k	15x100k	10x10M
5x220R	10x2k2	5x22k	5x220k	
5x470R	10x4k7	10x47k	5x470k	

ISO Metric Steel Screw Kits

A range of kits of bright zinc plated slotted pan head screws and full nuts and washers. All sizes of screw and nut are individually packed in resealable polythene bags.

KT3090 M2.5 Screw Kit. **£6.50;** 5+ 4.61; 25+ 3.65

Contents

100	M2.5 6mm Screws	
100	M2.5 12mm Screws	
100	M2.5 20mm Screws	
300	M2.5 Nuts	
300	M2.5 Washers	Total 900 items

KT3100 M3 Screw Kit. **£6.95;** 5+ 4.84; 25+ 3.88

Contents:

200	M3 6mm Screws	
100	M3 12mm Screws	
50	M3 20mm Screws	
50	M3 25mm Screws	
400	M3 Nuts	
400	M3 Washers	Total 1200 items

KT3110 M4 Screw Kit. **£6.95;** 5+ 4.84; 25+ 3.88

Contents

100	M4 6mm Screws	
100	M4 12mm Screws	
50	M4 20mm Screws	
50	M4 25mm Screws	
300	M4 Nuts	
300	M4 Washers	Total 900 items

Self-Tapping Screw Kits

A range of kits of slotted pan head self tapping screws. Type AB screws finished in clear passivated zinc plate.

Contents:

No. 4 size	No. 6 size	No. 10 size
50 12.7mm	20 19.1mm	20 25.4mm
100 9.5mm	100 12.7mm	50 19.1mm
50 6.4mm	50 9.5mm	50 12.7mm
50 6.4mm	50 9.5mm	

Code	Type	1+	5+	25+
KT3120	No.4 size	**£3.20**	2.31	1.85
KT3130	No.6 size	**£2.95**	2.11	1.69
KT3140	No.10 size	**£3.95**	2.73	2.18

20mm Quick Blow Fuse Kit

KT3150 A kit of 77 20mm quick blow fuses Each type individually packed. Selection has been carefully chosen by rating. **£6.95;** 5+ 5.07; 25+ 4.58

Contents

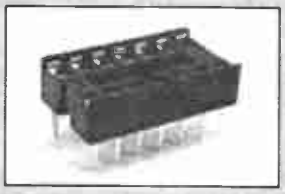
2 50mA	15 1A	10 5A
5 100mA	5 1.6A	6 6.3A
5 250mA	10 2A	
10 500mA	10 3.15A	

20mm Slow Blow Fuse Kit

KT3160 A kit of 102 20mm slow blow (time delay) fuses. Each fuse is individually packed in a resealable polythene bag. Selection has been carefully chosen by rating. **£11.95;** 5+ 8.97; 25+ 8.20

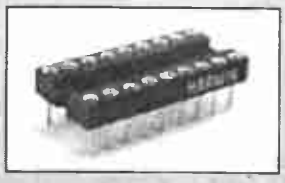
Contents

2 50mA	20 1A	5 3.15A
5 100mA	10 1.6A	10 5A
10 250mA	15 2A	10 6.3A
10 500mA	5 2.5A	



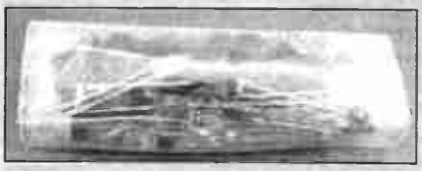
Low Profile DIL Sockets

KT3170 A pack of popular sizes of low profile DIL sockets comprising the following: 20x8pin; 20x14pin; 20x16pin; 5x18pin; 5x20pin; 5x22pin; 5x24pin; 10x28pin; 5x40pin. Total 90 sockets. **£8.20;** 5+ 6.50; 25+ 5.20



Turned Pin IC Sockets

KT3180 A pack of high quality turned pin IC sockets: 10x8pin; 20x14pin; 20x16pin; 5x18pin; 5x20pin; 5x22pin; 10x24pin; 10x28pin; 10x40pin. Total 95 sockets. **£21.95;** 5+ 16.50; 25+ 13.25



LED's

KT3190 A pack containing 60 LED's and clips in red, green and yellow. Contents: 10x3mm Red; 10x5mm Red; 10x3mm Green; 10x5mm Green; 10x3mm Yellow; 10x5mm Yellow; 30x3mm clips. 30x5mm clips. **£7.95;** 5+ 6.20; 25+ 4.95

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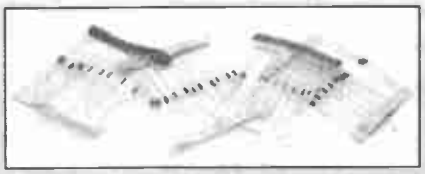


Zeners

KT3200 400mW 5% zener diodes, 10 each of all values from 2V7 to 36V. Total 280 zeners **£12.95; 5+ 9.25; 25+ 7.40**

ELECTRONIC PROJECT KITS

A range of easy to build electronic projects offering an ideal introduction to electronics circuitry and soldering techniques. All kits are supplied complete with all components required, solder, screen printed printed circuit boards and comprehensive instructions.

Pocket Transistor Radio

KT3410 Based on the popular ZN414, a miniature pocket radio kit that includes all components including tuning capacitor, headphone socket and crystal headphone. Excludes PP3 battery. Small enough to fit into your pocket but sensitive enough to pick up distant radio stations. **£10.95**

Water/Moisture Indicator

KT3420 A simple circuit which can be used to monitor the amount of water in soil or water levels in tanks etc. Supplied complete with PCB, components and probes. Excludes PP3 battery **£9.50**

Electronic Dice

KT3430 An electronic dice based on the NE555 and 4017B decade counter. LEDs indicate random dice selection which can be modified to become an 'LED' chase circuit. Includes PCB, components and switch. Excludes PP3 battery **£8.95**

RAILWAY MODELLERS PROJECT KITS

Many hundreds of these popular kits have already been sold since being published in our 'Modellers Guide to Electronics'. This gives full constructional details of all projects and is free on request. The kits are supplied with all necessary components and circuit board. Boxes are not included as in many cases projects will be built into existing equipment. The following 16 kits come complete with full constructional and circuitry details.

KT3621 Power Supply Unit. Uses mains transformer to provide a 'clean' stabilised 12v supply for projects from 15Vac. **£2.75; 10+** 1.82

KT3622 Flickering Fire. Simple circuit that created the effect of flickering flames in engine boxes or trackside bonfires **£1.50; 10+** 0.99

KT3623 Simple Signalling System. Reed switches in the track are operated by loco; signals are changed from green to red as train passes. Manual reset/over-ride. **£2.95; 10+** 1.95

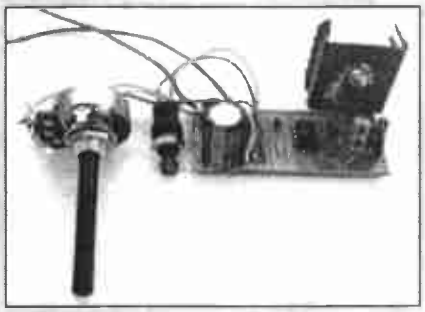
KT3624 Level Crossing Lights. As a train approaches the crossing the red LED's will flash. A second reed switch placed in the track after the crossing will turn them off. **£2.60; 10+** 1.72

KT3625 Two Tone Horn. A simple circuit operated by a changeover switch. **£2.95; 10+** 1.95

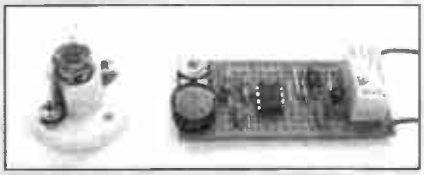
KT3626 Points Controller. Another small circuit that allows the heavy current required by points solenoids to be controlled by a small switch. **£3.10; 10+** 2.05

KT3627 Steam Whistle. This is a more complex circuit but simulates the sound quite accurately. Needs an amplifier and speaker. **£3.50; 10+** 2.31

KT3678 1 Watt Amplifier. A simple IC based circuit designed to run off 12v. Use with steam whistle and chuffer kits. **£3.50; 10+** 2.35



KT3672 Advanced Controller. This kit simulates the inertia of a train, by providing slow acceleration even if the speed control is turned rapidly, and also allows the train to 'coast' when the power is turned back to zero. For more rapid braking, there is a stop button. Supplied with case. **£12.95; 10+** 8.65



KT3673 Optical Sensor. An alternative to magnets and reeds - this kit uses a lamp one side of the track and a sensor the other. When the train interrupts the beam, a relay operates **£4.50; 10+** 3.02

KT3674 Infra Red Sensor Transmitter. A more sophisticated version of the above kit **£1.75; 10+** 1.17

KT3675 Infra Red Sensor Receiver. Use with above Transmitter. **£4.95; 10+** 3.32

KT3676 Chuffer Sound Effect. A novel kit accurately reproducing the chuffing noise of a steam loco. Needs amp and speaker. **£2.50; 10+** 1.68

KT3677 Automatic Chuffer. A more sophisticated version of the above kit - the kit controls the chuffing rate by sensing the track voltage, so the faster the train goes, the faster it chuffs. Needs amp and speaker. **£2.95; 10+** 1.98

Transmitter Kits

3V FM Transmitter

KT3570 The most powerful 'bug' available for its size, 3V supply and number of components. Guaranteed to transmit over 100 metres within buildings and to 500 metres in the open. Easily tunable in the FM band. Greater range at higher voltage and better aerial. **£6.95**

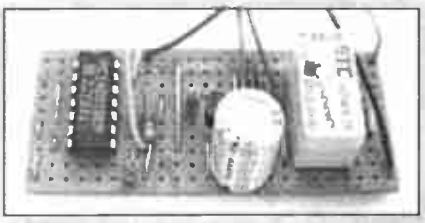
9V FM Transmitter

KT3580 More powerful FM transmitter 'bug' than above. Tank oscillator coil built into the circuit board. Can be tuned anywhere in FM band. 9V battery operation. Over 400m range in the open depending on aerial used. **£8.95**

Two Stage FM Transmitter

KT3590 Our most powerful FM 'bug' transmitter to date. A two stage FM transmitter with an RF transistor (2N3563 or ZTX320) in its output stage. 9V operation. On/off switch mounted on the PCB. **£8.95**

Please Note: These Transmitters are not licensable in the UK



KT3679 Automatic Reverse. This kit will reverse the direction of the train when it passes over a sensor in the track. **£4.00; 10+** 2.68

Sensing and Control Projects for the BBC Micro Kit

The kits for the projects in this book are designed to use the facilities provided on the BBC computer, but which are not often employed. They actually link the micro to the 'real world' with practical projects that maybe simple, but although no soldering or knowledge of electronics is required, are certainly not trivial.

Two kits are available, as the book is divided into two distinct section; Analogue to Digital Converter Projects (Kit1) and User Port Projects (Kit 2). Both kits contain all parts required to complete all projects in their particular section. All parts are available separately if required.

Code	Type	1+	10+
KT3500A	Book	£6.95	2.50
KT3500	Kit 1	£12.00	7.50
KT3510	Kit 2	£22.00	13.75

(Book FREE with either BBC Kit)

Adventures With Electronics Kit

Based on the book by Tom Duncan, the carefully chosen selection of parts enables the complete beginner in electronics to make working projects on the 'breadboard' supplied. No soldering is required, as the components simply push in the holes in S-Dec breadboard to make contact. Apart from showing how to build specific projects, the book contains a wealth of information on the subject generally, all written in a very readable manner. All parts are supplied in a strong compartment try with hinged lid. Things to make include simple lamp and battery circuits; parking light; rain detector; fire alarm; flashing lamp; morse buzzer; burglar alarm; organ; metronome; siren; intercom; 3 radios; timer; computer counter, everything supplied including wire and sleeving - you just need a 4.5V battery.

Code	Type	1+	10+
KT352A	Book	£7.95	-
KT3520	Kit	£25.95	18.00

Adventures With Microelectronics Kit

As with the previous kit, this includes all parts to build numerous projects, all based on integrated circuits. Again a breadboard is used so no soldering is required, and all the parts can be used again and again. All parts are supplied in a strong compartment tray with hinged lid. Things to make include two tone door bell; warbling wailing siren; two octave organ; light counter; reaction timer; MW/LW radio, etc. All that is required is a 9V battery.

Code	Type	1+	10+
KT353A	Book	£7.95	-
KT3530	Kit	£34.95	23.00

PC Etching Kit Mk V

KT3540 Many thousands of these popular kits have now been sold, establishing it as one of the most successful. Each kit contains an etching tray, Ferric Chloride, Etch resist pen, 100 sq ins assorted copper clad board, abrasive cleaner and full instructions. **£5.95;** 10+ 4.25

De Luxe Etching Kit

KT3550 High quality plastic tray 285x165x42mm with clip on lid for both etching boards and keeping kit together. Contains 2 packs Ferric Chloride, abrasive polishing block, etch resist pen with spare tip, two sheets of single sided photo resist coated board 160x100mm, 2 sachets developer, 200 sq ins, assorted single and double sided copper clad board, 1 pack DEK99 transfers, full instructions. **£15.95;** 10+ 11.39

10 in 1 Kit

KT3555 Mini electronic kit ideal for beginners - no soldering required. Build 10 exciting projects -kit contains breadboard and all parts needed to build any of the following great projects! Signal injector, Battery tester, Audio amplifier, Continuity tester, Light activated switch, Siren, Morse buzzer, Organ, Reaction game, Metronome. **All for £9.95**

Variable Power Supply Kit

KT3560 Simple kit using our Z660 power supply to give a 10 watt variable output from 4-20V, fully stabilized. Only needs 2 components added! Input must be at least 3V above max required output. Circuit features overload/short circuit protection and thermal cut-out. **£5.95**

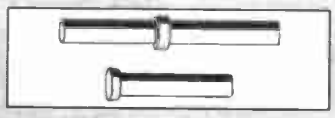
Specifications:

Input	7-25V DC, 1.5A
Output	4 -20v DC variable 10 watts max
Size	50x50x21mm
Weight	37.7g

PCB EQUIPMENT

Stripboard Cutter

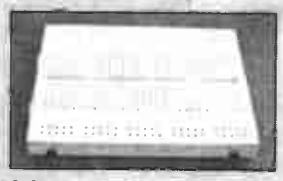
PC2060 Stripboard cutter for simple track cutting. Insert tool at the point where break is required and twist clockwise. **£1.95;** 10+ 1.31



Terminal Pins

Press fit terminal pins for use with stripboard. Supplied in packs of 100.

Code	Type	1+	25+	100+
PC2070	Single sided	64p	0.42	0.32
PC2080	Double sided	£1.38	0.90	0.69



Protobloc 1

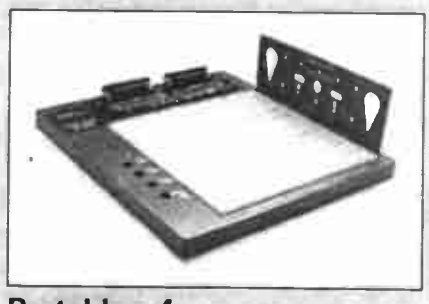
PC3110 Protobloc 1 has a total of 400 tie points consisting of two sets of 30 rows of 5 interconnected sockets plus 5 rows of 25 interconnected sockets running alongside, suitable for use as power supply rails. All contact positions are clearly defined on an alphanumeric grid. ABS polymer board mounted on an adhesive foam base. Will accommodate up to three 16 pin devices. An ideal introduction to solderless circuit development systems. Size 80x60mm. **£2.95;** 25+ 1.90

Protobloc 2

PC3120 Protobloc 2 has a total of 840 tie points consisting of tow sets of 64 rows of 5 interconnected sockets plus 4 rows of 50 interconnected sockets running alongside, suitable for use as power supply rails All contact positions are clearly defined on an alphanumeric grid. ABS polymer board mounted on an adhesive foam base. Will accommodate up to seven 16 pin devices. Size 172 x 64mm. **£4.95;** 25+ 3.40

Protobloc 2A

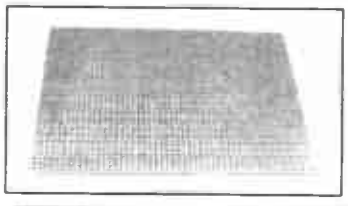
PC3130 As above but the ABS polymer board is mounted onto a rigid base plate complete with three 4mm terminals in red, black and green for power connections. A mounting bracket which clips into the base is also provided to accept a variety of components including switches and potentiometers. **£9.95;** 10+ 6.56



Protobloc 4

PC3140 Protobloc 4 has a total of 2320 tie points consisting of three sets of 64 rows of 5 interconnected sockets plus 8 rows of 50 interconnected sockets running alongside, suitable for use as power supply rails. Incorporated into the base plate are male and female RS232 connectors terminated to contact sockets to enable easy interface with computer systems, etc. The base plate also includes four 4mm terminals and a mounting bracket which clips into the base to accept a wide variety of components including switches and potentiometers, etc. Overall size 255x230. **£39.95;** 5+ £29.85

Stripboard



Fully pierced single sided copper strips 0.1" pitch. Available in the following sizes:

Code	Size (mm)	Tracks No.	Holes	1+	25+	100+
PC2010	25x64	9	25	22p	0.14	0.11
PC2020	64x95	24	37	74p	0.48	0.37
PC2030	95x127	36	50	£1.50	0.98	0.75
PC2040	95x432	36	170	£4.50	3.08	2.37
PC2050	119x455	46	179	£5.95	4.06	3.12

PRICES IN BOLD INCLUDE VAT; QTY PRICES IN LIGHT DO NOT

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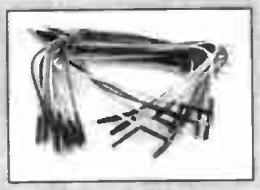
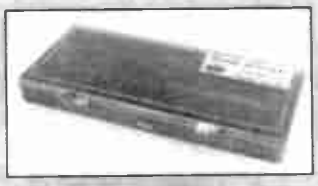


Jumper Links

PC2150 A set of 25 colour coded leads with specially designed plugs to minimise wear on connector Supplied in packs of 25, 5 of each of 50, 70, 100, 150 and 200mm lengths, assorted colours. **£5.95; 10+ 4.31**



Jumper Wire Kit

PC3160 Attractive hinged plastic case 270x122x30mm with 14 compartments housing 25 each of the following sizes jumper wires, all colour coded: 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 2.0, 3.0, 4.0 and 5.0 inches **£8.95; 10+ 6.12**

Printed Circuit Requirements

PC2170 Etch Resist Pen. For use on plain copper boards. **£1.05; 25+ 0.72**

PC3180 Ferric Chloride. Sealed bag containing 500g of quick dissolving granules when mixed with 1 litre of warm water. **£2.90; 10+ 1.81**

PC2190 Single Sided Photo Resist Coated Copper Clad Board, 160x100mm. Can be exposed by daylight, ordinary light bulb or UV lamp. Follow instructions on packet. **£2.75; 10+ 1.78; 25+ 1.45**

PC2200 Developer. Sachet of Sodium Hydroxide Crystals. Makes up 500ml of liquid when mixed with water. **£1.50; 10+ 1.01; 25+ 0.81**

PC2210 Abrasive Polishing Block. For cleaning PCB's. Cleans, degreases and polishes in one simple operation. **£2.25; 25+ 1.56**

POWER SUPPLIES & FANS

Unregulated Power Supplies

PS3300 Plug in power supply with 6 output voltages. Polarity switch and output it via a 4 way spider plug and 1.3mm dc Walkman plug. **£3.95**

Input Voltage	220/240V ac 50hz
Output Voltage	3,4.5,6,7.5 9 & 12Vdc
Output Current	300mA max
Stability	40%
Dims	75x62x54mm

Regulated Power Supplies

PS3310 A plug in regulated power supply, 3-12v dc output switchable. Reverse polarity switch and LED indicator. Designed for radios, walkmans, calculators, keyboards, toys etc. Supplied with 6 dc adapter plugs. .Features include. IC regulated output, automatic thermal cut off, short circuit protection and automatic overload cut off. **£6.50**

Input Voltage	220/240Vac 50hz
Output Voltage	3,4.5,6,7.5,9 & 12Vdc
Output Current	300mA max
Stability	2%
Ripple	10mV
Dims	87x62x62mm

PS3320 Plug in regulated power supply with 3-12Vdc switchable output. LED indicator and polarity switch. Complete with 6 DC adapter plugs. Features include. IC regulated output, automatic thermal cut off, short circuit protection and automatic overload cut off. **£7.95**

Input Voltage	220/240Vac 50hz
Output Voltage	3,4.5,6,7.5,9 & 12Vdc
Output current	650mA max
Stability	2%
Ripple	1mV
Dims	97x68x63mm

CB Power Supplies

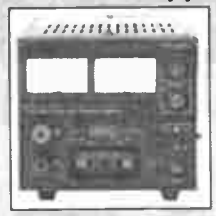
PS4330 Stabilised power supply unit for use with CB rigs, auto accessories, etc. High stability electronic regulation with internal fuse protection. Manufactured according to the requirements of the Electrical Safety Regulations for Domestic Use. **£19.95; 4+ 13.80**

Input Voltage	240Vac 50hz
Output Voltage	13.8Vdc
Output Current	3A continuous
Stability	5%
Ripple	10mV
Connections	4mm banana socket/ screw terminals
Dims	175x92x138mm

PS4340 High current regulated power supply for use with CB rigs, auto equipment. Good stability circuitry with high surge current capability. Overload protection. Manufactured according to the requirement of the Electrical Safety Regulation for Domestic Use. **£24.95; 4+ 19.50**

Input Voltage	240Vdc
Output Voltage	13.8V dc
Output	6A continuous, 7A max
Stability	1%
Ripple	25mV
Connection	4mm banana socket/ screw terminals
Dims	195x140x90mm

Variable Power Supplies



Benchtop Power Supply

PS4350 A compact, regulated DC power supply, which is recommended for the service field, school laboratories, and hobbyists alike. It offers variable voltage and current outputs which are displayed on precision analogue panel meters and also two independent 5V and 12V outputs. **£98.95; 4+ 68.00**

Specification:

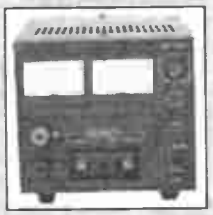
Output Voltage (adjustable)	0-30Vdc
Output Current (adjustable)	0-2.5A
Fixed Voltage (1)	5V @ 500mA
Fixed Voltage (2)	12V @ 500mA

Benchtop Power Supply

PS4360 A compact, regulated DC power supply, which is recommended for the service field, school laboratories and hobbyists alike. It offers variable voltage and current outputs which are displayed on LCD display meters and also two independent 5V and 12V outputs **£109.95; 4+ 80.00**

Specification:

Output Voltage (adjustable)	0-30Vdc
Output Current (adjustable)	0-2.5A
Fixed Voltage (1)	5V @ 500mA
Fixed Voltage (2)	12V @ 500mA

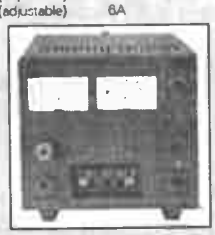


Benchtop Power Supply

PS4370 A compact regulated DC power supply Which is recommended for the service field, school laboratories and hobbyists alike. It offers variable voltage output and precision analogue panel meters displaying voltage and current. **£79.95; 4+ 58.00**

Specification:

Output Voltage (adjustable)	3-15Vdc
Output Current (adjustable)	6A



Benchtop Power Supply

PS4380 A compact high quality regulated DC power supply, ideal for the service field, school laboratories and hobbyists alike. It offers variable voltage output, analogue display, voltmeter and ammeter. **£119.95; 4+ 88.00**

Specification:

Output Voltage (adjustable)	3-15Vdc
Output Current (adjustable)	18A

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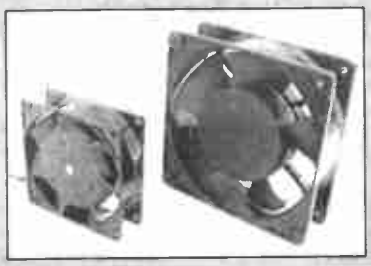
FANS

Two axial flow fans in standard sizes. Shaded pole, external rotor with class 'B' insulation. Self-starting. Impedance protected against stalling. Both types can be reverse mounted for blowing or sucking. Black die cast aluminium bodies with polycarbonate resin blades. Approved to UL, CSA, etc.



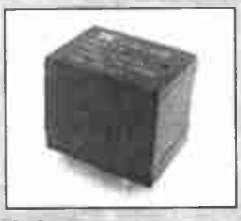
FN3005

Rated voltage	240Vac 50hz
Airflow	24 CFM (403/hr) min.
Rated speed	2300 RPM
Input	0.06A (15W)
Connection	300mm flying leads
Dims	80x80x42mm
Price	**£10.95**

FN3010

Rated voltage	240Vac 50hz
Airflow	75 CFM (1283/hr) min.
Rated speed	2700 RPM
Input	0.08A (19W)
Connection	Solder tags
Dims	120x120c38mm
Price	**£12.95; 10+ 9.50**

RELAYS



Sub Miniature

High power rating on SPCO contact: 6A at 24Vdc; 3A at 240Vac. 21.5x18.3x16.2mm. PCB mounted.

Code	Type	1+	25+	100+
RL2010	6V SPCO 100R	**80p**	0.55	0.44
RL2020	12V SPCO 400R	**80p**	0.55	0.44

Miniature

BT approved, this popular miniature DIL relay has 2A DPCO contacts (form C) and will fit on 0.1" matrix board, or in a standard 16 DIL socket. Operation range 80-110% of rated voltage. Highly reliable device with a life in excess of 25 million operations.

Code	Type	1+	25+	100+
RL2030	5V 36R	**£1.95**	1.20	0.95
RL2040	12V 280R	**£1.95**	1.20	0.95
RL2050	24V 4000R	**£1.95**	1.20	0.95

Octal

Heavy duty 8 pin relay with 10A 250V ac contacts. Size 51x36x38mm.

Code	Type	1+	25+	100+
RL2060	12V DC DPCO	**£5.00**	4.00	3.20
RL2070	230V AC DPCO	**£5.23**	4.18	3.35

RESISTORS

CR25 CARBON FILM RESISTORS

¼W 5% Resistors

High stability resistors for industrial and consumer applications.

Specification:

Wattage	0.25W at 70°C
Resistance range	4.7Ω-10M E12 Series
Tolerance	5%
Max working voltage	300V
Max overload voltage	600V
Typ temp coeff (ppm/°C)	-400
Temperature range	-25 to +70°C

Order as RS25 + value

Mixed values 1-99 2p; 100+ 0.015

100 per value 100+ 0.01; 1k+ 0.007; 5k+ 0.005
1000 per value 1k+ 0.0035; 10k+ 0.003; 25k+ 0.0025

Values available:

4R7	39R	330R	2k7	22k	180k	1M5
5R6	47R	390R	3k3	27k	220k	1M8
6R8	56R	470R	3k9	33k	270k	2M2
8R2	68R	560R	4k7	39k	330k	2M7
10R	82R	680R	5k6	47k	390k	3M3
12R	100R	820R	6k8	56k	470k	3M9
15R	120R	1k	8k2	68k	560k	4M7
18R	150R	1k2	10k	82k	680k	5M6
22R	180R	1k5	12k	100k	820k	6M8
27R	220R	1k8	15k	120k	1M	8M2
33R	270R	2k2	18k	150k	1M2	10M

Please state value on all resistors when ordering

¼W 1% Resistors

Miniature metal film type MR25 for use in precision electronic equipment.

Specification:

Wattage	0.25W at 70°C
Resistance range	10Ω-1M E24 Series
Tolerance	1%
Max working voltage	300V
Max overload voltage	600V
Max temp coefficient	50ppm/°C
Typical noise	0.01μV/V
Temperature range	-25 to +70°C

Order as RS21 + value

Mixed values 1-99 4p; 100+ 0.03

100 per value 100+ 0.02; 1k+ 0.012; 5k+ 0.01
1000 per value 1k+ 0.0063; 10k+ 0.0058; 25k+ 0.005

Values available:

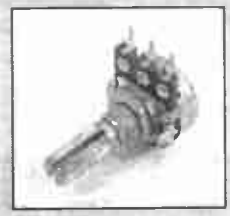
10R	100R	1k	10k	100k	1m
11R	110R	1k1	11k	110k	
12R	120R	1k2	12k	120k	
13R	130R	1k3	13k	130k	
15R	150R	1k5	15k	150k	
16R	160R	1k6	16k	160k	
18R	180R	1k8	18k	180k	
20R	200R	2k	20k	200k	
22R	220R	2k2	22k	220k	
24R	240R	2k4	24k	240k	
27R	270R	2k7	27k	270k	
30R	300R	3k	30k	300k	
33R	330R	3k3	33k	330k	
36R	360R	3k6	36k	360k	
39R	390R	3k9	39k	390k	
43R	430R	4k3	43k	430k	
47R	470R	4k7	47k	470k	
51R	510R	5k1	51k	510k	
56R	560R	5k6	56k	560k	
62R	620R	6k2	62k	620k	
68R	680R	6k8	68k	680k	
75R	750R	7k5	75k	750k	
82R	820R	8k2	82k	820k	
91R	910R	9k1	91k	910k	

Please state value on all resistors when ordering

Wirewound Resistors

2.5W wirewound resistors wound on a ceramic former with flame retardant silicone resin coating. Equivalent to Welwyn W21.

Code	Type	1+	25+	100+
RW20R1	0.1 ohm	**22p**	0.15	0.11
RW20R22	0.22 ohms	**22p**	0.15	0.11
RW20R33	0.33 ohms	**22p**	0.15	0.11
RW20R47	0.47 ohms	**22p**	0.15	0.11
RW21R	1 ohm	**22p**	0.15	0.11
RW22R2	2.2 ohms	**22p**	0.15	0.11
RW24R7	4.7 ohms	**22p**	0.15	0.11
RW210R	10 ohms	**22p**	0.15	0.11
RW222R	22 ohms	**22p**	0.15	0.11
RW247R	47 ohms	**22p**	0.15	0.11
RW2100R	100 ohms	**22p**	0.15	0.11
RW2150R	150 ohms	**22p**	0.15	0.11
RW2220R	220 ohms	**22p**	0.15	0.11



16mm Commercial Potentiometers

A range of competitive 16mm diameter carbon track single potentiometers suitable for PCB mounting offered in a range of popular values. Supplied with serrated 6mm shaft.

Code	Type	1+	25+	100+
RP2010	470 ohms lin	**50p**	0.33	0.29
RP2020	1k lin	**50p**	0.33	0.29
RP2030	4k7 lin	**50p**	0.33	0.29
RP2040	10k lin	**50p**	0.33	0.29
RP2050	47k lin	**50p**	0.33	0.29
RP2060	100k lin	**50p**	0.33	0.29
RP2070	470k lin	**50p**	0.33	0.29
RP2080	1M lin	**50p**	0.33	0.29
RP2100	470 ohms log	**50p**	0.33	0.29
RP2110	4k7 log	**50p**	0.33	0.29
RP2120	1M log	**50p**	0.33	0.29

24mm Commercial Potentiometers

A low cost carbon track single potentiometer offered in a range of popular values. Standard 6mm diameter spindles in nylon. Shaft length 50mm. Body diameter 24mm. Solder tag termination.

Code	Value	1+	25+	100+
RP2200	470 ohms lin	60p	0.38	0.30
RP2210	1k lin	60p	0.38	0.30
RP2220	4k7 lin	60p	0.38	0.30
RP2230	10k lin	60p	0.38	0.30
RP2240	22k lin	60p	0.38	0.30
RP2250	47k lin	60p	0.38	0.30
RP2260	100k lin	60p	0.38	0.30
RP2270	220k lin	60p	0.38	0.30
RP2280	470k lin	60p	0.38	0.30
RP2290	1M lin	60p	0.38	0.30
RP2300	2M2 lin	60p	0.38	0.30
RP2310	4k7 log	60p	0.38	0.30
RP2320	10k log	60p	0.38	0.30
RP2330	47k log	60p	0.38	0.30
RP2340	100k log	60p	0.38	0.30
RP2350	1M log	60p	0.38	0.30
RP2360	2M2 log	60p	0.38	0.30

Carbon Preset Potentiometers

Miniature open single turn presets. Rated at 0.1W. Suitable for 0.1in matrix boards. Linear law. Horizontal mounting style only.

Technical Specification:

Tolerance	30%
End resistance	2%
Power rating	0.1W at 40°C
Maximum Voltage	200V DC
Electrical rotation	220° ±10%
Rotation torque	20-300gm/cm
Temperature range	-20 to +70°C

Code	Value	1+	100+	500+
RP2400	100 ohms	10p	0.05	0.04
RP2405	220 ohms	10p	0.05	0.04
RP2410	470 ohms	10p	0.05	0.04
RP2415	1k	10p	0.05	0.04
RP2420	2k2	10p	0.05	0.04
RP2425	4k7	10p	0.05	0.04
RP2430	10k	10p	0.05	0.04
RP2435	22k	10p	0.05	0.04
RP2440	47k	10p	0.05	0.04
RP2445	100k	10p	0.05	0.04
RP2450	220k	10p	0.05	0.04
RP2455	470k	10p	0.05	0.04
RP2460	1M	10p	0.05	0.04

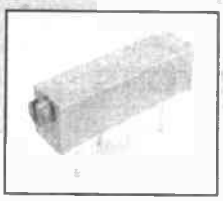
Multiturn Cermet Potentiometers

A high quality 3/8in square 25 turn cermet potentiometer of robust construction, fully sealed for board washing. Top screw adjustment. May be mounted directly onto PCBs either vertically or horizontally. Bourns 3296W series.

Technical Specification:

Tolerance	10%
End Resistance	2 ohms or 2%
Power rating	0.5W at 70°C
Dielectric strength	1000V AC
Temperature coefficient	100ppm deg C
Temperature range	-55 to +125 deg C
Electrical rotation	25 turns

Code	Value	1+	25+	100+
RP2700	100 ohms	£1.20	0.75	0.68
RP2705	200 ohms	£1.20	0.75	0.68
RP2710	500 ohms	£1.20	0.75	0.68
RP2715	1k	£1.20	0.75	0.68
RP2720	2k	£1.20	0.75	0.68
RP2725	5k	£1.20	0.75	0.68
RP2730	10k	£1.20	0.75	0.68
RP2735	20k	£1.20	0.75	0.68
RP2740	50k	£1.20	0.75	0.68
RP2745	100k	£1.20	0.75	0.68
RP2750	200k	£1.20	0.75	0.68
RP2755	500k	£1.20	0.75	0.68
RP2760	1M	£1.20	0.75	0.68



Multiturn Cermet Potentiometers

A quality multiturn cermet trimmer of robust construction, fully sealed for board washing. Excellent setability. ¾in type. A high performance component offered at low cost. Bourns 3006P series.

Technical Specification:

Tolerance	10%
End resistance	2 ohms max
Power rating	0.76W at 70 deg C
Dielectric strength	315V DC or AC rms
Temperature coefficient	100ppm deg C
Temperature range	-55 to +125 deg C
Electrical rotation	15 turns

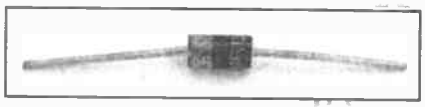
Code	Value	1+	25+	100+
RP2800	10 ohms	80p	0.55	0.38
RP2805	20 ohms	80p	0.55	0.38
RP2810	50 ohms	80p	0.55	0.38
RP2815	100 ohms	80p	0.55	0.38
RP2820	200 ohms	80p	0.55	0.38
RP2825	500 ohms	80p	0.55	0.38
RP2830	1k	80p	0.55	0.38
RP2835	2k	80p	0.55	0.38
RP2840	5k	80p	0.55	0.38
RP2845	10k	80p	0.55	0.38
RP2850	20k	80p	0.55	0.38
RP2855	50k	80p	0.55	0.38
RP2860	100k	80p	0.55	0.38
RP2865	200k	80p	0.55	0.38
RP2870	500k	80p	0.55	0.38

SEMICONDUCTORS

Signal Diodes

A range of general purpose signal diodes.

Type	VRRM	Mat	1+	100+	1k+
OA47	30V	Ge	20p	0.16	0.14
OA90	30V	Ge	10p	0.07	0.05
OA91	100V	Ge	12p	0.09	0.065
IN4148	75V	Si	4p	0.02	0.009



Silicon Rectifier Diodes

1 amp range, plastic, axial leads

Type	V	I	1+	100+	1k+
IN4001	50	1A	5p	0.026	0.013
IN4002	100	1A	5p	0.028	0.014
IN4003	200	1A	5p	0.028	0.014
IN4004	400	1A	5p	0.028	0.014
IN4005	600	1A	6p	0.03	0.015
IN4006	800	1A	6p	0.03	0.015
IN4007	1000	1A	6p	0.032	0.016

3 amp range, plastic, axial leads

Type	V	I	1+	100+	1k+
IN5400	50	3A	12p	0.057	0.038
IN5401	100	3A	12p	0.057	0.038
IN5402	200	3A	12p	0.058	0.039
IN5403	300	3A	14p	0.061	0.041
IN5404	400	3A	14p	0.061	0.041
IN5405	500	3A	14p	0.063	0.042
IN5406	600	3A	14p	0.063	0.042
IN5407	800	3A	16p	0.069	0.046
IN5408	1000	3A	16p	0.072	0.048

Zener Diodes

400mW BZY88 Series 5% in the following values: 2V7, 3V, 3V3, 3V6, 3V9, 4V3, 4V7, 5V1, 5V6, 6V2, 6V8, 7V5, 8V2, 9V1, 10V, 11V, 12V, 13V, 15V, 16V, 18V, 20V, 22V, 24V, 27V, 30V, 33V.

Order as BZY88 + voltage

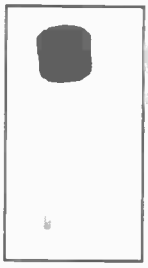
Price per value 7p; 100+ 0.035; 1k+ 0.025

1.3W BZX61 Series 5% in the following values:

4V7, 5V1, 5V6, 6V2, 6V8, 7V5, 8V2, 9V1, 10V, 11V, 12V, 13V, 15V, 16V, 18V, 20V, 22V, 24V, 27V, 30V, 33V, 36V, 39V.

Order as BZX91 + voltage

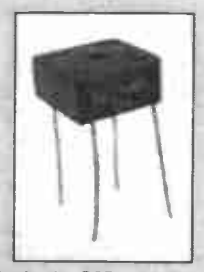
Price per value 15p; 100+ 0.075; 1k+ 0.05



Bridge Rectifiers

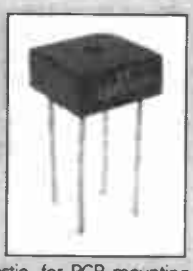
1.5A range, plastic, for PCB mounting.

Type	V	I	1+	100+	1k+
W005	50	1.5A	28p	0.14	0.095
W02	200	1.5A	28p	0.14	0.096
W04	400	1.5A	30p	0.15	0.10
W06	600	1.5A	30p	0.15	0.102
W08	800	1.5A	34p	0.17	0.111



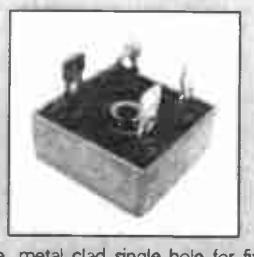
3A range, plastic, for PCB mounting.

Type	V	I	1+	100+	1k+
BR32	200	3A	48p	0.24	0.21
BR34	400	3A	52p	0.28	0.23



6A range, plastic, for PCB mounting.

Type	V	I	1+	100+
DB602	200	6A	84p	0.54
DB608	600	6A	92p	0.61



12A range, metal clad single hole for fixing with tabs.

Type	V	I	1+	25+	100+
BR121	100	12A	£1.92	1.20	1.03
BR124	400	12A	£2.20	1.28	1.10

25A range, metal clad single hole for fixing with tabs.

Type	V	I	1+	25+	100+
DB2502	200	25A	£3.60	2.25	1.80
DB2506	600	25A	£4.20	2.63	2.10

35A range, metal clad single hole for fixing with tabs.

Type	V	I	1+	25+	100+
BYW61	100	35A	£4.70	2.94	2.35
BYW64	400	35A	£5.60	3.50	2.80

DIAC

BR100 Silicon bi-directional trigger diode for use in triac firing circuits. DO14 glass case. 25p; 25+ 0.16; 100+ 0.13

Thyristors

Type	Case	VRRM	IT	1+
2N5061	T092	60V	0.8A	39p
TIC106D	T0220	400V	4A	49p
TIC116D	T0220	400V	8A	82p
TIC126D	T0220	400V	12A	90p

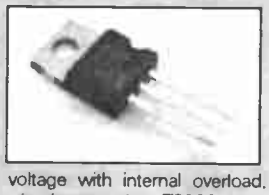
Triacs

Type	Case	VRRM	IT	1+
Z0102	T092	600V	0.8A	71p
TIC206	T0220	400V	3A	80p
TIC226	T0220	400V	8A	89p
TIC246	T0220	400V	16A	£1.28

Voltage Regulators

100mA fixed voltage with internal overload, thermal and short circuit protection. T092 plastic cases.

Type	Voltage	1+
78L05	+5V	34p
78L12	+12V	34p
78L15	+15V	34p
79L05	-5V	37p
79L12	-12V	37p
79L15	-15V	37p



1A fixed voltage with internal overload, thermal and short circuit protection. T0220 case.

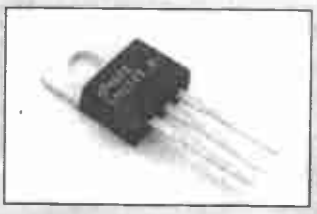
Type	Voltage	1+
7805	+5V	40p
7808	+8V	40p
7812	+12V	40p
7815	+15V	40p
7818	+18V	40p
7824	+24V	40p
7905	-5V	42p
7908	-8V	42p
7912	-12V	42p
7915	-15V	42p
7918	-18V	42p
7924	-24V	42p

2A fixed voltage as above.

Type	Voltage	1+
78S05	+5V	60p
78S12	+12V	60p

3A fixed voltage regulation in T03 case. Thermal overload and short circuit protection

Type	Voltage	1+
LM323K	+5V	£3.05



Variable voltage regulation.

Type	Case	V range	I	1+
LM317L	T092	+1.2-37	0.1	35p
723	T099	+2-37	0.1	55p
723	14DIL	+2-37	0.1	37p
LM317T	T0220	+1.2-37	1.2	55p
LM317K	T03	+1.2-37	1.5	£1.88

TRANSISTORS

Type	Price	Type	Price
AC127	36p	BDV65C	£1.75
AC128	36p	BDW93C	90p
AD161	£1.00	BDW94C	92p
BC107	14p	BF259	40p
BC107B	16p	BFX85	40p
BC108	14p	BFX88	40p
BC108B	15p	BFY50	34p
BC10BC	16p	BFY51	34p
BC109	14p	BFY52	36p
BC109C	16p	BU208A	£2.50
BC140	40p	BU326A	£2.95
BC141	40p	BU508A	£2.88
BC142	40p	MU2501	£260
BC177	20p	MJ2955	£1.80
BC178	20p	MJ3001	£2.35
BC179	20p	MJE340	62p
BC182	12p	MJE350	70p
BC182L	12p	MPSA13	35p
BC183	12p	MPSA42	35p
BC183L	12p	MPSA92	35p
BC184	12p	TIP29A	39p
BC184L	12p	TIP29C	47p
BC212	12p	TIP30A	46p
BC212L	12p	TIP30C	50p
BC213	12p	TIP31A	44p
BC213L	12p	TIP31C	49p
BC214	12p	TIP32A	53p
BC214L	12p	TIP32C	59p
BC237B	15p	TIP33A	90p
BC238B	16p	TIP41A	62p
BC327	16p	TIP42A	70p
BC337	16p	TIP47	72p
BC338	16p	TIP120	80p
BC441	43p	TIP121	80p
BC461	40p	TIP122	83p
BC477	36p	TIP125	80p
BC47B	36p	TIP126	80p
BC479	36p	TIP127	90p
BC517	28p	TIP141	£1.95
BC547B	14p	TIP142	£1.70
BC548B	12p	TIP146	£1.70
BC549B	12p	TIP147	£1.70
BC557B	14p	TIP2955	£1.10
BC558B	14p	TIP3055	£1.05
BCX38B	40p	TIPL760A	£2.20
BCY70	22p	TIPL760B	£2.20
BCY71	22p	TIPL770	£1.10
BCY72	22p	TIPP32A	50p
BD131	54p	ZTX300	20p
BD132	54p	ZTX302	22p
BD135	48p	ZTX450	26p
BD136	48p	ZTX453	30p
BD139	48p	ZTX500	20p
BD140	48p	ZTX502	24p
BD437	54p	ZTX550	32p
BD438	60p	ZTX553	39p
BD540C	70p	ZTX651	40p
BD679	68p	ZTX653	50p
BD680	64p	ZTX751	50p

TEL: 01703 236363
FAX: 01703 236307
GREENWELD
27 Park Road · Southampton · SO15 3UQ

Type	Price	Type	Price
ZTX753	54p	2N3055H	85p
2N2222A	36p	2N3702	12p
2N2369A	32p	2N3703	12p
2N2905	40p	2N3704	12p
2N2905A	44p	2N3705	12p
2N2907A	36p	2N3706	12p
2N3053	38p	2N3904	12p
2N3054	£1.40	2N3906	12p
2N3055	58p		

Field Effect Transitors

Type	Price	Type	Price
8F244B	52p	2N3819	40p

Unijunction Transistors

Type	Price
2N2646	95p

Programmable Unijunction Transistors

Type	Price
2N6027	60p

INTEGRATED CIRCUITS

74 Series Logic

Type	Price	Type	Price
7400	30p	7482	60p
7401	30p	7483	60p
7402	30p	7485	£1.20
7403	30p	7486	60p
7404	36p	7489	£1.30
7405	36p	7490	75p
7406	48p	7491	80p
7407	48p	7492	80p
7408	30p	7493	66p
7409	30p	7494	£1.20
7410	30p	7495	80p
7411	30p	7496	96p
7412	30p	7497	£1.80
7413	65p	74100	£1.50
7414	80p	74107	60p
7416	44p	74109	55p
7417	44p	74111	70p
7420	30p	74119	£2.00
7421	70p	74120	86p
7422	52p	74121	60p
7425	44p	74122	85p
7427	44p	74123	95p
7430	30p	74125	75p
7432	36p	74126	70p
7433	36p	74128	70p
7437	36p	74132	95p
7438	46p	74141	£1.10
7440	36p	74145	£1.25
7442	90p	74147	£1.95
7446	£1.40	74148	£1.70
7447	£1.15	74150	£2.10
7448	£1.30	74151	80p
7450	38p	74153	95p
7451	38p	74154	£1.60
7453	38p	74155	95p
7454	38p	74157	95p
7460	38p	74160	90p
7470	70p	74161	£1.30
7472	70p	74162	£1.30
7473	70p	74163	£1.30
7474	66p	74164	£1.65
7475	78p	74165	£1.30
7476	52p	74166	£1.50
7480	60p	74167	£2.40

Type	Price	Type	Price
74170	£2.40	74197	£1.30
74173	£1.60	74198	£2.40
74174	£1.30	74199	£1.80
74175	£1.30	74251	40p
74177	£1.40	74273	£2.20
74179	£1.60	74279	45p
74180	£1.30	74283	£1.15
74181	£2.60	74290	£1.60
74182	£1.70	74293	£1.10
74190	£1.60	74298	£2.00
74191	£1.60	74365	£1.00
74192	£1.60	74366	£1.00
73193	£1.60	74367	£1.00
74194	84p	74368	£1.00
74195	95p	74390	£1.30
74196	£1.60	74393	£1.30

LS Series

Type	Price	Type	Price
LS00	20p	LS125	32p
LS01	20p	LS126	32p
LS02	20p	LS132	32p
LS03	20p	LS133	27p
LS04	20p	LS136	23p
LS05	20p	LS138	38p
LS08	20p	LS139	38p
LS09	20p	LS145	84p
LS10	20p	LS147	£1.90
LS11	20p	LS148	£1.05
LS12	20p	LS151	38p
LS13	20p	LS153	38p
LS14	27p	LS154	£1.05
LS15	20p	LS155	38p
LS20	20p	LS156	38p
LS21	20p	LS157	39p
LS22	20p	LS158	39p
LS26	20p	LS160	48p
LS27	20p	LS161	48p
LS28	20p	LS162	48p
LS30	20p	LS163	48p
LS32	20p	LS164	38p
LS33	20p	LS165	71p
LS37	20p	LS166	39p
LS38	20p	LS168	50p
LS40	20p	LS169	40p
LS42	37p	LS170	44p
LS47	63p	LS173	37p
LS48	63p	LS174	37p
LS49	63p	LS175	37p
LS51	20p	LS181	£2.00
LS54	20p	LS183	78p
LS55	20p	LS190	37p
LS69	40p	LS191	37p
LS73	25p	LS192	37p
LS74	25p	LS193	37p
LS75	29p	LS194	37p
LS76	38p	LS195	37p
LS78	50p	LS196	37p
LS83	46p	LS197	37p
LS85	53p	LS221	55p
LS86	29p	LS240	48p
LS90	34p	LS241	48p
LS91	40p	LS242	48p
LS92	46p	LS243	48p
LS93	38p	LS244	48p
LS95	38p	LS245	48p
LS96	76p	LS247	48p
LS107	34p	LS249	56p
LS109	31p	LS251	38p
LS112	31p	LS253	38p
LS113	31p	LS257	38p
LS114	31p	LS258	38p
LS122	46p	LS259	38p
LS123	46p	LS260	38p
LS124	60p	LS261	56p

Type	Price	Type	Price
LS266	20p	LS377	44p
LS273	48p	LS378	93p
LS279	37p	LS379	£1.20
LS280	38p	LS390	37p
LS283	38p	LS393	37p
LS290	50p	LS395	38p
LS293	50p	LS398	60p
LS295	80p	LS399	93p
LS298	38p	LS534	60p
LS299	£1.50	LS540	71p
LS321	£2.20	LS541	71p
LS323	£2.60	LS590	£3.00
LS352	38p	LS592	£3.60
LS353	38p	LS620	£1.40
LS365	32p	LS640	£1.17
LS366	32p	LS645	71p
LS367	32p	LS646	£3.00
LS368	32p	LS669	£1.47
LS373	44p	LS670	£1.05
LS374	44p	LS682	£1.35
LS375	50p	LS688	£1.26

CMOS

Type	Price	Type	Price
4000	20p	4063	53p
4001	20p	4066	32p
4002	20p	4067	21p
4006	50p	4068	20p
4007	20p	4069	20p
4008	46p	4070	20p
4009	34p	4071	20p
4010	34p	4072	20p
4011	20p	4073	20p
4012	20p	4075	20p
4013	27p	4076	47p
4014	46p	4077	20p
4015	46p	4078	20p
4016	27p	4081	20p
4017	41p	4082	20p
4018	39p	4085	38p
4019	34p	4086	38p
4020	46p	4093	40p
4021	46p	4096	27p
4022	50p	4099	63p
4023	20p	4501	45p
4024	38p	4502	63p
4025	20p	4503	48p
4026	53p	4507	68p
4027	27p	4508	£1.68
4028	38p	4509	£1.40
4029	41p	4510	49p
4030	20p	4511	49p
4031	80p	4512	49p
4032	60p	4514	£1.47
4033	80p	4515	£1.47
4034	£1.40	4516	44p
4035	60p	4518	38p
4038	60p	4519	47p
4040	53p	4520	43p
4041	53p	4521	93p
4042	39p	4522	75p
4043	53p	4526	75p
4044	53p	4527	66p
4046	47p	4528	66p
4047	39p	4529	66p
4048	53p	4531	60p
4049	29p	4532	49p
4050	29p	4534	£3.36
4051	38p	4536	£2.95
4052	38p	4538	43p
4053	38p	4539	93p
4054	53p	4541	49p
4055	53p	4543	84p
4056	53p	4549	£7.05
4060	46p	4553	£2.10

CMOS (Continued)

Type	Price	Type	Price
4555	57p	40106	35p
4556	57p	40109	77p
4558	£1.60	40160	62p
4559	£7.05	40161	62p
4560	£1.89	40162	62p
4572	50p	40163	83p
4582	60p	40173	71p
4583	60p	40174	70p
4584	35p	40175	69p
4585	49p	40192	70p
40014	40p	40193	93p
40098	40p	40194	93p

EPROMS

NMOS Types

Types	Access Time	Price
2716	450ns	£8.80
2732	250ns	£9.00
2764-180	180ns	£7.20
27128-200	200ns	£7.20
27256-200	200ns	£7.20

CMOS Types

Types	Access Time	Price
27C64-250	250ns	£5.90
27C128-150	150ns	£5.90
27C256-150	150ns	£6.80
27C512-150	150ns	£7.20
227C1001-150	150ns	£9.0
27C2001-150	150ns	£12.80
27C4001-120	120ns	£19.90

CMOS Lower Power Static RAMs

Type	Price
6116LP10	£2.80
6264LP10	£5.80
62256LP10	£9.00
628128LP10	£21.00

Dynamic RAMs

Code	Type	Price
4164-15	64k (64kx1)	£2.80
41256	256k (256kx1)	£4.40
514256-80	1M (256kx4)	£12.00

Linear IC's

Code	Function	Manuf-acturer	Package	1+
TL061	Low power operational amplifier	SGS	DIL8	70p
TL062	Dual low power operational amplifier	SGS	DIL8	70p
TL064	Quad low power operational amplifier	SGS	DIL14	70p
TL071	Single operational amplifier	SGS	DIL8	70p
TL072	Dual operational amplifier	SGS	DIL8	70p
TL074	Quad operational amplifier	SGS	DIL14	70p
TL081	Single operational amplifier	SGS	DIL8	60p
TL082	Dual operational amplifier	SGS	DIL8	70p
TL084	Quad operational amplifier	SGS	DIL14	70p
L165V	High power operational amplifier	SGS	5/T0220	£2.00
TLC271	Programmable operational amplifier	SGS	DIL8	56p
TLC272	Programmable operational amplifier	SGS	DIL8	96p
L272M	Dual power operational amplifier	SGS	DIL8	£1.66
L293E	Stepper motor control/drive	SGS	DIL20	£3.20
L297	Stepper motor control/drive	SGS	DIL20	£4.90
L298	Dual full bridge driver	SGS	Multiwatt	£5.30
LM301A	Operational amplifier	SGS	DIL8	40p
LM311	High speed comparator	SGS	DIL8	40p
LM318	High slew rate operational amplifier	SGS	DIL8	84p
LM324	Quad operational amplifier	SGS	DIL14	28p
LM334Z	3 terminal adjustable current source	SGS	T092	84p
LM335Z	Temperature sensor 0-100°C	SGS	T092	94p
LM339	Quad comparator	SGS	DIL14	28p
LM348	Quad 741 operational amplifier	SGS	DIL14	58p
LF351	Bi-fet operational amplifier	SGS	DIL8	40p
LF353	Bi-fet wide band operational amplifier	SGS	DIL8	49p
LF356	Bi-fet operational amplifier	SGS	DIL8	78p
LM358	Low power operational amplifier	SGS	DIL8	28p
LM380	2W audio amplifier	National	DIL14	£1.12
LM381	Low noise dual preamplifier	National	DIL14	£3.40
LM386	Low voltage preamplifier	National	DIL8	58p
LM393	Dual comparator	SGS	DIL8	20p
ZN423	Precision voltage reference	Plessey	T092	£1.50
ZN425E	8-bit D to A converter	Plessey	DIL16	£5.60
ZN426E	8-bit D to A converter	Plessey	DIL16	£3.20
ZN427E	8-bit succ approx A to D converter	Plessey	DIL18	£10.20
ZN428E	8-bit D to A (complimentary to 427E)	Plessey	DIL16	£8.30
ZN448E	8-bit succ approx A to D converter	Plessey	DIL18	£10.60
SL486	Infra red preamplifier	Plessey	DIL14	£3.00
NE531	High slew rate operational amplifier	Philips	DIL8	£2.10
NE555	Single timer	SGS	DIL8	25p
ICM7555	Single low power timer	SGS	DIL8	46p
NE556	Dual timer	SGS	DIL14	36p
ICM7556	Dual low power timer	SGS	DIL14	£1.28
NE565	Precision phase locked loop	Philips	DIL14	£1.54
NE566	Voltage controlled oscillator	Philips	DIL8	£1.54
NE567	Tone decoder	Philips	DIL8	42p
NE571	Telephone comparator	Philips	DIL16	£3.20
LM710	Differential comparator	Philips	DIL14	80p
741	Compensated operational amplifier	SGS	DIL8	25p
LM747	Dual operational amplifier	SGS	DIL14	42p
LM748	Operational amplifier	SGS	DIL8	39p
TBA820M	Audio amplifier	SGS	DIL8	42p
SAA1027	Stepper motor driver	Philips	DIL16	£4.00

Code	Function	Manuf-acturer	Package	1+
LM1458	Dual operational amplifier	SGS	DIL8	28p
ULN2003	Transistor array - 7 matched	SGS	DIL16	40p
ULN2004	Transistor array - 7 matched	SGS	DIL16	40p
TDA2004	10W stereo amplifier	SGS	Multiwatt	£1.94
TDA2030H	14W Hi-Fi power amplifier	SGS	Pentawatt	£1.36
XR2206	Waveform generator	SGS	DIL16	£4.40
ULN2803	Gas discharge driver, 9 darlingtons	SGS	DIL18	70p
LM2917N8	Frequency to voltage converter	National	DIL8	£3.20
CA3080E	Operational transconductance amplifier	Harris	DIL8	80p
CA3130E	Mosfet operational amplifier	Harris	DIL8	£1.18
CA3140E	Mosfet operational amplifier	Harris	DIL8	62p
CA3240E	Dual mosfet amplifier	Harris	DIL8	£1.60
MC3302	Quad comparator	Motorola	DIL14	60p
MC3340	Electronic attenuator	Motorola	DIL8	£1.90
LM3909	LED flasher oscillator	National	DIL8	£1.80
LM3914	LED bar/dot display driver-linear	National	DIL18	£3.20
LM3915	LED bar/dot display driver-log	National	DIL18	£3.20
RC4558	High performance operational amplifier	Texas	DIL8	37p
NE5532	Dual low noise operational amplifier	Texas	DIL8	90p
NE5534	Single low noise operational amplifier	Texas	DIL8	76p
ICL7106	CMOS 3 digit A to D converter	Teledyne	DIL40	£7.80
ICM7555	Single low power timer	SGS	DIL8	46p
ICM7556	Dual low power timer	SGS	DIL14	£1.28
ICL8038	Function generator	Intersil	DIL14	£4.90
LM13600	Dual transconductance amplifier	National	DIL16	£1.10

A much larger range of semiconductors, including many obscure, obsolete and hard to obtain items are on a separate list, available on request.

Surplus semiconductors appear from time to time in our Bargain Lists

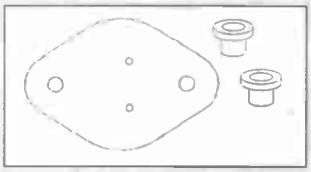
PRICES IN BOLD INCLUDE VAT; QTY PRICES IN LIGHT DO NOT

TEL: 01703 236363
FAX: 01703 236307
GREENWELD
27 Park Road · Southampton · SO15 3UQ

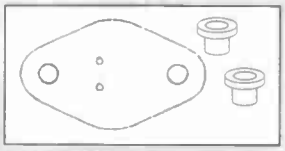
SEMI HARDWARE

Mica Semiconductor Mounting Kits

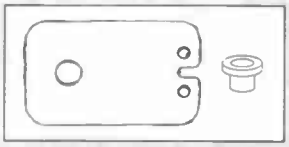
Mounting kits for semiconductors including mica washers and bushes



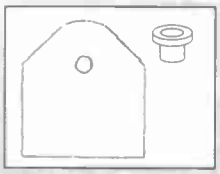
SH2010 T03 kit. Contains 10 mica washers and 20 bushes. To suit 2N3055, etc. **£1.30**



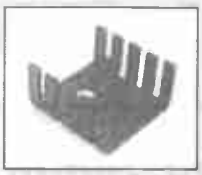
SH2020 T066 kit. Contains 10 mica washers and 20 bushes. To suit AD161/2 etc. **£1.30**



SH2030 T0220 kit. Contains 10 mica washers and 10 bushes. To suit TIP31, 7805 etc. **92p**

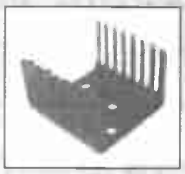


SH2040 M13055 kit. Contains 10 mica washers and 10 bushes. To suit TIP3055, etc. **96p**



T0220 Bolt On Heatsink

SH2100 Black anodised pre-drilled heatsink to accept a wide variety of T0220 packaged semiconductors, i.e. voltage regulators and power transistors. Bolt on sink, may be mounted horizontally or vertically. Thermal resistance 21°C/W. Dimensions 9.5x19.1x19.1. **25p;** 25+ 0.16; 100+ 0.14



T03 Twisted Vane

SH2105 A compact horizontal or vertical mounting heatsink with black anodised finish predrilled for T03 devices. Thermal resistance 7.1°C/W. Dimensions 42x38x25(h). **99p;** 25+ 0.65; 100+ 0.50

SERVICE AIDS

Foam Cleanser

SV3155 Multi-purpose cleanser that will remove grease and grime from woodwork, glass, metal, paint work, vinyl surfaces, etc. 400ml aerosol tin **£2.75;** 12+ 1.85

Contact Cleaner and Lubricant

SV3160 Super Servisol 10 is an effective switch and contact cleaner which also provides a residual lubricating film to protect contact surfaces. Quickly removes tarnish, dirt, grease, dust, oil, grime and other deposits increasing contact areas and reduces resistance. Complete with extension nozzle for inaccessible areas. Supplied in CFC free 176ml can. **£2.75;** 12+ 1.85

Circuit Freezer

SV3170 To assist in locating faults in transistors, resistors, capacitors etc. A chemical preparation that instantly reduces the temperature of a component to approximately -60°C in about 2 seconds, saving valuable time tracing intermittent faults. Supa Freeze - it can also be used for cooling thermostats in electric irons, blankets etc. in order to obtain "cold reading" immediately after switch off. Net contents 226g **£3.95;** 12+ 2.75

Glue Gun

SV3180 An improved design hot melt gun suitable for industrial or educational use providing a trouble free supply of tough adhesive. The gun has an electronically controlled heating element which melts the long solid glue when inserted into the back of the gun. A smooth flow of adhesive is controlled by the trigger feed mechanism. Double insulated construction with 25W element rated at 240V. Suitable for a wide range of materials including most metals, PVC, plastics, glass, etc. Glue sticks, 10mm in diameter are supplied as a separate item in packs of 12, 100mm in length. It is recommended that the glue gun should be fused with a 3A fuse. GS approved **£7.95;** 10+ 5.25

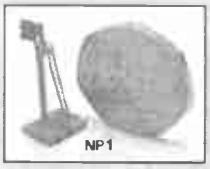
SV3190 Pack of 12 glue sticks **£1.00;** 10+ 0.65

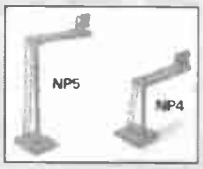
SIGNALS

Ideal for the Model Train Enthusiasts - these superb Colour Light Signals are available in both '00' and 'N' gauge. Produced by PATRONICS, each one is individually hand built and painted. Just look at these specifications.

1) All completely assembled and ready for use
2) LED's used - Resistors included
3) Voltage range 3-12V DC
4) Metal soldered construction
5) Large range and variations*
6) Wiring Instructions included
7) British Made
8) Back-up service available for any queries

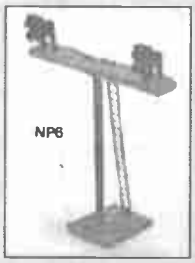
**All Bracket Signals available left or right mounting. All Two Aspect Signals available Home or Dist mounting. (Please specify)*





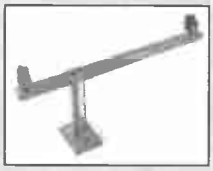
'N' Gauge Colour Light Signals

NP1 2 aspect post (Home or dist). **£6.80**
NP2 3 aspect post **£9.40**
NP3 4 aspect post (Red/amber/green/amber) **£11.00**
NP4 2 aspect offset bracket, platform mounting, left or right **£7.94**
NP5 2 aspect offset bracket, base board mounting, left or right. **£8.10**

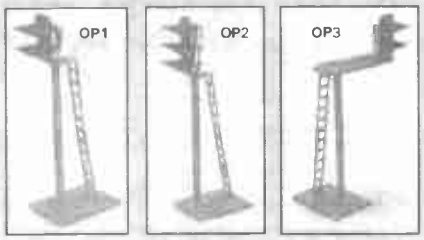


NP6 2+2 aspect 'T' bracket, base board mounting. **£10.20**
NP7 2+2 aspect 'T' bracket, platform mounting. **£10.00**
NP8 2+2 aspect offset bracket, base board mounting, left or right. **£12.00**

NP9 2 road gantry, 2 aspect. **£16.20**
NP10 Ground position signal, 2 aspect. (Red/amber or red/green) **£4.00**
NP11 2+2 aspect offset 'T' bracket, base board mounting. **£10.20**

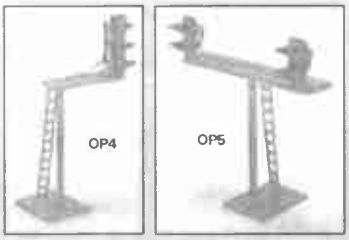


NP12 Left hand, 2+2 aspect offset bracket, platform mounted. **£12.00**

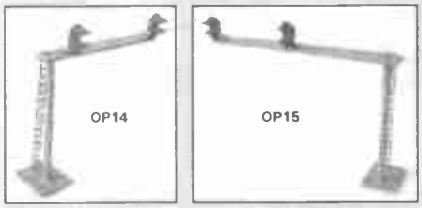


'OO' Gauge Colour Light Signals

OP1 2 aspect post (Home or dist). **Price £7.02**
OP2 3 aspect post **Price £8.56**
OP3 2 aspect offset bracket, platform mounting, left or right **£8.10**
OP3B 2 aspect offset bracket, base board mounting, left or right **£8.60**



OP4 3 aspect offset bracket, platform mounting, left or right. **£9.60**
OP4B 3 aspect offset bracket, base board mounting, left or right **£10.10**
OP5 2+2 aspect 'T' bracket, platform mounting. **£11.20**
OP5B 2+2 aspect 'T' bracket, base board mounting **£11.70**
OP6 2 aspect head complete with lights (Home or dist) **£4.50**
OP7 3 aspect head complete with lights. **£5.50**
OP8 2 aspect platform starter **£6.80**
OP9 2+3 aspect 'T' bracket, platform mounting **£12.60**
OP9B 2+3 aspect 'T' bracket, base board mounting **£13.10**
OP10 2 aspect replacement lights **£2.02**
OP11 3 aspect platform mounting post **£8.20**
OP12 3 aspect replacement lights **£2.80**



OP14 Right hand, 2+2 aspect offset bracket, base board mounting **£12.80**
OP15 Right hand, 2+3 aspect offset bracket, base board mounting **£13.20**
OP16 Left hand, 2+2 aspect offset bracket, base board mounting **£13.80**
OP17 Left hand, 2+3 aspect offset bracket, base board mounting **£14.00**

OL1 'OO' Station Lamps Old style. **£4.20**

SOLDERING EQUIPMENT

Please note that ALL mains rated soldering irons come complete with a fitted mains plug.

Antex C Miniature Soldering Iron

This 15 watt iron is a derivative of the same miniature soldering iron which has been a market leader for many years. Weighing only 21 gms these iron can be held between the fingers and manipulated extremely sensitively. A range of 11 bits is available for use with these iron offering a wide selection of tip profiles. It is available in a variety of input voltages between 24 and 250 volts. Thermally balanced to maintain constant tip temperatures (370°C). These irons have a standard cable of 1.65m.

Code	Volts	Watts	1+	10+
SO3000	250V	15W	**£13.95**	10.10
SO3010	115V	15W	**£13.95**	10.10
SO3020	24V	15W	**£14.95**	10.80

Antex CS 17 Watt Soldering Iron

The CS soldering iron is a thermally balance iron with a nominal 17 watt rating. It is available in a choice of input voltages, the most popular being 220/240, 115 and 24V typically found in domestic, industrial and educational use. The CS iron has available to it a choice of 7 soldering bits of various profile, easily interchangeable. Standard models are supplied with 1.65m cable. Operating tip temperature is 390°C

Code	Volts	Watts	1+	10+
SO3110	240V	17W	**£14.50**	10.60
SO3120	115V	17W	**£14.50**	10.60
SO3130	24V	17W	**£15.50**	11.20

Antex XS 25 Watt Soldering Iron

The XS is a thermally balanced 25 watt soldering iron. It is available with a choice of input voltages (according to model), the most popular being 220/240, 115 and 24 volts, typically found in domestic, industrial and educational use. The XS iron has available to it a choice of 9 soldering bits of various profiles and easily interchangeable. Standard models are supplied with 1.65m cable. Operating tip temperature at 420°C

Code	Volts	Watts	1+	10+
SO3210	240V	25W	**£14.50**	10.60
SO3220	115V	25W	**£14.50**	10.60
SO3230	24V	25W	**£15.50**	11.20

Antex SK2/SK5/SK6 Soldering Kits

These kits are identical with the exception of the power of the soldering iron
SO3310 includes 15 watt Model C
SO3320 includes 17 watt Model CS
SO3330 includes 25 watt Model XS
All kits also include an SO3410 bench stand, a length of solder and a booklet 'How to Solder', making them ideal for the 'first-time' soldering-iron user. A selection of soldering bits is available with a wide range of profiles to enable the user to match closely his needs.

Code	Volts	Watts	1+	10+
SO3310	240V	15W	**£17.95**	14.52
SO3320	240V	17W	**£17.95**	14.52
SO3330	240V	25W	**£17.95**	14.52

Antex MLXS 'Auto' Soldering Kit

This iron is designed for use where mains voltage is unavailable and is widely used on cars, boats and caravans. Using the rugged XS 25 watt soldering iron it is powered from any 12 volt supply. The lead is 4.5m long equipped with two rugged crocodile clips for connection to car or similar batteries. A length of solder is provided, all packed in a tough clear wallet. This model is very popular with model boat, aircraft and car enthusiasts who sometimes have to make urgent repairs in the field.

Code	Volts	Watts	1+	10+
SO3340	12V	25W	**£15.95**	11.50

Antex TCS Adjustable Temperature Soldering Iron

The TCS 'in-handle' adjustable temperature controlled soldering iron has a range of 200-450°C with extremely accurate temperature control. The 220/240V version plugs directly into the mains giving all the benefits of a temperature controlled soldering station at a more economical cost. The 24 volt version plugs into any 24 volt power supply rated at 50 watts or more (eg Antex PSU-24) thus turning a power supply into a soldering station. A range of 7 bits is available for use with TCS offering a wide range of tip profiles. TCS240 has 1.5m standard cable, the TCS24 has 1.5m silicone rubber (burnproof) cable.

Code	Volts	Watts	1+	10+
SO3430	240V	50W	**£41.75**	31.86
SO3440	24V	50W	**£43.95**	36.41

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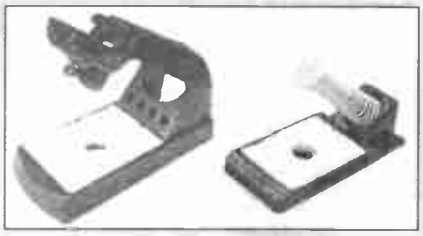


Antex SO3410/SO3420 Bench Stands

The Antex SO3410 bench stand comprises a phenolic base, spring iron holder, sponge and 4 rubber feet. It has provision for screwing to a bench if required. The iron holder will take any Antex or competitive iron. The SO3420 is the professional's version. Similar to the SO3410 it has a steel base to give added stability. Designed specially for Antex soldering irons (but also suitable for some competition models). Screw holes for bench fixing are provided as are four rubber feet.

Code	1+	10+
SO3410	£4.50	2.97
SO3420	£7.95	6.22

Replacement Elements

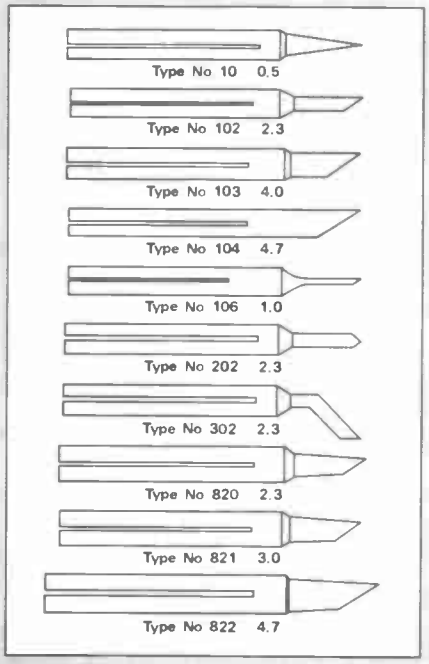
All Antex soldering irons are repairable should the element fail or be damaged. This is simply done by a competent person. When ordering a replacement element ensure that the soldering iron model and voltage are stated. Replacement elements are packaged with full instructions.

Code	Volts	Watts	1+	10+
SO2500	240V	15W	£5.61	3.93
SO2505	115V	15W	£5.75	4.02
SO2510	24V	15W	£6.00	4.20

Code	Volts	Watts	1+	10+
SO2515	240V	17W	£5.75	4.02
SO2520	115V	17W	£5.87	4.10
SO2525	24V	17W	£6.12	4.28

Code	Volts	Watts	1+	10+
SO2530	240V	50W	£17.87	12.51
SO2535	24V	50W	£17.87	12.51

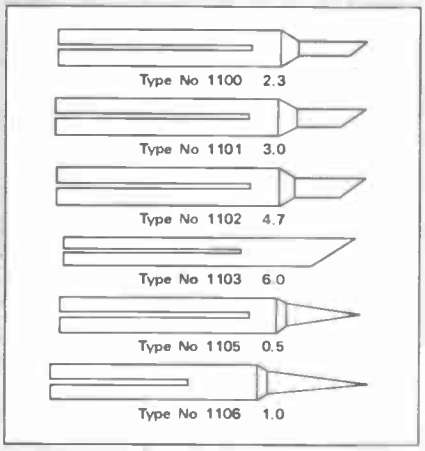
Code	Volts	Watts	1+	10+
SO2540	240V	25W	£5.75	4.02
SO2545	115V	25W	£5.87	4.11
SO2550	24V	25W	£6.12	4.20
SO2555	12V	25W	£6.12	4.20



Replacement Bits

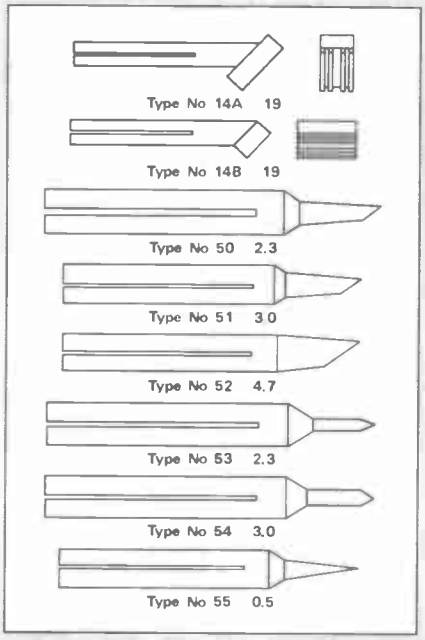
(a) For C Irons

Code	Type	Description	1+	10+
SO2600	10	0.5mm pencil	£2.35	1.54
SO2605	102	2.3mm parallel	£2.35	1.54
SO2610	103	4mm parallel	£2.35	1.54
SO2615	104	4.7mm parallel	£2.35	1.54
SO2620	106	1mm parallel	£2.35	1.54
SO2625	202	2.3 chisel	£2.35	1.54
SO2630	302	2.3mm 45°	£2.35	1.54
SO2635	820	2.3mm tapered	£2.35	1.54
SO2640	821	3mm tapered	£2.35	1.54
SO2645	822	4.7mm tapered	£2.35	1.54



(b) For CS & TCS Irons

Code	Type	Description	1+	10+
SO2700	1100	2.3mm parallel	£2.45	1.54
SO2705	1101	3mm parallel	£2.45	1.54
SO2710	1102	4.7mm parallel	£2.45	1.54
SO2715	1103	6mm parallel	£2.45	1.54
SO2720	1105	0.5mm pencil	£2.45	1.54
SO2725	1106	1mm semi-taper	£2.45	1.54
SO2730	1108	3mm chisel	£2.45	1.54
SO2735	1109	5mm chisel	£2.45	1.54



(c) For XS Irons

Code	Type	Description	1+	10+
SO2800	14A	19mm desolder	£8.99	7.00
SO2805	14B	19mm desolder	£8.99	7.00
SO2810	50	2.3mm semi-taper	£2.45	1.54
SO2815	51	3mm semi-taper	£2.45	1.54
SO2820	52	4.7mm semi-taper	£2.45	1.54
SO2825	53	2.3mm chisel	£2.45	1.54
SO2830	54	3mm chisel	£2.45	1.54
SO2835	55	0.5mm chisel	£2.45	1.54

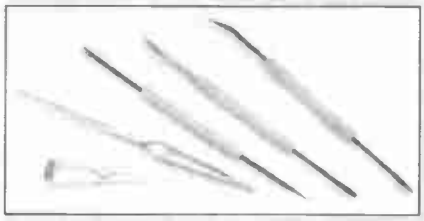
Solder

SO2900 500gm reel 18g multicore solder. £5.50; 10+ 4.28, 25+ 3.43

SO2905 500gm reel 22g multicore solder £5.95; 10+ 4.65, 25+ 3.72

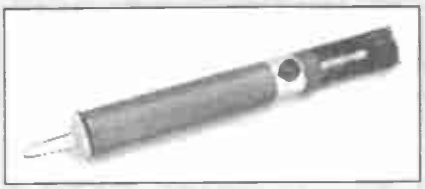
SO2910 Card containing 1.83m of 18g multicore solder **70p**

SO2915 Card containing 2.5m of 22g multicore solder **70p**



Soldering Aids Set

SO2920 A set of five useful tools for use when soldering PCBs. The set comprises fork/hook, knife/needlepoint, wire brush/scraper, heatsink and tweezers **£4.95**



Desoldering Tool

SO3925 High suction pump with automatic ejection. Finest quality all-metal construction. Heavy duty return spring and close tolerance manufacture give extra-high suction. Teflon nozzle. Blue and black. Dims 19(dia)x192mm. **£3.95;** 10+ 2.41

SO2930 Spare nozzle. **85p;** 10+ 0.52

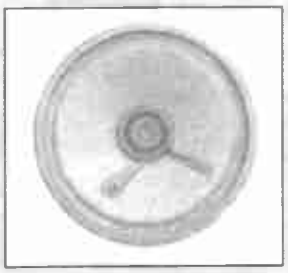
Solder Remover

SO2935 A specially treated wick draws up molten solder, leaving joints clean for removal of components or re soldering. Length 1.5 metres. Supplied on plastic dispenser. **£1.30;** 10+ 0.81

SPEAKERS/SOUNDERS

Miniature Loudspeaker

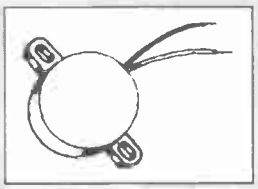
SP3010 A miniature speaker measuring just 38mm in diameter for use in miniature portable equipment. Fitted with paper cone and alnico magnet. Solder connection tags. Impedance 8 ohms. Handling capacity 100mW. **£1.20;** 25+ 0.81; 100+ 0.65



Miniature Loudspeaker

A miniature speaker for use in small portable equipment. Fitted with paper cone and ferrite magnets. Solder connection tags. Both types 66mm diameter 21mm deep. Handling capacity 300mW.

Code	Type	1+	25+	100+
SP3020	8 ohm	**96p**	0.65	0.53
SP3030	64 ohm	**£1.04**	0.71	0.57

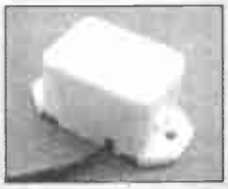


Miniature Piezo Transducer

SP2040 A miniature flange mounting piezo audio transducer with flying leads housed in a compact package. Requires an external drive circuit. **85p;** 25+ 56, 100+ 0.45

Technical Specification

Operating voltage (V p-p max)	25V
Sound output	85dB at 10cm
Resonant frequency	52.8kHz
Current consumption	8mA
Capacitance (±30%)	18,000pF
Weight	4.0 gm
Operating temperature	-20°C to +60°C



Transistor Oscillator Buzzer

Miniature transistor oscillator buzzer available with flying leads or PCB mounting options. These buzzers offer long life and maximum efficiency with minimum current dissipation.

Technical Specification

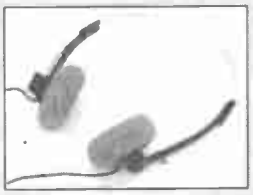
Operating voltage	3V type	2-5V DC
	6V type	4-9V DC
	12V type	9-20V DC
Current consumption		25mA
Sound output		75dB at 30cm
Frequency		400Hz

Code	Type	1+	25+	100+
SP2050	3V buzzer (leads)	**£1.12**	0.76	0.61
SP2060	6V buzzer (leads)	**90p**	0.58	0.49
SP2070	12V buzzer (leads)	**90p**	0.58	0.49

Earphones

Low and high impedance earphones fitted with 0.8 metres of twin cable and terminated with a 3.5mm jack plug. Available in either magnetic (low impedance 8 ohm) or crystal (high impedance 3 Megohm).

Code	Type	1+	25+	100+
SP2080	Magnetic	**28p**	0.21	0.17
SP2090	Crystal	**£1.20**	0.81	0.65



Headphones

SP3100 Ultra-lightweight, low cost mini headphones. Packed in attractive triangular gift box. **£1.40;** 10+ 0.68, 25+ 0.56

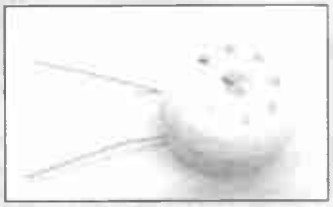
Impedance	32Ω
Response	40-20,000Hz
Power	100mW
Lead	1.15m straight screened
Plug	3.5mm
Weight	40g

Stereo/Mono Headphones

SP4110 Stereo/mono Headphones. Soft padded headband and earpieces. Rotary volume controls and stereo/mono switch. All black construction. 2 metre straight lead. **£6.95;** 10+ 4.90, 25+ 4.40

Technical Specification

Impedance	8Ω
Response	30-18000Hz
Power	500mW
Lead	2.8m coiled screened
Plug	6.35m stereo
Extras	Rotary volume controls and mono/stereo switch
Weight	325g

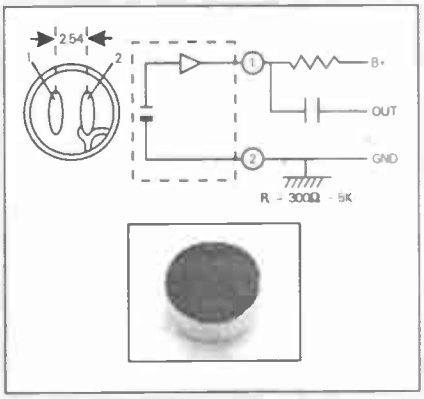


Ceramic Microphone Insert

SP2120 Miniature ceramic microphone insert. All plastic body. Connection by flying leads. 90p; 100+ 0.60

Technical Specification

Impedance	8 ohms
Frequency response	200Hz to 7kHz
Sensitivity	-70dB ±4dB at 1kHz
Dimensions	23mmx11mm



Electret Microphone

A subminiature omni directional electret microphone insert. Available with solder pads or with PCB pins for direct mounting to printed circuit boards.

Technical Specification

Frequency response	50Hz to 12kHz
Impedance	300 ohms
Sensitivity	-60 ±3dB (0dB= 1V/1µ bar, 1kHz V_{cc}=4.5V, R_L=1K)
Operation voltage	1.5V to 10V (standard voltage 4.5V)
Dimensions	10x7mm
Signal to noise ratio	>40B
Current drain	0.4mA max.
Maximum input	120dV SPL

Code	Type	1+	25+	100+
SP2130	Insert (solder pad)	**60p**	0.40	0.32
SP2140	Insert (PCB)	**64p**	0.43	0.34

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Dynamic Microphone

SP3150 Good quality plastic bodied dynamic microphone with black mesh head. On/off switch and integral 2.8m lead **£5.95**; 10+ 3.45

Type	Uni-directional dynamic
Impedance	600R
Response	100-10,000Hz
Sensitivity	76dB @ 1500hz
Head diameter	52mm
Length	215mm

SWITCHES

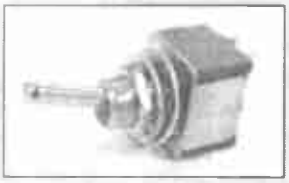
Sub-miniature Toggle Switches

A range of low cost sub-miniature toggle switches providing an excellent value switch to be used where space is at a premium

Technical Specification

Size Single Pole	26.4x10x5.2
Double Pole	26.4x10x9.2
Contact rating	3A 125V, 1A 250V AC
Initial contact resistance	<20mΩ
Insulation resistance	>10GΩ at 500V DC
Contact material	Copper alloy with silver inlay, silver plated
Body material	Flame retardant alkyd
Electrical life	>20x10⁴ cycles at full load
Operating temperature	-20°C to +80°C

Code	Type	1+	25+	100+
SW2010	SPST	66p	0.45	0.36
SW2020	SPDT	68p	0.46	0.37
SW2030	DPDT	75p	0.51	0.41



Miniature Toggle Switches

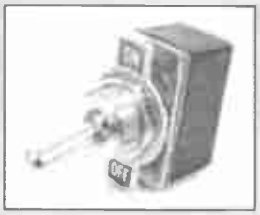
A range of low cost miniature toggle switches providing exceptional value available in single pole or double pole options including momentary biased options. All switches are fully approved to UL and CSA

Technical Specification

Size Single Pole	34.2x13.2x7.3
Double Pole	34.2x13.2x12.1
Contact rating	6A 125V, 3A 250V AC
Initial contact resistance	<20mΩ
Insulation resistance	>100MΩ at 500V DC
Contact material	Copper alloy with silver inlay, silver plated
Body material	Flame retardant alkyd
Electrical life	>5x10⁴ cycles at full load
Operating temperature	-20°C to +85°C

Code	Type	1+	25+	100+
SW2050	SPDT	64p	0.44	0.35
SW2060	SPDT centre off	68p	0.46	0.37
SW2070	SPDT on-off-(on)	89p	0.60	0.48
SW2080	SPDT (on)-off-(on)	89p	0.60	0.48
SW2090	DPDT	82p	0.56	0.45
SW2100	DPDT centre off	91p	0.62	0.50
SW2110	DPDT on-off-(on)	£1.10	0.75	0.60
SW2120	DPDT (on)-off-(on)	£1.10	0.75	0.60

For biased switches (on) indicates momentary action.



Standard Toggle Switches

A range of low cost standard size toggle switches. Complete with on/off plate. Rated at 250V 15A AC. These switches are not recommended for industrial applications. Panel cutout 12mm

Code	Type	Body dim	1+	25+	100+
SW2130	SPST	25x14x14	50p	0.39	0.31
SW2140	DPDT	28x18x14	82p	0.56	0.45

SPST and DPST Miniature Rocker Switches

Miniature single pole and double pole rocker switches with a curved rocker in a compact package. On position is clearly marked by a legend printed in white on the rocker face. Black bezel with matt black concave rocker. 4.8x0.8mm connections. The SPST is UL, CSA, VDE and SEMKO approved. The DPST is UL, CSA and VDE approved.

Technical Specification

	SPST	DPST
Size	21x18x15	21.2x24x15
Contact rating	4A 250V ac 8A 125V ac	4A 250V ac 8A 125V ac
Initial contact resistance	<20mΩ	<50mΩ
Insulation resistance	>50mΩ at 500V dc	>100M at 500V dc
Contact material	Silver plated copper	
Body material	Nylon 6/6 (UL94V-2)	
Mechanical life	>10⁶ cycles	>10⁵ cycles
Electrical life	>2x10⁴ cycles	>10⁴ cycles
Operating temperature	-20 to +65°C	-20 to +65°C

Code	Type	1+	25+	100+
SW2150	SPST	66p	0.45	0.36
SW2160	DPST	£1.00	0.68	0.55

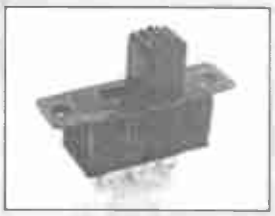
Illuminated Rocker Switches

A range of low cost illuminated rocker switches with concave rocker with modern ergonomic appearance. Matt black bezel with rocker in red. The switch provides clear power on indication during 240V AC operation. 4.8x0.8mm crimp connections. UL, CSA approved. Size 32.5x33.5x23.2

Technical Specification

Contact rating	10A 250V AC 16A 125V AC
Insulation resistance	>100MΩ
Initial contact resistance	<50M max
Mechanical life	>3x10⁵ cycles
Electrical life	>10⁴ cycles
Operating temperature	0°C to +85°C

Code	Type	1+	25+	100+
SW2180	SPST illum red	£1.07	0.73	0.58
SW2190	DPST illum red	£1.35	0.93	0.75



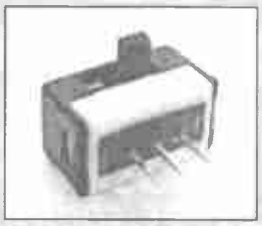
Miniature Slide Switch

SW2200 A miniature slide switch with solder tag connections with break before make DPDT contacts. Suited to a wide range of miniature electronic equipment. Contacts rated at 0.3A, 125V AC. Size 19x18.5x7.2 **16p**; 25+ 0.11, 100+ 0.09

Standard Slide Switch

Standard slide switches with solder tag connections with break before make DPDT contacts available also in centre off. Suited to a wide range of miniature electronic equipment. Contacts rated at 0.3A, 125V AC. Size 35x23x12.5

Code	Type	1+	25+	100+
SW2210	DPDT std slide	25p	0.18	0.14
SW2220	DPDT centre off slide	27p	0.19	0.15



Ultra-miniature Slide Switches

A range of vertical mounting and right angle PCB mounting slide switches having pins on a 0.1 in grid. Silver plated contacts close with a positive action. Sealed terminals are flux immune.

Technical Specification

Size Single Pole	14x15.2x7.8
Double Pole	14x15.2x12.8
Contact rating	2A 250V AC
Minimum load	100mA 10v
Initial contact resistance	10MΩ max
Electrical life	2x10⁴ cycles
Temperature range	-40 to +85°C

Code	Type	1+	25+	100+
SW2230	SPDT vertical	77p	0.52	0.42
SW2240	DPDT vertical	90p	0.62	0.50
SW2250	SPDT right angle	88p	0.60	0.48
SW2260	DPDT right angle	£1.00	0.70	0.56

Miniature Push Switches

Miniature low cost push to make switches with all plastic body and chrome locking nut offered in a variety of button colours. Non-locking action. Overall dimensions 28mm long, 10.5mm diameter. Rated 250mA 125V Ac. Panel cutout 7mm. These switches are not recommended for industrial applications.

Code	Type	1+	25+	100+
SW2300	Red push switch	26p	0.18	0.15
SW2310	Black push switch	26p	0.18	0.15
SW2320	Green push switch	26p	0.18	0.15
SW2330	Yellow push switch	26p	0.18	0.15
SW2340	Blue push switch	26p	0.18	0.15
SW2350	White push switch	26p	0.18	0.15

Push Switch

SW2366 Miniature low cost push to break switch with black button. Non-locking. Overall dimensions 28mm long, 10.5mm diameter. Rated 250mA 125V AC. Panel cutout 7mm. This switch is not recommended for industrial applications. **38p;** 25+ 0.27; 100+ 0.20

Square Push Switches

A range of attractive large push switches with actuator button in red or black. Available in non-locking push to make or SPST latching models. Body dimensions 34x15x15mm. Panel cutout 12mm. Contacts rated 1A 250V AC.

Code	Type	1+	25+	100+
SW2400	SPST red non-locking	**53p**	0.36	0.29
SW2410	SPST black non-locking	**53p**	0.36	0.29
SW2420	SPST red latching	**63p**	0.42	0.34
SW2430	SPST black latching	**63p**	0.42	0.34

Miniature Tilt Switch

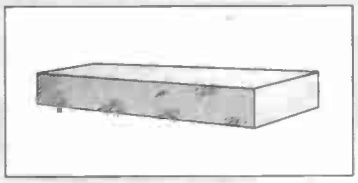
SW2450 A miniature tilt switch consisting of a mercury bubble in small glass envelope. Overall dimensions 18x5mm diameter. Contacts rated at 1A 14V DC. Switch will operate at tilt angle at 10°. **CAUTION** - this switch contains mercury and should NEVER be broken open. **68p;** 25+ 0.47; 100+ 0.40

Reed Switch

SW2460 A miniature sensitive reed switch specifically designed for switching low signals but equally capable of switching higher loads if required. Single pole normally open rhodium contacts. Suitable magnet is available - see next item. **45p;** 25+ 0.33; 100+ 0.28

Technical Specification

Contact material	Rhodium
Contact rating	12VA max
Switching current max	1 A ac or dc
Switching voltage	220V ac
Pull in range	20 - 30 AT
Max switching frequency	240Hz
Max operate time (125% pi)	2ms
Max release time (without diode)	0.05ms
Max bounce time	0.2ms
Glass dimensions	19x2.6mm
Overall length	55mm



Miniature Magnet

SW2470 A miniature magnet suited to operating the aforementioned reed switch. Dimensions 12.7 x 3.2 x 1.6mm. **25p;** 25+ 0.17, 100+ 0.14

Rotary Switches

A range of high quality rotary switches moulded in glass filled nylon. Make before break contacts. Adjustable rotation stop. Mounting bush 9.8mm diameter. Spindle length 40mm.

Technical Specification

Contact rating	150mA 250V AC
Initial contact resistance	20mΩ max
Electrical life	15×10^3 full rotation cycles
Temperature range	-20 to +85°C

Code	Type	1+	25+	100+
SW2480	1 pole 12 way	**£1.00**	0.68	0.55
SW2485	2 pole 6 way	**£1.00**	0.68	0.55
SW2490	3 pole 4 way	**£1.00**	0.68	0.55
SW2495	4 pole 3 way	**£1.00**	0.68	0.55

DIL Switches

Standard DIL package with 4,6,8 or 10 single pole switches incorporated.

Code	Type	1+	25+	100+
SW2500	4 way 8 DIL pkg	**60p**	0.38	0.30
SW2505	6 way 12 DIL pkg	**90p**	0.56	0.45
SW2510	8 way 16 DIL pkg	**£1.10**	0.69	0.55
SW2515	10 way 20 DIL pkg	**£1.30**	0.81	0.65

Microswitches

A range of high quality standard size microswitches offering a switching capacity of 15A at 250V AC. Connection may be made by a ¼in. connector or soldering. Type V3.

Technical Specification

Contacts	Silver
Rating	15A 250V AC resistive
Mechanical life	$>10^7$ operations

	button	lever	roller	short roller
Pretravel	1.2	3.3	3.3	1.5
Differential	0.15-0.4	1.25 max	1.25 max	0.4
Operating force	400g	200g	200g	400g
Release force	80g	28g	28g	85g

Code	Type	1+	25+	100+
SW2550	Button	**95p**	0.65	0.56
SW2560	Lever	**95p**	0.65	0.56
SW2570	Roller	**95p**	0.65	0.56
SW2580	Short roller	**95p**	0.65	0.56

TEST EQUIPMENT

Analogue Multimeter

TS3015 Input Impedance 30kΩ; 24 Ranges (Including 10Adc); Diode & Fuse Protection. Polarity Reverse Switch; Transistor Test Ranges. Battery Test Ranges; Test Leads With Shrouded 4mm Plugs; Battery & Instruction Leaflet Included. **£24.95;** 10+ 18.00

Specification

AC Volts	0-10-30-10-300-1000V ±3%
DC Volts	0-3-10-30-100-300-1000V ±3%
DC Current	0-100µ-3m-30m-300m-10Adc ±3%
Resistance	0-1k-10k-1M-10MΩ ±3%
Battery Test	1.5V AA, 1.5V C & D, 9V PP3
Protection	Fuse and Diodes
Dimensions	160 x 110 x 50mm

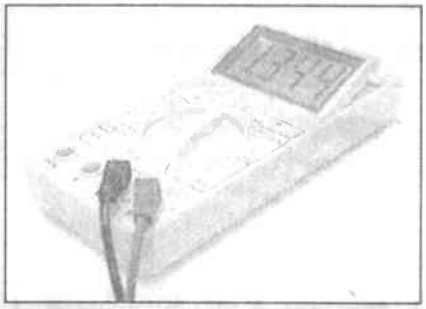
Digital Multimeter

TS3020 Digital Multimeter in yellow housing. 10A socket, Diode test, NPN/PNP Transistor testing. Power supply 1 x 9V -battery (not included). **£14.99;** 10+ 8.81

Specification

Display	3½ digits, LCD 13mm
Ranges/Accuracy	
DC V	200/200mV/20/200/1000V ±0.5%
AC V	200/750V, ±1.2%, 40-450 Hz
DC A	2000µA/20/200mA/10A, ±1%
	200µA, ±1%
Resistance	200/2000Ω/20/200/2000 kΩ ±8%

PRICES IN BOLD INCLUDE VAT; QTY PRICES IN LIGHT DO NOT



Digital Multimeter

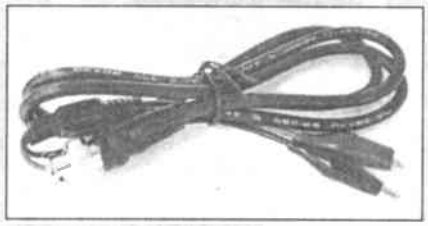
TS3030 Multi-purpose 3.5 digit meter with 21mm high tiltable digital display. This model incorporates a transistor checker, diode testers and has a separate 20A socket. **£36.00;** 10+ 26.00

Specification

DC volts	200mV/2/20/200/1000v ±5%
AC volts	200mV/2/20/200/750V ±40-400Hz
DC current	20/200µA/2/20/200mA/2/20A ±1%
AC current	20/200µA/2/20/200mA/2/20A ±1.5% 40-400Hz
Resistance	200R/2/20/200k/2/20m ±0.8%
Transistor test	HFE 0-1000
Diode test	Forward voltage
Input resistance	10M
Continuity buzzer	50R
Power supply	9V battery
Size	186x86x36mm
Weight	360g

Voltage Tester

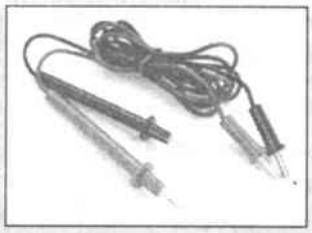
TS3040 Dual function screwdriver type circuit tester. Used as an inductance tester it will detect buried live cables, breaks in cables etc. Touching a live par with the tip will indicate the voltage level on the LCD screen. AC or DC up to 250V max. **£3.95;** 20+ 2.70



Test Leads

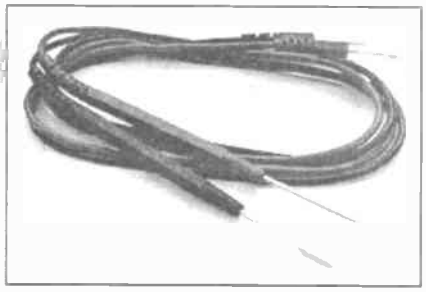
TS3050 50Ω coaxial lead with BNC plug on one end. Red and black crocodile on the other end. **£2.50;** 10+ 1.65

Maximum current	3A cont
Length	0.9m
Wire diameter	5.5mm



TS3060 Standard long prods to standard 4mm banana plugs. Red and Black. **£1.65;** 25+ 1.05

Maximum current	1.8A cont
Length	1.1m
Wire diameter	2.7mm

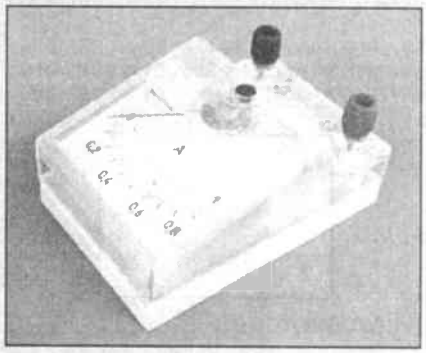


TS3070 Standard basic test leads. Prods ends 2mm. Red and Black. **£1.20;** 25+ 0.75

Maximum current	1.8A cont
Length	0.85m
Wire diameter	27mm

Resistance Substitution Box

TS2080 A rapid system for selecting a correct resistor valve within a circuit. A neat swivelling disc provides close tolerance hand-held substitution resistors of 36 preferred values from 5Ω to 1MΩ. Simply attach crocodile clips into circuit and swivel until optimum result is achieved. Feature high stability 0.25W 5% resistors. **£13.50;** 10+ 9.19

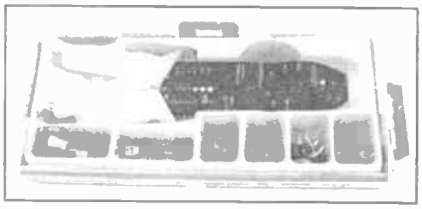


Educational Meters

A range of moving coil bench mounted meters ideally suited to educational users. The meters are terminated by marked 4mm terminals. Accuracy typically 4%. Housed in robust case with large clearly defined scales. Dimensions 80x100x48mm.

Code	Type	1+	10+
TS3101	0-1A	£6.95	4.90
TS3102	0-2A	£6.95	4.90
TS3105	0-5A	£6.95	4.90
TS3106	0-6V DC	£6.95	4.90
TS3115	0-15V DC	£6.95	4.90

TOOLS

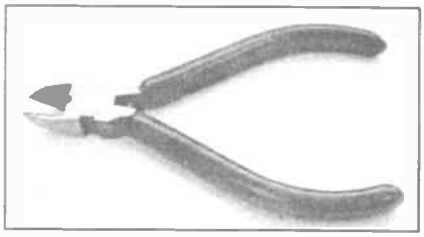


Crimp Tool Kit

TL3010 A kit containing a varied selection of crimp connectors and insulated crimping tool housed in a hinged plastic case. Comprises 80 assorted insulated terminals and 40 assorted non insulated terminals. Tool incorporates wire cutter and wire stripper **£4.95;** 10+ 3.25

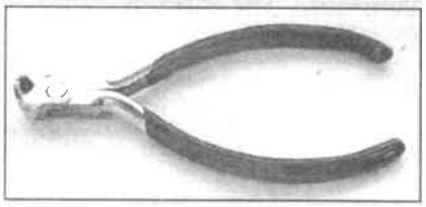
Economy Pliers and Side Cutters

A range of economy electrical and electronic side cutters and pliers offering excellent value for money. Large contract purchases placed with manufacturers enable us to offer these tools at a fraction of their cost elsewhere.



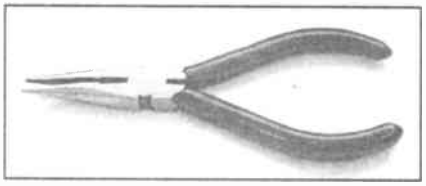
Electronics Side Cutters

TL2020 A pair of economical good quality lap jointed miniature side cutters with insulated handles and return spring. Size 115mm. **£2.75;** 10+ 1.87



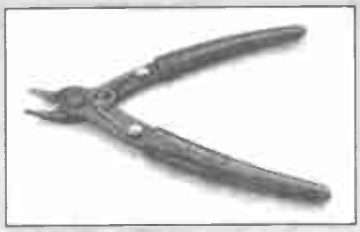
Electronics Top Cutters

TL2030 A pair of economical good quality lap jointed miniature top cutters with cutting edge for use in confined spaces. Insulated handles and return spring. Size 115mm. **£2.95;** 10+ 2.06



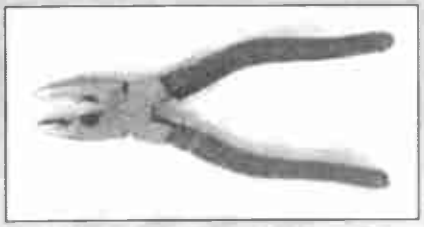
Electronic Snipe Nose Pliers

TL2040 A pair of economical good quality lap jointed miniature snipe nose pliers with insulated handles and return spring. Size 115mm. **£2.60;** 10+ 1.75



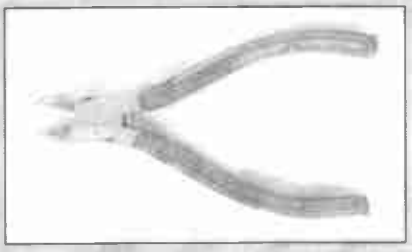
Light Duty Cutters

TL2050 A pair of economical light duty cutters. flush cutting edges for soft wires. Opening spring fitted. Complete with PVC grips. Cutting capacity 0.2-1.2mm copper wire. **£2.50; 10+ 1.50**



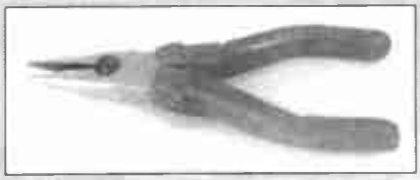
Electrician's Pliers

TL2100 A pair of economical lap jointed electrician's pliers with PVC covered handles. Nominal length 150mm. **£3.95; 10+ 2.47**



Side Cutters

TL2104 A pair of economical lap jointed electrician's side cutters with PVC covered handles. Nominal length 150mm. **£3.60; 10+ 2.34**

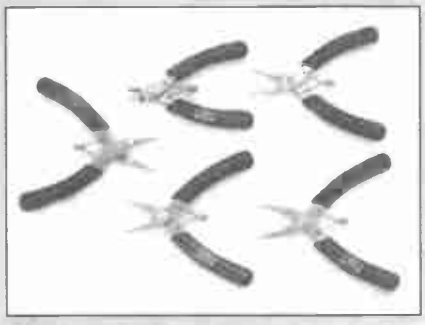


Snipe Nose Pliers

TL2106 A pair of economical lap jointed electrician's snipe nose pliers with PVC covered handles. Nominal length 200mm. **£3.60; 10+ 2.34**

Wire Strippers

TL2115 Light duty wire strippers. A handy wire stripper incorporating an adjustable gauge selector. Insulated handles with spring for automatic opening. **£2.65; 10+ 1.85**



Precision Tool Set

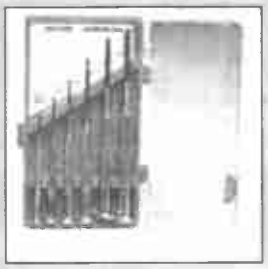
TL3260 5 piece pressed stainless steel tool set with precision ground blades. The set comprises side cutters, bent nose pliers, round nose pliers, long nose pliers and flat nose pliers. Sprung insulated handles. Length 100mm. **£14.95; 5+ 9.86**

Screwdrivers

A range of high quality screwdrivers with fully hardened and tempered high grade steel shafts. Chrome vanadium steel blades.

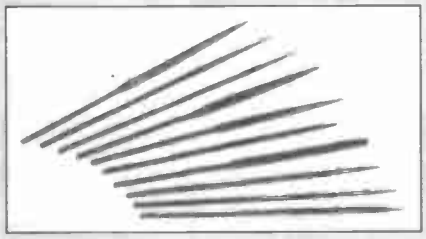
Flat bladed, round shaft parallel tip.

Code	Type	1+	12+
TL2200	75x3mm flat blade	48p	0.30
TL2205	100x3mm flat blade	50p	0.31
TL2210	150x5mm flat blade	85p	0.52
TL2215	200x5mm flat blade	£1.00	0.59



Miniature Flat Blade Screwdriver Set

TL2220 Six precision flat blade screwdrivers in a hinged plastic case with transparent cover. Each consists of a specially hardened nickel chrome molybdenum steel blade set in a chromed brass holder with swivel cap. Blade widths, 0.9, 1.2, 1.8, 2.4, 3.0, 3.5mm. **£1.45; 10+ 0.95**



Needle Files

TL2230 Needle Files. A pouch containing 10 various profiled files 140mm long for precision work at an economical price. **£2.30; 10+ 1.50**

Automatic Wire Strippers

TL3240 Automatic Wire Strippers. Will cope with insulated wire up to 6mm² dia and will strip up to 20mm, incorporates cable cutter. **£2.95; 10+ 2.00**

Automatic Centre Punch

TL2250 A hand operated centre punch which does not require a hammer. The tool is simply positioned and then depressed. The punch then indents the material to the depth set by the adjuster. The tool reset when removed from the material. Suitable for use on PCB materials. **£3.10; 10+ 2.00**

Mini Drill

TL2270 Precision geared plastic mini drill. Brass chuck will hold bits up to 1.2mm. Drill bit storage in handle. Length 115m. **£2.25; 36+ 1.60**

Precision PCB Mini Drill

TL3280 Precision PCB mini-drill. Nominally 12V DC, but works from 5-14V. Supplied with collett for 0.8-12mm bits, +1mm bit. Power input via 3.5mm plug. On/off switch. Current 250mA no load to 3.5A stalled. 6000 rpm no load speed. 35mm dia x165mm long. **£7.95; 10+ 4.70**

TEL: 01703 236363
FAX: 01703 236307
GREENWELD
27 Park Road · Southampton · SO15 3UQ

Miniature Vice

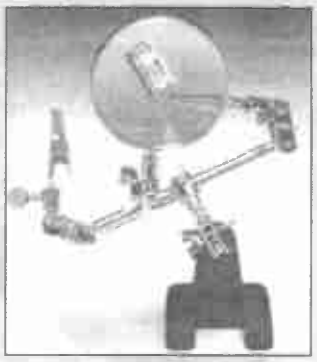
TL2290 Miniature plastic and metal vice with strong suction base. Single level action to secure to smooth, non porous surface. Aluminium covered jaws open to 40mm. 60x80x68mm **£1.95**; 36+ 1.20

Low Cost G-Clamps

Available in two sizes
TL4300 6" G-Clamp **£3.95**
TL4310 8" G-Clamp **£4.95**

Pick Up Tool

TL2420 Spring loaded pearl grip pick-up tool for small components. Four fingers extend to 14mm dia when the plunger is pressed and close up when retracted. Chrome metal Pocket clip. Length 127mm **£2.60**; 25+ 1.90



Assembly Aid

TL3380 An extremely versatile aid to assist in the soldering of PCBs, position of components, or wiring of connectors, etc. Two arms containing crocodile clips hold the components or PCB which may be adjusted through 360°. A 2.5 inch steel framed glass magnifier (2.5 magnification) is also featured to assist with accurate positioning and soldering of small components. The entire assembly is firmly mounted onto a heavy case base to prevent accidental tipping **£5.95**; 10+ 3.55

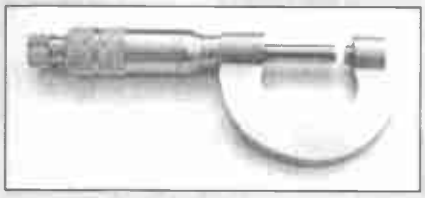
Snap-Off Blade Knives

A pair of general purpose disposable snap-off blade knives. Both type incorporate full retractable blades which can be locked into position. The blades are scored in 7 places permitting the end to be broken to expose a new unused cutting edge. Suitable for many light cutting jobs.

Code	Type	1+	25+
TL2390	Small knife	**80p**	0.28
TL2400	Large knife	**95p**	0.49

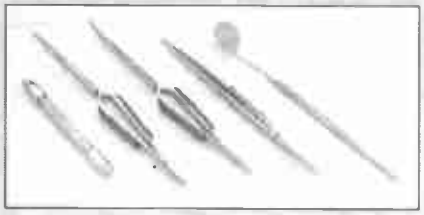
Precision Knife Set

TL3410 A 13 piece precision knife set comprising two miniature precision holders and a heavier duty precision holder with an ABS handle. A total of 13 blades are supplied enabling the user to employ knives for a wide variety of cutting operations. The blades are retained on a magnetic holder held in the lid of the hinged case. Case dimensions 160x65x35mm **£6.95**; 10+ 3.78



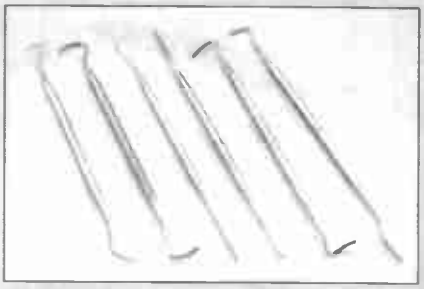
Micrometer

TL2430 Micrometer, 0-25mm supplied in case. Superb value for money **£8.95**



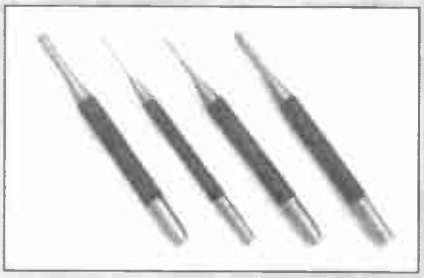
Tweezers

TL2610 Double ended low cost pin vice **£1.95**
TL2620 Self closing tweezers, straight points, 160mm long. **£2.50**
TL2630 As above but angled points **£2.50**
TL2640 Locking tweezers, 155mm long **£2.25**
TL2650 Inspection mirror, steel, 170mm long. **£1.95**



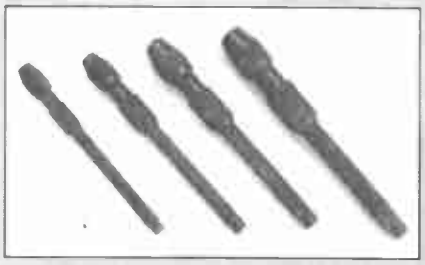
Probe Set

TL2660 Useful set of low cost stainless steel instruments, average length 150mm **£6.95**



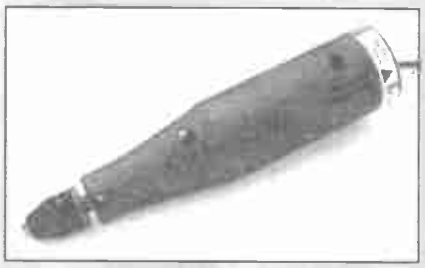
Drive Pin Punches

TL2670 Set of 4 drive pin punches - 1/16, 3/32, 1/8 and 5/32". Supplied in plastic wallet and boxed **£4.95**



Pin Vices

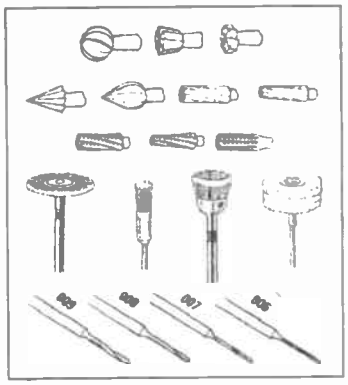
TL2680 Set of 4 pin vices. Covering 0.8-4.8mm. Supplied in plastic wallet and boxed. **£6.95**



Zircon Drill

TL3440 Zircon Drill. Expo's new 12V dc Zircon drill has been designed for power, size and ease of handling. The power is derived from the T section magnets and the drill produces more torque than other drills twice its size. Being only 160mm long and 35mm in diameter with a tapered front for fingertip control, the drill is ideal for the amateur and professional uses. It comes complete with an automatic 3-jaw chuck, ground shaft and ball race drive for precision drilling **£20.95**

TL3450 Also available as a kit with 20 tools **£34.99**



Code	Product	Price
TL3460	Set of 12 tools	£9.99
TL3470	Set of 20 tools	£14.99
TL3480	Set of 10 shank drill bits	£9.99
TL3490	Model railway service kit	£9.99

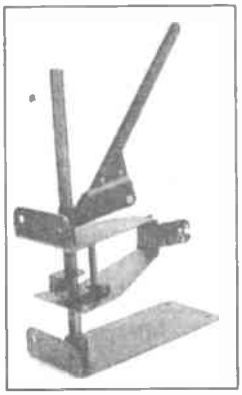
Reliant Drill

TL3500 Reliant Drill. Although smaller than the Zircon, with a cylindrical body measuring 75mm (3in) long by 34mm (1.34in) diameter, the Reliant drill is a powerful sturdy tool designed for smaller and more delicate jobs. Built in on/off switch and connecting cable. Torque at stall: 270g.cm (3.8 oz ins.) Reliant Drill with 3 auto chuck 0.1-3.0mm. **£12.99**

TL3510 Also available as a kit with 20 tools **£26.99**

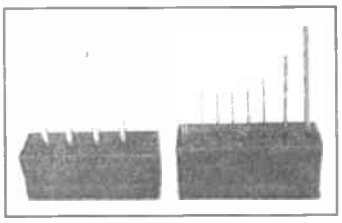
Pin Chuck

TL2520 A pin chuck enables small twist drills to be held. All steel construction with blackened finish. Automatic 3 jaw pin chuck. **£7.99**



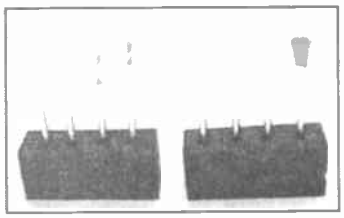
Drill Stand

TL3530 Multi-Purpose Drill Stand. A strong ingeniously designed all metal drill stand for use with all drills by means of a bracket. It can be used either vertically as a bench drill with a throat capacity of 112mm (4.4in) or horizontally as a bench mounted miniature grinder, polisher etc. Please specify for which drill. **£29.99**

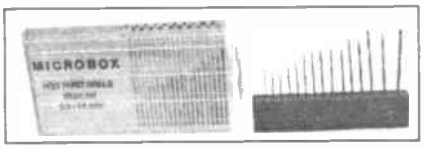


Drill Sets

Drill sets for Expo drills. 5 new sets contained in clear plastic cases.
TL2540 4 burrs. **£2.99**
TL2550 8 HSS twist drills, 0.5-2.0mm. **£5.50**



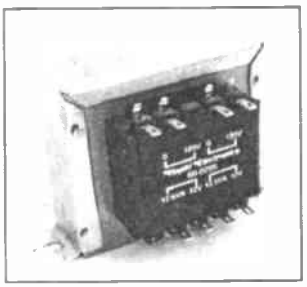
TL2560 4 HSS 3/32" shanked drills - 0.6, 1.0, 1.4, 1.6mm. **£3.99**
TL2570 4 mounted abrasive stones. **£2.99**
TL2580 Circular saw set - 12.5 and 19.3mm dia blades and mandrel. **£4.99**



Miniature HSS Twist Drills

Two sets of miniature HSS twist drills for the modeller.
TL2590 16 drills from 0.5 to 2mm. **£6.95**
TL2600 20 drills in plastic dispenser, from 0.3 to 1.6mm. **£7.50**

TRANSFORMERS



Chassis Transformers

A range of clamp mounting low voltage transformers in four power ratings from 6 to 50VA. Each transformer has two independent primary windings which may be connected in series for 240V or parallel for 120V input. All transformers conform to centre tap working. Double bobbin construction. All transformers conform to BS415.

6VA Miniature

3VA per secondary winding. Regulation typically 25%. Dims 45x37x38. FC 53x4BA.

Code	Output	1+	10+	25+
TX3010	0-6, 0-6V at 0.5A	£4.50	2.95	2.27
TX3020	0-9, 0-9V at 0.33A	£4.50	2.95	2.27
TX3030	0-12, 0-12V at 0.25A	£4.50	2.95	2.27
TX3040	0-15, 0-15V at 0.2A	£4.50	2.95	2.27
TX3050	0-20, 0-20V at 0.15A	£4.50	2.95	2.27

12VA Type

6VA per secondary winding. Regulation typically 10%. Dims 55x45x45. FC 65x2BA.

Code	Output	1+	10+	25+
TX3110	0-6, 0-6V at 1A	£6.95	4.73	3.64
TX3120	0-9, 0-9V at 0.6A	£6.95	4.73	3.64
TX3130	0-12, 0-12V at 0.5A	£6.95	4.73	3.64
TX3140	0-15, 0-15V at 0.4A	£6.95	4.73	3.64
TX3150	0-20, 0-20V at 0.3A	£6.95	4.73	3.64

25VA Type

12.5VA per winding. Regulation 7%. Dims 68x58x59. FC 84x2BA.

Code	Output	1+	10+	25+
TX3210	0-6, 0-6V at 2A	£8.95	6.08	4.68
TX3220	0-9, 0-9V at 1.3A	£8.95	6.08	4.68
TX3230	0-12, 0-12V at 1A	£8.95	6.08	4.68
TX3240	0-15, 0-15V at 0.8A	£8.95	6.08	4.68

50VA Type

25VA per winding. Regulation 10%. 63x65x78. FC 92x2BA.

Code	Output	1+	10+	25+
TX3310	0-6V, 0-6V at 4.1A	£10.95	7.60	5.85
TX3320	0-9, 0-9V at 2.7A	£10.95	7.60	5.85
TX3330	0-12, 0-12V at 2A	£10.95	7.60	5.85
TX3340	0-15, 0-15V at 1.6A	£10.95	7.60	5.85
TX3350	0-20, 0-20V at 1.2A	£10.95	7.60	5.85

NOTES

INDEX

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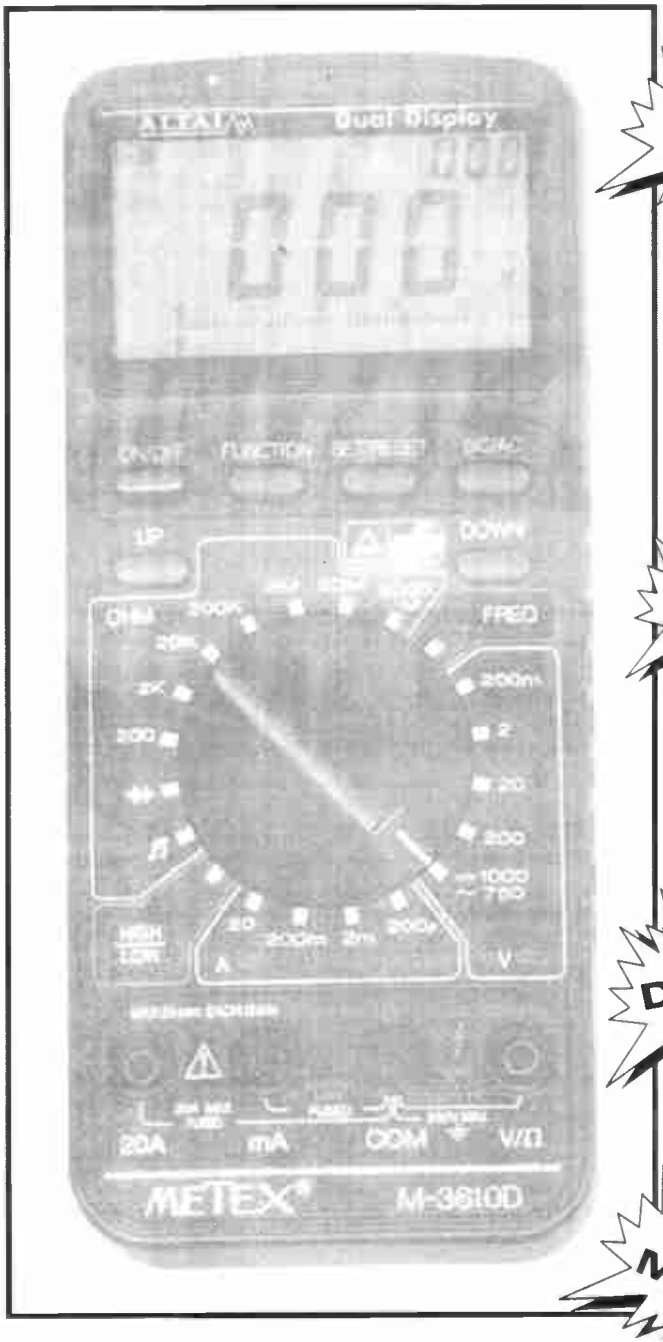

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From the North, follow A33 Take right turn at roundabout signposted A35 Ring Road and General Hospital Then turn left at the next roundabout into Hill Lane Turn right at the bottom, back into Shirley Road and then first left after the traffic lights into Sir George's Road

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Solent Blue Line - 15, 18 and 19

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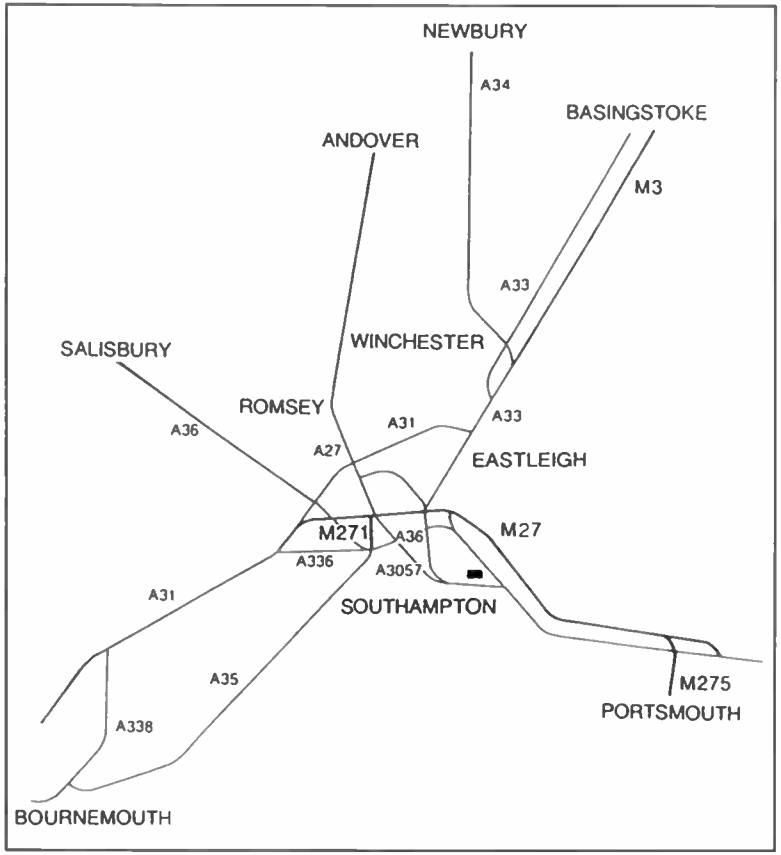
City Bus - 21
Solent Blue Line - 30, 31, 38 and 39



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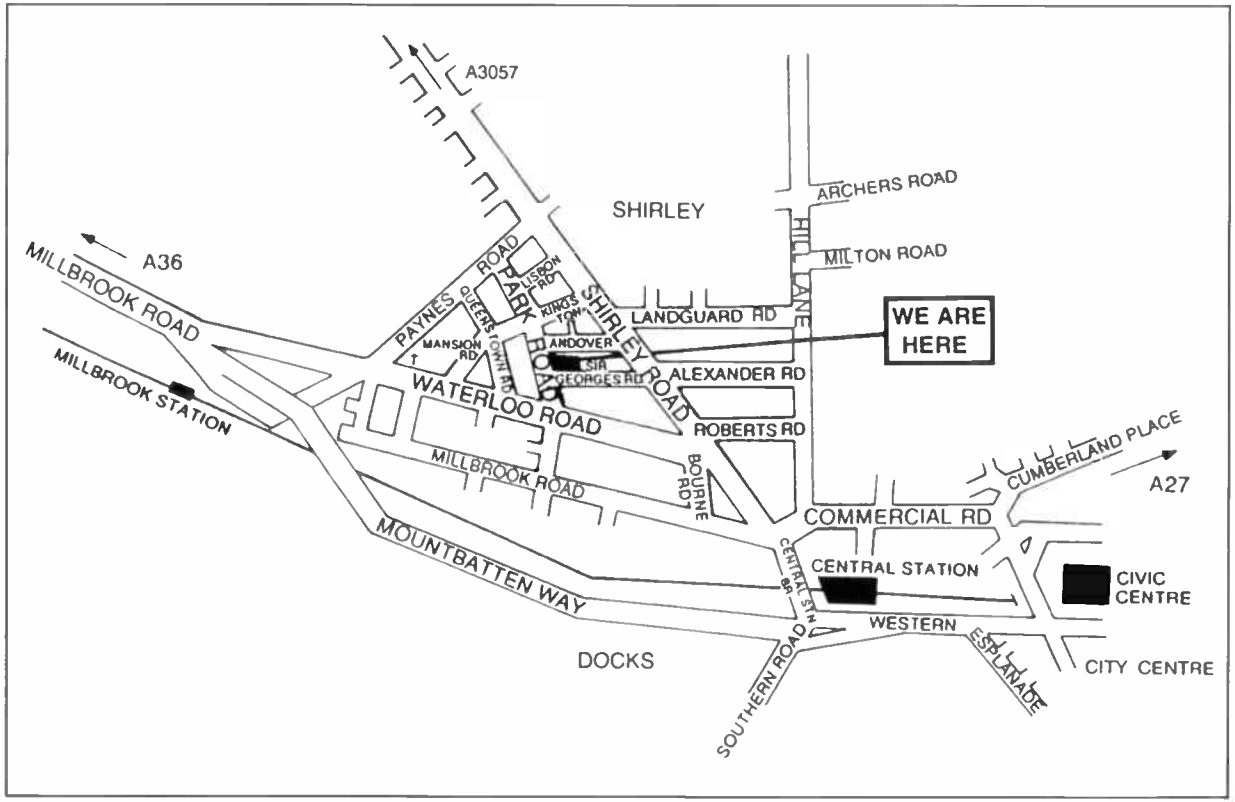


GREENWELD

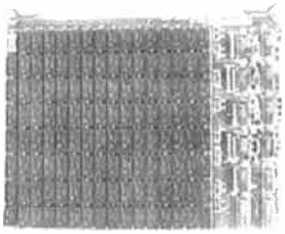
The following 8 pages are an addition to our 1998 Catalogue, especially for Everyday Practical Electronics readers, containing just a few of our super surplus bargains. All the products will be of special interest to the modeller and electronics enthusiast. All the prices within this supplement are inclusive of VAT...just add £3.00 postage and packing as per any normal order. Please use the standard order form on page 41 of the 1998 catalogue.

SUPERDEAL ON FLEX!

Bulk buy of 16/0.2 PVC insulated flex enables us to offer this at a great price!
X7107 (4000) Blue 25m coil. **£1.00**
X7106 (4000) Brown 25m coil. **£1.00**

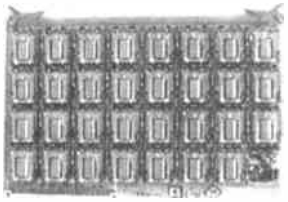
RELAY PANELS

Please Note: On the two panels listed below, one or two relays have been damaged to prevent re-use of the board.



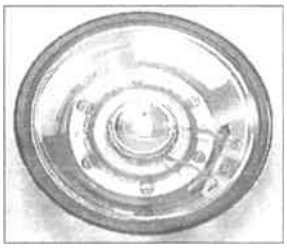
X6845 (100) This is a great scoop! It seems unlikely you'd find relays at less than 12p each - yet by buying this panel, that's exactly what you will get! 128 miniature BT style DPCO 5V relays + 32 BC337 transistors, 16 x BC327, 4 x NE590 (addressable peripheral driver - 8 open collector darlington outputs cost £6.62 each), 4 x NE591, 4 x LS chips, 128 diodes, Rs, Cs, etc. Board value is over £400!

Only £20.00



X6846 (200) This one has 32 low profile 4P make relays with 2A contacts and 24V coil, 64 x 1N4004 and a 64 pin DIN connector.

Only £5.00

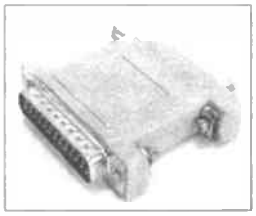


WATERPROOF SPEAKER

Z5690 These are entirely submersible, having a clear plastic sealed cone. Have music in your bath...literally! 88mm diameter (3½"), rated 12 watts, 8R, 60mm diameter magnet. Super quality and value!

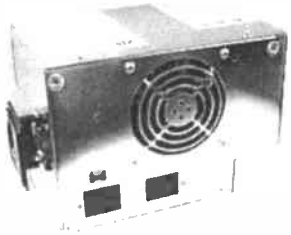
Only £2.95 Each

GENDER CHANGER



P2915 Gender changer 25W D plug to 25W D plug.

£3.95



X9132 (550) Excellent value, brand new 220W PC supply! Mains in/out; switched; built in brushless 12V fan; output leads with connectors Spec: 120/240V input, outputs +5V 23A, +12V 8A, -5V -0.5A, -12V 0.5A. Case size 212 x 150 x 150mm.

Special Low Price £15.00

X6855 (1500) Excellent 12V solenoid. 58 x 32 x 25mm. Through plunger has 25 x 2mm disc one end and 31 x 2.3mm diameter spindle the other. **£2.00**

X3945 (3000) Geared 16V DC reversible motor (works well on 12V). Size 61 x 33mm diameter. 10mm diameter gear on spindle. Final drive speed 200RPM. **£3.00**

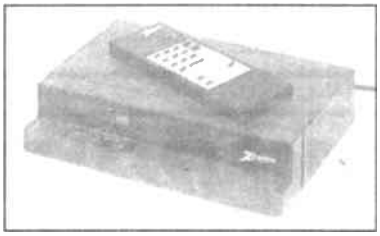
X6147 Versatile soft padded instrument case measuring 250 x 250 x 80mm, with expanding side pocket 175 x 80 x 90mm. Both have velcro fasteners. On one side are two apertures, one 15 x 15mm and the other 80 x 40mm covered by a leatherette flap. Strong carrying handle. Grey material with black edging. Stacks of uses! **Only £2.95**

RECHARGEABLE BATTERY

X6508 Yuasa NP2.3-12 rechargeable lead acid battery. New. 12V 2.3Ah.

Only £5.00

CABLE TV UNIT

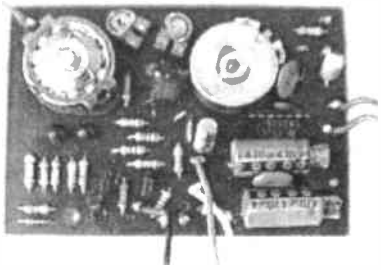


X9035 Scoop purchase of these Zenith cable TV receivers - complete with remote control unit! They have been removed from customers premises. (We do not however guarantee this item). The unit measures 245 x 170 x 60mm and has a brown plastic case over a metal chassis. Inside is a switch mode power supply, modulator/demodulator modules, AA nicad, dual 7 seg display, IR receiver circuitry and lots of small modern components. On the rear panel are input and output sockets and a 2m mains lead with 13A plug attached. The remote control has 17 buttons. **£6.95**

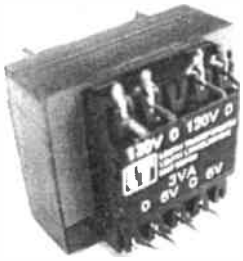
TOP QUALITY CHISELS

X9167 (40) Top quality, guaranteed unbreakable handled chisel set. Made by Marples. These hand forged, split proof, bevel edged chisels are probably the best money can buy. Set of four: 25mm, 19mm, 13mm and 6mm. These normally retail at around £60.00 a set or between £13.00 and £17.00 individually.

Bargain At £34.95

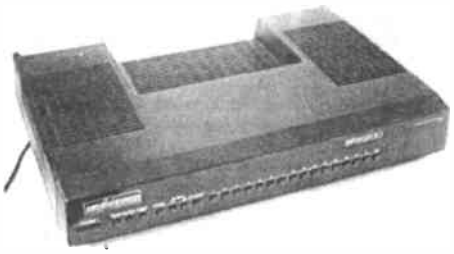


Z914 Audio amp panel. 95 x 65mm with TBA820 chips. Gives 1W output with 9V supply. Switch and volume control. Just connect battery and speaker. Full details supplied. **£1.50**



X7234 (490) 120V 0 120V 0 primary, with 0 6V 0 6V secondary 3VA. Made by Louth Transformers Brand new **£1.50**

SKY TV BOXES

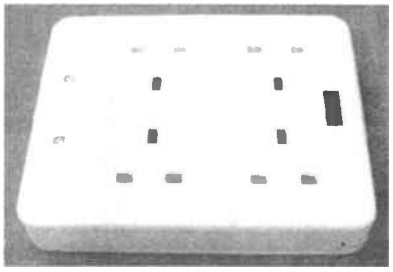


X9196 (175) Sky TV box - sold for spares only 16 channel, made by Amstrad Fidelity, model number SRX200 320 x 220 x 60mm. The sockets on the back include. LNB IN via 'F' type socket, Scart socket, audio out - left and right, two phonos -interface via 15 pin high density 'D' type socket, RF out and RF in, TV co-ax plug and socket. Lots of spares - too many to list - including modulators, 7 seg displays, transformer, mini switches, IC's, capacitors, resistors and circuitry to receive a remote control (Remote control not included) **£8.95**

LITHIUM BATTERY

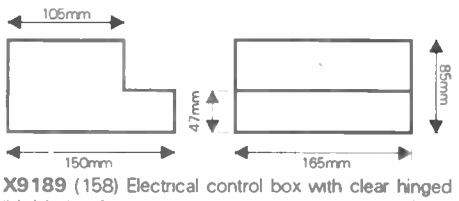
Z2450 Tadiran AA size lithium battery. 3.6V PC mounting. Date code 6/89. DP on these is £5.17. **£2.00**

X9170 (100) Adastra L73 public address horn 10W, 8Ω, 5¼" diameter, 5" in length White with metal mounting bracket **£6.95**



X7269 (78) Square type 4 way mains block rated at 13 amps 250V ac. Complies to BS-1363/A Made by PMS with red neon. Length 160mm, width 122mm, depth 28mm **£3.95**

X4745 (285) Tri colour LED Red and green in neat metal housing with screw thread and nut for mounting. LED size 5mm, thread diameter 10mm, total length including legs 36mm **3 for £2.00**



X9189 (158) Electrical control box with clear hinged lid. Made of an impact resistant polycarbonate. Has 4 optional knock outs below and 3 at the back of the enclosure. Made by Brentomat in light grey **£6.00**

X7488 (58) Toroidal transformer. 95mm in diameter. 35mm high. weight 900grms. Gives 8 voltages out 9V AC. 42 8V AC. 53V AC. 60V AC. 68V AC. 79V AC. 113V AC and 123V AC (These have been measured under no load). Not sure what wattage Brand new **£6.00**

X7468 (52) Toroidal transformer. 78mm diameter. 35mm high. Weight 750grms. Mains primary measures 20V AC with no load and 19V AC with a 1 5Amp load. **£5.95**

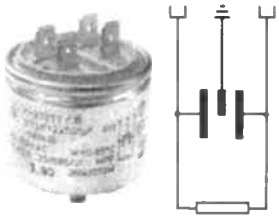
X9210 (200) A4 double sided cutting mat with Dafa roller style cutter and spare blade The green cutting mat measures 300 x 220mm and is 3mm thick The roller cutter has a safety cover for the blade which is very sharp. **£6.50**

X7288 (24) Padsaw for cutting internal holes which are away from the edge of the work. Made by Marples with nice wooden handle. **£5.95**

X7289 (25) Plasterboard saw Total length 290mm, blade length 150mm Nice wooden handle Made by Marples **£5.95**

X7287 (12) Cabinet maker's saw 6" (150mm) Made by Marples with nice wooden handle **£5.95**

X9168 (72) Hacksaw. Strong metal frame with tension adjuster Has facility to cut at an angle Supplied with 1 x 12" blade Good quality and good value **£6.95**

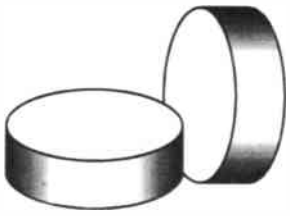


X7536 (1298) Suppressor. 250V ac. 16 Amp. 0·5Mfd + 2 x 0·01Mfd + 680kΩ Believed to be designed for vacuum cleaners **£2.00**

X7546 (675) Delta formation capacitor 1 x 0·15Mfd + 2 x 0·005Mfd + 1M5Ω 250V ac working **2 for £1.00**

X7557 (600) 330Mfd 200V electrolytic capacitor. 36mm high x 29mm diameter PCB mounting **£1.25**

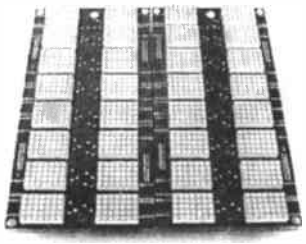
X7550 (2950) 4.8V Nicad PCB mounting Old and a little bit of corrosion. not fully working Take a chance. Can be split down. **10 for £1.00**



X7007 (240,000) Magnets Small. powerful. ferrite type 82mm diameter x 4 3mm thick **14 for £1.00; 100 for £4.00**

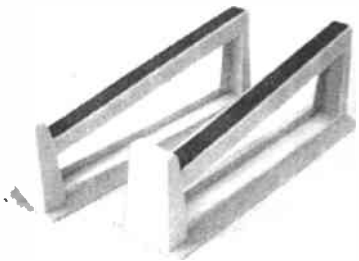
X7551 (288) Epoxy adhesive - contains 1 x epoxy adhesive resin and 1 x epoxy adhesive hardener Made by Bond It Suitable for bonding metals, wood. ceramics and much more Net weight 34g **£2.00**

DISPLAY PANEL



X6877 Four in one display panel Consists of:
(a) The driver display card with 66 chips - including ULN2003A x 26. 74HC595 x 22. HD64180 CPU. 6264 RAM and 27C256 EPROM + Rs. Cs. xtal. connectors. etc;
(b) Transistor card with 14 x BUK455/60A power MOSFETs on small heatsinks (60V 125W. 41A devices). 16 x T092 transistors and connectors for board (c) to plug into:
(c) Two identical LED display panels. each with 16 x 1 25" high 7x5 dot matrix displays. plus connectors Total component value is easily in excess of £200.00! **COMPREHENSIVE DATA INCLUDED.**

Only £20.00



X7584 (1000) Printer stand. A robust two piece moulded ABS printer stand which may be adjusted to accommodate standard or wide carriage dot matrix printers Complete with anti-slip rubber feet. **£2.50**

TBP305 Brand new battery pack by Ora, measuring 90 x 58 x 19mm Contains 5 x AA ni-cads rated 700mA **£3.95**

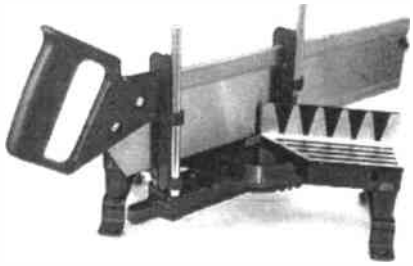
POLYTHENE BAGS

Free samples of the following polythene bags are available on request.

X7529 (5000) 200 microns clear polythene bags, 205mm wide x 470mm deep **Pack of 100 for £1.50**

X7530 (80,000) 350 microns clear polythene bags, 225mm wide x 200mm deep **Pack of 100 for £1.00**

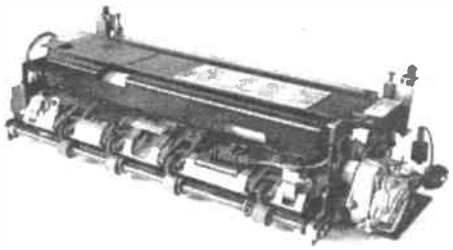
X7507 (96) Butane gas pencil torch. Made by Black Spur Tools. 200mm in length. **£5.95**



X9221 (8) Mitre saw. Ideal for cutting wood, plastic and soft metal. The mitre saw has quick-lock positions for cutting at 22.5°, 30°, 36°, 45° and 90° angles. Made by Nobex. Includes saw. **£24.95**

X9222 (220) 18" bolt croppers. Made in China Finished in red with black rubber hand grips. **£7.95**

X9220 (6) 9.6V cordless drill-driver. Made by Richmond. Supplied with charger and battery. Six level torque control (2.4 - 8.0 N-m), variable speed 0 - 550 RPM, removable battery, reversible drive, keyless chuck, electronic brake, two reversible screw driver bits, 3 hour charging time. **£49.95**



X9227 (300) 5kg lump from a photocopier. Consists of 1 x crouzet 240V 10RPM motor, 1 x 220V 1300W, 420mm long bulb. Loads of rollers, gears and a few springs. 450 x 180 x 95mm **£5.95**

X7615 (20) Pye radio 6 channel AM 120 - 160MHz, 25kHz. Supplied with battery and aerial. Regret crystals have been removed. Size excluding battery and aerial is 165 x 77 x 45mm. Cat No P5001 H2. Used but in good condition. **£30.00**

X7647 (137) Speaker switch (same as A098 on page 11 of 1996 catalogue). Switches 4 pairs of speakers where stereo amplifier only allows one pair. 1, 2, 3 or 4 pairs can be used in any combination. Input via two phono sockets; output via quick-action spring terminals. Series and parallel resistive protection. Black metal case. 148 x 85 x 50mm **£13.95**

ANOTHER GREENWELD BARGAIN!

X9230 (50) A very neat two part terminal, clipping together via a 50 way Centronics plug and socket.

Part 1 - PSU Unit

A metal case measuring 290 x 205 x 60mm. This unit consists of a potted transformer with 0-120V-0-120V primary and 0-18V-0-18V secondary @ 15VA, 1 x GS-R4055 step down power regulator module by SGS Thomson, designed to take any dc voltage between 8 and 46V in and give 5.1V dc out at 4 amps, (this unit normally retails over £50.00 on its own), 4 x 2,200Mfd 40V caps, 1 x bridge rectifier, 1 x ZSIR52405 24V dc in, 5V dc 250mA out, dc-dc converter, 1 x 5V dc 4PCO relay, 2 x LT1081CN dual RS232 driver/receiver 16 pin DIL IC, 4 x 15 pin D type connectors.

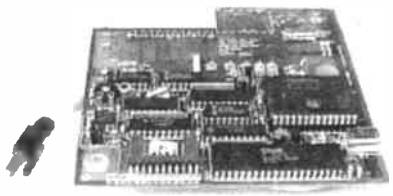
Part 2 - Display Unit

A metal case measuring 315 x 230 x 40mm. Consisting of 1 x Optrex, 16 x 2 LCD display, 80 way key pad, 3 x EF6840, 2 x 6116, 2 x EF6803, 1 x EF6850, 3 x EF6821, 1 x ULA5C124J4, 1 x Z80 A CPU, 1 x 2764, 1 x bar code reader chip HBCR-1800 8903, plus tants, R's, 74 series chips, 3 x 4 way DIP switches, 1 x buzzer, 1 x, 4Mhz + 1 x 3.6864MHz crystal, 1 x DS1225Y non volatile S RAM with battery back up.

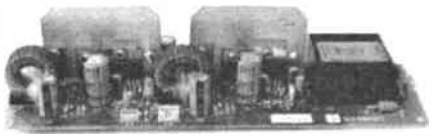
All brand new and boxed.

WOW! ALL THIS FOR ONLY

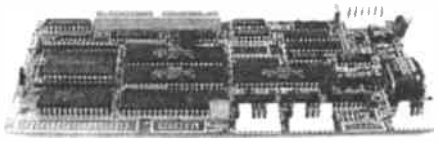
£25.00



X7653 (800) Kitty card, 120 x 120mm PCB with the following parts soldered into the board: 3.6V 100mA Varta NiCad, Piezo buzzer, GM76C256L-85, 27C512-12 (in socket), 80C32, 16V8, 25PC/4, 74LS367, 74HCT373, 74HCT244, M624B, 74LS14, 74HCT32, 11.0592 xtal, plus a few resistors and capacitors. **£2.00**



X7654 (1100) Nice board for suppression/ regulation PCB size 215 x 57mm, with the following parts soldered in: 4903, 2 x BT152-400 SCR, 2 x L296 (4A switching regulator voltage range 5.1V to 40V - these normally sell for £5.00+ each), 2 x MB11 1045 diode, 78L05, Belling Lee L2770/3 3 amp filter, 2 x torroidal suppression chokes plus resistors and capacitors **£3.95**



X7652 (800) Crow card. PCB size 210 x 97mm with the following parts soldered in: 3.6V 100mAh Varta Nicad, 7812, 27C256-20 (in socket), D43256AC-85L, 74HCT30, 74HCT373, 2 x 74HCT240, 3 x Z0853006PSC, P80C32, 2 x MC1488, MC1489, 74HCT14, 74HCT174, 4541, 74HCT32, 74LS04, 16V8H-25PC/4, 22V10-15PC/4 and 3.579545 xtal. **£2.00**

X9207 (800) Mains heavy duty fan 10 inch diameter, made of steel. Mounted via 4 screws (not included) on the motor in the centre of the fan, so the outer can spin. WARNING. There are no protection guards on this fan. **£5.00**

X7648 (7900) Heatsink. Suitable for Intel 486 50MHz microprocessor. 48 x 48 x 9mm. Thermal resistance 8°C/W (natural convection), 2.5°C/W (air velocity 400ft per minute) approx. Supplied with black plastic retaining clip. These normally sell for £4.00 in 100+ quantity New and boxed **£1.00**

X7610 (8000) Tubular 0.22Mfd 1000V DC 300V AC capacitor. Axial leads. Body size 33mm long, 14mm diameter **Pack of 10 for £1.00**

X7665 (2000) 4mm banana plug Black with screw for fixing cable. **Pack of 8 for £1.00**
X7664 (2000) 4mm banana plug Red with screw for fixing cable **Pack of 8 for £1.00**

X7594 (65) Compaq mouse 2 button type terminating to a 6 pin mini DIN plug. Rated at 5V dc 15mA. Brand new **£6.50**

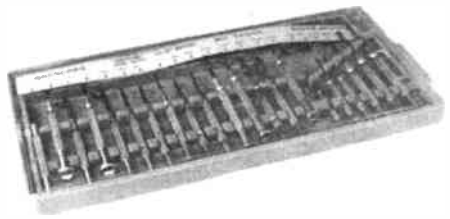
X7697 (146) 8" long nose pliers with insulated handles and cutting facility. **£2.75**

X7696 (36) 8" bent nose pliers with insulated handles and cutting facility **£2.75**

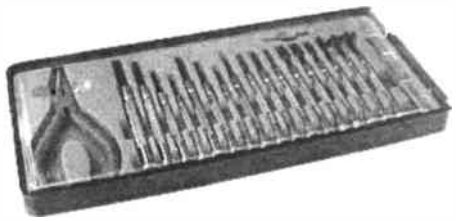
X7698 (92) 4½" mini end cutting pliers. Made by Golden Shark. Spring loaded with insulated cushion grip handles. **£2.00**

X7699 (92) 4½" mini flat nose pliers. Made by Golden Shark. Spring loaded with insulated cushion grip handles **£2.00**

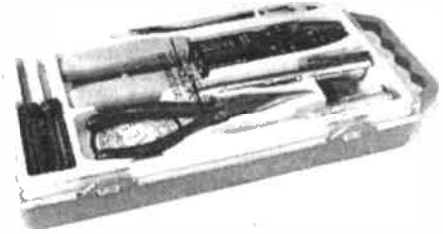
X7701 (96) Knife and mitre box set. A model making 30 piece tool kit containing 3 knife handles (light, medium and heavy duty), fine blade hand saw, sanding block, mitre block, scriber, tweezers, miniature screwdriver and 24 knife blades. All contained in a neat plastic case. **£10.00**



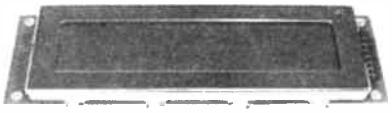
X7702 (108) 21 piece precision screwdriver set, supplied in neat case with clear lid. Contains 5 x wrenches (4, 4.5, 5, 5.5 and 6mm), 2 x crosspoint screwdrivers (Nos. 0 & 1), 3 x hex key wrenches (1.5, 2 and 2.5mm), 5 x nut drivers (3, 3.5, 4, 4.5 and 5mm), 6 x flat bladed screwdrivers (0.8, 1.4, 2, 2.4, 2.9 and 3.8mm), 1 x small tommy bar **£5.50**



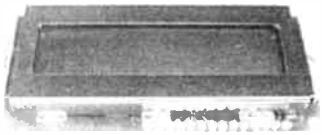
X7704 (108) 19 piece precision tool set in plastic case with clear lid. Contains 1 pair of long nose pliers with cutting edge, 4 x flat bladed screwdrivers, 3 x phillips screwdrivers, 1 x point, 3 x hex drivers, 3 x nut drivers, 3 x box spanners, 1 pair tweezers **£5.00**



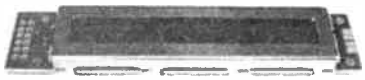
X7703 (100) Electricians tool kit, supplied in a neat case with a clear plastic lid. Contains: 1 x small penlight torch; 1 x 6/12/24V screwdriver style tester, 1 pair of long nose pliers, 1 roll of PVC insulation tape; 1 x phillips screwdriver; 1 x flat bladed screwdriver, 1 x 60-500Vac neon tester, 1 x crimping tool and a selection of crimp connectors **All this for just £6.00**



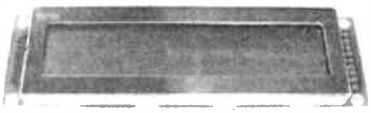
X4959 (16) LCD display. Made by Epson, model number EAN20016AR 20 x 1. Overall size 120 x 35 x 8mm. Some data supplied. **£2.50**



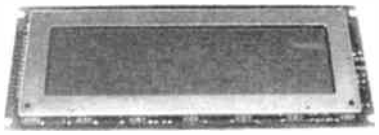
X7686 (100) LCD display Made by Epson, model number EAN16025AR 20 x 2. Module size 83 x 35 x 8mm Some data supplied **£3.00**



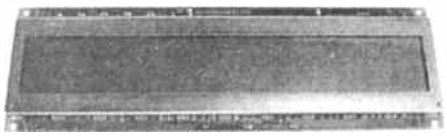
X7679 (680) LCD display, miniature type Made by Epson model number EAC20017AR. 20 x 1 Character size 4 45 x 7.75mm. Overall size 100 x 22 x 9mm Some data supplied **£2.50**



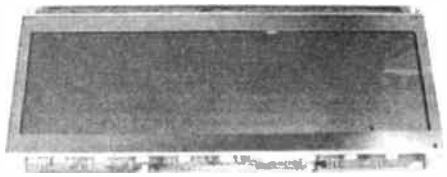
X7680 (76) LCD display Made by Epson, model number EAX24017AR 24 x 1 Overall size 120 x 35 x 8mm Some data supplied **£3.00**



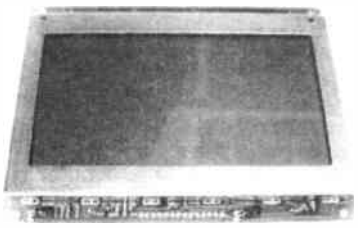
X7667 (600) LCD display Made by Epson, model number EG2401AAR 256 x 64 Overall size 175 x 68 x 8mm Some data supplied **£6.00**



X7690 (8) LCD display Made by Epson, model number EG2801AAR. 512 x 64. Overall size 270 x 85 x 10mm. Some data supplied. **£8.00**

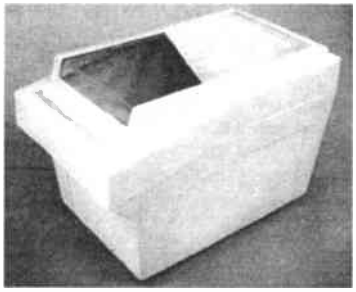


X7684 (25) LCD display Made by Epson, model number EG4801AAR 512 x 128 Overall size 265 x 115 x 8mm Some data supplied **£8.00**

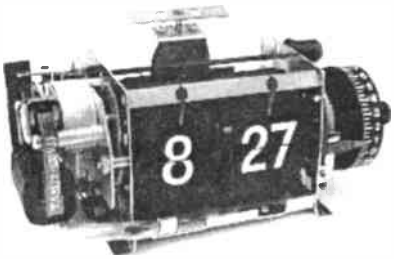


X7678 (54) LCD display Made by Epson, model number EG4401AAR 256 x 128. Overall size 145 x 115 x 8mm Some data supplied **£5.50**

X7709 (361) Chassis mounting 5 pin XLR plug Metal. Made by HRS. **£1.00**



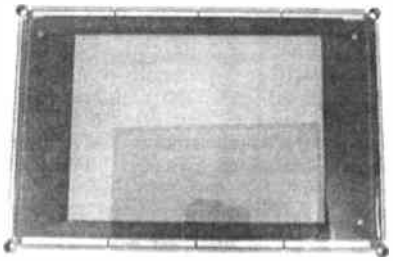
X9195 (100) 3.5" disk storage box for 40 disks with transparent plastic lid Snap on easy open/close **£2.50**



X7708 (100) Mains 24 hour clock No case, just the mechanism Neat flip style digits keeps the time perfect. Just wire it up to the mains, mount it in a case and away you go! **£5.00**

X7755 (210) Cyclon sealed lead acid cell 2V 12.5Ah. Ex-equipment Made by Hawker Batteries Body size 120mm long x 52mm diameter Guaranteed working **£8.00**

GRAPHICS PLASMA DISPLAY UNIT

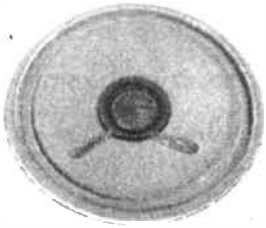


Front

Rear

X9163 (50) MD400F640PD2A. DC type Graphics Plasma Display Unit Consists of display panel with polycarbonate frame and driver electronics Made by Panasonic. 400 x 640 dots. Display area 144 x 192mm. Actual size 190 x 285mm Colour is neon orange TTL signal level needs 5V and 205V to operate. Total power consumption 35W. Brand new Some data supplied

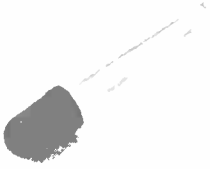
ONLY £20.00



X7727 (1000) Miniature 2¼" diameter 8Ω speaker Made by Altai Brand new **50p each**

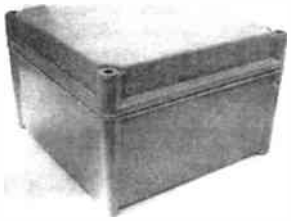
X7718 (68,000) Standard 5mm red LED's, leads cut to 13mm long. **Pack of 200 for £4.00**

X4970 (2000) Green standard 5mm LED **25 for £1.00**



X7719 (3500) 5mm standard red LED **Pack of 100 £2.50**

X9248 (2) Waterproof ABS grey box with 4 fixing screws for lid. Medium duty. 340 x 340 x 165mm 4 fixing screws for a PCB inside. **£8.00**



X9247 (7) Water proof ABS box, grey with 4 fixing screws for lid. Medium duty. 250 x 250 x 165mm with 4 fixing screws for a PCB inside. **£6.00**

X9244 (12) Waterproof ABS box. Grey with 4 fixing screws for lid. Medium duty. 160 x 160 x 130mm with 4 fixing screws for a PCB inside. **£4.00**

X9240 (18) Waterproof ABS box. Grey with 4 fixing screws for lid. 160 x 115 x 120mm with 4 fixing screws for a PCB inside. **£3.50**

X9242 (11) Waterproof ABS box. Grey with 4 fixing screws for lid. 120 x 120 x 120mm with 4 fixing screws for a PCB inside. **£3.00**

X9245 (6) Waterproof ABS box. Grey with a clear lid which is fixed by 4 screws. 160 x 160 x 120mm Also 4 screws inside box for fixing a PCB **£4.50**

X9241 (15) Waterproof ABS box. Grey with clear lid which is fixed by 4 screws 160 x 120 x 120mm 4 screws inside for fixing a PCB **£4.00**

X9243 (8) Waterproof ABS box. Grey with a clear lid which is fixed by 4 screws. 120 x 120 x 120mm. 4 screws inside for fixing a PCB. **£3.50**

X7716 (42) Black ABS box with glue together designed lid. 4 screws inside for mounting a PCB. Ideal as a tamperproof unit. 150 x 70 x 40mm **£1.25**

X9246 (74) White ABS box. Lid fixed via 4 screws 150 x 78 x 48mm **£1.75**

X7717 (325) Grey ABS box with PP3 battery compartment. 56 x 78 x 20mm. Ideal for FM bug kits? **£1.50**

X7715 (20) Black ABS box. Hand held meter case style with cut out for LCD 170 x 95 x 37mm **£2.50**

X7720 (2286) A "ring" crimp connector with yellow insulation for 2.7-6.6mm² cable Ring size 8mm diameter hole **25 for £1.00**
X4972 (500) A "ring" crimp connector with blue insulation for 1.0-2.6mm² cable Ring size 6BA. **25 for £1.00**
X4973 (1120) A "ring" crimp connector with blue insulation for 1.0-2.6mm² cable Ring size M3/3.5/4BA. **25 for £1.00**
X4974 (1470) A "ring" crimp connector with blue insulation for 1.0-2.6mm² cable Size of ring M5/2BA. **25 for £1.00**
X4975 (460) A "ring" crimp connector with yellow insulation for 2.7-6.6mm² cable. Ring size M3/3.5.4BA. **25 for £1.00**
X4976 (1023) A "ring" crimp connector with yellow insulation for 2.7-6.6mm² cable Ring size M5/2BA. **25 for £1.00**

X4981 (5200) A "spade" crimp connector with red insulation for 0.25-1.6mm² cable M3/3.5/4BA size. **25 for £1.00**
X4982 (745) A "spade" crimp connector with yellow insulation for 2.7-6.6mm² cable. Spade size M5/2BA. **25 for £1.00**
X4983 (222) A "spade" crimp connector with yellow insulation for 2.7-6.6mm² cable Spade size M6/0BA. **25 for £1.00**

X4979 (2777) A "flat tab" crimp connector with red insulation for 0.25-1.6mm² cable. Tab size 10mm long x 2mm wide. **25 for £1.00**
X4980 (1413) A "flat tab" crimp connector with yellow insulation for 2.7-6.6mm² wire Tab size 10mm long x 3mm wide. **25 for £1.00**

X4977 (490) A "receptacle" crimp connector with blue insulation for 1.0-2.6mm² cable Size of receptacle is ¼" **25 for £1.00**

X4978 (222) A "piggyback" crimp connector with blue insulation for 1.0-2.6mm² cable ¼" size blade and receptacle **10 for £1.00**

X4985 (1595) A "receptacle" crimp connector supplied with separate clear boot to give full insulation ¼" size receptacle **25 for £1.00**

X4986 (570) A "receptacle" crimp connector with fully shrouded insulation for 2·7-6·6mm² cable Size of receptacle is ¼" **25 for £1.00**

X4984 (603) A straight through/butt splice crimp connector with blue insulation for 1·0-2.6mm² cable **25 for £1.00**

X4971 (73) A 5 pin 180° DIN socket to socket adaptor enables you to plug two plugs together 43mm long **£1.00 each**

COMPAQ AC ADAPTOR

X9253 (200) An AC adaptor from Compaq for the Contura Aero Range of Notebook/Laptop computers. Type number Z832A Supplied with figure 8 lead Input voltage 100/120V - 220/240AC 50/60Hz. Output voltage 17·5V DC @ 1·8A.

Bargain At Only £5.00

STAR TREK MODELS

SPECIAL COLLECTOR'S EDITION SERIES

CAPTAIN JAMES T. KIRK

X9249 (18) Captain James T. Kirk. A highly detailed 12" tall vinyl model kit. Unpainted. Made by AMT.

FIRST OFFICER MR. SPOCK

X9250 (19) First Officer Mr. Spock. A highly detailed 12" tall vinyl model kit. Unpainted. Made by AMT.

DOCTOR LEONARD McCOY

X9251 (12) Doctor Leonard McCoy. A highly detailed 12" tall vinyl model kit. Unpainted. Made by AMT.

ALL MODELS ONLY £7.50 EACH!