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418 MHz Remote Control System

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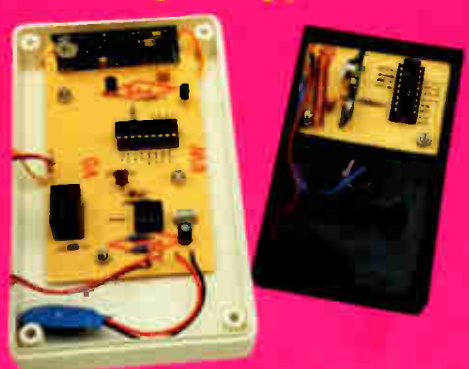

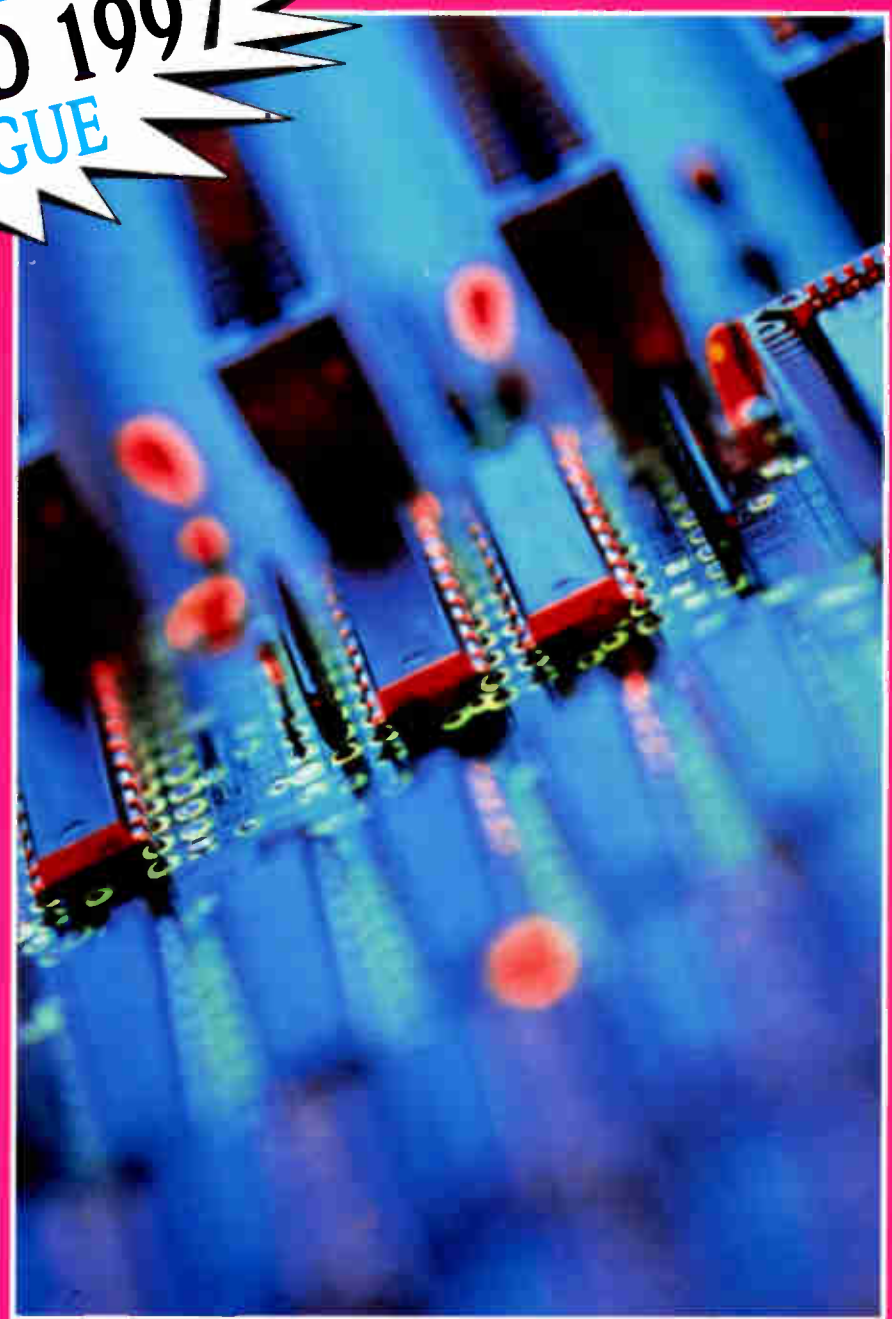

PIC-Agoras

A computer for almost any wheeled vehicle
Measures and interprets angular rotation

MIDI Matrix

Stop swapping leads with this switching unit

MPEG 2 Digital Television

We unravel the technicalities

The No. 1 Magazine For Electronics Technology & Computer Projects

Ingenuity Unlimited, Circuit Surgery, New Technology Update, Innovations

9 770262 361072 04

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

VEGA RUSSIAN MULTIBAND World communications receiver, 9 wave bands, (5 short, 1 LW, 1FM, 1MW) internal ferrite and external telescopic aerials, mains or battery Large, typically Russian radio! £45 ref VEGA

NEW LASER POINTERS <5mw, 75 metre range, hand held unit runs on two AA batteries (supplied) 670nm £29 ref DEC49

MULTIBAND RADIO Compact general purpose radio receiver covering air, pb, tv, cb etc Squelch vol and tuning £24 ref MB1

DIVINING RODS £3.99 a pair! ref EF111

MOONSHINE BIBLE 270 page book covering the production of alchohol from potatoes, rice, grains etc Drawings of simple home made stills right through to commercial systems £12 ref MS3

NEW HIGH POWER MINI BUG With a range of 800 metres or more and up to 100 hours use from a PP3 this will be popular! Bug measures less than 1" square! £28 Ref LOT102

BUILD YOU OWN WINDFARM FROM SCRAP New publication gives step by step guide to building wind generators 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

TRACKING TRANSMITTER range 1 5-5 miles, 5,000 hours on AA batteries, also transmits info on car direction and motion!Works with any FM radio 1 5" square. **£65 ref LOT101**

ELECTRIC DOOR LOCKS Complete lock with both Yale lock and 12v operated deadlock (keys included) £10 ref LOT99

SURVEILLANCE TELESCOPE Superb Russian zoom telescope adjustable from 15x to 60x! complete with metal tripod (impossible to use without this on the higher settings) 66mm lense, leather carrying case £149 ref BAR69

WIRELESS VIDEO BUG KIT Transmits video and audio signals from a minature CCTV camera (included) to any standard television! All the components including a PP3 battery will fit into a cigarette packet with the lens requiring a hole about 3mm diameter Supplied with telescopic aerial but a piece of wire about 4" long will still give a range of up to 100 metres A single PP3 will probably give less than 1 hours use **£99** REF EP79 (probably not licensable!)

GPS SATELLITE NAVIGATION SYSTEM Made by Garmin, the GPS38 is hand held, pocket sized, 255g, position, altitude, graphic compass, map builder etc £179 ref GPS1

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

INFRA RED POWERBEAM Handheld battery powered lamp, 4 inch reflector, krypton bulb, gives out powerful infrared light! 4 D cells required £29 ref PB1

MONO VGA MONITORS, Perfect condition, Compaq, 14", 3 months warranty £29 ref MVGA

SUPER WIDEBAND RADAR DETECTOR Detects both radar and laser , X K and KA bands, 360 degree coverage, front and rear wave guides, may be illegal to use! 1 1"x2 7"x4 6" £149 ref RD2

9 WATT CHIEFTAN TANK LASERS

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

TWO WAY MIRROR KIT Includes special adhesive film to make two way mirror(s) up to 60"x20" (glass not included) includes full instructions £12 ref TW1

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!

WIND UP FLYING PARROT! Genuine parrot that flaps its wings and flies for up to 50 meters £6 ref EF2

RADIO CONTROLLED CARS FROM £6 EACH!!!! All returns from famous manufacturer, single channel (left,right,forwards,backwards) £6 ref LOT1 Two channel with more features £12 ref LOT2

THOUSANDS AVAILABLE RING/FAX FOR DETAILS!

MAGNETIC CARD READERS (Swipes) £9 95 Cased with flyleads, designed to read standard credit cards! they have 3 wires coming out of the head so they may write as well? complete with control elctronics PCB, 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 EP74

COIN OPERATED TIMER KIT Complete with coinslot mechanism, adjustable time delay, relay output, put a coinslot on anything you like! TV,s, videos, fridges, drinks cupboards, HIFI takes 50p's and £1 coins DC operated, price just £7 99 ref BAR27

ZENITH 900 X MAGNIFICATION MICROSCOPE Zoom, metal construction, built in light, shrimp farm, group viewing screen, lots of accessories £29 ref ANAYLT

AA NICAD PACK Pack of 4 tagged AA nicads £2 99 ref BAR34

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,
16 character 2 line, 99x24mm **£2.99 ref SM1623A**
20 character 2 line, 83x19mm **£3.99 ref SM2020A**
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 ref TAL-1, £249

SOLAR ENERGY/GENERATOR PLANS For your home, loads of info on designing systems etc £7 ref PV1

SOLAR COOKERS Comprehensive guide to building solar powered cookers, includes plans, recipes, cooking times etc £7 ref SBC1

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CENTRAL POINT PC TOOLS Award winning software, 1,300 virus checker, memory optimiser, disc optimiser file compression, low level formatting, backup scheduler, disk defragmenter, undelete, 4 calculators, D base disc editor, over 40 viewers, remote computing, password protection, encryption, comprehensive manual supplied etc £8 ref lot 97 3 5" disks

COLOUR CCTV VIDEO CAMERAS, BRAND NEW AND, CASED, £119.

PERFECT FOR SURVEILLANCE, INTERNET,VIDEOCONFERENCING, SECURITY, DOMESTIC VIDEO

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, 10 or more £99 ea

MICRO RADIO It's tiny, just 3/8" thick, auto tunning, complete with headphones FM £9 99 ref EP35

HANDHELD SCANNERS 10 channel built in charger, LCD display £119 ref B110B, 100 channel model £229 ref B110E

SMOKE MACHINE 42 3 cubic metres a min from this mains operated machine £299 ref G002B, smoke fluid £25 (5 litres) gives about 2 5 hours use ref GOO2AA

Check out our WEB SITE full colour interactive 1997 catalogue

http//www.pavilion.co.uk/bull-electrical

IBM PS2 MODEL 150Z CASE AND POWER SUPPLY Complete with fan etc and 200 watt power supply **£9.95** ref EP67

1.44 DISC DRIVES Standard PC 3 5" drives but returns so they will need attention **SALE PRICE £4.99** ref EP68

1.2 DISC DRIVES Standard 5 25" drives but returns so they will need attention **SALE PRICE NOW ONLY £3.50** ref EP69

PP3 NICADS Unused but some storage marks £4 99 ref EP52

GAS HOBS AND OVENS Brand new gas appliances, perfect for small flats etc Basic 3 burner hob **£19** ref BAR316 Basic small built in oven **SALE PRICE £59** ref EP73

ENERGY BANK KIT 100 6"x6" 6v 100mA panels, 100 diodes, connection details etc £99 ref EF112

PASTEL ACCOUNTS SOFTWARE, does everything for all sizes of businesses, includes wordprocessor, report writer, windowing, networkable up to 10 stations multiple cash books etc 200 page comprehensive manual 90 days free technical support (01342-326009 try before you buy!) **SALE PRICE** £9 95 ref SA12. SAVE £120!!!

PC PAL VGA TO TV CONVERTER 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

YUASHA SEALED LEAD ACID BATTERIES Two sizes currently available this month 12v 15AH at £18 ref LOT8 and 6v 10AH at just £6 ref LOT7

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

PROJECT STRIPPERS Small cased UNITS ideal for stripping, lots of useful goodies including a smart case 120X150X50mm with feet etc , and lots of components **SALE PRICE JUST £10 FOR FIVE** REF MD1 or a pack of 20 for £19 95 ref MD2

SOLAR POWER LAB SPECIAL You get TWO 6"x6" 6v 130mA solar cells, 4 LED's, wire buzzer, switch plus 1 relay or motor Superb value kit **SALE PRICE JUST £4.99** REF SA27

13.8V 1.9A PSU cased with leads Just £9 99 REF MAG10P3

UNIVERSAL SPEED CONTROLLER KIT Designed by us for the C5 motor but ok for any 12v motor up to 30A Complete with PCB etc A heat sink may be required £17 00 **REF: MAG17**

SOLAR NICAD CHARGERS 4 x AA size £9 99 ref 6P476, 2 x C size £9 99 ref 6P477

VIEWDATA SYSTEMS made by Phillips, complete with internal 1200/75 modem, keyboard, psu etc RGB and composite outputs, menu driven, autodialler etc **SALE PRICE £12.99** REF SA18

MEGA POWER BINOCULARS Made by Helios, 20 x magnification, precision ground fully coated optics, 60mm objectives, shock resistant caged prisms, case and neck strap £89 ref HPH1

GIANT HOT AIR BALLOON KIT Build a 4 5m circumfrence, 1.8m high 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

VIDEO 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 100' range! (tune TV to a spare channel) 12v DC op Price is £25 **REF: MAG15** 12v psu is £5 extra **REF: MAG5P2**

***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 once is £18 REF EF62 (kit) Transmits to any FM radio Built and tested version now available of the above unit 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

6"X12" AMORPHOUS SOLAR PANEL 12v 155x310mm 130mA **SALE PRICE £4.99** REF SA24

FIBRE OPTIC CABLE BUMPER PACK 10 metres for £4 99 ref MAG5P13 ideal for experimenters! 30 m for £12 99 ref MAG13P1

MIXED GOODIES BOX OF MIXED COMPONENTS WEIGHING 2 KILOS YOURS FOR JUST £5.99

4X28 TELESCOPIC SIGHTS Suitable for all air rifles, ground lenses, good light gathering properties £24 95 ref R/7

GYROSCOPES Remember these? well we have found a company that still manufactures these popular scientific toys, perfect gift or for educational use etc £6 ref EP70

HYPOTHERMIA SPACE BLANKET 215x150cm aluminised foil blanket, reflects more than 90% of body heat Also suitable for the construction of two way mirrors! £3 99 each ref O/L041

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

LENSTATIC RANGER COMPASS Oil filled capsule, strong metal case, large luminous points Sight line with magnifying viewer 50mm dia, 86gm £10.99 ref O/K604

RECHARGE ORDINARY BATTERIES UP TO 10 TIMES! With the Battery Wizard! Uses the latest pulse wave charge system to charge all popular brands of ordinary batteries AAA, AA, C, D, four at a time! Led system shows when batteries are charged, automatically rejects unsuitable cells, complete with mains adaptor BS approved Price is £21 95 ref EP31

TALKING WATCH Yes, it actually tells you the time at the press of a button Also features a voice alarm that wakes you up and tells you what the time is! Lithium cell included £7 99 ref EP26

RUBBER COATED HELIOS Binoculars, 10 x 25, fully coated optics £45 ref RP1, same spec but nitogen filled and waterproof £75 ref RP2

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

3" DISCS As used on older Amstrad machines, Spectrum plus3's etc £3 each ref BAR400

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

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

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

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VOL. 26 No. 4 APRIL 1997

EVERYDAY PRACTICAL ELECTRONICS

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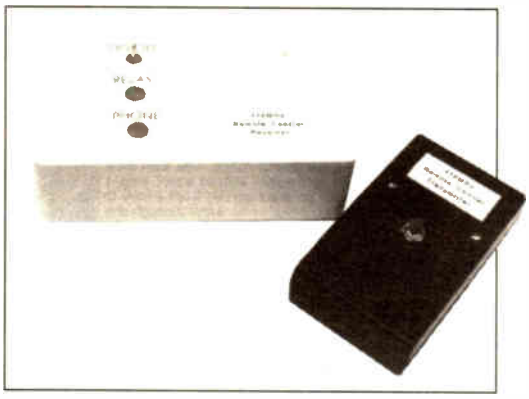
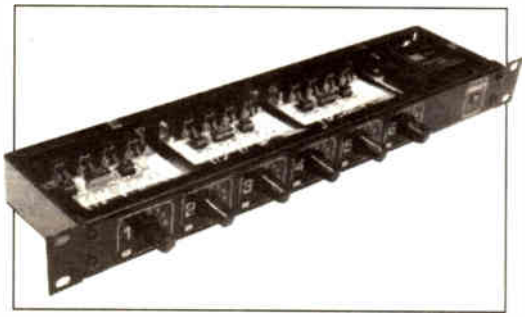
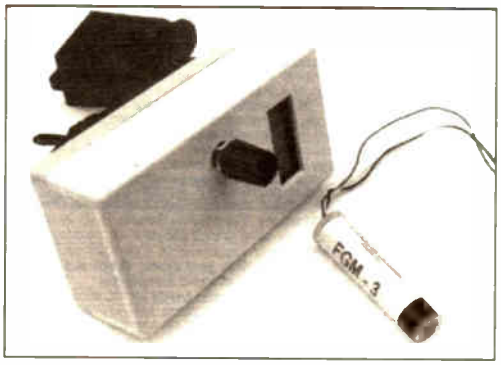
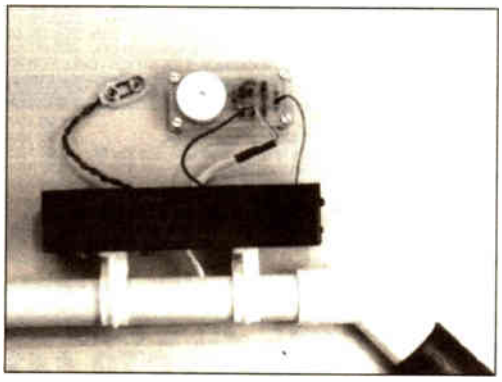
The No. 1 Magazine for Electronics, Technology and Computer Projects









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Series and Features

Regulars and Services

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Our May '97 issue will be published on Friday, 4 April 1997. See page 263 for details.

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THE *ORIGINAL* SURPLUS WONDERLAND!

THIS MONTH'S SELECTION FROM OUR VAST EVER CHANGING STOCKS

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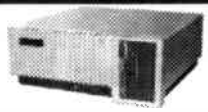
LOW COST PC's -

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 !*

Order as HIGRADE 286 *ONLY £129.00* (E)

Optional Fitted extras: VGA graphics card	**£29.00**
1.4Mb 3½" floppy disk drive (instead of 1.2 Mb)	**£19.95**
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* Only

Many other options avaieble - call for details. **£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)
3½" **Mitsubishi** MF355C-L 1.4 Meg. Laptops only	**£25.95**(B)
3½" **Mitsubishi** MF355C-D. 1.4 Meg. Non laptop	**£18.95**(B)
5¼" **Teac** FD-55GFR 1.2 Meg (for IBM pc's) RFE	**£18.95**(B)
5¼" **Teac** FD-55F-03-U 720K 40/80 (for BBC's etc) RFE	**£29.95**(B)
5¼" **BRAND NEW Mitsubishi** MF501B 360K	**£22.95**(B)
Table top case with integral PSU for HH 5¼" Flopp or HD	**£29.95**(B)
8" **Shugart 800/801** 8" SS refurbished & tested	**£195.00**(E)
8" **Shugart 610** 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)
8" **FUJITSU** M2322K 160Mb SMD I/F RFE tested	**£195.00**(E)
Hard disc controllers for MFM , IDE, SCSI, RLL etc. from	**£18.95**

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 Telebox's is (B)

DC POWER SUPPLIES

Virtually every type of power supply you can imagine.Over 10,000 Power Supplies Ex Stock Call for info / list.

IC's -TRANSISTORS - DIODES

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6,000,000 items EX STOCK

For *MAJOR* SAVINGS - CALL FOR SEMICONDUCTOR HOTLIST

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)

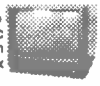
Just In - Microvitec 20" VGA (800 x 600 res.) colour monitors. Good SH condition - from £299 - CALL for Info

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 H13¾" 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)



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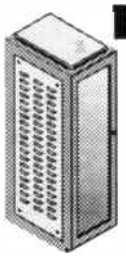

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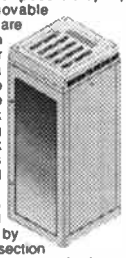

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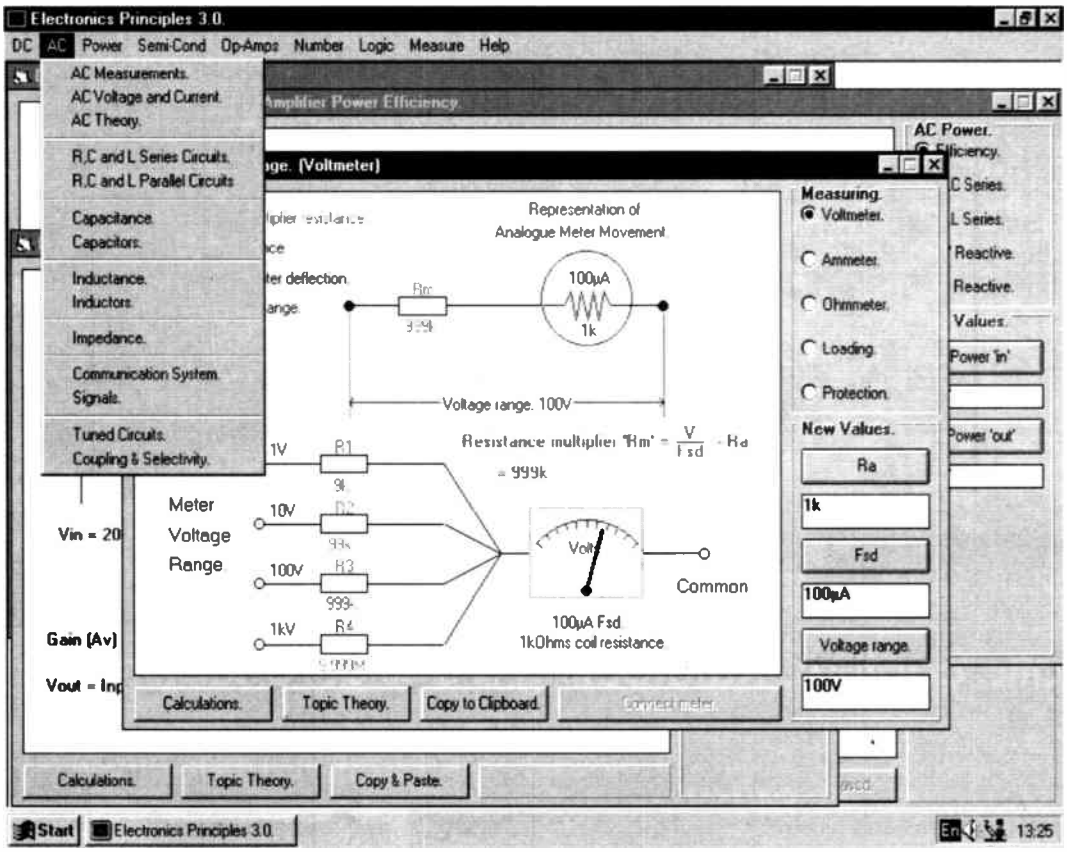

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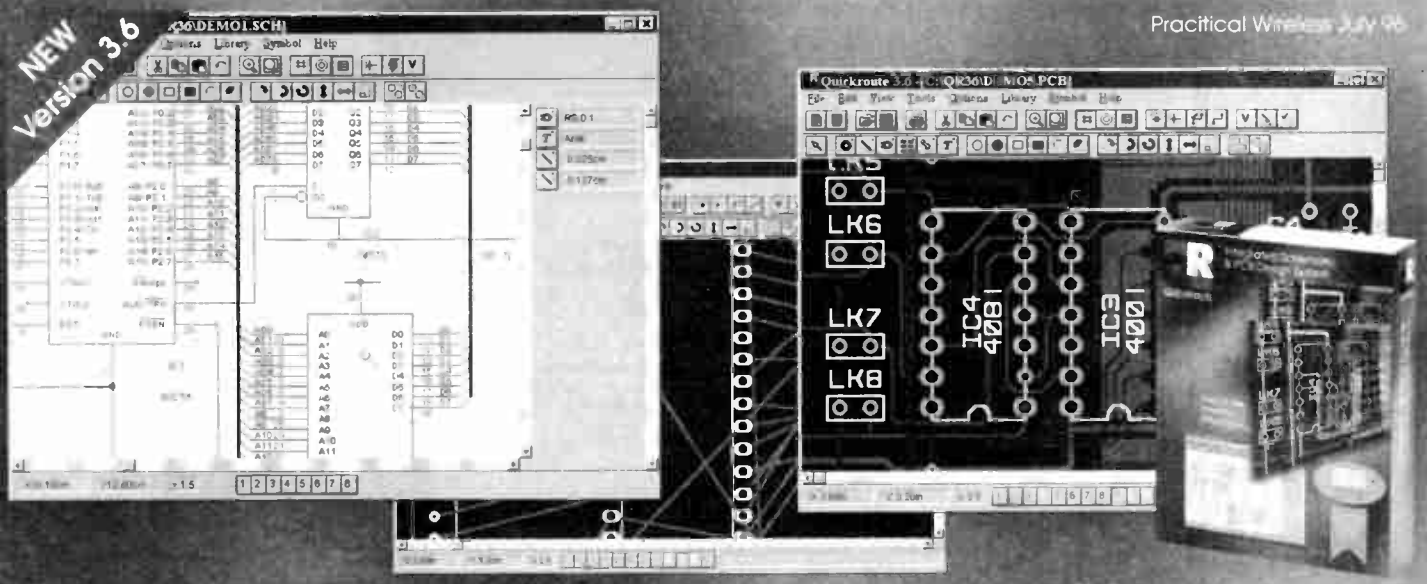

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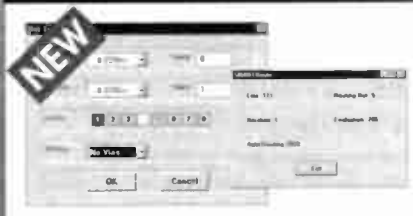

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QLX180 Crystal Controlled Telephone Transmitter
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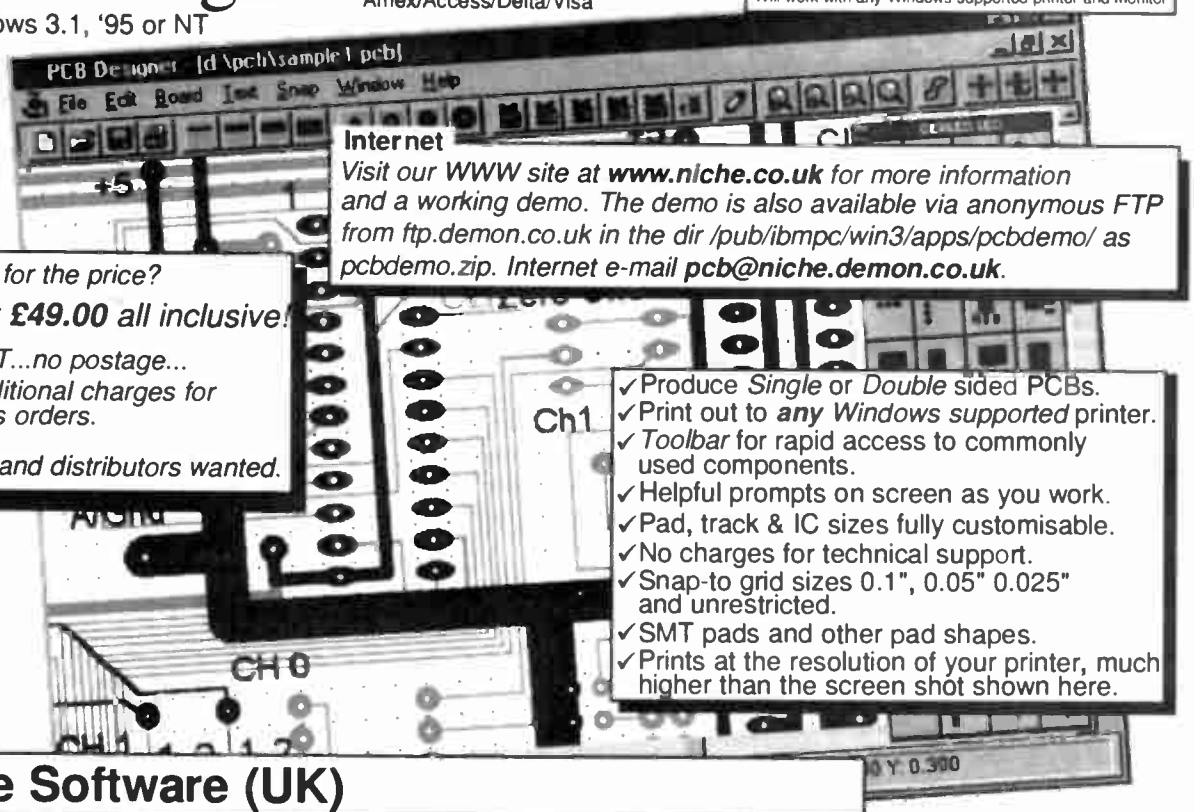

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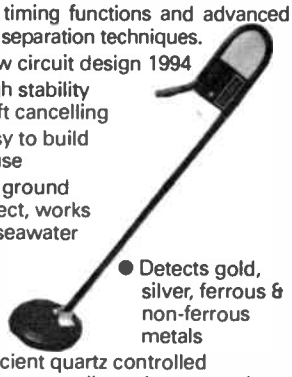

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DIGITAL LCD THERMOSTAT

A versatile thermostat using a thermistor probe and having an l.c.d. display. MIN/MAX memories, – 10 to 110 degrees Celsius, or can be set to read in Fahrenheit. Individually settable upper and lower switching temperatures allow close control, or alternatively allow a wide 'dead band' to be set which can result in substantial energy savings when used with domestic hot water systems. Ideal for greenhouse ventilation or heating control, aquaria, home brewing, etc. Mains powered, 10A SPCO Relay output. Punched and printed case.

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

KIT 842.....£22.56

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A really professional looking project. Kit is supplied with a punched and printed front panel, case, p.c.b. and all components. Quartz controlled accuracy of 1%. Large clear 5-digit display and high speed operation. Ideal for beginners – as the µF, nF and pF ranges give clear unambiguous read out of marked and unmarked capacitors from a few pF up to thousands of µF.

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SUPER ACOUSTIC PROBE

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

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KIT 856.....£28.00

★ TENS UNIT ★

NEW!

DUAL OUTPUT TENS UNIT

As featured in this issue.

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

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

1000V & 500V INSULATION TESTER

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

KIT 848.....£32.95

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

KIT 845.....£64.95

ULTRASONIC PEsT SCARER

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

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

KIT 812.....£14.81

SPACEWRITER

NOW WITH PIC16C84 EEPROM CHIP & SOFTWARE DISK

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

KIT 849.....£16.99

12V EPROM ERASER

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

KIT 790.....£28.51

INSULATION TESTER

A reliable and neat electronic tester which checks insulation resistance of wiring and appliances etc., at 500 Volts. The unit is battery powered, simple and safe to operate. Leakage resistance of up to 100 Megohms can be read easily. A very popular college project.

KIT 444.....£22.37

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NEW!

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

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

KIT 861.....£24.99

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

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

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

KIT 815.....£45.95

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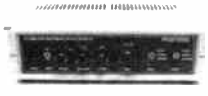
Experience the delight of SURROUND SOUND in your own home. This project brings full Genuine PRO-LOGIC surround sound to you at a fantastic price. The circuit meets all *Dolby specifications, with "Stereo", "3-Stereo" and "Surround Sound" selections.



For minimum cost the "Short Form Kit" is ideal. This is complete except for the case and power transformer. It includes the switches, sockets, and pots, and is ideal for building into a custom set-up with pre-amp and power-amp modules, where power is available.

The alternative "Full Kit" gives the best value option. With a printed front panel, punched rear panel, power transformer and mains lead and black brushed aluminium knobs. This kit produces a complete stand-alone decoder that can be used with any audio.

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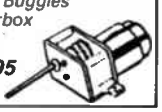

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SIMPLE PIC PROGRAMMER

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

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

Power Supply £3.99

EXTRA CHIPS: PIC 16C84 £7.36

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

PIC16C84 LCD DISPLAY DRIVER

INCLUDES 1-PIC16C84 WITH DEMO PROGRAM SOFTWARE DISK, PCB, INSTRUCTIONS AND 16-CHARACTER 2-LINE **LCD DISPLAY**

Kit 860 **£17.99**

Power Supply £3.99

FULL PROGRAM SOURCE CODE SUPPLIED – DEVELOP YOUR OWN APPLICATION!

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

★ Chip is pre-programmed with demo display ★

SUPER PIC PROGRAMMER

NEW!

- READS, PROGRAMS, AND VERIFIES
- WINDOWS™ SOFTWARE
- PIC16C6X, 7X, AND 8X
- USES ANY PC PARALLEL PORT
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Kit 862 **£29.99**

Power Supply £3.99

PIC STEPPING MOTOR DRIVER

NEW!

INCLUDES: PCB, PIC16C84 WITH DEMO PROGRAM, SOFTWARE DISK, INSTRUCTIONS AND MOTOR.

Kit 863 **£18.99**

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

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

PIC16C84 MAINS POWER 4-CHANNEL CONTROLLER & LIGHT CHASER

- WITH PROGRAMMED 16C84 AND DISK WITH SOURCE CODE IN MPASM
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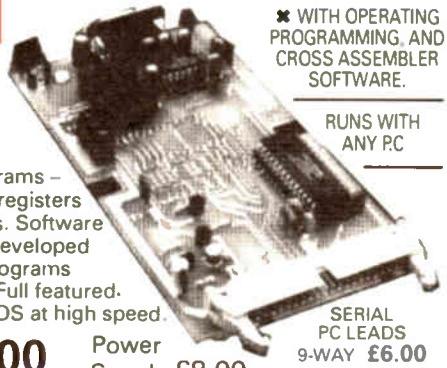
IN CIRCUIT EMULATOR – WITH ON-LINE MONITOR. The easiest way to get started. Allows single stepping through programs – displaying the internal registers and driving the I/O pins. Software and hardware can be developed and tested together. Programs 16C54, 5, 6, & 7 chips. Full featured. software runs under DOS at high speed.



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RUNS WITH ANY P.C

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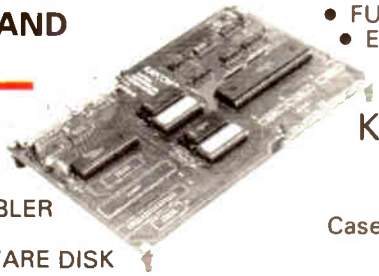

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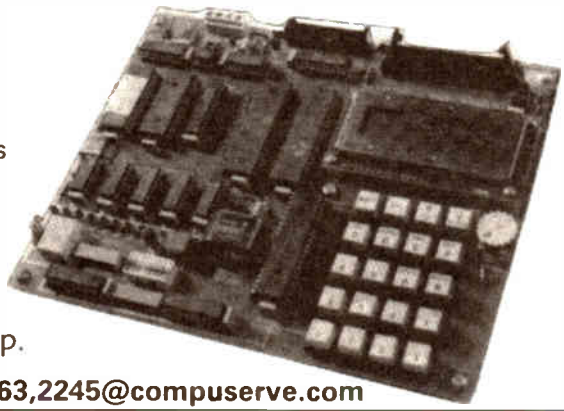
As featured in *EPE* and now published as Teach-In 7. All parts are supplied by Magenta. *Teach-In 7* is £3.95 from us or *EPE*
Full Mini Lab Kit – £119.95 – Power supply extra – £22.55
Full Micro Lab Kit – £155.95 Built Micro Lab – £189.95



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40193	£0.60	74LS40	£0.14	AD9696KN	£7.73
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7407	£0.40			ADM222AH	£3.55
ADM232AA	£3.55	TDA2611A	£1.88	OA200	£0.56
ADM485JN	£2.97	TDA2822A	£1.68	OA202	£0.29
ADM690AN	£5.13	TEA5115	£3.11	Zeners 2.7 to 33V	
ADM691AN	£6.48	TL061CP	£0.35	400mW	£0.08
ADM695AN	£6.48	TL062CP	£0.60	1.3W	£0.14
ADM699AN	£3.58	TL064CN	£0.72	**Bridge Rectifiers**	
CA741CE	£0.26	TL071CP	£0.48	1.5A 50V	£0.19
CA747CE	£0.39	TL072CP	£0.40	1.5A 200V	£0.20
CA3046	£0.37	TL074CN	£0.50	1.5A 400V	£0.22
CA3059	£1.16	TL081	£0.33	1.5A 600V	£0.22
CA3080E	£0.73	TL082CP	£0.54	1.5A 800V	£0.27
CA3130E	£0.98	TL084CN	£0.50	1.5A 1kV	£0.24
CA3140E	£0.51	TL494CN	£1.46	3A 200V	£0.36
CA3189E	£1.22	TL7705ACP	£1.62	3A 400V	£0.40
CA3240E	£1.12	TLC271	£0.54	3A 600V	£0.33
DG211CJ	£1.55	TLC272	£0.88	6A 200V	£0.70
DG212CJ	£1.55	TMP01FP	£5.60	6A 800V	£0.59
DG411DJ	£3.11	ULN2003	£0.52	10A 400V	£1.39
EL2030CN	£5.67	ULN2004A	£0.48	25A 200V	£1.68
ICL7106	£2.95	ULN2803	£0.90	25A 600V	£1.80
ICL7611DCP	£1.06	ULN2804A	£1.64	**Thyristors**	
ICL7621	£1.70	ULN2806	£1.20	C106D	£0.36
ICL8038	£4.89	XR2206	£5.37	PO102AA	£0.30
ICM7555	£0.36	ZN414Z	£1.16	TIC116D	£0.66
ICM7556	£0.98	ZN416E	£1.99	TIC126D	£0.77
L165V	£3.98	ZN1034E	£3.11	**Triacs**	
L272M	£1.86	**EPROM's**		ZO105DA	£0.42
L293E	£4.35	2716	£4.74	TIC206D	£0.65
L297	£6.37	2732	£4.84	TIC226D	£0.94
L298	£6.99	2764-25	£4.20	BTA08-600B	£0.99
L6219	£4.48	27C64-25	£3.44	TIC236D	£0.96
LF347N	£0.46	27C010	£5.74	**Diac, Si. Switch**	
LF351N	£0.43	27128-20	£4.08	DB3, 32V	£0.20
LF353N	£0.42	27C128-20	£4.08	BRY39	£1.30
LF356	£0.84	27C256-20	£4.85	**Transistors**	
LM301A	£0.25	27C256-20	£3.68	2N1613	£0.31
LM308N	£0.58	27C512	£3.42	2N1711	£0.26
LM311N-8	£0.32	**RAM**		2N1893	£0.29
LM318	£0.98	4164-15	£1.90	2N2218A	£0.28
LM319N-14	£0.90	6116-10	£1.53	2N2219A	£0.25
LM324	£0.24	6264-10	£3.16	2N2222A	£0.18
LM335Z	£1.52	41256-10	£2.80	2N2646	£1.12
LM339N	£0.24	62256-10	£4.22	2N2904A	£0.25
LM348N	£0.31	511000-8	£8.54	2N2905A	£0.25
LM358N	£0.27	514256-8	£6.80	2N2907	£0.20
LM377	£2.57	**A/D Converters**		2N2907A	£0.20
LM380N	£0.88	**Data Acquisition**		2N2926	£0.16
LM381N	£2.64	AD420AN	£25.38	2N3053	£0.27
LM386	£0.79	AD557JN	£8.75	2N3054	£0.85
LM392N	£0.79	AD574AJN	£18.48	2N3055	£0.58
LM393N	£0.21	AD755JN	£18.48	2N3439	£0.62
LM709T	£0.79	AD7226KN	£25.69	2N3440	£0.50
LM733	£1.04	AD7528JN	£8.63	2N3702	£0.09
LM748CN-8	£0.37	AD7545AKN	£14.04	2N3703	£0.10
LM759CP	£3.38	AD7828KN	£20.33	2N3704	£0.10
LM1458	£0.37	ICL7109CPL	£7.75	2N3705	£0.10
LM1881	£3.92	TLC549IP	£3.51	2N3706	£0.10
LM2917N8	£3.10	ZN425E	£5.94	2N3771	£1.44
LM3900N	£0.72	ZN426E	£3.13	2N3772	£1.51
LM3909N	£1.76	ZN427E	£9.25	2N3773	£1.70
LM3914	£2.30	ZN428E	£5.94	2N3819	£0.42
LM3915	£2.70	ZN448E	£7.50	2N3820	£0.66
LM13600	£1.66	**Voltage Regulators**		2N3904	£0.10
LMC660CN	£2.16	7805	£0.35	2N3905	£0.10
LMC60321N	£1.55	7808	£0.50	2N3906	£0.10
LP311N	£0.74	7812	£0.38	2N4036	£0.34
LP324N	£0.67	7815	£0.38	2N5245	£0.80
LP339N	£0.73	78L05	£0.23	2N5296	£0.57
LT1013CN8	£2.99	78L08	£0.23	2N5321	£0.57
LT1014CN	£10.20	78L12	£0.23	2N5322	£0.57
MAX202CPE	£2.97	78L15	£0.24	2N5401	£0.11
MAX208CN	£6.99	78L24	£0.39	2N5551	£0.11
MAX220CPE	£5.06	78S05	£0.98	2N6107	£0.60
MAX222CPE	£5.06	78S12	£0.98	2N6491	£1.58
MAX232CPE	£1.80	78S15	£0.98	2SB548	£0.30
MAX483CP	£3.13	7905	£0.40	2SD1730	£1.44
MAX485CP	£2.58	7912	£0.30	AC126	£0.44
MAX631ACP	£4.99	7915	£0.38	AC127	£0.50
MAX635ACP	£4.99	7924	£0.38	AC128	£0.40
MC1488	£0.39	79L05	£0.23	AC187	£0.48
MC1489	£0.39	79L12	£0.23	AC188	£0.48
MC3302	£0.56	79L15	£0.28	ACY17	£3.84
MC3340P	£1.60	79L24	£0.30	BC107	£0.16
MC4558P	£0.36	ADM666AN	£3.44	BC107B	£0.17
MV601DP	£2.97	LL200CV	£1.30	BC108	£0.14
NE521N	£6.39	L296	£6.87	BC108B	£0.16
NE531	£1.47	L387A	£3.24	BC108C	£0.15
NE555N	£0.25	LM2940CT	£2.30	BC109	£0.17
NE556N	£0.36	LM317T	£0.50	BC109C	£0.19
NE565	£1.84	LM323K	£2.84	BC114	£0.19
NE566N	£0.90	LM334Z	£1.35	BC115	£0.41
NE567N	£0.39	LM337T	£0.68	BC116	£0.41
NE571N	£2.47	LM338K	£5.52	BC118	£0.41
NE592	£0.62	LM723	£0.29	BC132	£0.36
NE5532N	£0.60	LP2950CZ	£2.70	BC134	£0.36
NE5534N	£0.64	REF01CP	£3.44	BC135	£0.36
NE5539N	£4.35	REF02CP	£4.66	BC140	£0.25
NE5560N	£2.31	REF12Z	£1.28	BC141	£0.27
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OP213FP	£5.20	1N4001	£0.06	BC170B	£0.16
OP275GP	£2.57	1N4002	£0.07	BC171	£0.11
OP282GP	£2.27	1N4003	£0.07	BC171B	£0.16
OP283GP	£5.20	1N4004	£0.07	BC172	£0.13
OP290GP	£5.40	1N4005	£0.07	BC172B	£0.13
OP297GP	£5.74	1N4006	£0.08	BC177	£0.18
OP400GP	£11.81	1N4007	£0.08	BC178	£0.18
OP495GP	£8.69	1N4148	£0.05	BC179	£0.18
RC4136	£1.00	1N4149	£0.06	BC179A	£0.17
SAA1027	£4.46	1N5400	£0.09	BC182	£0.11
SG3524N	£0.96	1N5401	£0.09	BC182A	£0.11
SG3543	£6.88	1N5402	£0.10	BC182B	£0.12
SL486	£2.88	1N5404	£0.11	BC182LB	£0.08
SSM2015P	£12.32	1N5406	£0.12	BC183	£0.08
SSM2017P	£3.38	1N5407	£0.14	BC183L	£0.08
SSM2131P	£4.19	1N5408	£0.15	BC183LB	£0.08
SSM2141P	£4.21	BA157	£0.10	BC184	£0.08
SSM2142P	£6.40	BA158	£0.10	BC184L	£0.08
SSM2143P	£3.78	BA159	£0.10	BC186	£0.33
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TBA860	£0.70	BY127	£0.18	BC206B	£0.72
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TBA820M	£0.40	OA47	£0.28	BC208	£0.72
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TDA2002	£1.04	OA91	£0.10	BC212	£0.08
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TDA2030	£1.18			BC212LB	£0.08
TDA2050V	£3.40			BC213	£0.08
				BC213B	£0.08
				BC213LC	£0.08
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				BC214L	£0.08
				BC225	£0.15
				BC237B	£0.09
				BC238B	£0.09
				BC238C	£0.09
				BC239C	£0.10
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				BC251	£0.13
				BC252	£0.13
				BC261B	£0.30
				BC262B	£0.24
				BC267B	£0.30
				BC307	£0.10
				BC308	£0.10
				BC319C	£0.13
				BC327	£0.10
				BC327-25	£0.10
				BC328	£0.10
				BC328-16	£0.10
				BC337	£0.10
				BC337-25	£0.12
				BC338	£0.10
				BC338-25	£0.10
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				BC357	£0.25
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				BD225	£0.42
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				BD238	£0.44
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				BD244C	£0.53
				BD245C	£1.18
				BD246	£1.18
				BD246C	£1.18
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				BD442	£0.37
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				BD535	£0.50
				BD536	£0.65
				BD581	£0.62
				BD597	£0.92
				BD646	£0.52
				BD648	£0.52
				BD650	£0.53
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				BD708	£1.04
				BD807	£0.80
				BDX32	£1.78
				BDX33C	£0.56
				BDX34C	£0.50
				BDX53C	£0.47
				BDX54C	£0.50
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				BF182	£0.31
				BF185	£0.58
				BF194	£0.31
				BF194B	£0.19
				BF195	£0.19
				BF244	£0.35
				BF244B	£0.40
				BF244C	£0.35
				BF257	£0.33
				BF259	£0.33
				BF337	£0.40
				BF355	£0.38
				BF423	£0.13
				BF451	£0.19
				BF459	£0.33
				BF469	£0.36
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				BFX84	£0.31
				BFX85	£0.32
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				BFY51	£0.25
				BFY52	£0.28
				BS107	£0.21
				BS170	£0.23
				BSW66	£1.35
				BU126	£1.32
				BU205	£1.41
				BU208A	£1.24
				BU326A	£1.40
				BU500	£1.54
				BU508A	£0.98
				BU508D	£1.44
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				BUT11A	£1.30
				BUT11AF	£1.30
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				TIP48	£0.62
				TIP50	£0.53
				TIP121	£0.48
				TIP122	£0.48
				TIP125	£0.46
				TIP127	£0.40
				TIP132	£0.46
				TIP137	£0.56
				TIP142	£1.30
				TIP147	£1.12
				TIP2955	£0.97
				TIP3055	£0.70
				VN10KM	£0.48
				ZTX300	£0.16
				ZTX500	£0.16

No Minimum Order Value

SAMEDAY DESPATCH

Quality Components

Electrolytic Radial

µF	16v	25v	40v	63v	100v
0.47	---	---	---	£0.05	---
1.0	---	---	---	£0.05	£0.05
2.2	---	---	---	£0.05	---
4.7	---	---	£0.05	£0.05	£0.05
10	£0.05	£0.05	£0.05	£0.05	£0.09
22	£0.05	£0.05	£0.05	£0.07	£0.11
33	£0.05	---	£0.05	---	---
47	£0.05	£0.05	£0.07	£0.10	£0.19
100	£0.06	£0.06	£0.10	£0.13	£0.26
220	£0.08	£0.09	£0.13	£0.25	---
330	£0.09	---	£0.19	---	---
470	£0.12	£0.17	£0.24	£0.33	---
1000	£0.15	£0.33	£0.34	---	---
2200	£0.27	£0.55	£0.70	---	---
3300	---	£0.94	---	---	---
4700	£0.67	£1.05	---	---	---

Electrolytic Axial

16v	25v	40v	63v	100v	250v	450v
---	---	---	---	---	---	---
---	---	---	£0.13	---	---	£0.22
---	---	---	£0.13	---	---	£0.30
---	---	---	£0.13	---	---	£0.41
£0.12	---	£0.12	£0.13	£0.17	£0.40	£0.51
£0.12	£0.13	£0.14	£0.15	£0.21	£0.52	£1.06
---	---	---	---	---	---	---
£0.13	£0.13	£0.15	£0.19	£0.32	£0.57	---
£0.14	£0.16	£0.19	£0.26	£0.44	---	---
£0.19	£0.20	£0.27	£0.39	£0.48	---	---
---	---	---	---	---	---	---
£0.24	£0.28	£0.43	£0.53	---	---	---
£0.33	£0.43	£0.59	£1.08	---	---	---
£0.53	£0.66	£1.11	£1.55	---	---	---
---	---	---	---	---	---	---
£0.86	£1.11	---	---	---	---	---

Ceramic Mini Disc

1.0,1.2,1.5,1.8,2.2,2.7,3.3,3.9,4.7,5.7,6.8,8.2

1.0pF to 22nF 100V £0.06

47nF & 100nF 50V £0.07

Dipped Ceramic Multilayer

10,22,33,47 and multiples.

10pF to 100nF 100V £0.10

220nF 100V £0.14

330nF 100V £0.16

470nF 100V £0.22

1.0µF 100V £0.29

Full Technical Specification available

Also in stock - Mylar Film, MKT, Boxed & Dipped Polyester, Tantalum, Sub-miniature, low Leakage & 105°C Radials

Resistors - Please State Value Required

¼W Carbon Film 5%	E12 Series	1Ω-10M	£0.02 Each, £0.60 per 100
¼W Metal Film 1%	E24 Series	10Ω-1M	£0.04 Each, £1.72 per 100
½W Carbon Film 5%	E12 Series	1Ω-10M	£0.02 Each, £0.95 per 100
1W Carbon Film 5%	E12 Series	1Ω0-10M	£0.07 Each, £3.90 per 100
2W Carbon Film 5%	E12 Series	1Ω0-10M	£0.12 Each, £5.99 per 100
2.5W Wirewound 5%	E12 Series	0Ω1-220Ω	£0.23 Each

(per 100 of one value only)

Preset Resistors - Please State Value Required

Enclosed, 10mm Square Horz / Vert.	100Ω - 1M0 0.15W	£0.15 Each
Skeleton, 10mm Dia. Horz / Vert.	100Ω - 1M0 0.1W	£0.11 Each
Sub-min, 6mm Dia, Horizontal	E3 100Ω-1M0 0.2W	£0.19 Each
Multiturn, 10mm Square, Top Adjust.	E3 100Ω-1M0 0.5W	£1.00 Each
Multiturn, 19mm Long, End Adjust.	E3 50Ω-2M0 0.5W	£0.64 Each

Potentiometers - Please State Value Required

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

ORDERING INFORMATION - Carriage £1.25+Vat, Prices Exclude Vat (17½%), Add Carriage & Vat to all orders. Payment with Order. PO/Cheques payable to ESR Electronic Components. ALL Credit Card Orders Accepted. NO Credit Card Surcharges. Trade discount for Schools & Colleges.

EVERYDAY PRACTICAL ELECTRONICS

VOL. 26 No. 4 APRIL '97

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COMPLEXITY

Everyday news on new high tech. instruments lands on my desk; as equipment gets more and more complex and relies more on large-scale dedicated chips, it seems that there is less that the hobbyist can build. You only need to read the *MPEG2 Digital Television* feature in this issue to realise how complex such a system will be. There is no way that most modern equipment can be built by the hobbyist for less than the cost of buying the ready-made unit, whether it is hi-fi, TV, video, computers or communications equipment like mobile phones or amateur band transceivers. So how do we continue to pursue our hobby?

There are still plenty of unusual projects that can be built by the hobbyist for less than commercial items – mainly because there is only a small market for them, or because they are new ideas and prices have not yet fallen. This issue is an example of such projects. On the very simple side is the *Puppy Puddle Probe* – it's easy to build, useful and demonstrates some very simple electronics well. Rather more refined is the *Midi Matrix* which solves a very real problem, for those with MIDI set-ups, in an elegant way, relatively inexpensively.

TAKE YOUR PIC

The other side of the coin is demonstrated by our *PIC-Agoras* project. You can buy a bike computer for much less, but *PIC-Agoras* is very versatile, can be tailored to use with a wide range of wheel sizes and could even be adapted to measure say skateboard speed. While you *could* compare it with a commercial bike computer it can be used for a variety of tasks which are well outside the capabilities of any commercial product.

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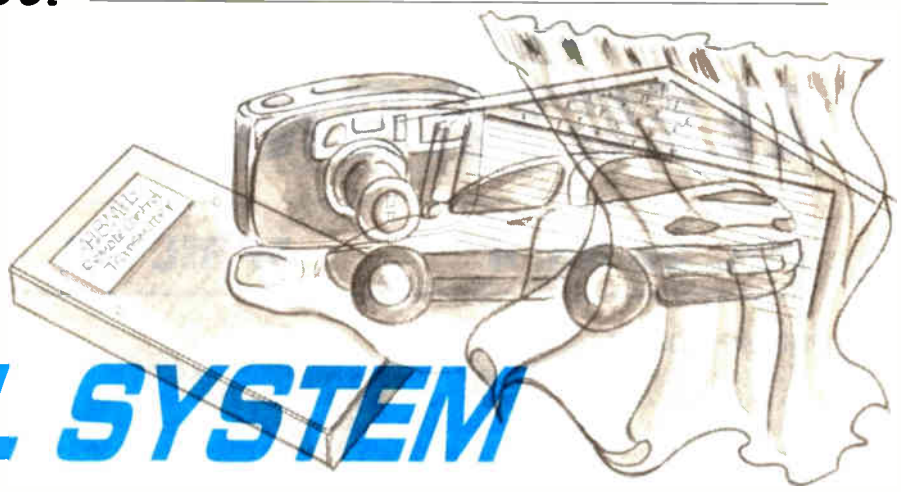
418MHz REMOTE CONTROL SYSTEM



ROBERT PENFOLD

You do not need a licence to use this coded transmission and reception control system, and it's easy to build using pre-aligned modules.

THE frequency of the 418MHz Band has been allocated to licence-exempt radio links, and its main use is probably for remotely switching intruder alarms on and off. It is open for use in other applications though, and there must be many potential uses for this type of radio link.

Transmission powers are very low, however, and only simple aerials are permitted at the transmitter. This limits the maximum operating range to about 100 to 200 metres in open terrain, or about 30 metres if the signal has to pass through buildings. While this precludes the use of 418MHz links in some applications, there are many situations where this sort of range is perfectly adequate.

For example, a camera remote control system is normally used over a range of about five to 100 metres. "Wireless" serial data links for computers also operate over a similar range.

It is not practical for the home constructor to produce 418MHz radio equipment, as it would not be possible to get the equipment approved by the radio authorities. On the other hand, it is possible to produce systems based on ready-made transmitter and receiver modules which have DTI approval, and meet the relevant standards.

Ready-made 418MHz modules are not exactly "dirt cheap", but prices have fallen to the point where they are now a practical proposition for the average electronics experimenter. The basic remote control system featured here uses commercially produced 418MHz transmitter and receiver modules that provide an operating range of up to about 100 metres in open terrain.

The use of ready-built modules means that the completed system requires no setting up or alignment of any kind, and **it can be used legally without having to obtain an operating license.**

SYSTEM OPERATION

The block diagram of Fig. 1 helps to explain the way in which the system functions. The transmitter is the more simple of the two units, and the transmitter module itself is basically just an oscillator and a lowpass filter to give a "clean" output signal. The very low power levels involved here do not warrant the use of a power amplifier stage.

Some simple audio processing at the audio input prevents any form of over-modulation. The type of modulation used is wide band frequency modulation (w.b.f.m.), which is the same type that is used for Band II broadcast transmissions.

On the face of it, the transmitter can consist of nothing more than the transmitter module, a battery, and a pushbutton to provide on/off switching. In reality such a basic system would be vulnerable to frequent spurious operations.

The problem is simply that there is only one channel available. A system that relies on basic switching of the carrier will be activated by the carrier wave from any nearby 418MHz transmitter. Your remote controlled curtains (or whatever) could operate every time a neighbour switches their car alarm on or off!

The solution to the problem is to transmit a digitally encoded carrier signal, and to have a receiver that will only respond to a correctly coded signal. Special chips to provide the encoding and decoding are readily available. The transmitter chip is fed with a 12-bit binary code, which gives a choice of 4096 different code combinations. The 12-bit code is converted to a form of serial signal which is at a low enough baud rate to be handled by the 418MHz transmitter and receiver modules.

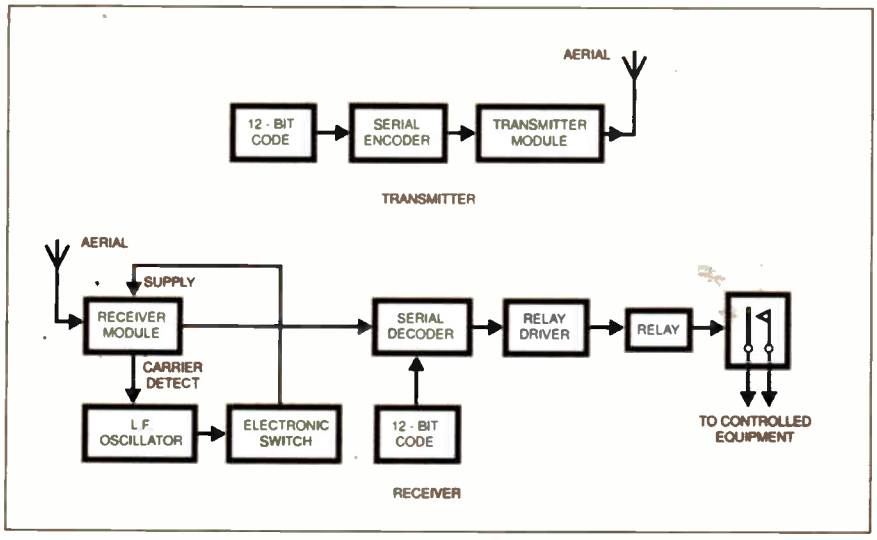


Fig. 1. The 418MHz Remote Control System block diagram.

At the receiver, the decoder converts the serial signal back into 12 bits of parallel data, and compares the decoded signal with the 12-bit binary pattern on its inputs. Provided the same 12-bit code is used at the transmitter and the receiver, the two codes will match, and the decoder chip will set its output terminal high.

This technique does not absolutely guarantee that the system will be free from spurious operations, but unwanted activation of the receiver can only be caused by a nearby transmitter using the right one of the 4096 codes, and the same method of serial encoding. This is unlikely to occur in practice, but if necessary the code number can be changed to one that is free from interference.

The receiver module is relatively complex, and it is actually a form of double conversion superhet receiver. Its sensitivity is good, with an input of 0·5µV giving a 20dB signal-to-noise ratio. The receiver has three outputs, one of which is an audio output. This is useful for monitoring the transmitter, but is otherwise unused.

The main output is a processed audio signal which provides a "squared" version of the audio signal that can directly drive the serial input of the decoder chip. When a suitable signal is received, the output of the decoder goes high, switching on a relay via a simple driver circuit. A pair of relay contacts then closes and activates the controlled equipment.

When the signal from the transmitter ceases, the serial decoder no longer receives a valid signal, and its output goes low again. Therefore, the relay is only switched on while the transmitter is switched on.

CONSERVING BATTERIES

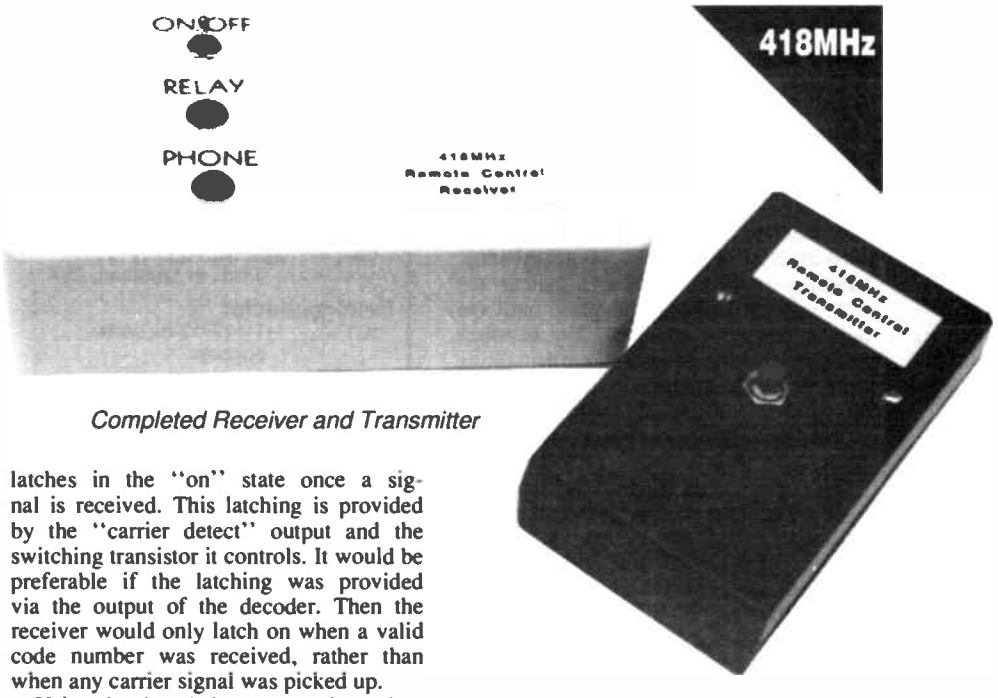
Since the receiver module only consumes about 13 milliamps from a 6V supply, battery operation is possible. As the receiver may be required to operate for very long periods, a lower current consumption would be preferable though. This can be achieved by pulsing the receiver module under standby conditions, rather than having it run continuously. This mode of operation is made possible by the third output of the receiver module, which can operate an external switching transistor when a carrier signal is detected.

The basic idea is to have a low frequency oscillator which controls the power to the receiver module via an electronic switch. The module is switched on and off several times a second, and in this case it is switched at a rate of about 25 times per second. A crucial factor here is that the "on" time is made something under one tenth of the "off" time.

With the receiver module turned off for the majority of the time its current consumption is greatly reduced, and is typically a little over one milliamp. The overall current consumption of the circuit is a little higher at around two milliamps, but this is low enough to give over 1000 hours of continuous operation from each set of four HP7 size batteries.

Of course, this pulsed method of operation only operates properly if the receiver latches in the "on" state once a signal is received. This latching is provided by the "carrier detect" output and the switching transistor it controls. It would be preferable if the latching was provided via the output of the decoder. Then the receiver would only latch on when a valid code number was received, rather than when any carrier signal was picked up.

Using the decoded output tends to slow things down though, possibly giving a perceptible delay between the transmitter being activated and the relay contacts closing. Using the carrier detection method there is still a delay through the system, but it is too short to be apparent to the user, and will not be significant in most applications.



Completed Receiver and Transmitter

TRANSMITTER CIRCUIT

In Fig. 2 is shown the circuit diagram for the 418MHz Remote Control Transmitter, which is based on a Radio-Tech TXM-418-A transmitter module. This module requires a supply potential of between six and 12 volts, and here a 9V battery supply is used.

Switch S1 is the on/off control, and C1 is the supply decoupling capacitor. The aerial is a simple home constructed helical type, which gives good performance despite its very small size.

The serial encoder chip is an HT-12E (IC1). This has a built-in clock generator that requires only one discrete component, which is timing resistor R1. The serial output at pin 17 of IC1 can directly drive the modulation input of the transmitter module. The audio input of the transmitter has built-in lowpass filtering, etc. that prevents any out-of-band signals being radiated.

Pin 14 of IC1 is taken high to inhibit transmission on the serial output, or low to enable it. In this application, IC1 must produce a serial signal whenever the transmitter is switched on, and pin 14 of IC1 is therefore permanently connected to the 0V rail. The required 12-bit binary code is hard-wired via link wires on the printed circuit board. Each address input must be connected to a high ("H") or low ("L") terminal on the p.c.b.

Typical current consumption of the transmitter is about 11 milliamps, but it can be as high as 16 to 17 milliamps. A PP3 size battery is adequate to power the circuit despite this relatively high consumption, because the transmitter will normally be used only in very short and intermittent bursts.

REMOTE CONTROL TRANSMITTER

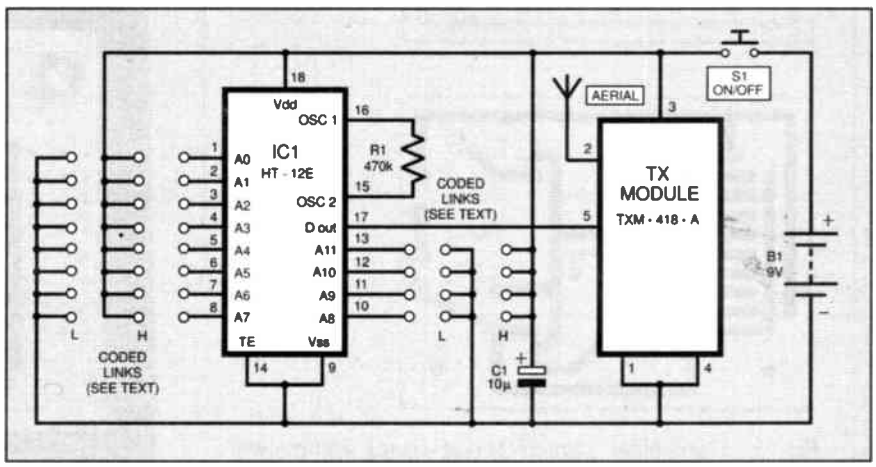


Fig. 2. Circuit diagram for the 418MHz Transmitter.

TRANSMITTER CONSTRUCTION

Details of the transmitter printed circuit board are provided in Fig. 3. This board is available from the *EPE PCB Service*, code 142.

Although this board is very simple, there are several points that are worthy of amplification. IC1 is a CMOS device, and accordingly it requires the usual anti-static handling precautions. Use a holder for IC1, and do not fit it into place until the unit is otherwise complete. Try to touch the pins as little as possible when fitting IC1 into place, and keep it well away from any likely sources of static electricity (computer monitors, static-prone carpets, etc.).

The binary code used on the prototype is 000000001111, and this is the code shown in Fig. 4. Obviously you can use any one of the 4096 available codes, but make sure that every common ("C") pad is connected to *either* a high ("H") *or* a low ("L") pad. If there are problems with interference from other 418MHz transmitters once the system is "up and running", there should be no difficulty in rewiring one of the links to try a new code. Remember to temporarily remove IC1 from the board while the change is made.

Capacitor C1 must be a high quality component that will work well at high frequencies. It can be either a tantalum capacitor or a high quality radial electrolytic type. A "bog standard" electrolytic might not give good performance in this application.

The transmitter module is mounted on the board vertically, and due to its asymmetric base it will only fit the right way round. Fit four single-sided solder pins to the board at the positions where connections will be made to switch S1 and the battery clip.

COMPONENTS

TRANSMITTER

Resistor

R1 470k 0·25W 5% carbon film

Capacitor

C1 10µ high quality radial elect., or tantalum, 25V

Semiconductor

IC1 HT-12E 12-bit serial encoder

Miscellaneous

TX TXM-418-A 418MHz transmitter module (Radio-Tech).

S1 push-to-make switch

B1 9V battery (PP3 size)

Printed circuit board, available from the *EPE PCB Service*, code 142; plastic case about 105mm × 61mm × 28mm; PP3 type battery connector; 18-pin d.i.l. socket; 24 s.w.g. (0·56mm) enamelled copper wire for aerial; wire; solder, etc.

See SHOP TALK Page

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

AERIAL

To remain within the regulations, the transmitter must only be used with a simple aerial that does not provide gain. This gives a choice of three basic types which are helical, whip, and loop. These each have their advantages and drawbacks, but for most purposes a helical aerial is probably the best choice. It offers reasonable efficiency together with small size. In fact a helical aerial is small enough to be mounted on the p.c.b., just like any other component.

The aerial is home constructed, and it merely consists of 26 turns of 24 s.w.g. (0·56mm diameter) enamelled copper wire wound on a temporary 3·5mm diameter former (e.g. the shank of a 3·5mm twist drill). The coil should be about 25mm long initially, but once the system is working it can be expanded and contracted in an attempt to find the optimum length.

Leave a few millimetres of excess wire at one end of the coil to form a leadout wire, and scrape the insulation from this lead using a modelling knife or miniature file. "Tin" the leadout wire with a small amount of solder, and it should then connect easily and reliably to the printed circuit board.

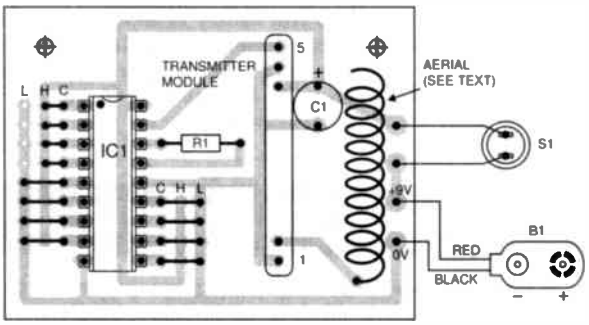
Ideally, the aerial should be mounted where it is well clear of any metal objects, but this is not really possible if the transmitter is to be kept reasonably small. More than adequate performance seems to be obtained even with the aerial in close proximity to printed circuit tracks and other pieces of metal. However, the transmitter will not work with the aerial within a metal case.

CASE

The prototype transmitter is housed in a small plastic box having a built-in compartment for the PP3 size battery. At about 105mm × 61mm × 28mm this case is somewhat larger than is really necessary, but it is still quite "pocketable". The printed circuit board is mounted on the top half of the case, at the opposite end to the battery compartment, using 6BA or metric M3 nuts and bolts. Use short spacers or extra nuts between the case and the board, or the board might distort and crack as the mounting nuts are tightened.

Switch S1 is mounted on the top panel of the case so that it fits into the vacant area between the battery and the circuit board.

To complete the transmitter, wire the battery clip and S1 to the four solder pins, and fit IC1 into its holder. To be within the regulations, the transmitter must have a label affixed to the case which has the wording "MPT 1340 W.T. Licence Exempt" (see Fig. 4). The lettering should be no less than two millimetres high.



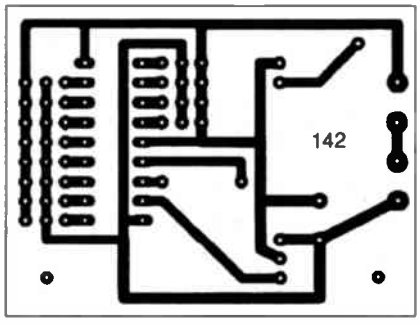
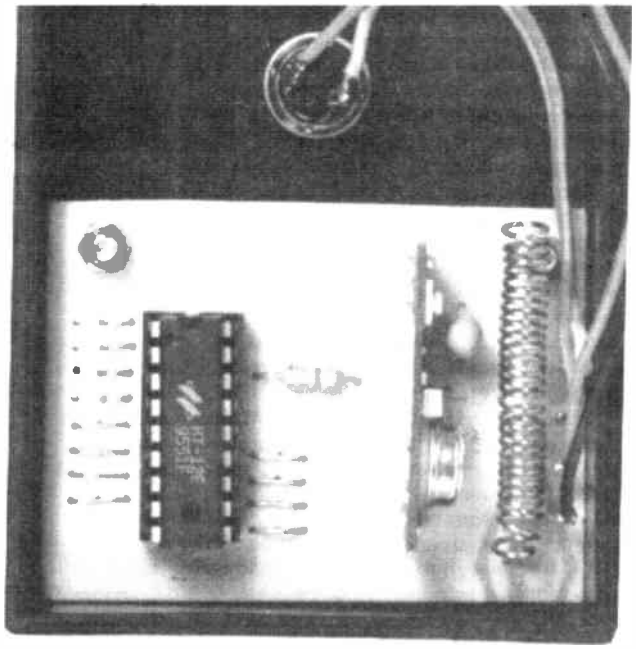


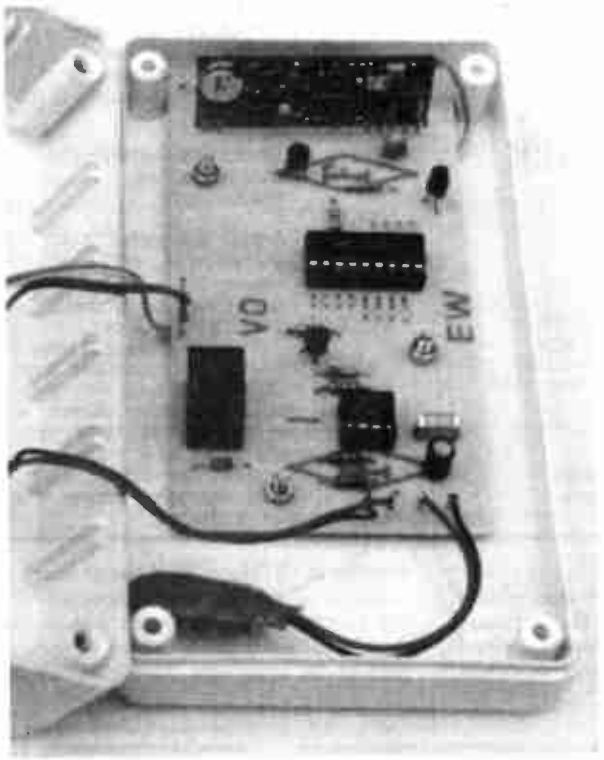
Fig. 3. Transmitter printed circuit board component layout, interwiring and full size copper foil master.

MPT 1340
W.T. LICENCE
EXEMPT

Fig. 4



Layout of components on completed Transmitter board.



The completed Receiver board mounted in the base of the case.

RECEIVER CIRCUIT

The circuit diagram for the 418MHz Remote Control Receiver appears in Fig. 5. This circuit is based on a Radio-Tech applications circuit for the SILRX-418-A receiver module.

As with the transmitter, the aerial is a simple helical type. On the output side of the receiver module, the demodulated audio signal is fed direct to socket SK2. The audio signal can be monitored using a crystal earphone, *but no other type of earphone or headphone should be connected to SK2.*

The "squared" audio signal at pin 7 of the module is fed direct to the serial input at pin 14 of IC1, which is the decoder chip, type HT-12F. This has a built-in clock oscillator which requires only one discrete component, which is timing resistor R2.

Like the encoder, the decoder has the 12-bit binary code set via link wires on the p.c.b. Pin 17 of IC1 goes high when the correct code is received, and this turns on the relay via transistor TR1, used as a common emitter switch. Diode D1 is the usual protection diode which suppresses the high reverse voltage spikes which would otherwise be generated across the relay coil each time it switched off.

IC2 pulses the supply to the receiver module via switching transistor TR3, and the decoupling network comprised of resistor R3 and capacitor C2. The output of IC2 is high while capacitor C3 charges via resistors R4 and R5, and low while C3 discharges through R5 and an internal transistor of IC2. The charge time is therefore about eleven times longer than the discharge time.

Transistor TR3 and the receiver module are switched on during the discharge periods, which gives the required power saving. When a carrier is detected, IC2 latches with its output low, so that TR3 and the receiver module are held switched on. IC2 must be a low power version of the 555 timer, since a standard 555 would consume nearly as much current as it would save!

Transistor TR2 is switched off when a carrier is detected, which results in IC2 latching with its output low due to the coupling through R6 which takes the reset input low. Power is then supplied to the receiver module continuously. Normal standby operation is resumed when the carrier ceases, and TR2 switches off again.

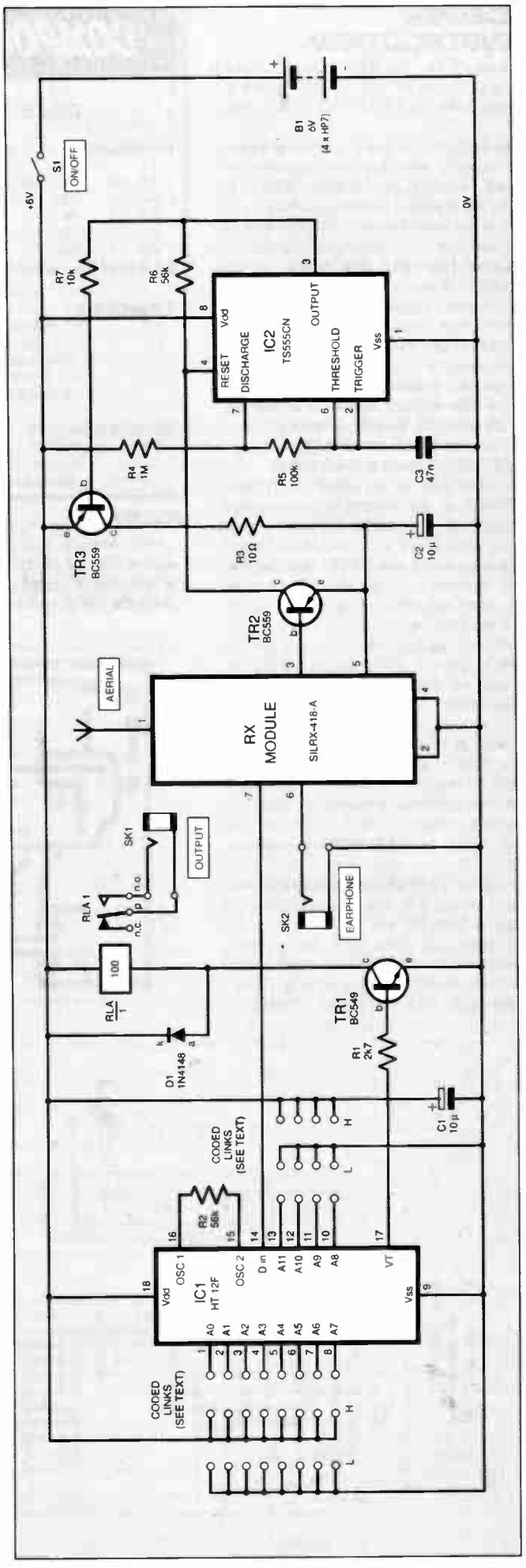


Fig. 5. Complete circuit diagram for the 418MHz Remote Control Receiver.

RECEIVER CONSTRUCTION

Details of the Receiver printed circuit board are shown in Fig. 6. This board is available from the *EPE PCB Service*, code 142.

Both IC1 and IC2 are CMOS devices, so use sockets with them and observe the standard handling precautions. Note that IC2 has the opposite orientation to IC1.

The aerial is identical to the one used in the transmitter. Capacitor C2 should be a tantalum type or a high quality radial electrolytic. When adding the twelve links to set the code number for IC1, make sure that the code used exactly matches the one used on the transmitter. Fig. 6 shows the link-wires for the 000000001111 code used on the prototype system. Do not overlook the ordinary link-wire just above IC2. The receiver module is mounted vertically on the board, making sure its pins are fully pushed down into the board.

The relay can be mounted on the circuit board in the normal way provided the specified component is used. From the electrical point of view, the receiver should work using any 6 volt relay that has a coil resistance of about 100 ohms or more, plus suitable contacts for its intended application.

However, alternative relays are almost certain to have a different pin configuration, and are mostly much larger than the specified relay. This would make it necessary to mount the relay on the case and hard wire it to the printed circuit board. Unless there is a good reason for using an alternative relay it is definitely advisable to use the specified component. This has changeover contacts rated at 2A at 24V d.c. or 240V a.c. (1A with an inductive load).

Be careful to fit diode D1 the right way round. Getting this wrong could result in damage to both D1 and TR1. Once all the components and links have been added, complete the board by fitting single-sided solder pins to take the hard wiring. "Tin" the tops of the pins with plenty of solder.

COMPONENTS

Approx Cost Guidance Only **£32** excluding Batts.

RECEIVER

Resistors

R1	2k7
R2, R6	56k (2 off)
R3	10Ω
R4	1M
R5	100k
R7	10k

All 0·25W 5% carbon film

See SHOP TALK Page

Capacitors

C1	10μ radial elect., 25V
C2	10μ high quality radial elect., or tantalum, 25V
C3	47n polyester (7·5mm lead spacing)

Semiconductors

D1	1N4148 signal diode
IC1	HT-12F 12-bit serial decoder
IC2	TS555CN low power CMOS 555 timer
TR1	BC549 *npn* transistor
TR2, TR3	BC559 *pnp* transistor (2 off)

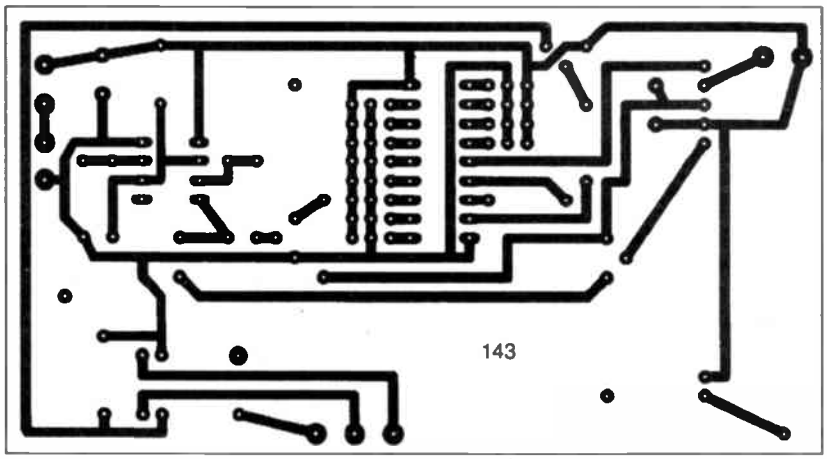
Miscellaneous

RX	SILRX-418-A 418MHz receiver module (Radio-Tech)
SK1, SK2	3·5mm jack socket (2 off)
B1	6V battery (4 × HP7 size cells)
S1	s.p.s.t. min. toggle switch
RLA1	6V 100Ω coil, single changeover contact relay

Printed circuit board, available from the *EPE PCB Service*, code 143; plastic case about 143mm × 82mm × 44mm, 8-pin d.i.l. socket, 18-pin d.i.l. socket; plastic holder for 4 × HP7 size cells; battery connector (PP3 type); 24 s.w.g. (0·56mm) enamelled copper wire for aerial; wire; solder, etc.

CASE

Any medium size plastic case should comfortably accommodate the receiver. Do not use a metal case as this would screen the aerial and prevent the unit from working at all. The printed circuit board is mounted on the rear panel using 6BA or M3 fixings. Fit it well to one side so that there is sufficient space left for the battery pack on the other side. Switch S1 and the



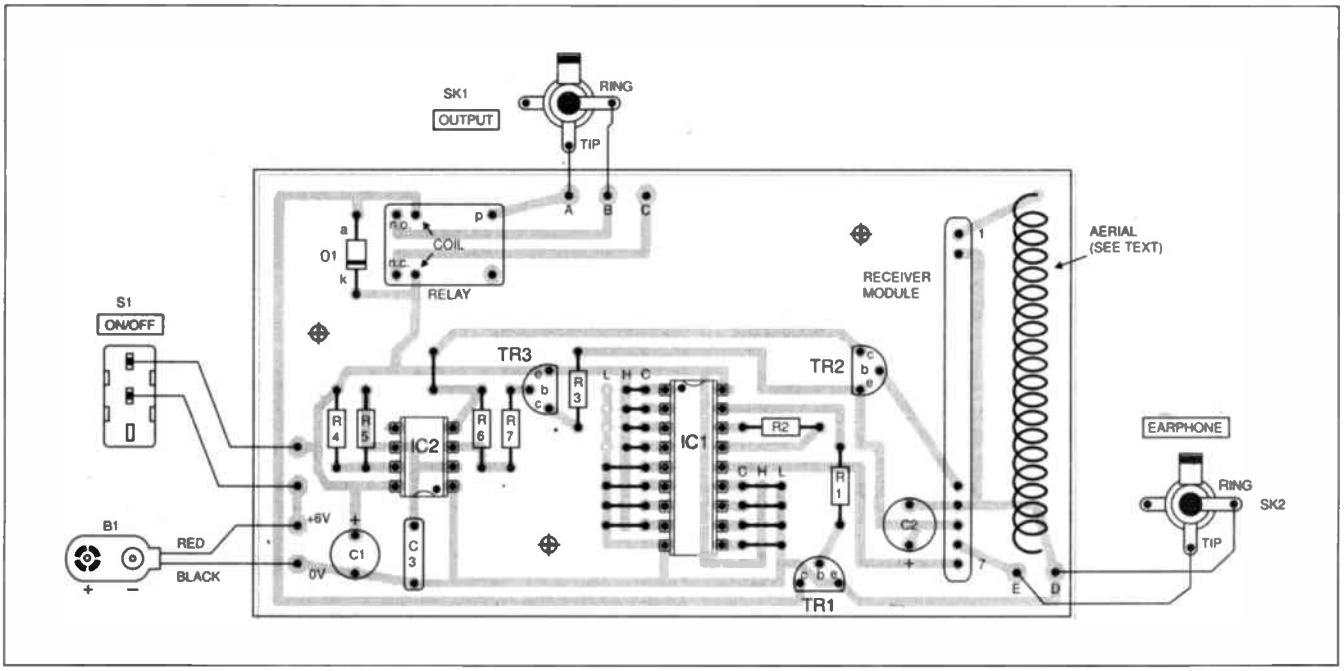


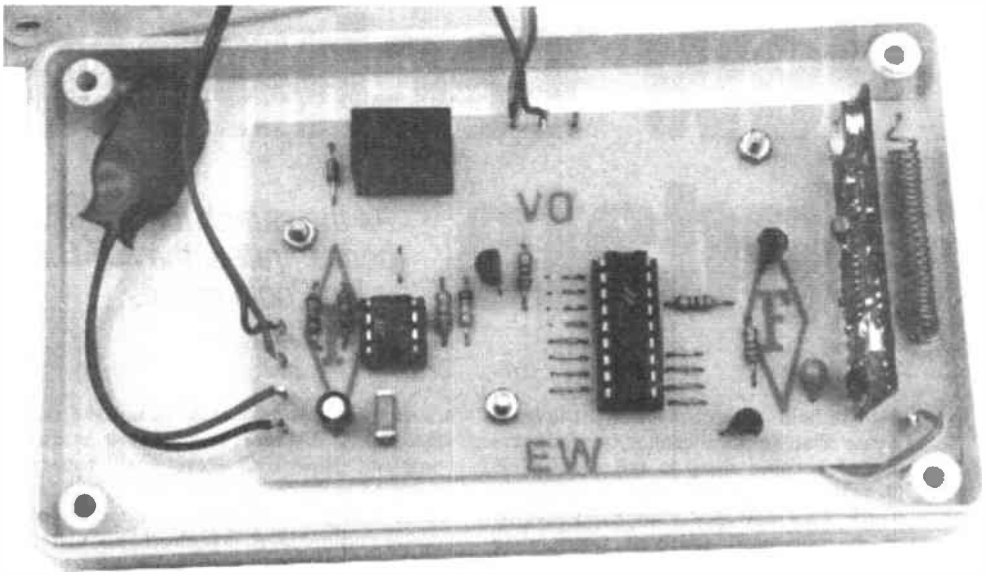
Fig. 6. Receiver printed circuit board component layout, interwiring and full size copper foil master pattern (top).

two sockets, SK1 and SK2, are mounted at any desired places on the front panel, but make sure that they are positioned well clear of the battery pack.

To complete the receiver, add the small amount of hard wiring. This is also shown in Fig. 6. The method of connecting socket SK1 to the relay contacts shown in Fig. 6 is correct if normally open operation is required (i.e. the relay contacts are normally open, and they close while switch S1 at the receiver is closed).

If normally closed operation is needed, connect SK1 to pin "C" on the circuit board instead of pin "B". To complete the unit add the battery connector, which is a standard PP3 type.

Note that in this form the receiver should only be used with battery powered equipment, such as a camera. It should only be used with mains powered equipment if it is constructed and installed by someone with the requisite knowledge and experience, and it must conform to the normal safety standards.



Layout of components on the completed Receiver board. Note that the aerial "lead" on the far right is soldered to the p.c.b. at one end only.

IN USE

As the transmitter and receiver modules are pre-aligned, the completed system should work immediately over a reasonable range. For operation over distances of up to about 10 or 20 metres there will probably be no need to "tweak" the aerials for optimum results.

For operation over longer ranges, it might be necessary to expand/compress the aerials in order to optimise performance. This is really just a matter of using trial and error, but monitoring the audio output signal of the receiver can be helpful. A strong signal gives a "clean" sounding "buzz" having a low background "hiss" level. Weak reception produces a rougher sounding "buzz" with a generally higher background noise level.

For operation at short ranges, the relative orientations of the two aerials seems to be unimportant. At longer operating distances the aerials should both be more-or-less vertical.

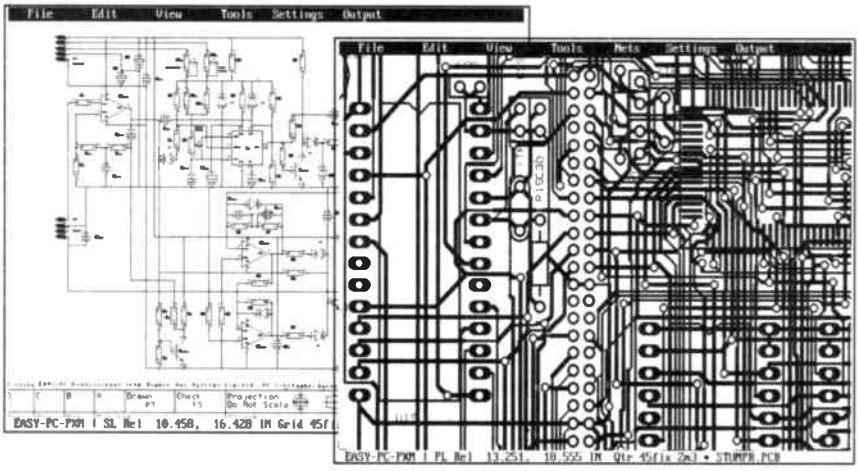
Remember that the range of the system will be reduced if it is used within buildings, but the signal from the transmitter seems to be able to penetrate several average internal walls. In this respect a radio control system is far superior to an infra-red type, which cannot operate through anything opaque.

ACKNOWLEDGEMENT

The author thanks Radio-Tech Ltd. for their helpful cooperation with regard to the transmitter and receiver modules used in this design. They are also offering these devices at a specially discounted price to *EPE* readers, see *Shop Talk* page.

EASY-PC Schematic and PCB CAD

From Super Schematics



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New Technology Update

As the search for better VDU materials becomes more concentrated, the F.E.D.s seem to have an answer – Ian Poole reports.

IN THE field of electronics it is often the case that an idea cannot be fully exploited because there is not a complete understanding of the way in which it works. This may appear surprising in view of the enormous advances which have been made in our knowledge of science in recent years. However, as new developments are made, often new principles are involved and time is required before they are fully understood.

It has been the case many times in the past, that an electronic device has been made to work and fulfil a valuable function without a full understanding of its operation. Thermionic valves represent a very good example.

In the early days of their existence it was thought that valves needed a small amount of gas inside their glass envelope for them to be able to operate correctly. Only when an American named Langmuir proved that these gasses were not needed, were fully evacuated or "hard" valves produced and their performance improved by a considerable degree.

The "cat's whisker" was another fine example of an effect which had been noticed and put to good use. However, it took many years before the physics behind it was understood, and progress could be made on making semiconductor diodes in a much more reliable way.

Phosphor Performance

The same is true today about the understanding we have about the way in which materials like phosphors emit light. Although much is known, there is still a lot we do not understand.

Even though these phosphors are the cornerstone upon which the cathode ray tube (c.r.t.) depends, there is still much to be learnt about the mechanics behind this useful phenomenon. Unfortunately, research into material physics is not easy, and can be very costly. Nevertheless it can bring large rewards, especially if new devices can be made in large quantities.

Obviously the limitations in our knowledge of these phosphors has not limited their use in c.r.t.s. Currently, they are still the most widely used type of display, with hundreds of millions of them being manufactured each year.

However, it has brought about a number of problems when they have been used in other applications. In order to make them emit light, large voltages and relatively high powers are needed. Domestic televisions require several kilovolts. The higher the voltage, the brighter the picture can be made.

As most televisions are powered from the mains, this does not present a real problem. However, when small battery powered units are required, this brings far more stringent requirements in terms of power consumption. It is clearly not viable to have a small battery powered unit which consumes the levels of power required by a c.r.t.

L.C.D. Performance

Even though c.r.t.s are not being used in small battery powered pieces of equipment, the new phosphor field emission displays (f.e.d.s) are growing in popularity and are being used increasingly. Although l.c.d.s (liquid crystal displays) can be used in many applications, they have a number of limitations.

They do not perform well in conditions of high ambient light, and sometimes they require the use of a back-light, a factor which itself uses significant amounts of power. They also do not operate at low temperatures, and even at ambient temperatures they have a very slow response time. They are also far too slow for television applications.

Another problem is the small viewing angle. Combined, all of these limitations mean that the l.c.d. is not going to achieve widespread acceptance for applications like television, even though they are used in vast quantities for many other applications, including laptop computers.

However, anyone using a laptop will soon see the shortcomings of the l.c.d., although its low power consumption means that it is the only viable option. If a display with a better performance and lower cost could be devised, the returns on any investment would be vast. Not only would it be used in many computer applications, but if it could be used for televisions this would bring another vast market within its reach.

Investigating F.E.D.s

As a result of the power constraints, it has become more important to investigate methods of improving the efficiency of phosphor f.e.d. displays. As the efficiency of the displays is primarily governed by that of the light conversion, this has recently come under close scrutiny now that a new development initiative has been launched. Funded by the American Government, Sandia Laboratories in Albuqurque, New Mexico are undertaking the research, and they have started to make progress and make some interesting discoveries.

When commencing their study, the researchers decided to concentrate on just one material, a zinc oxide based phosphor. This reduced the number of variables, and allowed the basic theories and methods to be tried on just one substance. Any results could be extended to other materials at a later date, as the same basic principles apply.

The studies showed that light is emitted from areas where there are surface defects, such as missing oxygen atoms. This indicated that the light emission is purely a function of the surface.

Previously it had been thought that the thickness or density of the material had an effect, but this is not the case. Working along these lines, the researchers have changed the chemistry of the test material to alter the surface and they have successfully increased the luminescence.

Laser information

Much of the crucial information about the light emission has been gained from an instrument called a photo-thermal deflection spectroscope. Using this, samples of the phosphor have a liquid introduced into them.

As the mixture is heated, the reflection of a laser beam is noted. The degree of deflection for a given amount of heat passed into the mixture enables a measurement of the optical absorption of the material to be made.

This research will pay large dividends with phosphor based f.e.d.s.. Optimising the phosphors will enable them to operate with much lower voltages, possibly down to less than 0·5kV. This is a considerable reduction when compared to the voltages which were previously required.

It will mean that f.e.d.s will be used in a variety of applications where they may have been too power hungry before. They will be ideal for use in commercial laptop computers. If the f.e.d. can gain a significant foothold in this market it may also start to catch on in other areas as well.

Although there is still more work to be undertaken, the project has already made a valuable contribution to display technology. It is also likely that as different aspects of the phosphors are monitored and investigated, improvements in other areas may be made. Any improvement in our understanding of the way in which these phosphors emit light will enable them to be used more effectively, and give better products for the future.

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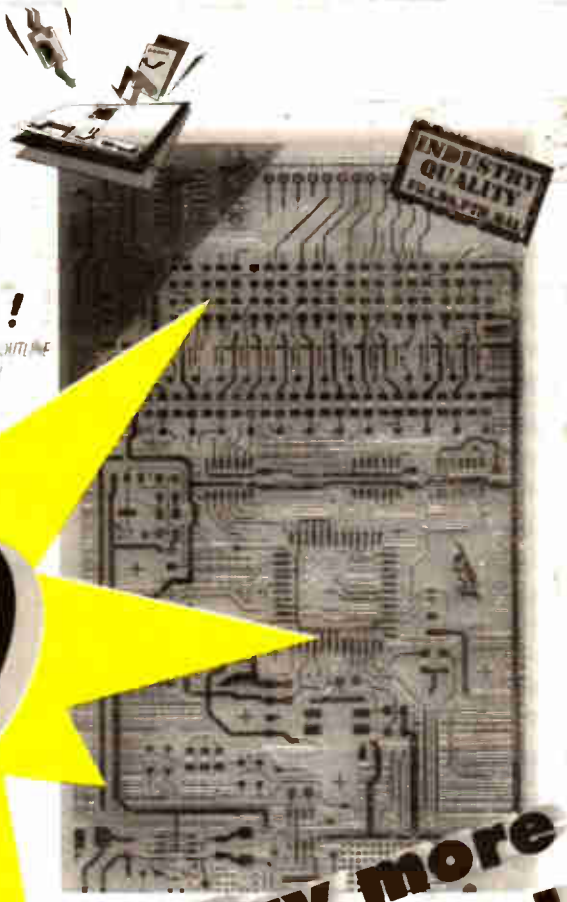

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Innovations

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

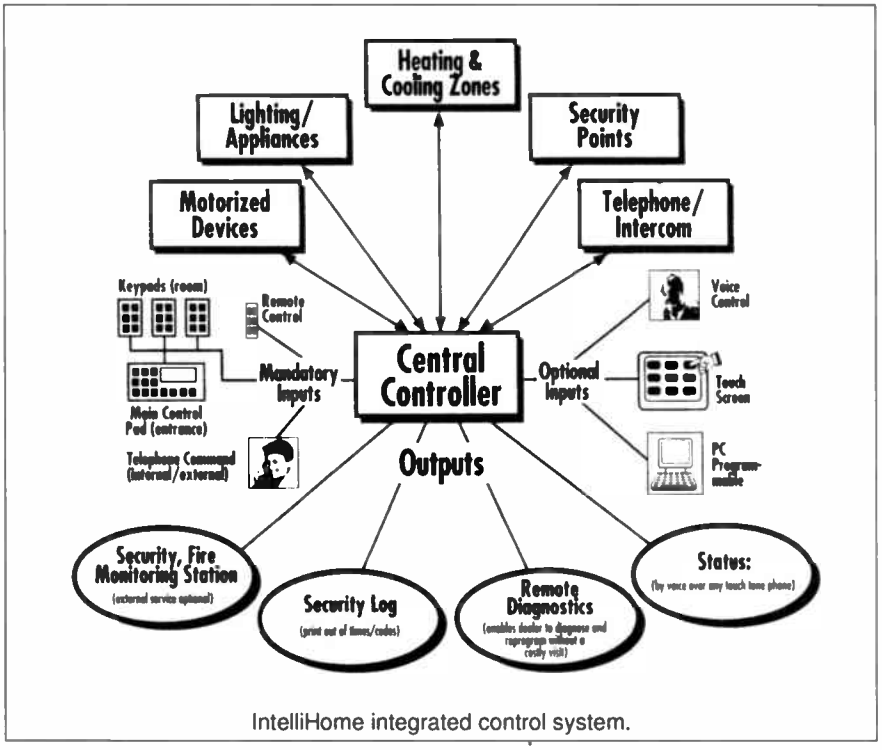
THE BUTLER DID IT!

Alexander, the electronic butler in the IntelliHome automated home control system, can be held responsible for almost everything – *by Hazel Cavendish*

THE internationaly-famous French architect Le Corbusier was the first man to suggest that a house should be "a machine for living", yet no-one so far has put this concept into totally practical effect. Now an Aberdeen Scot called Charles Davidson and his partner Jack McLaughlin have introduced their electronically-inspired IntelliHome to England in a £1,000,000 show house in Surrey, due to open to the public soon. This house claims to have the most extensive fully-automated voice-activated system in the British Isles.

In August last year *EPE* included Davidson's original "Thinking House" in the *Innovations* round-up of *Marvels for the Millennium*. Its success has been taken up by one of England's leading house builders in the South and a similar system is being developed for pubs and shops. Considerable interest is being shown by European builders.

Davidson believes his new system will become standard in new homes throughout Britain in five years, as he has devised a way of manufacturing it so economically that a householder is likely to recover the cost of the system in the first couple of years, through impressive economies in heating and lighting.



IntelliHome integrated control system.

BUTLERIAN REVOLUTION

The 1997 IntelliHome is based around an electronic "butler" which Davidson calls Alexander. The basic voice-activated system, with around 60 functions, costs about £1,500, although the really sophisticated versions for luxury homes with swimming pools and music rooms can cost up to £70,000.

Security is possibly the most important part of the system. Alexander will call the emergency services and a nominated neighbour if there is a break-in, and if someone comes to the door when the owner is away, Alexander transfers the call to the owner's mobile phone, so that he can speak to the visitor over the intercom, giving the impression that he is at home. It is even possible to send a video image of the caller to him if he is abroad, so he can tell Alexander whether or not it is safe to admit the caller.

Alexander's video surveillance system has many unique and highly secure design features. It consists of a video panel to which four cameras are connected. A slave video panel can also be connected to allow up to eight cameras to be controlled. A remarkable economy is achieved through the wiring, which requires no special tools and has been developed to utilise standard burglar alarm wire, making installation costs nominal. It should be possible to fit cameras to wherever wires have been run to detectors.

Alexander keeps a careful eye on the weather and the thermometer, and can make sure the dimmer switches are used when the house is unoccupied and the heating kept low, with resultant economy saving. One of Alexander's features is that the owner can phone him for confirmation that the heating is turned up to eliminate danger of burst pipes, and that the electric blanket will be on when he returns!

EVEN THE MENIALS

Even plants and pets are catered for. Plants can be watered in an owner's absence, and dogs and cats be fed automatically from special compartmentalised dishes. There is also an electronic rake which cleans out the cat's litter tray and leaves the detritus sealed in a plastic bag!

In homes having a swimming pool, spacious lawns and elaborate gardens, outside chores can also be assisted. Alexander can be told to maintain the swimming pool, filtering and vacuuming it twice daily, and other such operations. He can also ensure that lawns are watered daily in summer, except when it has rained, and hanging baskets are watered twice in 24 hours.

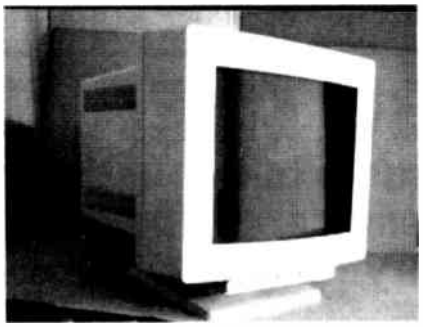
"As far as I know," says Mr Davidson, "Nobody has ever put so many devices under one roof before. We have created a sophisticated wiring infrastructure as the base of the system. Every room in the house can be wired so that from anywhere the occupants will have access to video, audio, telephone, computer links, automation control, temperature control, security system and access control.

BUTLERING GRANNY

Three new developments – described as "stand-alone" products – comprise a unique security lamp called ShadowGuard, which uses a variety of effects to create the illusion of occupancy, a revolutionary digital CCTV system, recording onto a computer hard disk, which includes a neighbourhood watch function, allowing householders to monitor each others' homes, and an "intelligent" wall socket. The latter can be switched on and off from anywhere in the world by touch-tone telephone.

Whilst the full-scale IntelliHome is designed to answer the needs of the very rich, the very busy and the very powerful, in its simpler version it could revolutionise many ordinary lives. Last year, Scottish Homes asked Charles Davidson's company to create a "Granny-friendly home" in a sheltered complex, and a major Sheltered Housing charity has asked for a pilot scheme for disabled people, which, if adopted, should allow many to live on in their own homes with the aid of the most helpful items of the new technology. Such schemes can be programmed according to individual requirements, and by the use of the fool-proof voice-activated system which any user can quickly understand.

What a Picture!



A FAMILIAR scenario for many electronic enthusiasts and small business: you're fed-up with trying to do CAD, DTP or graphics work on that 15-inch monitor, but cannot afford the dosh to get a larger one!

Well, there seems to be light at the end of the tunnel for you – Barry Eudall of BBA Ltd has developed a way of running Sparc Station monitors on a standard 486 or above PC, using any 1Mb or greater graphics card. Available in 17-inch and 20-inch versions, and costing just £225 and £325 respectively (plus VAT), these superb second-user monitors come with a three month return-to-base warranty.

Performance-wise, they will reach XVGA level, 0·26 dot pitch, 1024 × 768 resolution at 70 or 75 cycles in Windows 3.1, 95 or NT (all DOS applications must be run within Windows). It's a serious electronic designer's dream!

Furthermore, there is even a technical hot-line available to help you, should you experience any problems with installation.

So, give BBA a ring on 01664 482600 and give your eyesight a rest, with no more tunnel vision. Alternatively, write to BBA at 22 Granville Road, Melton Mowbray, Leicestershire LE13 0SN.

Internet Satellites

"SATELLITES have the potential to take the information superhighway to every corner of the globe," enthuses Science and Technology minister, Ian Taylor. "In the long run, they could make using the Internet faster and cheaper and enable it to be accessed from any point on the planet, no matter how remote."

Mr Taylor was commenting on the announcement of a programme to encourage industry to come up with new ways to deliver multimedia services via satellite. Under the Satellite Multimedia Applications Demonstration Programme (SMADP), which is being sponsored by the British National Space Centre (BNSC), consortia will be invited to put forward proposals on how to provide information technology services more efficiently.

"A frequent complaint from Internet users is how long it takes to locate the information they are looking for." We whole-heartedly agree!

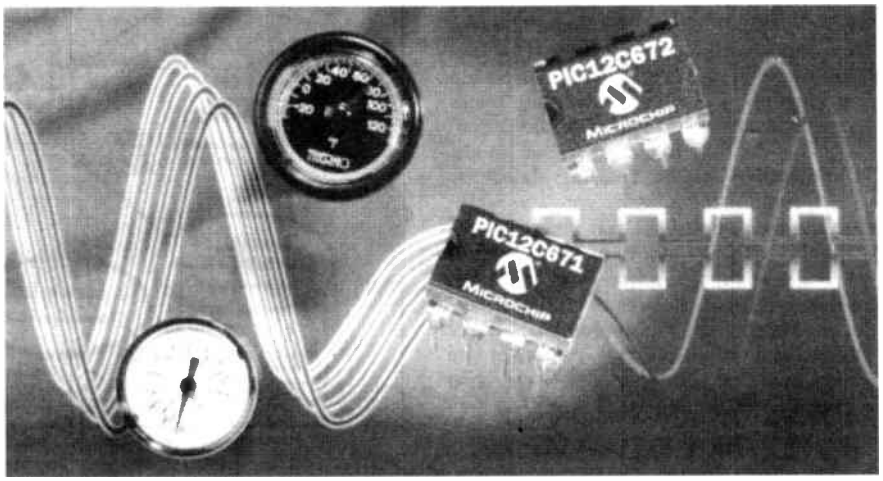
BIDDING-UP DIGITAL TV

IAN TAYLOR, Minister for Science and Technology has welcomed the substantial bids the Independent Television Commission has received for multiplex licences for digital terrestrial TV.

"The receipt of bids", he says, "marks a major step in our development of a new digital environment in the UK. The real commercial interest now evident gives the lie to all Jeremiahs and the prophets of doom who said that DTT would be of no commercial interest."

"It is now up to the ITC to select the winning bids and for the competition authorities to consider any issues arising out of those bids. Whatever the outcome, the future for Digital in the UK is one we can look forward to with confidence."

A new free telephone hot-line to up-date callers with details of information technology opportunities across the UK went live on 1st February. The hot-line – 0800 456 567 – is part of the government's *IT For All* campaign which is intended to take the mystery out of information technology and help banish technophobia in Britain by giving hands-on opportunities to see what IT can do. This commitment to technology is welcomed; all to often the opposite seems to have prevailed.

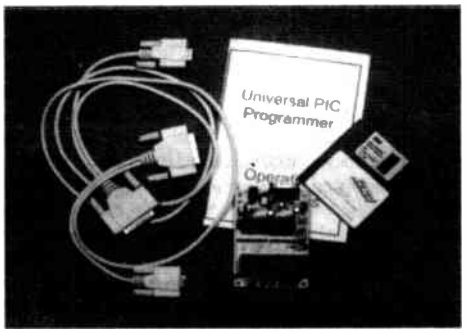


MINI PIC-CHIP

MICROCHIP'S revolutionary 8-pin microcontroller family – the world's smallest – now includes devices with advanced analogue-to-digital features. The PIC12C671 and PIC12C672 8-bit one-time-programmable (OTP) microcontrollers enable intelligent features to be integrated into mechanical designs. They will compete directly with 4-bit microcontrollers (yes, 4-bit technology still has its place), but offer significantly enhanced performance.

The advanced features include an on-chip ADC and two analogue channels. Respectively, the two chips have 1024 and 2048 words of program memory, plus 128 bytes of user RAM. They also provide six multiplexed I/O pins, 4MHz on-chip oscillator, 35 single-word instructions, and other usual features that you would expect to find on a PIC.

For more information, contact Arizona Microchip Technology Ltd., Unit 6, The Courtyard, Meadowbank, Furlong Road, Bourne End, Bucks, SI8 5AJ. Tel: 01628 851077. Fax 01628 850259.



KANDA MINI-PICS IT

KANDA System's Professional Universal PIC programmer will now program the new 8-pin 12C5xx series of microcontrollers. This is in addition to the 16C5x. 16C6x, 16C7x, 16C8x and 17C4x series (18-pin, 28-pin and 40-pin variants).

The intuitive windowed menu system allows access to all the processor features (unlike many low-cost units) and will work with code produced by any standard assembler or compiler, including C and Basic, and, Kanda tell us, MPASM and TASM as well.

This programmer normally retails for £169 but, for *EPE* readers, it is being offered at only £99 (excl. VAT), *and you will be given a free 8-pin processor.*

For further information on their range of products, contact Kanda Systems Ltd., Unit 11, Glanyravon Enterprise Park, Aberystwyth, SY23 9ZZ. Tel: 01974 282570. Fax 01974 282356. E-mail **Sales@Kanda-systems.com.**

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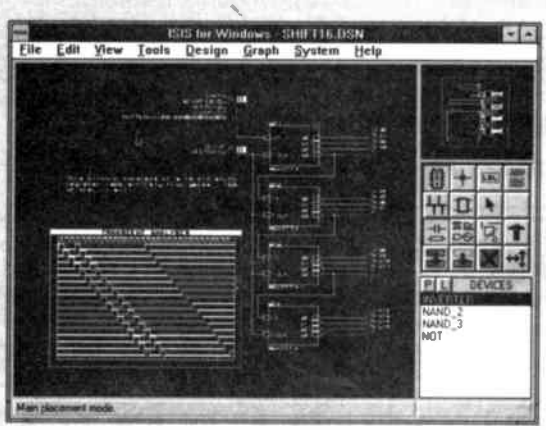

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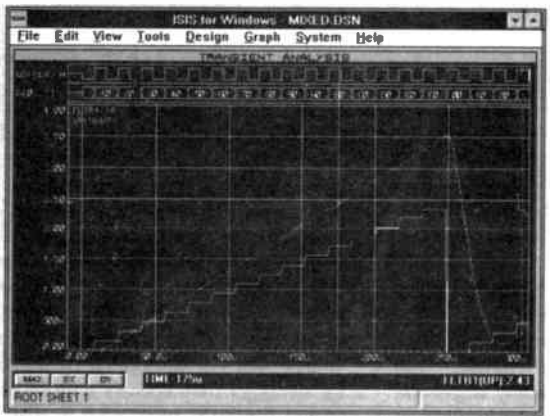

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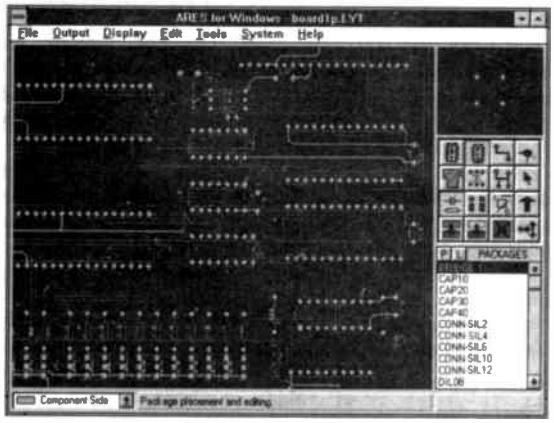

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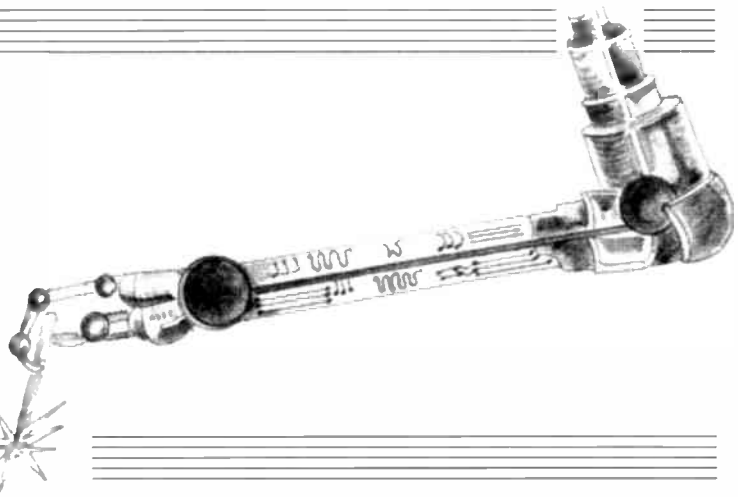


ALAN WINSTANLEY

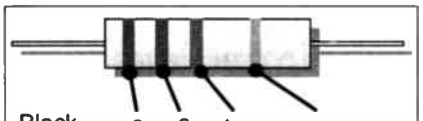
This month, the Readers' Help Desk manned by our regular 'Surgeon' helps with bizarre CMOS behaviour and takes resistors apart – literally!

Resistor Puzzle

OUR regular round-up of comments, queries and readers' questions starts with a puzzler concerning resistor types. We also get to grips with 4 and 5 band resistor codes. ***Jonathan Stott of Tamworth, Staffs.*** asks:

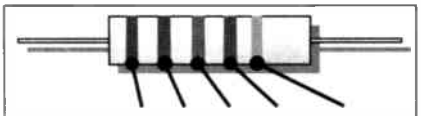
Dear Alan, I am 16 years old and enjoy making some of the projects in EPE. *A question recently arose which I hope you can help answer: what is the difference between carbon film and metal film resistors? One seems to be able to buy a wider range of resistances in metal film ranges. Is it all right to use metal film resistors even if carbon film types are specified in the Components List? Thanks for your help!*

Well Jonathan, **carbon film** resistors are the most popular choice because they offer a good balance between cost and performance. They are made by depositing a "carbon film" onto a ceramic body, which is then trimmed to the required ohmic value by cutting a spiral groove. They are a good, cheap and cheerful choice for most projects. Snip one in half and you will see the ceramic centre, coloured white; scrape off the surface paint and with luck you'll reveal the spiral resistance band underneath! Carbon film resistors are typically painted beige or brown and show four colour bands. The four-band code is straightforward and for the benefit of beginners it is shown in Fig. 1.



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%

Fig. 1. Four-band resistor code example: yellow-violet-orange-gold = 47,000 ohms (47k) 5%.



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

Fig. 2. Five-band resistor code example: yellow-violet-black-red-brown = 47,000 (47k) 1%.

Metal film are superior to carbon types because an alloy film is deposited as the resistive material. This produces a high stability resistor with low "noise" and close tolerance, but this is only important in sensitive circuits and the improvement will not be at all noticeable in most projects. Metal film resistors are typically coloured blue or grey and will have five colour bands to represent the resistor value. The five band code is given in Fig. 2.

See how four bands are used to determine the code whilst a fifth band is the tolerance. Note that Maplin's "Min Res" metal film 0·6 watt resistors are 1% tolerance, but the ordinary four-band code usually applies, they say, and if a fifth (red) band is shown, this may be an indicator of the resistor's *temperature coefficient* (see later), not the tolerance. Confusing!

Being Tolerant

The tolerance of a resistor is an indication of its accuracy. A 100 ohm 5% resistor could in practice be anything between 95 to 105 ohms. As far as the resistor values themselves are concerned, these are grouped into **preferred values** and most *EPE* constructional projects use the **E12** range, the most basic and widely available set of values used. These are based on 1, 1·2, 1·5, 1·8, 2·2, 2·7, 3·3, 3·9, 4·7, 5·6, 6·8 and 8·2 and their multipliers (100 ohms, 1·0 kilohms, 10 kilohms, etc.). Sometimes, "unusual" resistor values crop in circuits which are not of the E12 preferred range, and this worries novices who are unaccustomed to such peculiar values. For instance, you may see a *200 ohm* resistor rather than a more customary *220 ohm* (E12) value.

Fear not. The reason is often that the circuit designer may well be a professional or advanced constructor who simply works with the E24 preferred range! At his disposal he will have the following **E24** values: 1, 1·1, 1·2, 1·3, 1·5, 1·6, 1·8, 2·0, 2·2, 2·4, 2·7, 3·0, 3·3, 3·6, 3·9, 4·3, 4·7, 5·1, 5·6, 6·2, 6·8, 7·5, 8·2, and 9·1. Note the extra values available! So he may well have picked a 200 ohm resistor simply because that's what was around at the time.

In some cases (perhaps it's part of a voltage reference or biasing network), the resistor value is critical and will have been chosen for a specific reason. Such resistor values may be highlighted by the fact that the designer may specify a close tolerance (metal film) 1% type, so it is then best to stick with that value and not stray from the published design.

As often than not, though, you can substitute a near-value resistor (220 ohms, say) and in many examples this will not make any difference to your circuit. Don't be put off by those "funny" values which you may see from time to time, but check to see if there is a particular reason why such a part was specified in the design.

There are also even wider ranges of resistors available in the **E48** (48 values) and **E96** (96 values) ranges, which are only of interest to professionals and circuit developers. The far greater number of values available implies that closer tolerances are required, and metal film technology is therefore more appropriate, that's why there are seemingly more metal film than carbon film resistors on sale. For the technically orientated, British Standard BS 2488: 1966 (equivalent to IEC 63) is the *Schedule of preferred numbers for the resistance of resistors and the capacitance of capacitors for telecommunications equipment*. Yes, the same scheme of preferred values applies to capacitors, too.

Other factors which a designer would sometimes take into account include the "tempco" – **temperature co-efficient** – an indication of how much the value is likely to drift up or down when the temperature changes. This is expressed in terms of parts per million (ppm) per °C, and metal film resistors offer superior performance in this respect (50ppm compared with 200-500ppm for carbon film types). There is an excellent reference to this and those "E" values in the book *Newnes "Electronics Toolkit"* by Geoff Phillips (ISBN 0-7506-0929-X), which is a handy source of data.

To answer your final question, there is technically nothing to be gained by using metal film resistors if carbon film are specified in Components Lists. When funds are restricted, I recommend gradually building up a "resistor kit" – 5% 0·25W carbon film resistors are perfectly adequate for hobbyists' needs – perhaps purchasing ten or twenty of some of the most popular values each time you place an order. I simply store them in re-sealable poly bags, with a large bag holding each E12 value (as listed earlier), and smaller bags within containing the resistors themselves.

Internet users may be interested in two freeware resistor colour code programs available from our FTP site at **ftp://ftp.epemag.wimborne.co.uk/pub/software. Resistor.zip** is a simple, neat 3-colour code display – type in the value to see the colours, or click to select a colour and see the resistance value computed. **Rescalc.zip** deals with 5-colour band types. Both programs run under Windows 3.x or Windows 95.

For readers who do not have Internet access, we can provide both these freeware files on an IBM-PC floppy disk for the sum of £2·50 (UK) which covers copying, mailing, postage and handling.

Redundant Pins Become Static-prone

An avid *"Ingenuity Unlimited"* contributor, the ***Rev. Thos. Scarborough*** of Cape Town, South Africa asks several questions in a recent letter: *"Why should unused pins of i.c.s be tied high or low, and what are the consequences of failing to do so?"* And another similar question cropped up in an Internet newsgroup recently:

"I'm just getting into electronics, and was working on a project when I noticed that my NAND gate (2-input quad 4011 CMOS chip) was not working properly. To test it out, I wired a basic circuit where one input always had power, and the other is connected to power via a pushswitch. The output was connected to an l.e.d. Theoretically, the l.e.d. should stay on unless the button is pressed. It sort of did this, but when I released the button, it remained off. I also noticed it would come back on again if I gently tapped the circuit."

CMOS technology was originally known as COS/MOS (Complementary-Symmetry Metal-Oxide Semiconductor) and was pioneered at the RCA Laboratories in Princeton, New Jersey in the early 1960s. RCA Solid State announced the first commercial COS/MOS series in 1968, nearly thirty years ago.

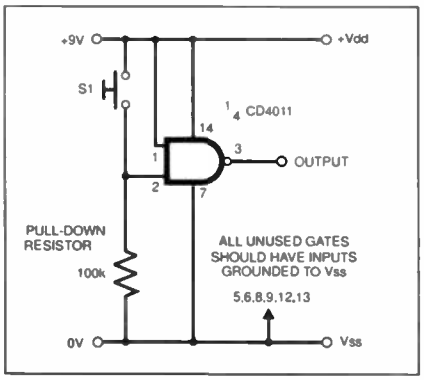


Fig. 3. A pull-down resistor is essential to prevent the input (pin 2) from "floating".

RCA utilised new on-chip *complementary p*-channel and *n*-channel MOS "transistors" in their new COS/MOS gates. These transistors are perhaps better thought of as "capacitors" since they are formed from an extremely thin sandwich of metal oxide and i.c. substrate acting as capacitor "plates", separated by a dielectric of silicon dioxide. The device works by transferring *charge* between the gate's internal CMOS "capacitors". Unlike a bipolar device, no noticeable input current flows, and instead the gate is purely voltage controlled.

Consequently, the MOS transistors are formed using extremely thin layers of oxide which are highly prone to damage by static electricity discharges. CMOS gates have a very high input impedance (10^{12} ohms or more) and contain an input-protection circuit consisting of a diode network which (one hopes) will shunt away any excess voltages created through the accumulation of static, or the application of excessive signal voltages or noise.

However, it's easy for a human body to acquire a charge of 10-20,000eV (electron volts) purely by walking on a nylon carpet, and this is sufficient to destroy a CMOS device if you discharge yourself into the chip. Hence we pin our hopes on anti-static precautions (wrist straps, etc.) and we hope that those built-in diodes will catch anything else; in fact the diodes provide protection up to about 4kV, less on older devices.

When building circuits which contain CMOS logic, it is best to ground any unused pins to 0V (V_{ss}). This equally applies to the input pins of *unused gates*. Failure to do so can force the CMOS transistors to move into their linear region, rather than acting as simple on-off switches. This causes larger currents to flow and results in faulty or erratic operation of the gate, or possibly the entire chip.

Our anonymous Internet friend also made the subtle mistake of keeping an input pin "floating" or unconnected to anything. A **pull-up** or **pull-down** resistor should always be used on CMOS inputs to prevent the CMOS transistors from partly conducting. In this example, he should hook a pull-down resistor, say 100k or so, between the pin and V_{ss}, remembering that the switch itself is connected to the input pin and positive rail ($+V_{dd}$). The resistor biases the pin to one supply rail or the other, see Fig. 3.

The very act of "tapping" the chip with a finger may have contributed to the CMOS gate's bizarre behaviour because he may have introduced further static or helped to shunt some of it away. I have witnessed odd behaviour with a counter chip which would display a seven-segment figure randomly when a finger was placed nearby. The cause was static accumulation on some unused pins of the counter!

With bipolar devices, it perhaps isn't compulsory to use biasing resistors but in many situations it is a wise precaution as it helps the stability of the circuit. The 555 timer shown in Fig. 4 has pull-up resistors on the trigger and reset pins, to prevent erratic operation.

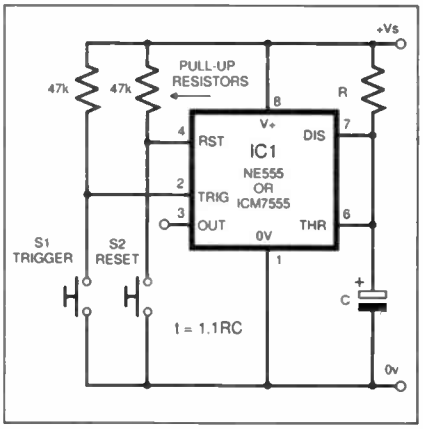


Fig. 4. Pull-up resistors are used to bias the trigger and reset pins to the positive rail.

If you have any questions 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.** We cannot guarantee a personal reply but will endeavour to offer help where possible.

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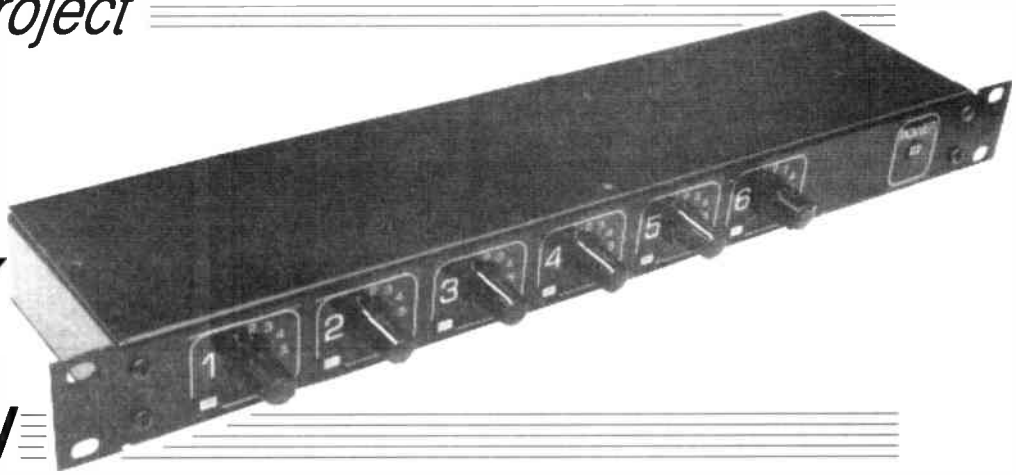
Constructional Project

MIDI MATRIX



NEIL JOHNSON

Eliminate the hassle of constantly replugging your MIDI gear with this six-channel switching unit.

MODERN electronic music systems rely on the Musical Instrument Digital Interface (MIDI) to connect together synthesizers, drum machines and computers. Unfortunately, even the most basic amateur electronic music system requires a reasonable amount of MIDI cabling. Before long, the swapping of MIDI cables between units results in a spaghetti jumble of cables and plugs.

The MIDI Matrix was designed to solve the cable swapping problem, using the "telephone exchange" principle – lots of signals coming in, lots of signals going out, and just a few switches providing interconnections between the two in any configuration required.

This project is aimed at any electronic musician, amateur or professional, who has even the remotest need to frequently change MIDI cabling arrangements. Once all your MIDI signals are connected to this unit you can forget about rummaging around the back of your synthesizers and modules to change your leads – with a twist of a switch, this unit can alter your MIDI layout *instantly*.

SYSTEM CONFIGURATION

The MIDI Matrix is built from two basic modules: a MIDI Interface module and a Power Supply Unit (PSU). The block diagram of the basic layout of the MIDI Matrix is shown in Fig. 1.

The MIDI Interface modules provide the interface between the MIDI signals and the internal electronics, transferring the MIDI signal onto one of the internal data channels. The actual signalling system used by MIDI is a type known as a current loop. Data is sent in a serial stream, similar to the common RS-232 system used by computers and terminals, using a current of 5mA to represent 0 and no current to represent 1.

The reason for this rather ancient system (current loops originated back in the days of mechanical teletypewriters) is that the standard MIDI Input circuitry must use an opto-isolator to provide electrical isolation between the transmitter and the receiver, a current of 5mA being sufficient to drive most common opto-isolators.

The purpose of the opto-isolator is to provide galvanic isolation: no direct electrical connection between the sender and receiver. This feature has two important properties, namely, electrical safety and improved noise immunity.

Of most interest to the musician is the second property – noise. Noise will get into an electrical system any way it can, and one subtle entry route is through an earth loop. As its name suggests, this is a loop of wire which is supposedly at earth potential. However, upon closer inspection you will find that the cable is joined to earth at only two points – its ends (see Fig. 2).

That earth wire loop forms a rather nice inductive loop antenna, liable to pick up all sorts of noise – mains hum, audio signals, radio signals, noisy electric motors – which will find its way into the audio signal path and ultimately into the recording equipment.

By placing an electrical barrier at the MIDI Input, we break this earth loop and prevent any induced noise finding its way, via the MIDI Matrix, into a synthesizer or mixer. It would be particularly disastrous, for example, if noise found its way into your mixer, where it would ruin your carefully crafted audio masterpiece.

Another reason for trying to keep out noise is that it could, if sufficiently strong, disrupt the MIDI data. This would cause data errors, interfering with the information between MIDI units. The effect of this would depend on what was happening at the time of the disruption. For instance, you have just waited five minutes for a long sample to download into your sampler; when the transfer process suddenly stops, the sampler says the data is corrupt and would you like to "Try Again (Yes/No/Abort) ?"

Alternatively, you could be centre-stage playing your lead solo when, just as you reach the crescendo, a blip in the MIDI data signals your synthesizer to stop what it is doing and retune itself, leaving you looking like a lemon under the stage lights.

The subject of safety cannot be overstressed, especially when dealing with some musicians who seem to have a very cavalier attitude towards electricity. There are many tales of musicians who have been killed through very dodgy mains earthing circuits – one poor chap did not

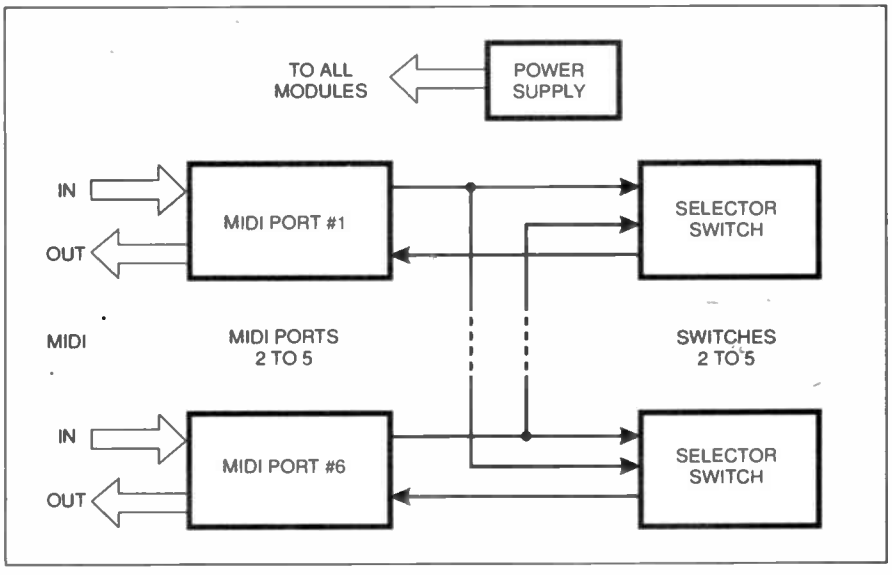


Fig. 1. Block diagram for the MIDI Matrix.

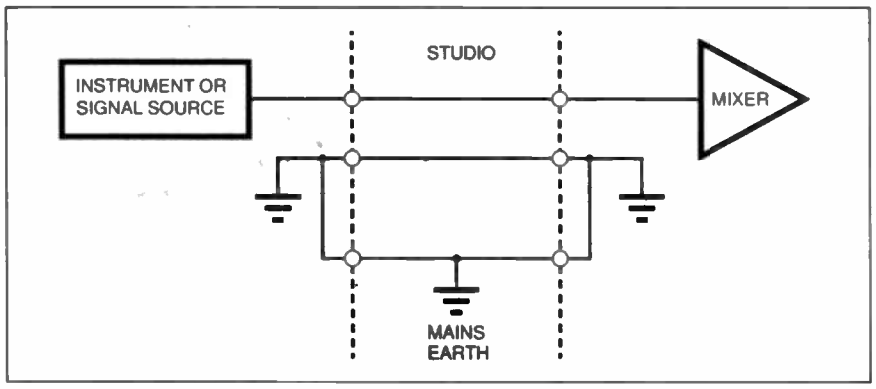


Fig. 2. Un-isolated connections between two units can create an undesirable earth loop.

realise his electric guitar was actually at mains voltage until he completed the circuit to earth through an earthed metal microphone body ...RIP

The opto-isolator specified for the MIDI Matrix has an isolation voltage rating of 2500V r.m.s., more than sufficient to block mains voltage. In the worst case, where one of the MIDI wires found itself at mains potential, the only damage to occur would be to the l.e.d. (light emitting diode) in the opto-isolator – much easier to replace a small lump of plastic than rewire a previously living, breathing musician.

Rotary Selector switches select the data channel routings. Each switch is connected to its own MIDI Out interface and can select any one of the available MIDI Input channels.

Finally, the PSU provides power at +5 volts for the complete system. For design simplicity and safety, a ready-made mains PSU module is used, together with an l.e.d. to provide power indication. No provision has been made for a power switch for two reasons, simplicity and safety (fewer components and no internal wiring at mains potential) since the MIDI Matrix will be required whenever the MIDI system is going to be used. The mains plug, of course, must be fitted with a suitably rated fuse.

HOW IT WORKS

The circuit diagram for the MIDI Interface module is shown in Fig. 3. Current flows into socket SK1, through resistor R1 and the l.e.d. in opto-isolator IC1, and back out through SK1 again. Diode D1 protects IC1 against accidental reverse connection.

When current passes through the internal l.e.d. of IC1, it shines on the light-sensitive base of a high gain transistor, and turns it on. The output of IC1 is the open collector of a second booster transistor, which is pulled high by resistor R2 when in the *off* state. The resulting digital signal is sent off-board to the Selector modules.

Resistor R3 provides a drain for the leakage current of the light-sensitive transistor, reducing the switching time of the device.

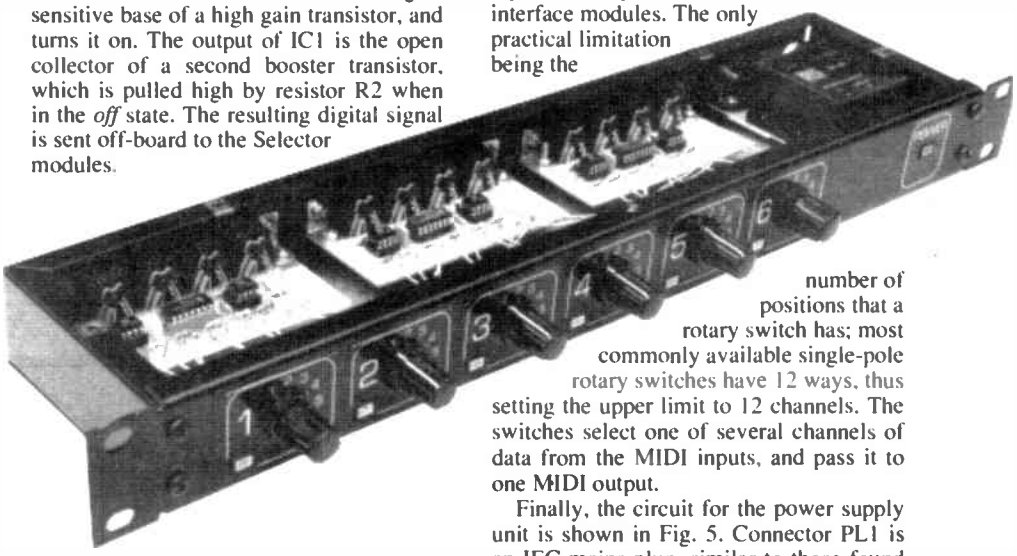
Returning signals are fed into a simple booster amplifier based on two of the inverters, IC2c and IC2d, within the hex Schmitt inverter package of IC2. Resistor R4 pulls the input high when no input signal is present, while resistors R5 and R6 complete the 5mA current loop.

Assuming a 1·7 volt drop across the receiver l.e.d. within IC1, the current flow will be:

$$I = (5 - 1{\cdot}7) / (3 \times 220) = 5\text{mA}$$

The third inverter, IC2e, together with resistor R7 and l.e.d. D2, indicate to the user whenever MIDI data passes through the output. This seemingly simple addition can save many a headache while running a MIDI system (thus speaks painful experience!).

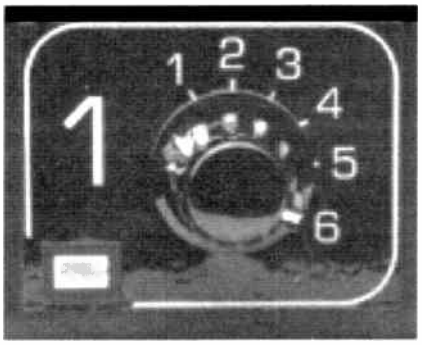
As shown in Fig. 4, the Selector switches, S1 to S6, are of the break-before-make rotary type. Although this article describes a unit with only six inputs, it is possible to add more MIDI interface modules. The only practical limitation being the number of positions that a rotary switch has; most commonly available single-pole rotary switches have 12 ways, thus setting the upper limit to 12 channels. The switches select one of several channels of data from the MIDI inputs, and pass it to one MIDI output.



Finally, the circuit for the power supply unit is shown in Fig. 5. Connector PL1 is an IEC mains plug, similar to those found on the back of computers and most professional electronic equipment. This feeds mains power directly into the PSU module. Indication of power is provided by l.e.d. D3, which is in series with current limiting resistor R8.

CONSTRUCTION

Ease of construction has been a main aim when designing this project. Virtually all of the components are mounted on printed circuit boards (p.c.b.s), with very minimal inter-board wiring. To reduce the



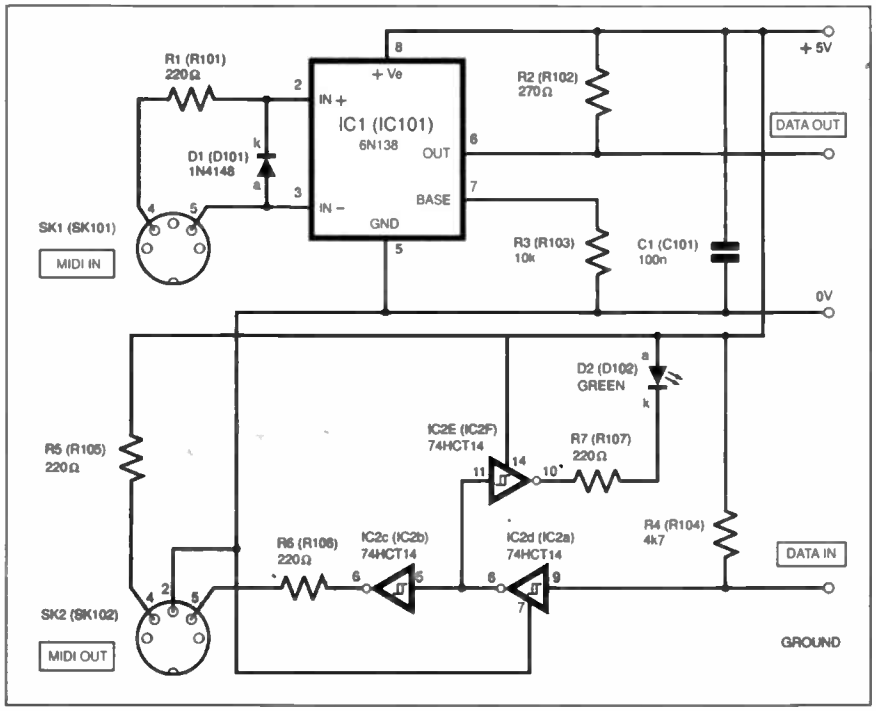


Fig. 3. MIDI Interface circuit diagram.

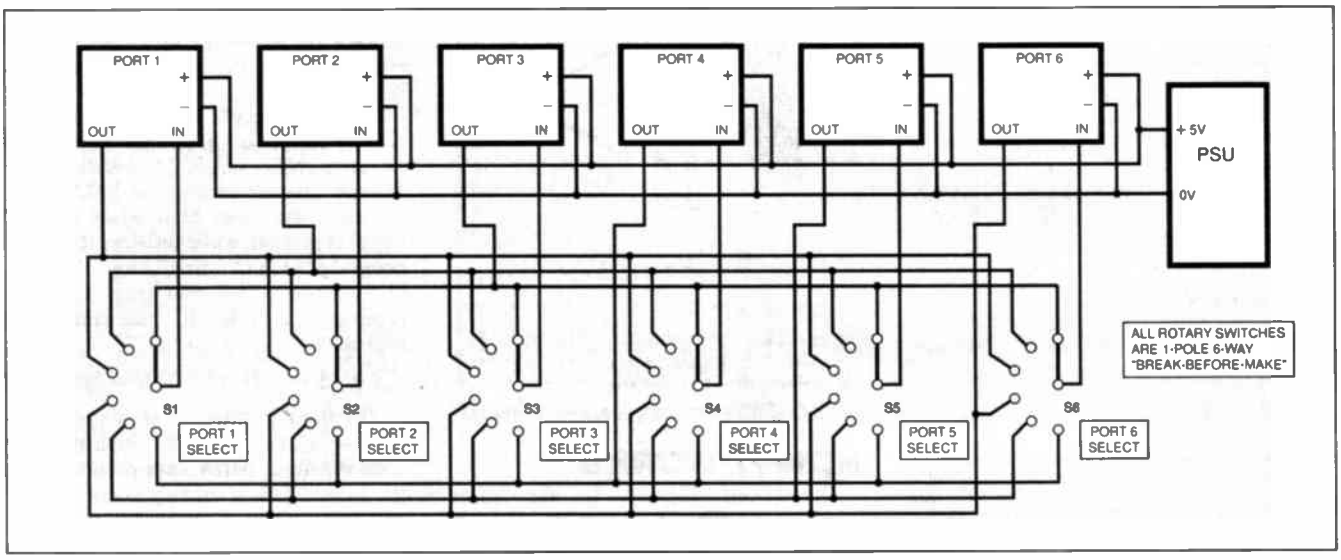


Fig. 4. Details of how the six ports are switched.

number of p.c.b.s and wiring, two complete channels are incorporated on each MIDI interface board. The boards are available from the *EPE PCB Service*, codes 147 (PSU) and 148 (Interface).

We will start by describing assembly of the PSU board, followed by the MIDI Interface board.

The PSU board is probably the simplest design you will ever come across for a mains PSU, there being only three components mounted on the board itself, as shown in Fig. 6. You only need one copy of this board. Start assembly with resistor R8, plug PL1 and then the PSU module itself. If you are going to use p.c.b. pins for the off-board terminations, they should be inserted after R8.

CAUTION: Hazardous mains voltages are present on the PSU board. Construction and assembly of this part of the project should only be done by experienced constructors. If you are in any doubt about the safety of your circuit, get it checked by a qualified electrician.

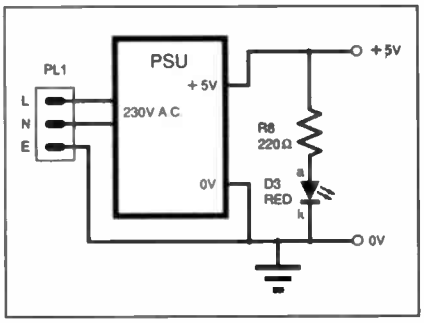


Fig. 5. Power Supply Details.

COMPONENTS

Resistors

NOTE: Quantites shown for control module p.c.b. mounted components are for one module only.

R1, R5 to R7, R101, R105 to R107	220Ω (8 off)
R2, R102	270Ω (2 off)
R3, R103	10k (2 off)
R4, R104	4k7 (2 off)
R8	270Ω

All 0·25W 5% carbon or better.

Capacitor

C1, C101	100n polyester (2 off)

See SHOP TALK Page

Semiconductors

D1, D101	1N4148 signal diode (2 off)
D2, D102	green l.e.d. (2 off)
D3	red l.e.d.
IC1, IC101	6N138 or 6N139 opto-isolator (2 off)
IC2	74HCT14 hex Schmitt inverter

Miscellaneous

PL1	IEC mains plug, right-angle, p.c.b. mounting
S1 to S6	1-pole 6-way rotary switch, break-before-make (6 off)
SK1, SK2, SK101, SK102	5-pin DIN socket, p.c.b. mounting (2 off)

Printed circuit boards, available from the *EPE PCB Service*, codes 147 (PSU – 1 off), 148 (Interface – 3 off); power supply module, mains powered, 5V d.c. 1W regulated output (see Shop Talk); case, 19-inch rack-mounting, 1/2U height; metal bracket; wire; solder, etc.

Approx Cost Guidance Only **£49** ***excl. case***

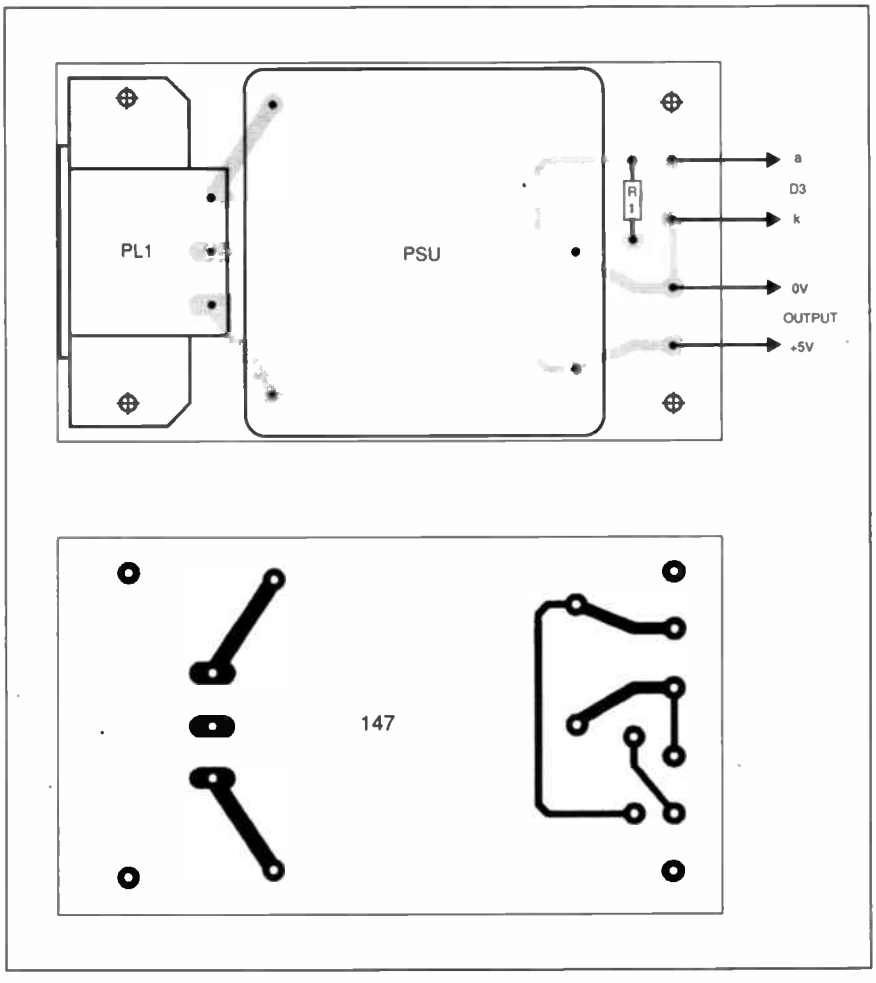


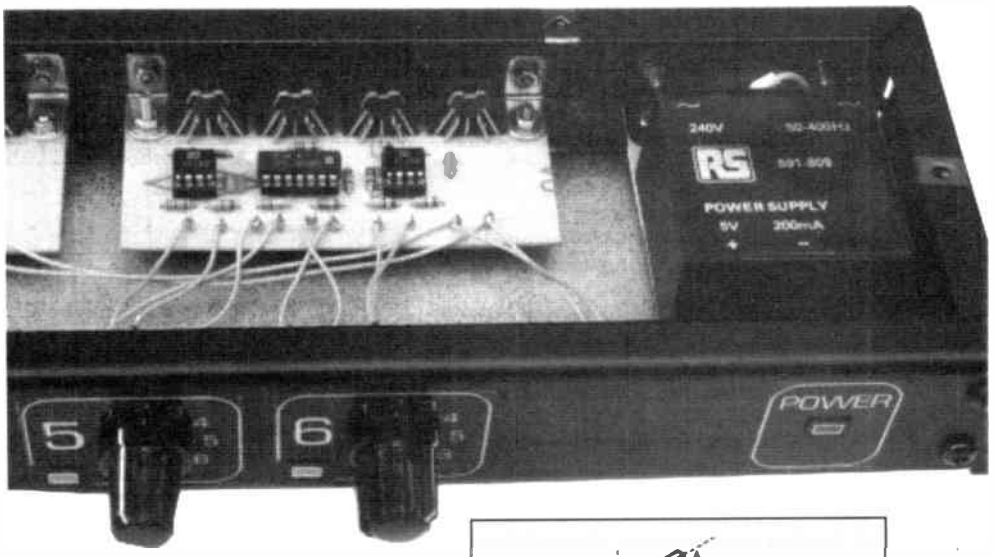
Fig. 6. Printed circuit board details for the power supply.

Two mounting holes are included on the board to secure it to the plug PL1 – *do not rely on the three solder joints to hold the board to this connector.*

Check the solder joints before gluing the cover to the board as shown in Fig. 7. This cover must be made of non-conducting material, such as acrylic (Perspex), SRBP, or fibre-glass sheet, and ensures that there is plenty of isolation distance between parts at mains voltage and the case.

Assembly details for the MIDI Interface board are shown in Fig. 8. You need one of these boards for each pair of Interface circuits, i.e. three for a 6-channel unit. Start with the d.i.l. (dual-in-line) sockets, then follow with the diodes, resistors and capacitor. Note that component numbers for the second channel, except for C1 and IC2, are prefixed by "10"; for example R1 becomes R101, D1 becomes D101, etc.

The group of four DIN sockets (SK1, SK2, SK101 and SK102) are designed to slot together to form one block of connectors. Insert them carefully into the board and solder in place, taking care to get the mating grooves properly overlapping.



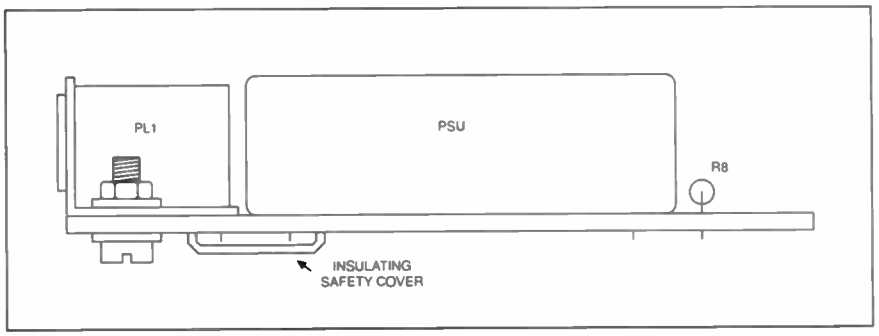


Fig. 7. Showing where the insulating cover is used on the power supply module.

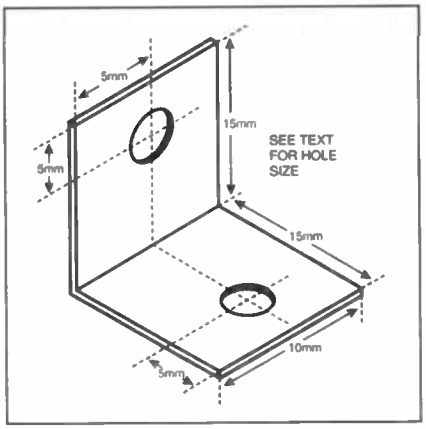


Fig. 9. Details of one of the mounting brackets.

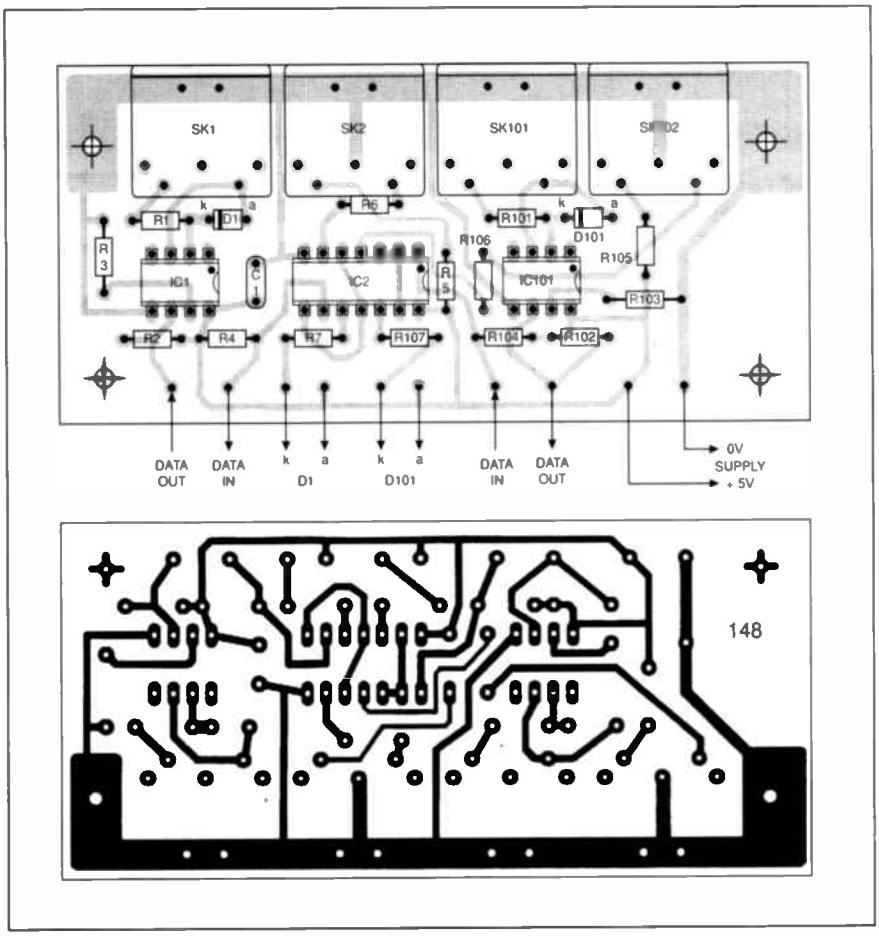


Fig. 8. Printed circuit board details for one dual-port control module.

CASE DETAILS

The last stage of construction is to drill and assemble the case, and connect the boards together.

Simplicity has again been a major influence in the choice of the case. By using a flat-pack 19-inch rack case, only two panels require holes to be drilled in them – the front and rear panels. The layout details and control legends can be seen in the photographs.

The front panel requires thirteen holes: six for the Selector switches, six for corresponding MIDI indicator l.e.d.s, and one for the power indicator l.e.d. The rear panel is slightly more complicated with 21 holes being required. Drill the holes to allow enough clearance for the l.e.d. clips and switch-mounting nuts.

The four modules – PSU and three MIDI Interface modules – can be mounted on the rear panel using 4BA screws. As stated, the MIDI Interface modules require small metal brackets to attach them perpendicular to the rear panel using 4BA or M3 nuts and bolts as appropriate.

The PSU requires particular attention since there are dangerous mains voltages present. The following assembly details should be followed to ensure your safety.

The last parts to fix to the board are the two mounting brackets at each end. These are small metal brackets with holes suitable for 4BA bolts (or M3·5 if you prefer metric). Dimensions are shown in Fig. 9.

The practical upshot of most of it is "Earth any metal which you can touch".

Begin by fixing the PSU to the back panel with two M3 screws. Then connect a piece of stout, insulated wire between the earth terminal on the mains connector (PL1) and an earth tag fixed to one of the mounting bolts. Use wire of grade 19/0·2 (19 strands of 0·2mm diameter) or greater, since in the case of a short-circuit, this wire must carry the full rupture current of the mains fuse.

The mains cable should be terminated at one end in an approved mains plug and an IEC socket at the other end. It is recommended that a ready-made cable with moulded plugs is used, since this obviates the need for any mains wiring at all. The mains plug should be fitted with a 3-amp rated fuse, sufficient to protect the cable.

Proceed with mounting the front panel and the rear panel. On one of the mounting screws place an earth tag between the front panel and the rear panel. Again using insulated stout wire, connect this to the earth terminal on PL1. Make up two more earth straps, one each for the top and bottom panels, long enough to reach the mounting screw holes.

Wiring up of the unit is fairly straightforward, and consists mostly of wires going between the MIDI Interface modules and the front panel. Begin with the wiring from the PSU module, including the front panel indicator, and daisy-chain the power leads from one MIDI Interface module to another.

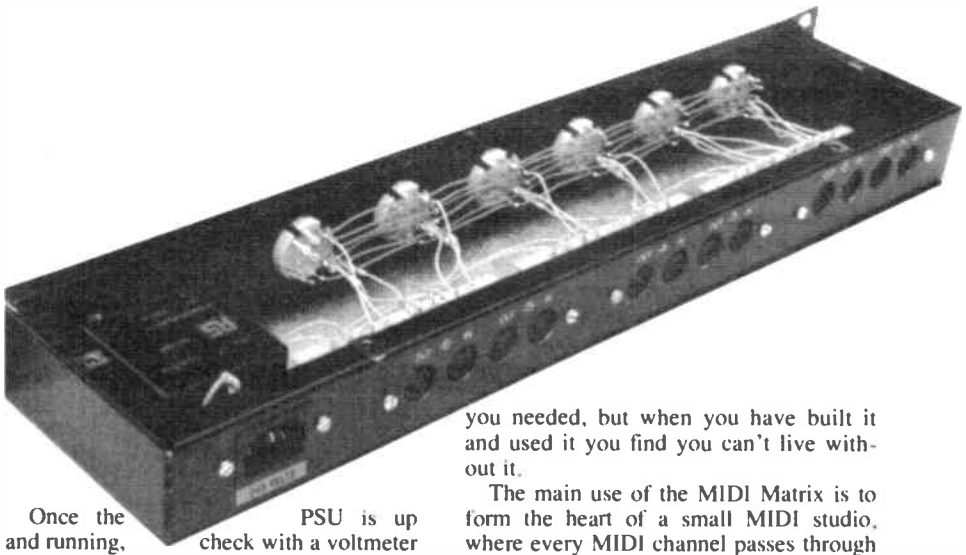
The wiring of the Selector switches consists of connecting together all the common terminals of the switches. This is best done with short lengths of PVC-covered solid-core wire. This is a slightly tedious job, there being thirty interconnections to be made. However, in practice, the repetitive pattern of interconnections helps identify any wiring errors that may occur.

The final wiring required is that between the MIDI Interface modules and the front panel l.e.d.s and Selector switches. This should be done with lengths of stranded wire, typically 7/0·2mm (seven strands, 0·2mm in diameter) or similar. Be careful to connect the l.e.d.s the correct way round. Should you accidentally get your wires crossed no harm will come to the l.e.d., but you could spend ages wondering why no MIDI data seems to be getting through!

The last task is to fit the top and bottom panels of the case. These slide on and are retained by the small screws supplied with the case.

TESTING

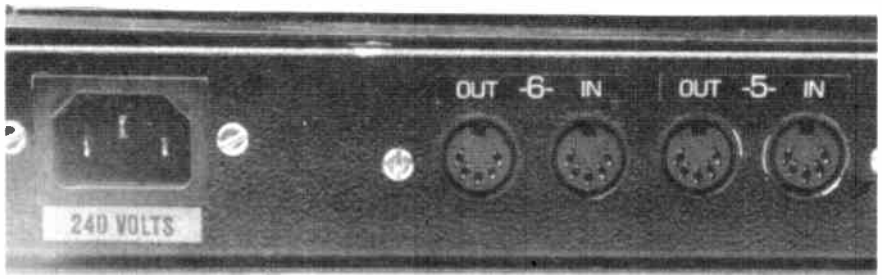
The first step in testing is to check the mains PSU. As has been clearly stated above: **take care!**



Once the PSU is up and running, check with a voltmeter that there are no voltages present on any of the inputs.

Likewise, check the outputs for any signs of untoward voltages. Operation can be quickly checked by pushing a low current l.e.d. directly into the holes of the DIN socket – cathode (k) into pin 5 and the anode (a) into pin 4. If all is okay, the l.e.d. should *not* light.

Now for the fun bit. Connect up a keyboard to one of the MIDI inputs and a synthesizer to one of the MIDI outputs. Turn everything on, select the appropriate input on the MIDI Matrix, and play a few notes. The data l.e.d. on the MIDI Matrix should flash and your synth should squawk, zzimm, boom, or whatever.



After repeating this test for the other inputs and outputs, you should now have a fully working MIDI Matrix. All that remains is to fit the unit into your studio, connect all your MIDI devices to it, and away you go, switching to your heart's desires.

As for setting up, there is none. It's just an excuse to go and have a nice cup of tea; if anyone asks you what you're doing, you can say something along the lines of "waiting for the unit to reach thermal equilibrium" (let the tea brew) before you make adjustments (add milk and sugar) to the main data switching module (get biscuit from tin), oh, and the tea's nice.

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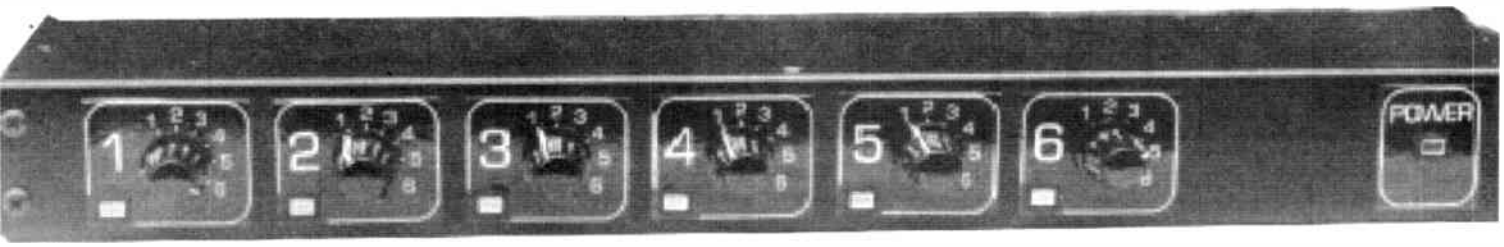

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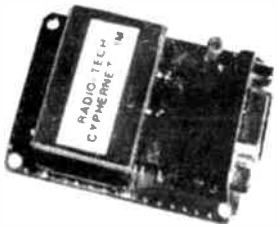

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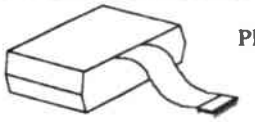

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INTERFACE

Robert Penfold

FREQUENCY SYNTHESISER USING A P.L.L. AND DIVIDE-BY-N COUNTER

Last month's *Interface* article dealt with precise frequency generation using a crystal oscillator and a programmable divider chain. This method is very simple, but gives non-linear scaling. At the high end of the frequency range the output frequencies are well spread out. At the low frequency end of the range the resolution is much finer.

For some applications it is more than a little helpful to have a constant increment from one frequency to the next. This can be achieved using a standard frequency synthesis technique which utilizes a p.l.l. (phase locked loop).

With this method a crystal oscillator and divider chain produce a low frequency clock signal. The divide-by-N and p.l.l. circuits then multiply this frequency by the required factor. For example, using a clock frequency of 1kHz (kilohertz), divisions of two, three, and four through the divide-by-N counter would give output frequencies of 2kHz, 3kHz, and 4kHz.

Locking Phasers

A p.l.l. is essentially quite simple, and uses the arrangement shown in the upper block diagram of Fig.1. The input signal is fed to one input of a phase comparator, and the output of a v.c.o. (voltage controlled oscillator) is fed to the comparator's other input. The output of the comparator drives the control input of the v.c.o. via a lowpass filter.

The output from the comparator is a pulse signal, but the lowpass filter smooths the pulses to produce a d.c. control voltage for the v.c.o. The d.c. control voltage is equal to the average output voltage from the phase comparator.

If the input frequency is at a lower frequency than the v.c.o., the average output voltage from the phase comparator is very low, and the v.c.o.'s output frequency is reduced. If the input frequency is higher than the v.c.o.'s frequency, the average output potential from the comparator is high, and the v.c.o.'s operating frequency is increased. This gives a form of negative feedback loop. Provided the input frequency is within the operating range of the v.c.o., the v.c.o. will be maintained at the same frequency as the input signal, and in phase with it.

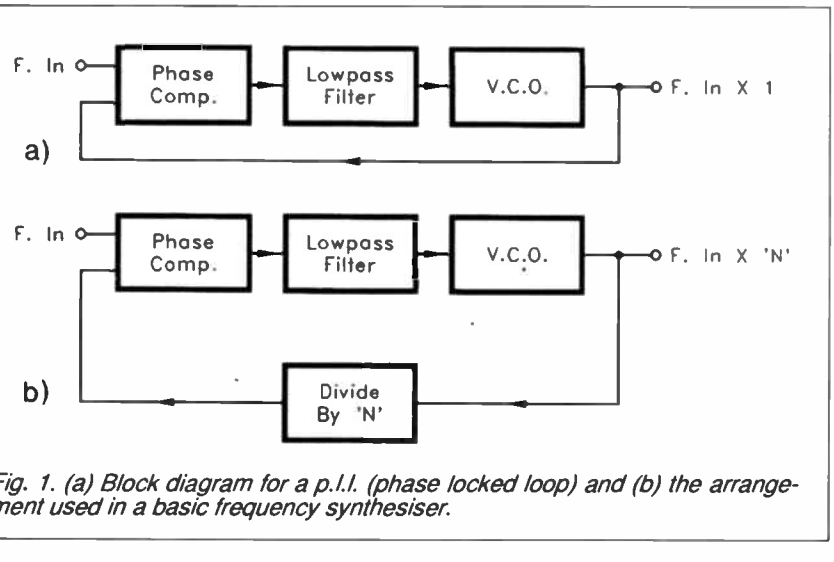

Fig. 1. (a) Block diagram for a p.l.l. (phase locked loop) and (b) the arrangement used in a basic frequency synthesiser.

A basic frequency synthesiser consists of a p.l.l. with a divide-by-N circuit added between the v.c.o. and the phase comparator (see the lower block diagram of Fig.1). This operates in much the same way as an ordinary p.l.l., with the two input signals to the phase comparator being maintained at the same frequency and in-phase.

However, the v.c.o. has to operate at a higher frequency in order to achieve this. If there is a division by ten through the divider circuit, the v.c.o. has to operate at ten times the input frequency. Provided the limits of the v.c.o. are not exceeded, the output frequency is equal to the input frequency multiplied by the division rate through the divide-by-N circuit.

Stepping Up

A block diagram for an experimental frequency synthesiser, based on the divide-by-N circuit described in last month's *Interface*, is shown in Fig. 2. A 4MHz crystal oscillator generates an accurate clock signal which is processed by a divide-by-eight counter, and a chain of four

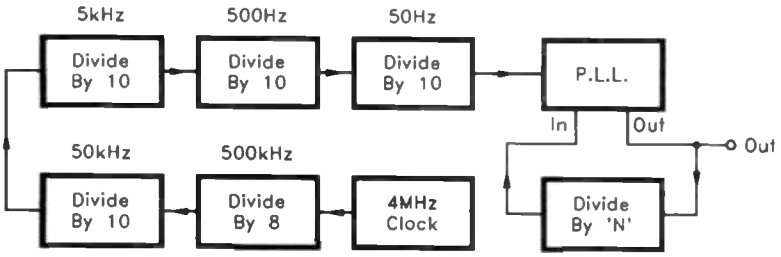

Fig. 2. Block diagram for the basic Frequency Synthesiser.

divide-by-10 counters. This gives a final clock frequency of 50Hz, which is fed to the input of the p.l.l.

The divide-by-N counter is connected between the p.l.l.'s v.c.o. output and phase comparator input. The output frequency from the v.c.o. is therefore equal to 50Hz multiplied by the division rate through the divide-by-N circuit.

The programmable divider must include the divide-by-two stage at its output, because the p.l.l. cannot lock onto the short pulse signal produced by the 74HC161 when large division rates are used. The flip/flop produces an accurate squarewave signal that is ideal for the p.l.l., but it does of course increase the minimum division rate from two to four.

The divider therefore covers a range of four to 482, rather than two to 241. This gives a theoretical output frequency range of 200Hz (50Hz×4) to 24·1kHz with a resolution of 100Hz.

On the face of it, the resolution should be 50Hz (i.e. equal to the final clock frequency). The reason for the inferior resolution is the divide-by-two flip/flop at the output of the divide-by-N counter.

Setting division rates of two, three, and four through the main divide-by-N circuit gives overall division rates of four, six, and eight. Divisions by odd numbers are not possible, giving a resolution of 100Hz instead of 50Hz. On the plus side, the maximum output frequency is doubled, and the inclusion of the flip/flop does not reduce the number of output frequencies available.

Frequency Synthesiser

The circuit diagram for the Divide-by-N Counter appears in Fig.3, and this is basically the same programmable divider circuit described previously, but with the oscillator stage omitted. Refer to last month's *EPE* for a full description of this circuit.

The circuit diagram for the clock and p.l.l. stages of the Frequency Synthesiser is shown in Fig. 4. Transistor TR1 is used in a conventional crystal oscillator which generates a 4MHz output signal. This is fed to the clock input of a seven stage binary "ripple" counter (IC1). In this circuit only the first three stages of IC1 are used, giving a divide-by-eight action and an output frequency of 500kHz.

Note that an ordinary 4024B" is *not* likely to work properly with a five volt supply and an input frequency of 4MHz. Its guaranteed maximum clock frequency with a five volt supply is just 2·5MHz. IC1 *must* therefore be a 74HC4024, which will operate at up to 70MHz.

The output of IC1 drives a series of four identical divide-by-10 stages. These are based on 4017BE one-of-ten decoders and decade counters.

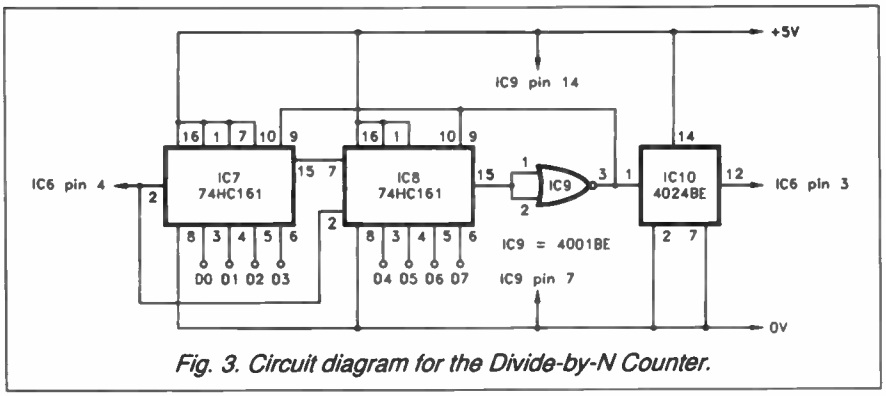

Fig. 3. Circuit diagram for the Divide-by-N Counter.

wider range once it has actually locked onto the input signal. Accordingly, the division rate through the divide-by-N counter should be set to a middle value initially so that the p.l.l. can easily lock onto the 50Hz input signal. It should then be able to track a substantial range of output frequencies.

Home Improvements

As already pointed out, in order to cover a really wide frequency span the circuit must have several operating steps, and 2Hz to 50Hz with 1Hz resolution. In this way the basic 25:1 frequency span of the synthesiser can be boosted to an output frequency range of 25000:1.

Modifying the circuit to cover a frequency span of 2kHz to 50kHz is not difficult. IC6 must have a 500Hz clock signal in order to give 1kHz resolution, and this can be achieved by omitting the last of the divide-by-10 stages.

Pin 12 of IC4 then connects to pin 14 of IC6. Also capacitor C4 must be made much lower in value at around 470p, be-

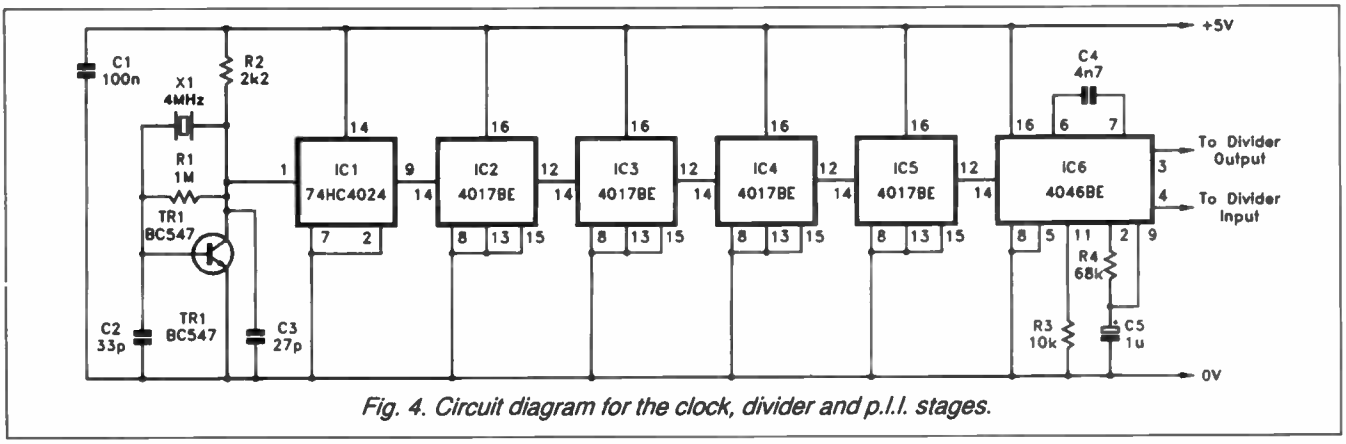

Fig. 4. Circuit diagram for the clock, divider and p.l.l. stages.

In this application only the "carry out" output at pin 12 is required, and the other ten outputs of each device are left unused. The inhibit and reset inputs at pins 13 and 15 serve no useful purpose in this application, and are connected to the zero volt (0V) rail.

A CMOS 4046BE "micro-power" p.l.l. chip is used for IC6. The only discrete components this requires are timing components capacitor C4 and resistor R3, and filter components R4 and C5. The 4046BE actually has two phase comparators with a common input terminal (pin 3), but their outputs are available separately at pins 2 and 13. The circuit will work with R4 connected to either of these outputs, but pin 2 seems to provide a slightly wider lock range in this application.

In theory, the divide-by-N counter provides a maximum output frequency that is well over one hundred times higher than the minimum output frequency. In reality the p.l.l. might not lock properly over such a wide frequency span. Some "tweaking" of R3's or C4's value should optimise the lock-in range for a given specimen of the 4046BE, but if a very wide frequency span is required it will almost certainly be necessary to cover it in two or more ranges.

It is normal for a p.l.l. to have a relatively small initial lock range, but a much ranges. There is more than one way of tackling this. One approach is to have a relatively high frequency range from the synthesiser, and to then use dividers to provide lower output frequencies.

For example, suppose that the synthesiser operates over a frequency range of 2kHz to 50kHz in 1kHz steps. Feeding the output to a divide-by-10 circuit would give an additional range of 200Hz to 5kHz with 100Hz resolution. Two further divisions by ten would give additional ranges of 20Hz to 500Hz in 10Hz cause the v.c.o. will operate over a higher frequency range.

The alternative method of obtaining more ranges is to use different clock frequencies, and replace C4 with several switched capacitors, one for each clock frequency. This is likely to prove more difficult in practice, and is not the approach that would be recommended. There is certainly plenty of scope for experimentation though, and this method should work well enough with the right values for capacitor C4.

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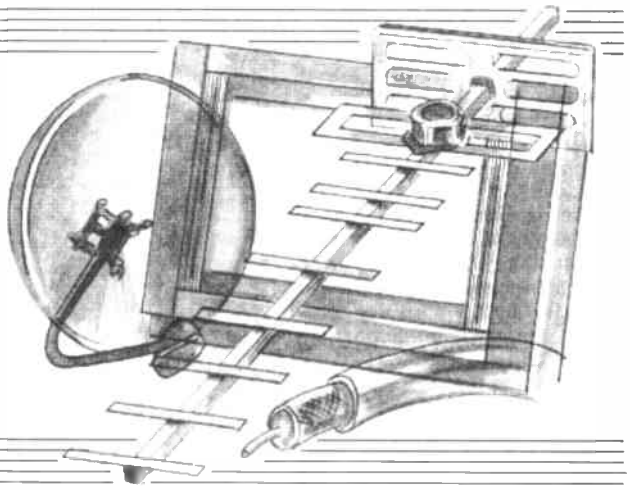
Special Review

DIGITAL TV AND MPEG2



MIKE RUTHERFORD

What is Digital TV, why all the fuss, and what on earth is MPEG2? Read on and find out!

WITHIN the space of twenty years, it has been said, all analogue forms of Radio and Television transmission could have been phased out in favour of a digital system of communication. The changes are just beginning to take place now. "Digital" is a word that is being bandied about more frequently by broadcasters, and has completely conquered the gramophone record industry in less than ten years.

This article attempts to explain the problems encountered in broadcasting television programmes in digital form, how they are overcome and what advantages accrue from going along the digital TV path.

Digital transmission of cable, satellite and terrestrial TV signals is based on MPEG2 coding, the digital compression standard set by the Motion Picture Experts Group of the International Electrotechnical Commission (IEC), and International Standards Organisation (ISO). Digital transmission of cable, satellite and terrestrial TV signals is based on this standard. Its relevance will become apparent as you read on.

ANALOGUE TO DIGITAL

The analogue system in use at present relies on exact synchronisation between camera and receiver to rewrite the transmitted picture at the point of presentation – the CRT (cathode ray tube) screen – 25 times a second. The complete picture is repeated every time, even if it contains no movement. In a digital television system the picture is created in memory and "read out" from there as a computer display reads out a graphics card.

To create a digital representation of an analogue signal requires the signal to be sampled at a high frequency, often two or three times the highest frequency present on the analogue signal. On every sampling cycle the voltage of the analogue signal is measured and turned into binary form. The principle is illustrated in Fig. 1.

For a TV picture, the result is a stream of binary data coming from the sampling process that represents the original picture dot-by-dot from top left to bottom right. A television picture is generally divided into columns and rows called pixels and lines. A pixel is a picture element.

In a 625-line picture, 576 lines are used for the picture, the remainder are blank or carry teletext data. If the aspect ratio of the picture is five units wide by four units high, you can calculate that, for equal vertical and horizontal definition, there should be 576 × 5 / 4 pixels in one line. The result is 720.

These 720 pixels have to be displayed in the time of one active line period, namely 52 microseconds, so that each pixel occupies a time of 72·2 nanoseconds. Assuming that each pixel alternately is black, then white, the highest frequency reached would be 6·9MHz. Therefore the lowest sampling frequency one could use for such a picture would be 14MHz, and, in fact, the luminance signal is sampled at 13·5MHz for MPEG2.

A colour television picture that was simply converted from its present 625-line, 25 frames per second, format into a stream of binary digits would require a bandwidth of 108MHz to transmit its 216Mbits/s (megabits per second) serial data stream. 108MHz could accommodate thirteen analogue channels – so what's the point in going digital?

THE POINT OF DIGITAL

There was very little point in going digital until broadcasting engineers began to study more closely the nature of television pictures, realising that much of the information transmitted in the analogue system was repetitive. The big advantage of the digital way was that memory could be used to store the picture, then only changes in the picture from frame to frame need be transmitted. In the receiver, the information could be used to up-date the original image in memory to make the next

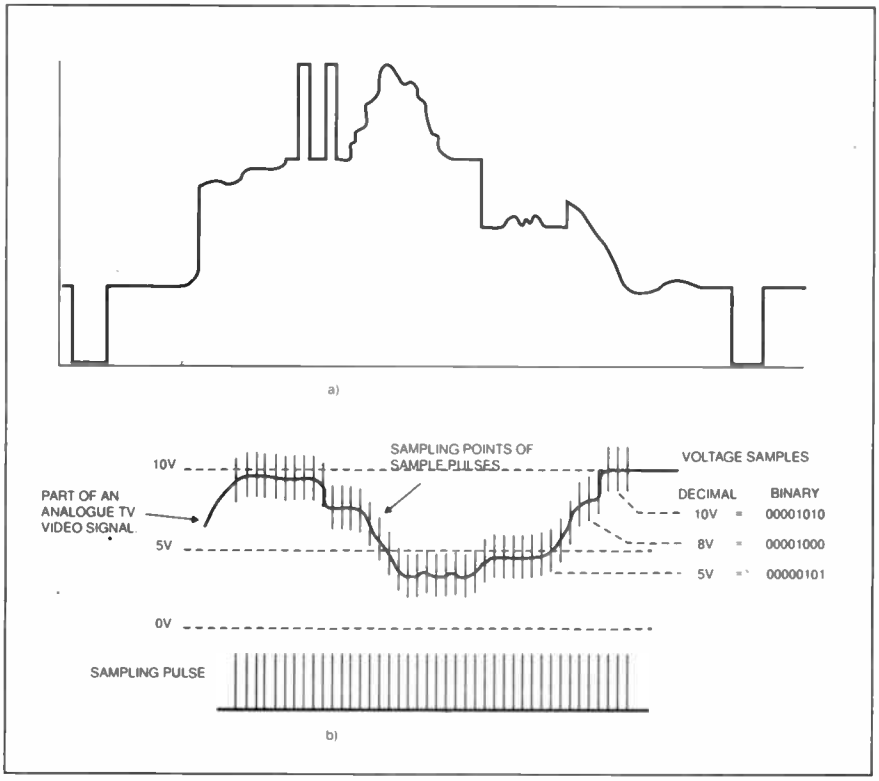


Fig. 1. (a) Typical analogue TV line, (b) analogue to digital conversion by sampling.

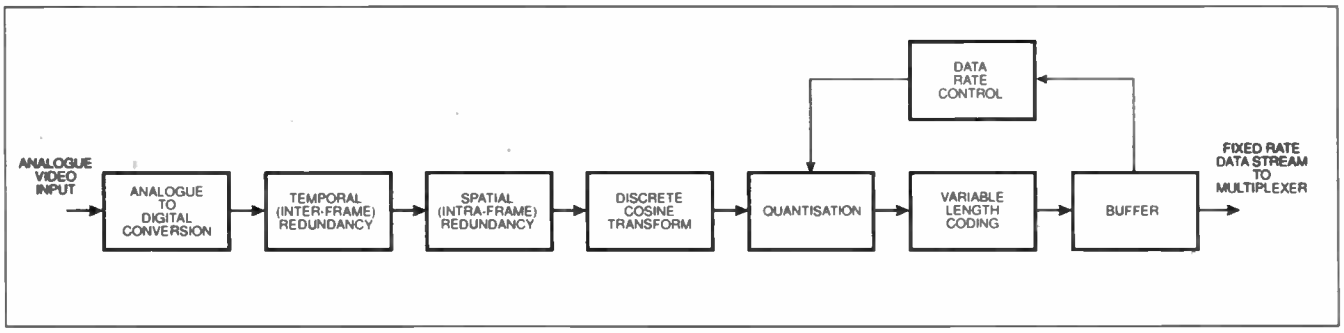


Fig. 2. MPEG2 processing stages.

frame! This is one of the bases of MPEG2, the data compression process used to transmit high-quality pictures (and sound) in a small bandwidth.

Since MPEG2 is going to feature largely in our lives in the future, it might be as well to examine its processes as a path to understanding the nature of digital TV. Between the studio console and the transmitter are seven steps of data processing that throw out repetitive data, split up the remainder into packets with identification and timing tags, and multiplex it with other television services all with sound and other data. Fig. 2 shows the seven stages of processing used by MPEG2 to achieve compression ratios of up to 160:1.

Very often the amount of redundant information in a television picture can be as high as 95%. Stage one, the analogue to digital conversion stage, samples the luminance and chrominance signals and turns them into streams of binary digits. The luminance signal is sampled at 13·5MHz and the R-Y and B-Y colour difference signals, known as Cr and Cb in their digital form, at 6·75MHz each. Eight-bit sampling will give 256 shades of grey, but ten-bit samples are more frequent in modern digital studios.

By comparing adjacent frames of a video sequence, the differences from frame to frame can be detected and these sent to the receiver to modify the picture in memory. If a still picture or, more rarely, a test card was transmitted it should be possible to send one frame and then turn the transmitter off! Unfortunately, anyone who turned his receiver on slightly late would get nothing at all, and for this reason a full frame is sent on a regular basis to allow for people channel-hopping and turning on the TV in the middle of something.

TEMPORAL REDUNDANCY

The process of discarding repetitive picture information from frame to frame is termed Temporal Redundancy and is the second stage shown in Fig. 2. Motion-picture cartoon animators use a similar process on the rostrum camera using overlays on a static background for some scenes as it avoids having to draw the same background repeatedly frame after frame.

Each frame is assembled into blocks of pixels, initially eight pixels by eight lines of luminance, then formed further into groups of four luminance blocks (16 pixels by 16 lines) with two chrominance blocks, one for Cr and the other for Cb. This larger grouping is called a macro-block, and is detailed more fully in Fig. 3.

Inter-frame comparisons are done at macro-block level. A process akin to subtraction is used to determine differences which are forwarded for more processing. The macro-blocks are assembled in sequence in exactly the same way as the original picture was scanned – left to right, top to bottom.

The assemblage of several adjacent macro-blocks into a sequence constructs what is called a "slice" (see Fig. 4). A slice forms a convenient collection of data for error-detection and correction purposes. The "slices" are assembled in sequence to compose one TV frame and a string of frames, usually twelve in

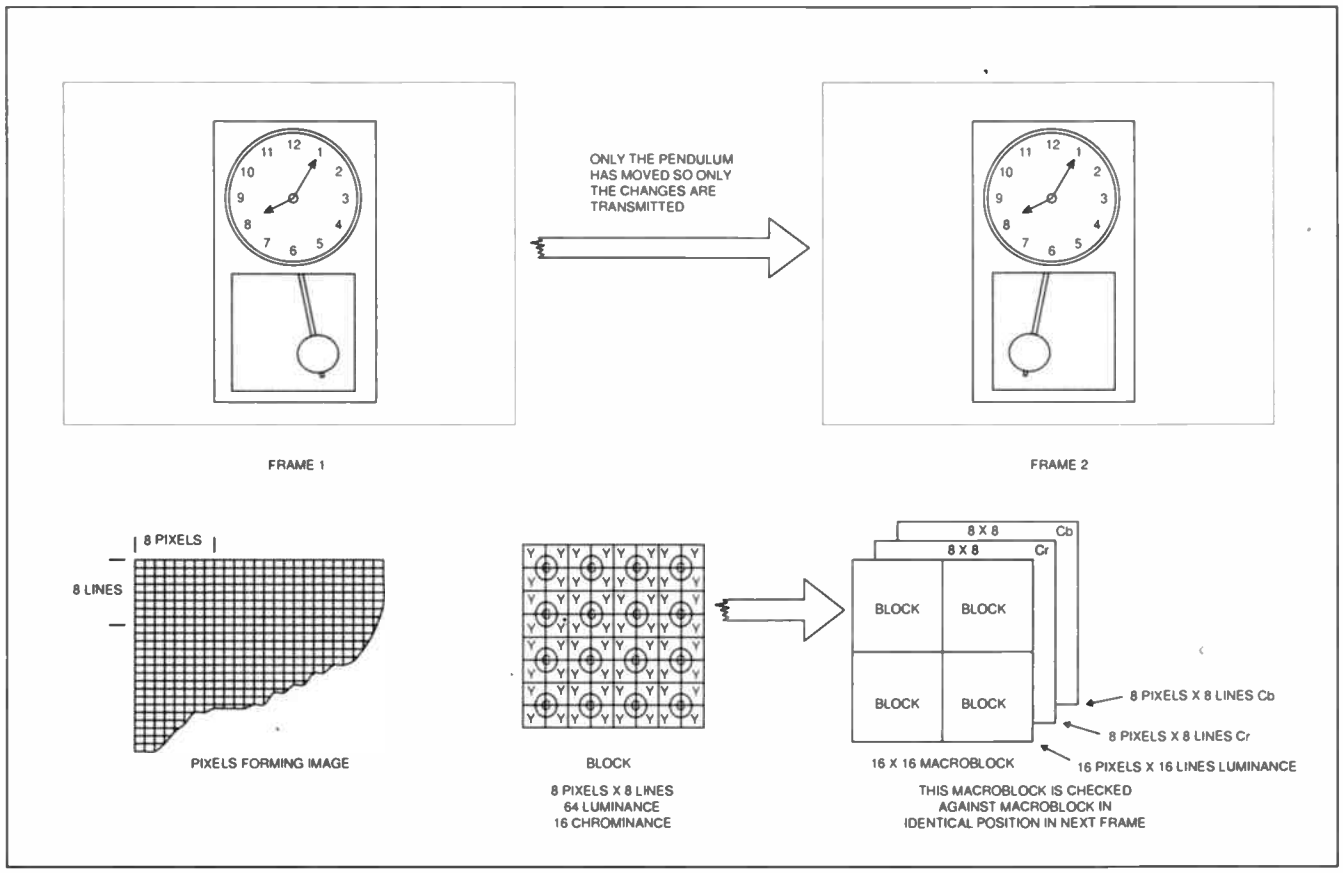
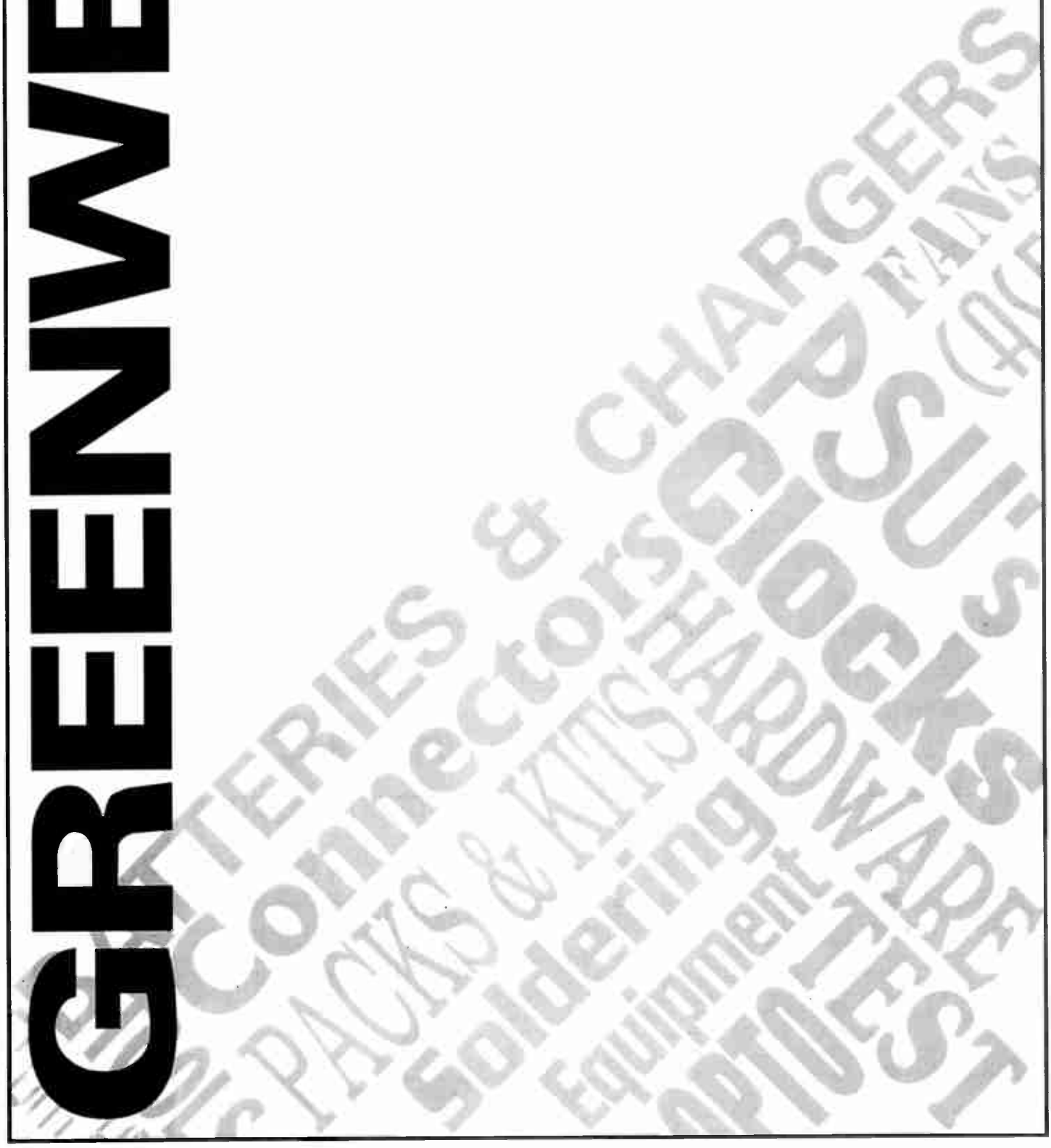


Fig. 3. Temporal redundancy – blocks and macro-blocks.

GREENWELD

1997 Catalogue



Welcome to our 1997 Catalogue of new stock products. All these items will be available from October 1996 and throughout the whole of 1997.
All the goods in this catalogue have been selected from our most reliable suppliers, thus ensuring availability is no problem.
If you are interested in our surplus job-lot items, we are producing 16 page A3 size supplements every month. All you have to do to receive your copy is 'phone, write, fax or call in the shop. Every ordering customer will automatically be put on our mailing list - unless you tell us otherwise.
Alternatively, see the details on the inside rear cover about becoming a subscriber. This will enable you to receive a monthly mailshot before the surplus items are even advertised.
With surplus items, once they're gone - that's it! We won't be able to obtain any more. We can never tell from one day to the next what will come in or the quantity, and believe me, some do not last long enough to even get on the list!
We at Greenweld look forward to receiving your order. We are open from 8.00am to 5.30pm, Monday to Saturday.

Kevin Jarvis
Managing Director

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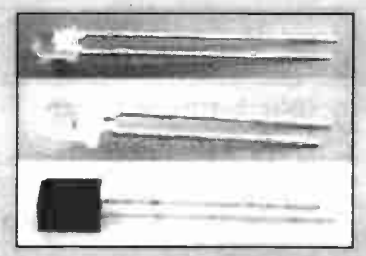


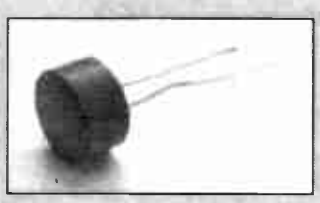
High Power Infra-Red Source and Sensor

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)		46µA typ.	

Code	Type	1+	25+	100+
OP2400	Standard emitter	20p	0.13	0.10
OP2405	High power emitter	26p	0.17	0.13
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

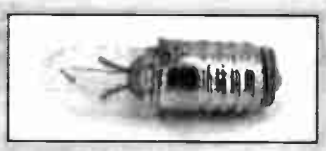
Dark resistance	1 Megohm
Resistance @ 1Flc	9 Kilohms
@ 100Flc	400 ohms
Max voltage	320V dc or ac peak
Max current	75mA

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



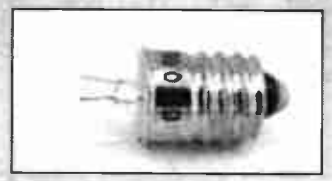
T1.5 LES Lamp

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



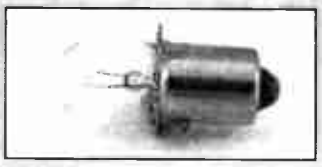
MES (E10) G3½ 11mm Lamps

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
3.6V	300mA	1.05	6.0	1000
6.0V	60mA	0.36	1.0	10000
12.0V	200mA	2.4	12.0	3000

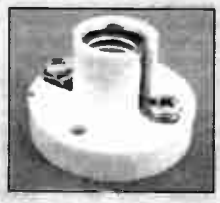
Code	Type	1+	25+	100+
OP2600	1.5V,300mA	15p	0.09	0.07
OP2610	2.5V,200mA	15p	0.09	0.07
OP2620	3.5V,300mA	15p	0.09	0.07
OP2630	6.0V,60mA	18p	0.11	0.08
OP2640	12.0V,200mA	18p	0.11	0.08



Pre-Focus

Flange 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



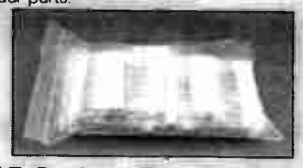
MES Lampholder

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	16x33K	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	10x680p	10x2n2
5x33p	20x100p	5x270p	5x680p	10x3n3
10x47p	5x120p	15x330p	5x820p	10x4n7
5x56p	10x150p	5x390p	20x1n	5x6n8
5x68p	5x180p	15x470p	10x1n5	20x1n
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	10x4µ 25V	5x470µ 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	10x470k	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

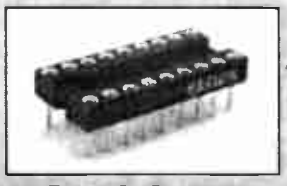
KT3160 A kit of 102 20mm slow blow (time delay) fuses. Each fuse is individually packed in a resealable polythene bag. Selection has been carefully chosen by rating. **£11.95;** 5+ 8.97; 25+ 8.20

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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27 Park Road · Southampton · SO15 3UQ

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 1.5Vac. **£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**

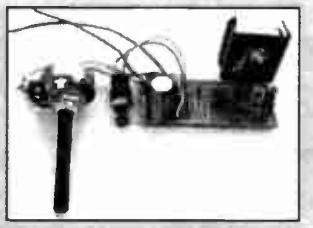
KT3625 Two Tone Horn. A simple circuit operated by a changeover switch. **£2.95; 10+ 1.95**

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**

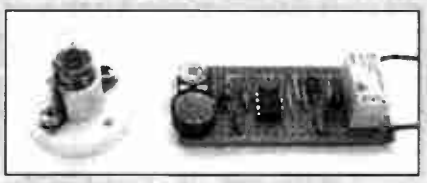
KT3627 Steam Whistle. This is a more complex circuit but simulates the sound quite accurately. Needs an amplifier and speaker. **£3.50; 10+ 2.31**

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**

KT3671 Simple Controller. Basic kit with one output that will enable a trains speed and direction to be controlled. Case supplied. **£11.95; 10+ 8.00**



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. **£9.95; 10+ 6.65**



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. **£5.95**

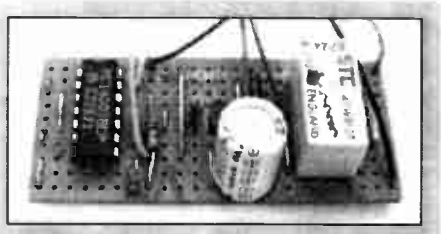
9V FM Transmitter

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. **£7.95**

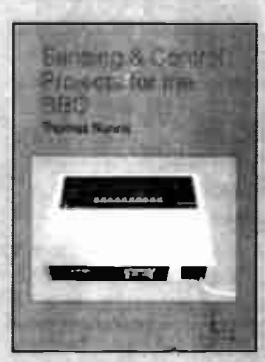
Two Stage FM Transmitter

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. **£7.95**

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

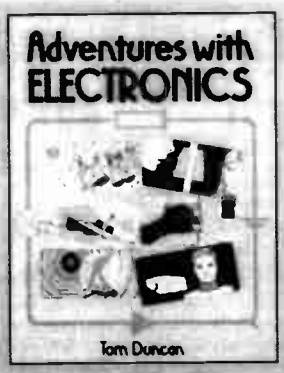
The kits for the projects in this book are designed to use the facilities provided on the BBC computer, but which are not often employed. They actually link the micro to the 'real world' with practical projects that maybe simple, but although no soldering or knowledge of electronics is required, are 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)

PRICES IN BOLD INCLUDE VAT; QTY PRICES IN LIGHT DO NOT



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	£22.95	15.30

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	£31.95	21.30

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**

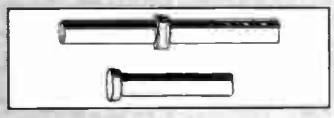
Specifications:

Input	7-25V DC, 1.5A
Output	4 -20v DC variable 10 watts max
Size	60x50x21mm
Weight	37.7g

PCB EQUIPMENT

Stripboard Cutter

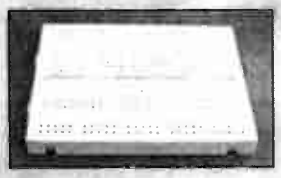
PC2060 Stripboard cutter for simple track cutting. Insert tool at the point where break is required and twist clockwise. **£1.95; 10+ 1.31**



Terminal Pins

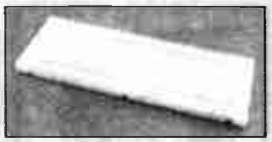
Press fit terminal pins for use with stripboard. Supplied in packs of 100.

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. **£2.60; 25+ 1.65**

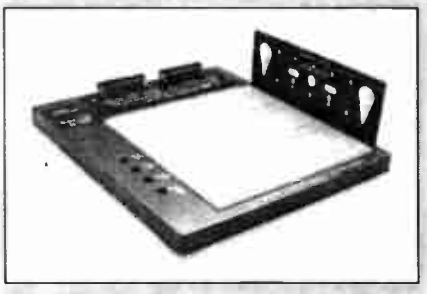


Protobloc 2

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 x64mm. **£4.50;** 25+ 3.25

Protobloc 2A

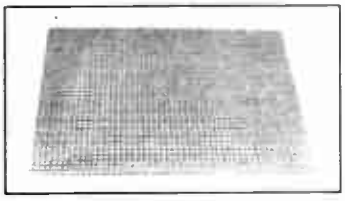
PC3130 As above but the ABS polymer board is mounted onto a rigid base plate complete with three 4mm terminals in red, black and green for power connections. A mounting bracket which clips into the base is also provided to accept a variety of components including switches and potentiometers. **£8.95;** 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

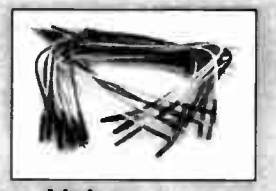


Fully pierced single sided copper strips 0.1" pitch. Available in the following sizes:

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

TEL: 01703 236363
FAX: 01703 236307
GREENWELD
27 Park Road · Southampton · SO15 3UQ



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. Simply press the tip to promote ink flow. Apply slow even pressure in use. **£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+ 1.35**

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. **£1.95; 25+ 1.46**

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	75x52x54mm

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	1V
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

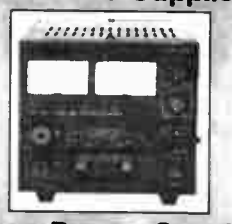
PS4330 Stabilised power supply unit for use with CB rigs, auto accessories, etc. High stability electronic regulation with internal fuse protection. Manufactured according to the requirements of the Electrical Safety Regulations for Domestic Use. **£17.95; 4+ 11.95**

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. **£22.95; 4+ 17.95**

Input Voltage	240Vdc
Output Voltage	13.8V dc
Output	5A 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. **£89.95; 4+ 63.00**

Specification:

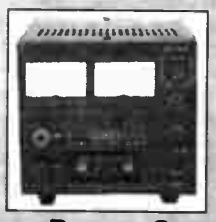
Output Voltage (adjustable)	0-30Vdc
Output Current (adjustable)	0-2.5A
Fixed Voltage (1)	5V @ 500mA
Fixed Voltage (2)	12V @ 500mA

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. **£99.95; 4+ 71.42**

Specification:

Output Voltage (adjustable)	0-30Vdc
Output Current (adjustable)	0-2.5A
Fixed Voltage (1)	5V @ 500mA
Fixed Voltage (2)	12V @ 500mA

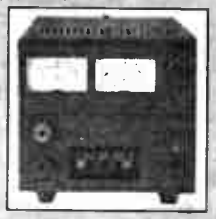


Benchtop Power Supply

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. **£69.95; 4+ 49.40**

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. **£109.95; 4+ 77.14**

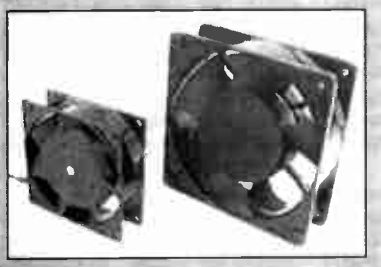
Specification:

Output Voltage (adjustable)	3-15Vdc
Output Current (adjustable)	18A

PRICES IN BOLD INCLUDE VAT; QTY PRICES IN LIGHT DO NOT

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.



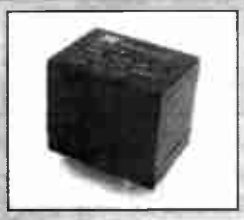
FN3005

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+ 8.43**

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:

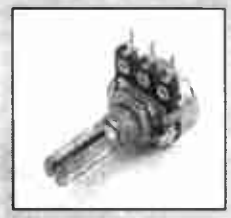
10R	100R	1k	10k	100k	1m
11R	110R	1k1	11k	110k	
12R	120R	1k2	12k	120k	
13R	130R	1k3	13k	130k	
15R	150R	1k5	15k	150k	
16R	160R	1k6	16k	160k	
18R	180R	1k8	18k	180k	
20R	200R	2k	20k	200k	
22R	220R	2k2	22k	220k	
24R	240R	2k4	24k	240k	
27R	270R	2k7	27k	270k	
30R	300R	3k	30k	300k	
33R	330R	3k3	33k	330k	
36R	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	0.26
RP2020	1k lin	**50p**	0.33	0.26
RP2030	4k7 lin	**50p**	0.33	0.26
RP2040	10k lin	**50p**	0.33	0.26
RP2050	47k lin	**50p**	0.33	0.26
RP2060	100k lin	**50p**	0.33	0.26
RP2070	470k lin	**50p**	0.33	0.26
RP2080	1M lin	**50p**	0.33	0.26
RP2100	470 ohms log	**50p**	0.33	0.26
RP2110	4k7 log	**50p**	0.33	0.26
RP2120	1M log	**50p**	0.33	0.26

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	0.65
RP2705	200 ohms	£1.20	0.75	0.65
RP2710	500 ohms	£1.20	0.75	0.65
RP2715	1k	£1.20	0.75	0.65
RP2720	2k	£1.20	0.75	0.65
RP2725	5k	£1.20	0.75	0.65
RP2730	10k	£1.20	0.75	0.65
RP2735	20k	£1.20	0.75	0.65
RP2740	50k	£1.20	0.75	0.65
RP2745	100k	£1.20	0.75	0.65
RP2750	200k	£1.20	0.75	0.65
RP2755	500k	£1.20	0.75	0.65
RP2760	1M	£1.20	0.75	0.65

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	0.75W 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

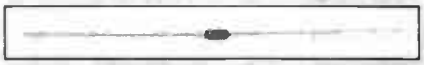
Silicon Rectifier Diodes

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.

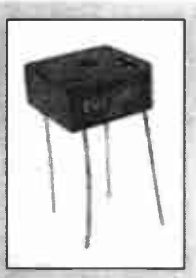
Order as BZX91 + voltage

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	34p	0.21	0.17
BR34	400	3A	38p	0.23	0.19

6A range, plastic, for PCB mounting.

Type	V	I	1+	100+	1k+
DB602	200	6A	58p	0.36	0.29
DB608	600	6A	70p	0.44	0.35

12A range, metal clad single hole for fixing with tabs.

Type	V	I	1+	25+	100+
BR121	100	12A	£1.92	1.20	0.96
BR124	400	12A	£2.20	1.28	1.03

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+ 0.15; 100+ 0.12

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

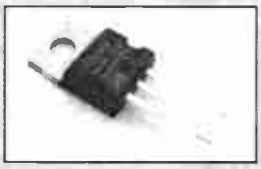
Triacs

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	-12V	37p



1A fixed voltage with internal overload, thermal and short circuit protection. T0220 case.

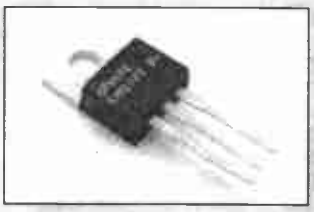
Type	Voltage	1+
7805	+5V	40p
7808	+8V	40p
7812	+12V	40p
7815	+15V	40p
7818	+18V	40p
7824	+24V	40p
7905	-5V	42p
7908	-8V	42p
7912	-12V	42p
7915	-15V	42p
7918	-18V	42p
7924	-24V	42p

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
BC108C	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
BC478	36p	TIP126	80p
BC479	36p	TIP127	90p
BC517	28p	TIP141	£1.95
BC547B	14p	TIP142	£1.70
BC448B	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

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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
BF244B	52p	2N3819	40p

Unijunciton 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
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
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	4096	27p
4021	46p	4099	63p
4022	50p	4501	45p
4023	20p	4502	63p
4024	38p	4503	48p
4025	20p	4507	68p
4026	53p	4508	£1.68
4027	27p	4509	£1.40
4028	38p	4510	49p
4029	41p	4511	49p
4030	20p	4512	49p
4031	80p	4514	£1.47
4032	60p	4515	£1.47
4033	80p	4516	44p
4034	£1.40	4518	38p
4035	60p	4519	47p
4038	60p	4520	43p
4040	53p	4521	93p
4041	53p	4522	75p
4042	39p	4526	75p
4043	53p	4527	66p
4044	53p	4528	66p
4046	47p	4529	66p
4047	39p	4531	60p
4048	53p	4532	49p
4049	29p	4534	£3.36
4050	29p	4536	£2.95
4051	38p	4538	43p
4052	38p	4539	93p
4053	38p	4541	49p
4054	53p	4543	84p
4055	53p	4549	£7.05
4056	53p	4553	£2.10
4060	46p	4555	57p

CMOS (Continued)

Type	Price	Type	Price
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
40106	35p		

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	38p
TL062	Dual low power operational amplifier	SGS	DIL8	44p
TL064	Quad low power operational amplifier	SGS	DIL14	60p
TL071	Single operational amplifier	SGS	DIL8	34p
TL072	Dual operational amplifier	SGS	DIL8	38p
TL074	Quad operational amplifier	SGS	DIL14	52p
TL081	Single operational amplifier	SGS	DIL8	34p
TL082	Dual operational amplifier	SGS	DIL8	37p
TL084	Quad operational amplifier	SGS	DIL14	57p
TBA120S	Limiting IF amplifier	Plessey	DIL14	64p
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	28p
LM311	High speed comparator	SGS	DIL8	20p
LM318	High slew rate operational amplifier	SGS	DIL8	84p
LM324	Quad operational amplifier	SGS	DIL14	22p
LM334Z	3 terminal adjustable current source	SGS	T092	84p
LM335Z	Temperature sensor 0-100°C	SGS	T092	94p
LM339	Quad comparator	SGS	DIL14	22p
LM348	Quad 741 operational amplifier	SGS	DIL14	31p
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	20p
LM380	2W audio amplifier	National	DIL14	£1.12
LM381	Low noise dual preamplifier	National	DIL14	£3.40
LM386	Low voltage preamplifier	National	DIL8	48p
LM393	Dual comparator	SGS	DIL8	20p
ZN414Z	AM receiver IC	Plessey	T092	£1.12
ZN416E	AM receiver IC	Plessey	DIL8	£1.84
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
SL490	Remote control transmitter	Plessey	DIL18	£3.10
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

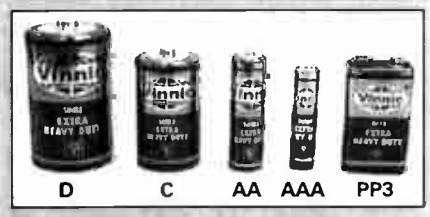
Code	Function	Manuf-acturer	Package	1+
LM747	Dual operational amplifier	SGS	DIL14	42p
LM748	Operational amplifier	SGS	DIL8	39p
TBA810	7W audio amplifier	SGS	14pin	78p
TBA820M	Audio amplifier	SGS	DIL8	42p
TDA1024	Triac controller	Philips	DIL8	£1.90
SAA1027	Stepper motor driver	Philips	DIL16	£3.20
ZN1034E	Precision timer	Plessey	DIL14	£3.20
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
ULN2068	Quad darlington driver. 1.5A 50V	SGS	DIL16	£1.26
XR2206	Waveform generator	SGS	DIL16	£4.40
UA2240	Precision timer	Texas	DIL14	£2.80
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
LM3900	Quad operational amplifier	National	DIL14	72p
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

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	-	LR59	-
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

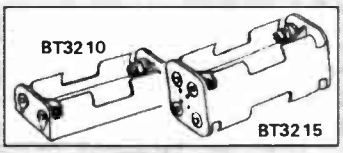
Code	Type	Dia	H	1+	10+	100+
BT2015	L621	6.8	2.1	**0.45**	0.30	0.14
BT2020	L726	7.9	2.6	**0.45**	0.30	0.14
BT2025	L736	7.9	3.6	**0.45**	0.30	0.14
BT2030	L754	7.9	5.4	**0.45**	0.30	0.14
BT2035	L1121	11.6	2.1	**0.45**	0.30	0.14
BT2040	L936	9.5	3.6	**0.45**	0.30	0.14
BT2045	L1131	11.6	3.1	**0.45**	0.30	0.14
BT2050	L721	7.9	2.1	**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

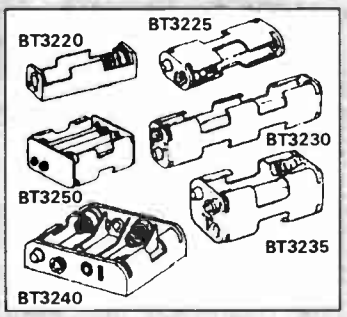
Code	Type	1+	10+	100+
BT2106	CR1620	**£1.75**	1.15	0.96
BT2107	CR2016	**£1.00**	0.66	0.55
BT2108	CR2025	**£1.00**	0.66	0.55
BT2109	CR2032	**£1.00**	0.66	0.55
BT2110A	CR2430	**£1.00**	0.66	0.60



Battery Holders

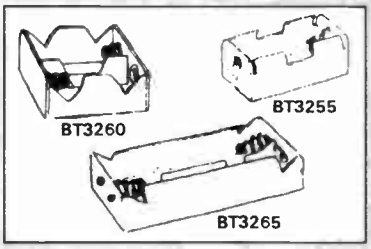
(a) AAA size (HP16 etc)

Code		1+	25+	100+
BT3210	Takes 2 AAA cells Solder terminals Dims 52x22x13mm	**34p**	0.19	0.15
BT3215	Takes 4 AAA cells Solder terminals Dims 52x26x25mm	**42p**	0.27	0.22



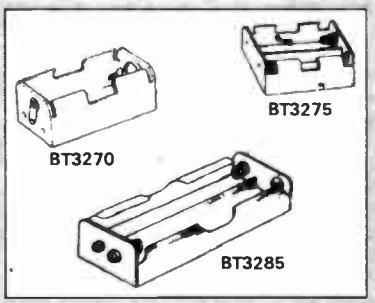
(b) AA size (HP7 etc)

Code		1+	25+	100+
BT3220	Takes single AA cell Dims 57x13x17mm	**12p**	0.08	0.06
BT3225	Takes 2 AA cells Dims 57x28x15mm	**14p**	0.09	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**	0.16	0.13
BT3265	Takes 4 (C) cells Snap terminals Dims 108x54x236	**28p**	0.18	0.15



(d) D size (HP2 etc)

Code		1+	25+	100+
BT3270	Takes 1 (D) cell Solder terminals Dims 68x36x30mm	**43p**	0.24	0.18
BT3275	Takes 2 (D) cells Snap terminals Dims 68x68x30mm	**31p**	0.17	0.14
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	**£10.44**	6.68
BT3140	6V, 1.2Ah	97x25x58	0.34kg	**£8.49**	5.48
BT3141	6V, 2.8Ah	134x34x67	0.60kg	**£11.71**	7.50
BT3142	6V, 4.0Ah	70x47x109	0.90kg	**£13.18**	8.44
BT3143	6V, 7.0Ah	151x34x101	1.25kg	**£17.77**	11.38
BT3144	6V, 10.0Ah	151x50x101	2.0kg	**£14.95**	9.44
BT3145	6V, 12.0Ah	151x50x101	2.06kg	**£19.82**	12.69
BT3146	12V, 0.8Ah	96x25x62	0.35kg	**£15.82**	10.13
BT3147	12V 1.2Ah	97x48x58	0.60kg	**£15.82**	10.13
BT3148	12V, 2.0Ah	150x20x84	0.7kg	**£18.26**	11.69
BT3149	12V, 2.1Ah	178x34x67	0.90kg	**£17.18**	11.19
BT3150	12V, 2.3Ah	178x34x64	0.94kg	**£20.51**	13.13
BT3151	12V, 2.8Ah	134x67x67	1.15kg	**£18.26**	11.69
BT3152	12V, 6.0Ah	151x65x103	2.40kg	**£22.07**	14.13
BT3153	12V, 7.0Ah	151x65x98	3.0kg	**£26.56**	17.00
BT3154	12V, 12.0Ah	151x98x98	4.0kg	**£44.92**	28.75
BT3155	12V, 15.0Ah	181x76x167	5.9kg	**£59.96**	38.38
BT3156	12V, 24.0Ah	166x175x125	8.65kg	**£68.65**	43.94

TEL: 01703 236363
FAX: 01703 236307
GREENWELD
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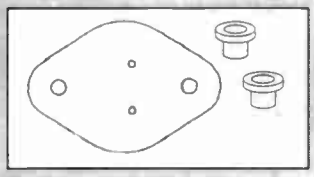
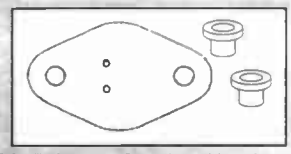
SEMI HARDWARE

Mica Semiconductor Mounting Kits

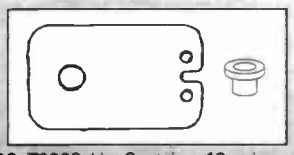
Mounting kits for semiconductors including mica washers and bushes.



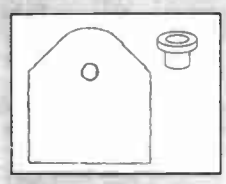
SH2010 T03 kit. Contains 10 mica washers and 20 bushes. To suit 2N3055, etc. **£1.30**



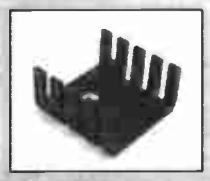
SH2020 T066 kit. Contains 10 mica washers and 20 bushes. To suit AD161/2 etc. **£1.30**



SH2030 T0220 kit. Contains 10 mica washers and 10 bushes. To suit TIP31, 7805 etc. **92p**

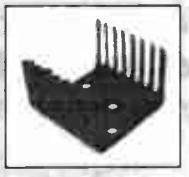


SH2040 M13055 kit. Contains 10 mica washers and 10 bushes. To suit TIP3055, etc. **96p**



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+ 0.13



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. **£2.35;** 12+ 1.60

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. **£2.35;** 12+ 1.60

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 glue sticks. **£1.00;** 10+ 0.65

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 12 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	**£12.95**	8.02
SO3010	115V	15W	**£12.95**	8.02
SO3020	24V	15W	**£13.95**	8.72

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. 1.5m Silicone rubber cables (burnproof) are available on request. Operating tip temperature is 390°C.

Code	Volts	Watts	1+	10+
SO3110	240V	17W	**£13.50**	8.41
SO3120	115V	17W	**£13.50**	8.41
SO3130	24V	17W	**£14.50**	9.21

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, but 1.5m silicone rubber (burnproof) cable is available on request. Operating tip temperature at 420°C.

Code	Volts	Watts	1+	10+
SO3210	240V	25W	**£13.75**	8.50
SO3220	115V	25W	**£13.75**	8.50
SO3230	24V	25W	**£14.75**	9.30

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	£14.95	10.46
SO3320	240V	17W	£14.95	10.46
SO3330	240V	25W	£14.95	10.46

Antex MLXS 'Auto' Soldering Kit

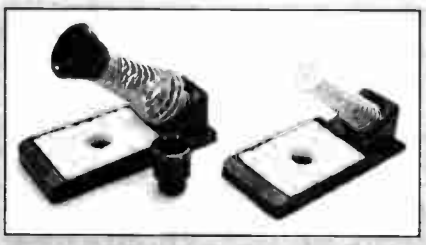
This iron is designed for use where mains voltage is unavailable and is widely used on cars, boats and caravans. Using the rugged XS 25 watt soldering iron it is powered from any 12 volt supply. The lead is 4.5m long equipped with two rugged crocodile clips for connection to car or similar batteries. 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	£14.95	10.46

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	£37.95	26.56
SO3440	24V	50W	£39.95	27.56



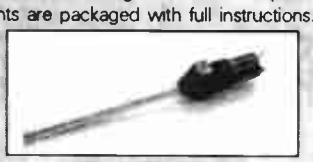
Antex SO3410/SO3420 Bench Stands

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, spring and two phenolic bezels 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.

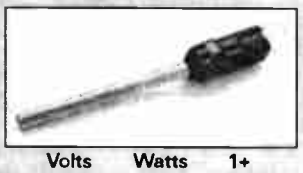
Code	1+	10+
SO3410	£3.95	2.76
SO3420	£7.50	5.25

Replacement Elements

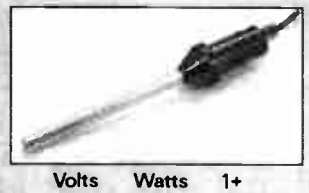
All Antex soldering irons are repairable should the element fail or be damaged. This is simply done by a competent person. When ordering a replacement element ensure that the soldering iron model and voltage are stated. Replacement elements are packaged with full instructions.



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

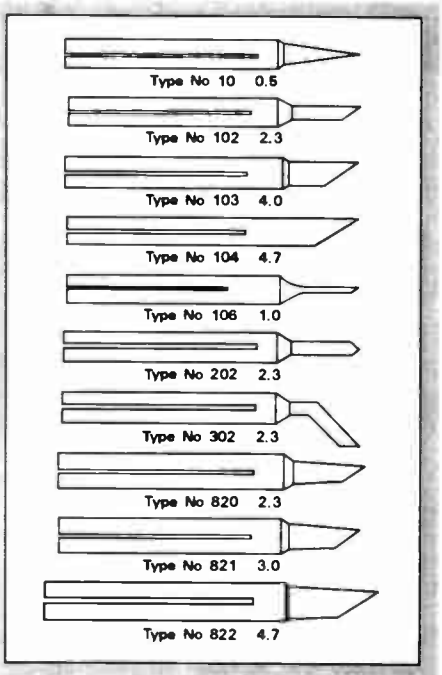


Code	Volts	Watts	1+	10+
SO2515	240V	17W	£5.75	4.02
SO2520	115V	17W	£5.87	4.10
SO2525	24V	17W	£6.12	4.28



Code	Volts	Watts	1+	10+
SO2530	240V	50W	£17.87	12.51
SO2535	24V	50W	£17.87	12.51

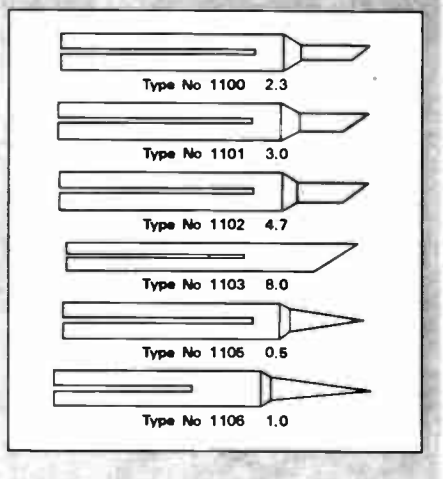
Code	Volts	Watts	1+	10+
SO2540	240V	25W	£5.75	4.02
SO2545	115V	25W	£5.87	4.11
SO2550	24V	25W	£6.12	4.20
SO2555	12V	25W	£6.12	4.20



Replacement Bits

(a) For C Irons

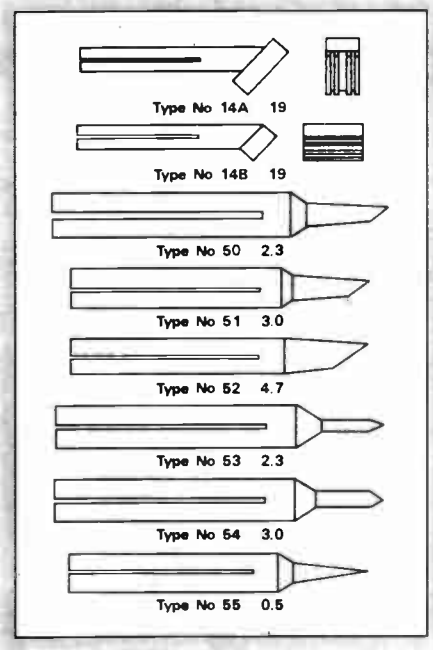
Code	Type	Description	1+	10+
SO2600	10	0.5mm pencil	£2.10	1.29
SO2605	102	2.3mm parallel	£2.10	1.29
SO2610	103	4mm parallel	£2.10	1.29
SO2615	104	4.7mm parallel	£2.10	1.29
SO2620	106	1mm parallel	£2.10	1.29
SO2625	202	2.3 chisel	£2.10	1.29
SO2630	302	2.3mm 45°	£2.10	1.29
SO2635	820	2.3mm tapered	£2.10	1.29
SO2640	821	3mm tapered	£2.10	1.29
SO2645	822	4.7mm tapered	£2.10	1.29



(b) For CS & TCS Irons

Code	Type	Description	1+	10+
SO2700	1100	2.3mm parallel	£2.25	1.29
SO2705	1101	3mm parallel	£2.25	1.29
SO2710	1102	4.7mm parallel	£2.25	1.29
SO2715	1103	6mm parallel	£2.25	1.29
SO2720	1105	0.5mm pencil	£2.25	1.29
SO2725	1106	1mm semi-taper	£2,25	1.29
SO2730	1108	3mm chisel	£2.25	1.29
SO2735	1109	5mm chisel	£2.25	1.29

TEL: 01703 236363
FAX: 01703 236307
GREENWELD
27 Park Road · Southampton · SO15 3UQ



(c) For XS Irons

Code	Type	Description	1+	10+
SO2800	14A	19mm desolder	£6.99	4.65
SO2805	14B	19mm desolder	£6.99	4.65
SO2810	50	2.3mm semi-taper	£2.25	1.29
SO2815	51	3mm semi-taper	£2.25	1.29
SO2820	52	4.7mm semi-taper	£2.25	1.29
SO2825	53	2.3mm chisel	£2.42	1.39
SO2830	54	3mm chisel	£2.42	1.39
SO2835	55	0.5mm chisel	£2.25	1.29

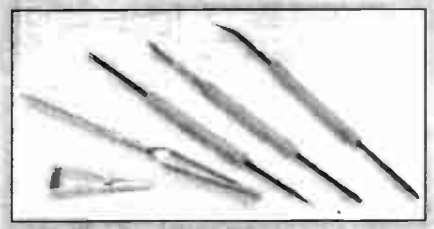
Solder

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**

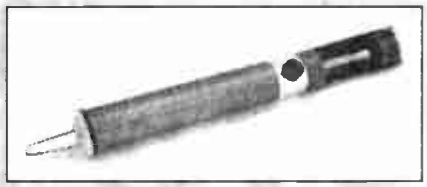
SO2910 Card containing 1.83m of 18g multicore solder. **70p**

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**

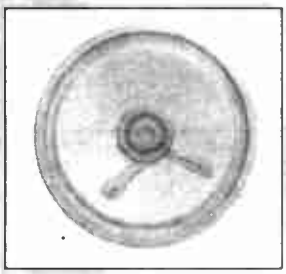
Solder Remover

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

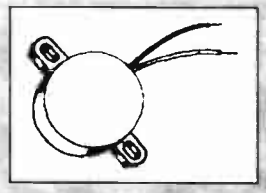
SP3010 A miniature speaker measuring just 38mm in diameter for use in miniature portable equipment. Fitted with paper cone and alnico magnet. Solder connection tags. Impedance 8 ohms. Handling capacity 100mW. **£1.20; 25+ 0.81; 100+ 0.65**



Miniature Loudspeaker

A miniature speaker for use in small portable equipment. Fitted with paper code 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

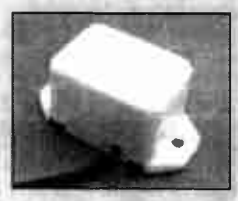


Miniature Piezo Transducer

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	86dB 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

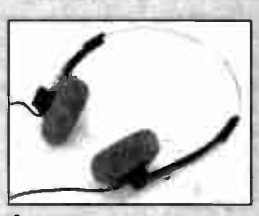
Operating voltage	3V type	2·6V DC
	6V type	4-9V DC
	12V type	9-20V DC
Current consumption		25mA
Sound output		75dB at 30cm
Frequency		400Hz

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	0.20	0.16
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	32W
Response	40-20,000Hz
Power	100mW
Lead	1.15m straight screened
Plug	3.5mm
Weight	40g

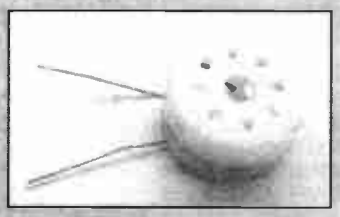
PRICES IN BOLD INCLUDE VAT; QTY PRICES IN LIGHT DO NOT

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	8W
Response	30-18000Hz
Power	500mW
Lead	2.8m coiled screened
Plug	6.35m stereo
Extras	Rotary volume controls and mono/stereo switch
Weight	326g

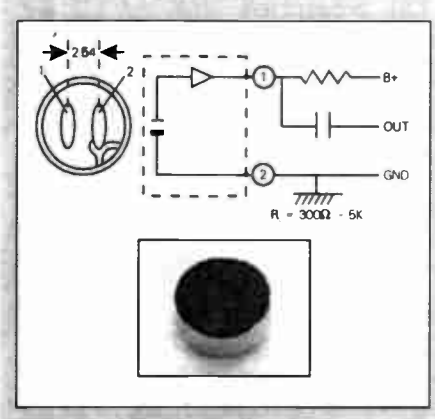


Ceramic Microphone Insert

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

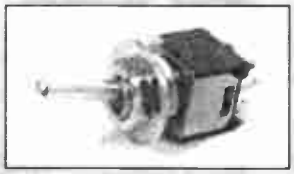
Code	Type	1+	25+	100+
SP2130	Insert (solder pad)	60p	0.40	0.32
SP2140	Insert (PCB)	64p	0.43	0.34

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	100-100,000Hz
Sensitivity	76dB @ 1500hz
Head diameter	52mm
Length	215mm

SWITCHES



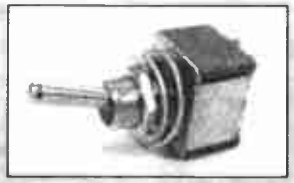
Sub-miniature Toggle Switches

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	28.4x10x9.2
Contact rating		3A 125V, 1A 250V AC
Initial contact resistance		‹20mΩ
Insulation resistance		›100MΩ at 500V DC
Contact material		Copper alloy with silver inlay silver plated
Body material		Flame retardent alkyd
Electrical life		›20x10⁴ cycles at full load
Operating temperature		-20°C to +60°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

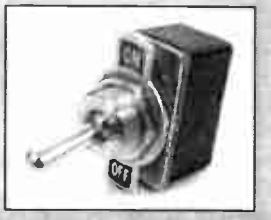
A range of low cost miniature toggle switches providing exceptional value available in single pole or double pole options including momentary biased options. All switches are fully approved to UL and CSA

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 retardent alkyd
Electrical life		›5x10⁴ cycles at full load
Operating temperature		-20°C to +65°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

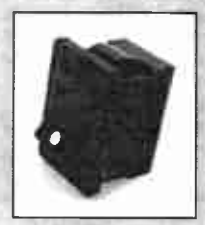
For biased switches (on) indicates momentary action.



Standard Toggle Switches

A range of low cost standard size toggle switches. Complete with on/off plate. Rated at 250V 1.5A 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	›10⁶ 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 blackbezel 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

TEL: 01703 236363
FAX: 01703 236307
GREENWELD
27 Park Road · Southampton · SO15 3UQ

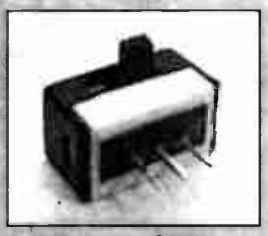
Miniature Slide Switch

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

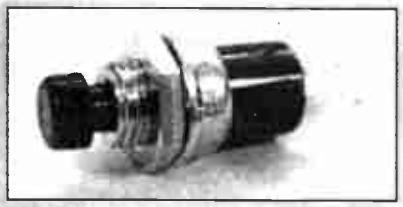
Size Single Pole	14x15.2x7.8
Double Pole	14x15.2x12.8
Contact rating	2A 250V AC
Minimum load	100mA 10v
Initial contact resistance	10MΩ max
Electrical life	$2x10^4$ cycles
Temperature range	-40 to +85°C

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

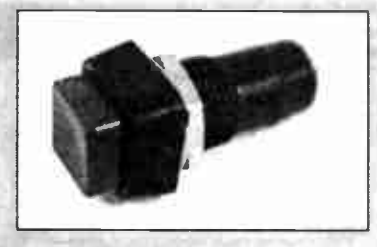
Miniature low cost push to make switches with all plastic body and chrome locking nut offered in a variety of button colours. Non-locking action. Overall dimensions 28mm long, 10.5mm diameter. Rated 250mA 125V Ac. Panel cutout 7mm. These switches are not recommended for industrial applications.

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. **26p;** 25+ 0.18: 100+ 0.15



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

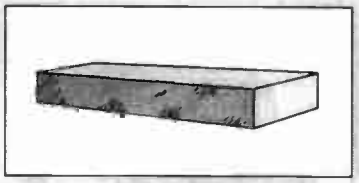
SW2450 A miniature tilt switch consisting of a mercury bubble in small glass envelope. Overall dimensions 18x5mm diameter. Contacts rated at 1A 14V DC. Switch will operate at tilt angle at 10°. **CAUTION** - this switch contains mercury and should NEVER be broken open. **68p; 25+** 0.47: 100+ 0.38

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+ 0.32: 100+ 0.26

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	$15x10^3$ full rotation cycles
Temperature range	-20 to +65°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

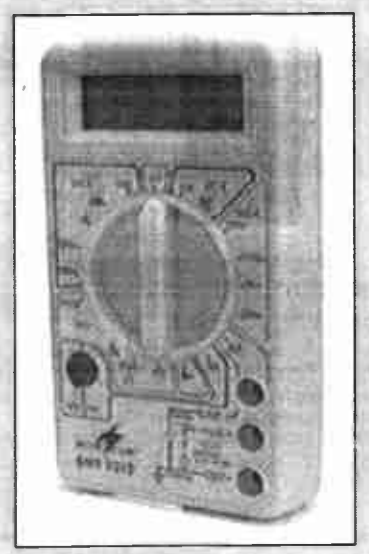
Code	Type	1+	25+	100+
SW2550	Button	**95p**	0.65	0.52
SW2560	Lever	**95p**	0.65	0.52
SW2570	Roller	**95p**	0.65	0.52
SW2580	Short roller	**95p**	0.65	0.52

TEST EQUIPMENT

Analogue Multimeter

TS3010 Input Impedance 20kΩ: 19 ranges (including 10Adc); Fuse and diode protection; Battery tester; Continuity buzzer; Audio output test; Ohms zero; Mirrored scale; Leads with 4mm plugs; Battery and instruction manual included. **£18.50; 10+ 12.63**

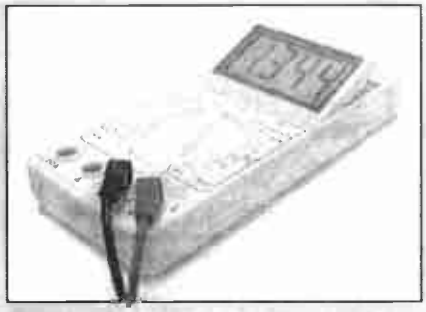
Specification	
AC volts	0-50-250-1kV ±5%
DC volts	0-2.5-10-50-250-1kV ±4%
DC current	0-5m-50m-500m-10A ±5%
Resistance	0-10k-100k-10MΩ ±4%
Battery check	1.5V/75e, 9V/450r
Decibels	-20 to +62dB
Audio power	-8 to +22dB
Protection	Fuse and diodes
Dims	135x89x40mm



Digital Multimeter

TS3020 Digital Multimeter in yellow housing. 10A socket; Diode test; NPN/PNP Transistor testing. Power supply 1 x 9V -trans. -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%



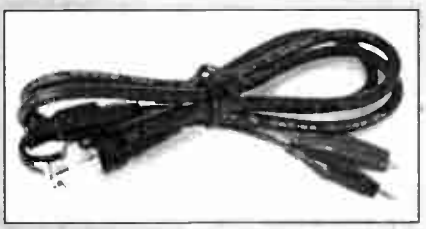
Digital Multimeter

TS3030 Multi-purpose 3.5 digit meter with 21mm high tiltable digital display This model incorporates a transisto checker, diode testers and has a separate 20A socket. **£32.00; 10+ 25.00**

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	185x85x35mm
Weight	350g

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**



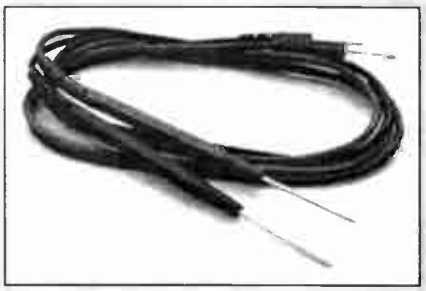
Test Leads

TS3050 50W coaxial lead with BNC plug on one end. Red and black crocodile on the other end. **£2.50; 10+ 1.47**

Maximum current	3A cont
Length	0.9m
Wire diameter	5.5mm

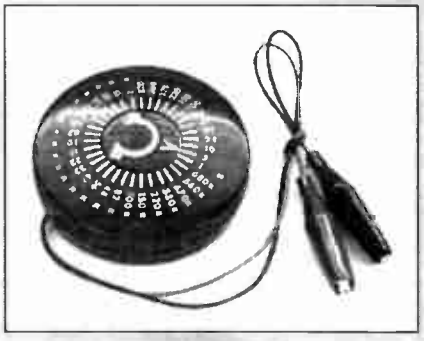
TS3060 Standard long prods to standard 4mm banana plugs. Red and Black. **£1.65; 25+ 1.05**

Maximum current	1.8A cont
Length	1.1m
Wire diameter	2.7mm



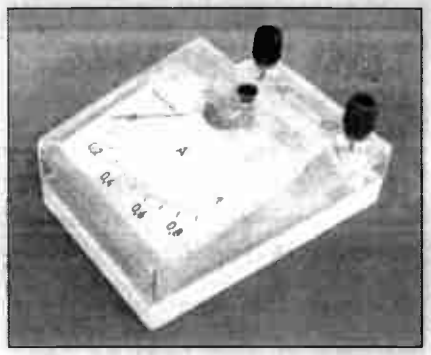
TS3070 Standard basic test leads. Prods ends 2mm. Red and Black. **£1.20; 25+ 0.75**

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

TEL: 01703 236363
FAX: 01703 236307
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TOOLS

Crimp Tool Kit

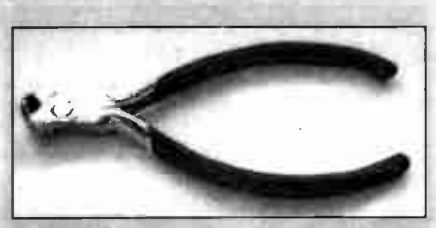
TL3010 A kit containing a varied selection of crimp connectors and insulated crimping tool housed in a hinged plastic case. Comprises 80 assorted insulated terminals and 40 assorted non insulated terminals. Tool incorporates wire cutter and wire stripper. **£4.40; 10+ 3.00**

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

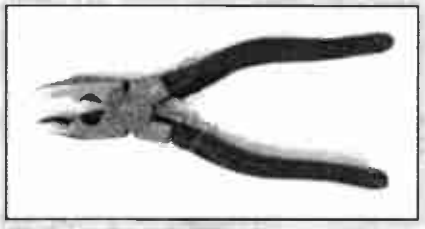
TL2030 A pair of economical good quality lap jointed miniature top cutters with cutting edge for use in confined spaces. Insulated handles and return spring. Size 115mm. **£2.95; 10+ 2.06**

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**

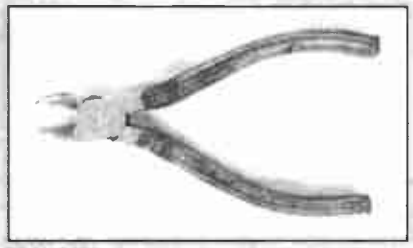
Light Duty Cutters

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. **£1.95; 10+ 1.30**



Electrician's Pliers

TL2100 A pair of economical lap jointed electrician's pliers with PVC covered handles. Nominal length 150mm. **£2.50; 10+ 1.62**



Side Cutters

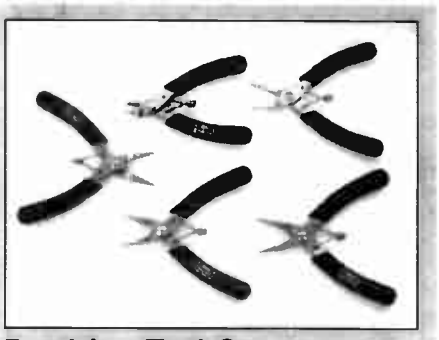
TL2104 A pair of economical lap jointed electrician's side cutters with PVC covered handles. Nominal length 150mm. **£2.20; 10+ 1.47**

Snipe Nose Pliers

TL2106 A pair of economical lap jointed electrician's snipe nose pliers with PVC covered handles. Nominal length 200mm. **£2.40; 10+ 1.62**

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**

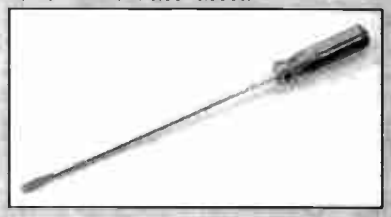


Precision Tool Set

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**

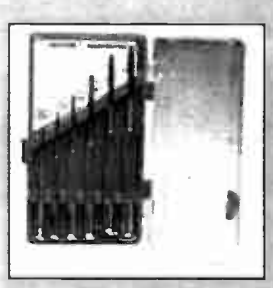
Screwdrivers

A range of high quality screwdrivers with fully hardened and tempered high grade steel shafts. Chrome vanadium steel blades.



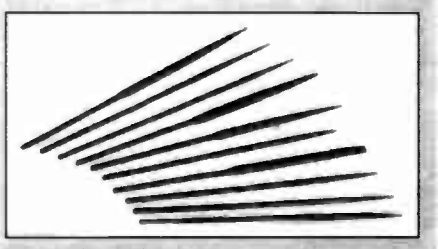
Flat bladed, round shaft parallel tip.

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



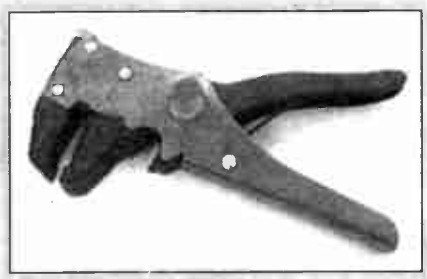
Miniature Flat Blade Screwdriver Set

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**



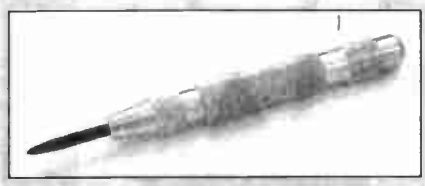
Needle Files

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

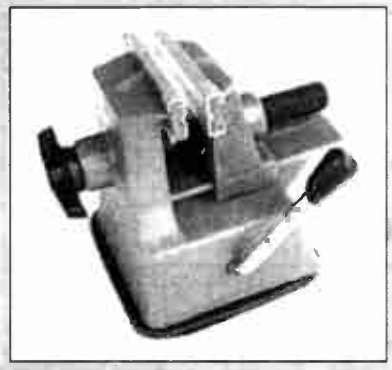
TL2250 A hand operated centre punch which does not require a hammer. The tool is simply positioned and then depressed. The punch then indents the material to the depth set by the adjuster. The tool reset when removed from the material. Suitable for use on PCB materials. **£2.60;** 10+ 1.60

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+ 1.40

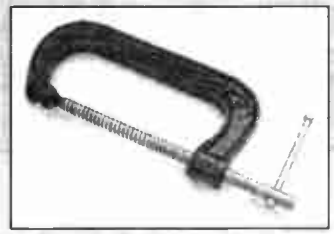
Precision PCB Mini Drill

TL3280 Precision PCB mini-drill. Nominally 12V DC, but works from 5-14V Supplied with collett or 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



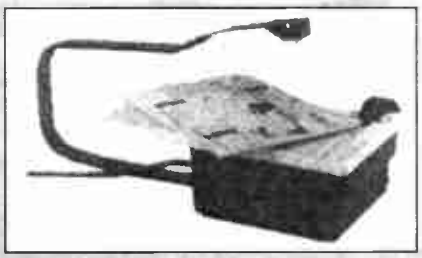
Miniature Vice

TL2290 Miniature plastic and metal vice with strong suction base. Single level action to secure to smooth, no 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**



Shapersaw

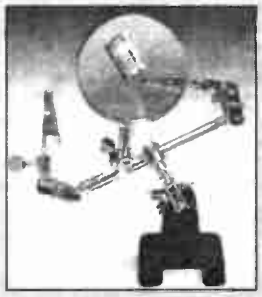
An improved design of this well established tool which permits the accurate, fast cutting of a variety of materials including wood, laminates and metal. The vibratory cutting action ensures even inexperienced operators are completely safe from accidental injury. A large work area of 300x150mm now includes a cutting guide. Blades are inserted and removed with a hexagon screwdriver supplied with the unit. Supplied complete with spare standard fret blades, moulded mains lead and plug and comprehensive instruction sheet. Blades are supplied in packs of 12.

Material type	Max thickness (mm) Code		Blade
Hardwood	8.0	Medium fret	TL2340
Plywood, chipboard	10.0	Medium fret	TL2340
Plastic, perspex	8.0	Medium fret	TL2340
Softwoods	25.0	Coarse fret	TL2350
Balsa, EPS	60.0	Standard fret	TL2330
Melamine	4.0	Standard fret	TL2330
Metals (general) •	up to 8.0	Fine piercing	TL2360
Metals (general)	0.8-3.0	Med piercing	TL2370
Mild steel	1.5	Fine piercing	TL2360
Aluminium	2.5	Med piercing	TL2360

Code	Description	Price
TL4320	Shapersaw	**P.O.A.**
TL2330	Pack standard fret blades	**£2.95**
TL2340	Pack medium fret blades	**£2.95**
TL2350	Pack coarse fret blades	**£2.95**
TL2360	Pack fine piercing blades	**£2.95**
TL2370	Pack medium piercing blades	**£2.95**

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. **£2.40;** 25+ 1.70



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

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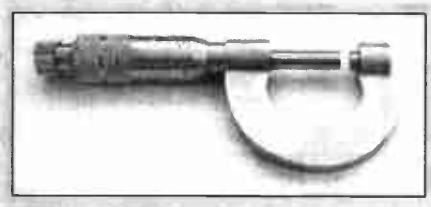
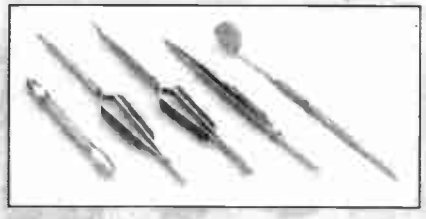


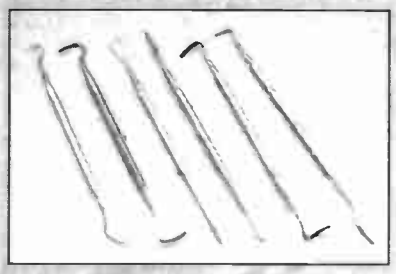
Micrometer

TL2430 Micrometer, 0-25mm supplied in case. Superb value for money. **£8.95**



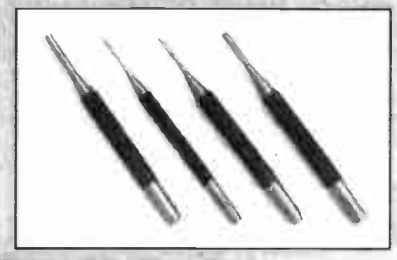
Tweezers

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**



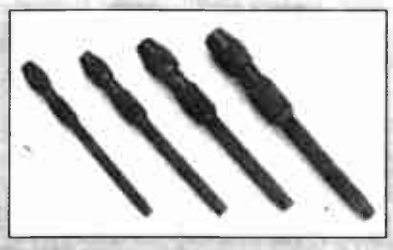
Probe Set

TL2660 Useful set of low cost stainless steel instruments, average length 150mm. **£6.95**



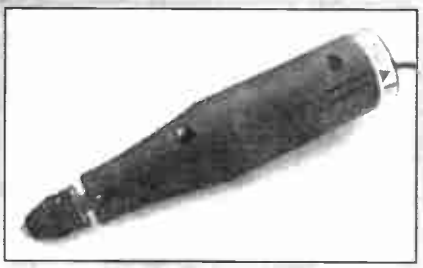
Drive Pin Punches

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

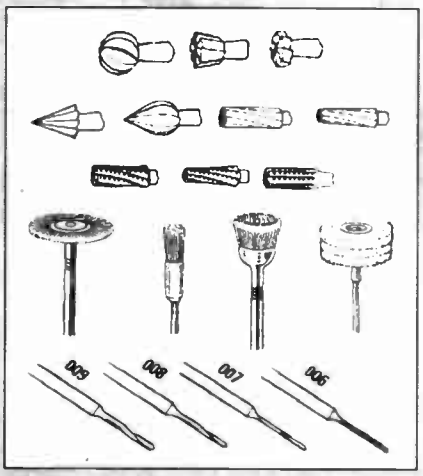
TL2680 Set of 4 pin vices. Covering 0.8-4.8mm. Supplied in plastic wallet and boxed. **£6.95**



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. **£19.99**

TL3450 Also available as a kit with 20 tools. **£32.99**



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**

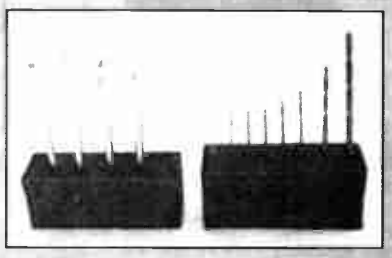
TL3510 Also available as a kit with 20 tools. **£26.99**

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**

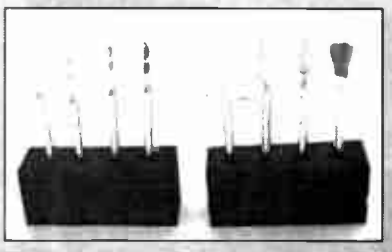
Drill Stand

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 or 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**

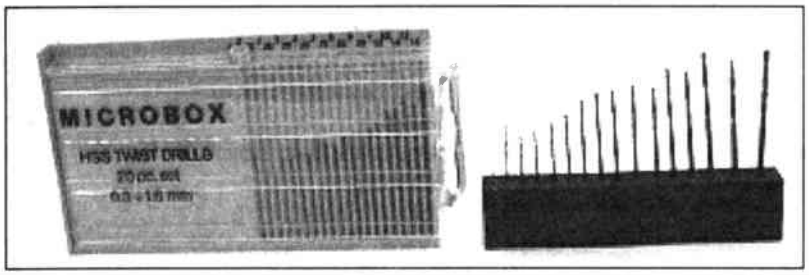


Drill Sets

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**



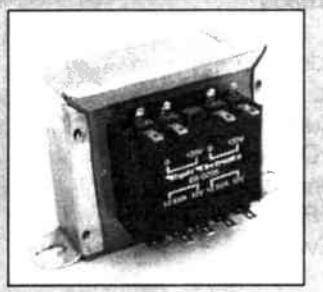
Miniature HSS Twist Drills

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 53x48A.

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

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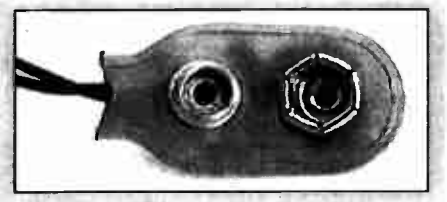
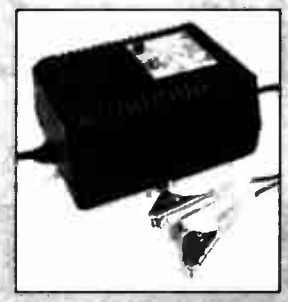


Battery Clips

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.

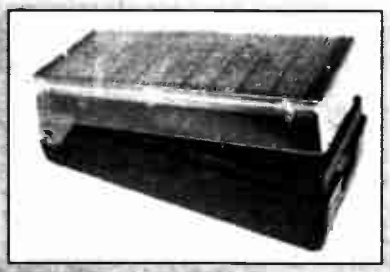
BT4325 6V 1A Charger. **£79.95**
BT4345 12V 1A Charger. **£79.95**

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 4 different sizes of battery: 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 Battery Charger

BT4310 A solar powered battery charger which will charge either 2 AAA, AA, C or D nickel cadmium cells when placed in direct sunlight or strong artificial light. Charging time is obviously dependent upon sunlight levels, but 2 AA cells may be charged in 3-4 hours. The charger is fitted with a stand which allows adjustment to optimum charging position. As the unit requires no mains electricity supply and operates at low voltages it may be used in education with young children with complete confidence. **£12.00;** 10+ 6.90

Technical Specification

Batteries charged	AAA, AA, C and D
Number charged	2 of any one type
Charging time (typical) AAA	1-2 hours
AA	3-4 hours
C	7-9 hours
D	9-12 hours

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	2.85
CB3305	Blue	0.05	2.85
CB3310	Brown	0.05	2.85
CB3315	Green	0.05	2.85
CB3320	Grey	0.05	2.85
CB3325	Orange	0.05	2.85
CB3330	Pink	0.05	2.85
CB3335	Red	0.05	2.85
CB3340	Violet	0.05	2.85
CB3345	White	0.05	2.85
CB3350	Yellow	0.05	2.85

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	2.75
CB3405	Blue	0.05	2.75
CB3410	Brown	0.05	2.75
CB3415	Green	0.05	2.75
CB3420	Grey	0.05	2.75
CB3425	Orange	0.05	2.75
CB3430	Pink	0.05	2.75
CB3435	Red	0.05	2.75
CB3440	Violet	0.05	2.75
CB3445	White	0.05	2.75
CB3450	Yellow	0.05	2.75

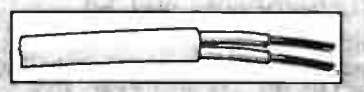
CB3499 Pack containing 5m of each colour. Total 55m. **Price £2.30/pack**

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	0.12	2.20
CB3605	Black extra-flex	0.12	2.20
CB3610	Blue extra-flex	0.12	2.20
CB3615	Green extra-flex	0.12	2.20
CB3620	Brown extra-flex	0.12	2.20
CB3625	White extra-flex	0.12	2.20
CB3630	Yellow extra-flex	0.12	2.20

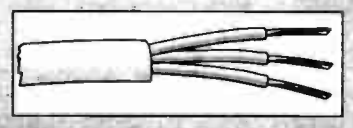
CB3677 Pack containing 5m of each colour total 35m. **Price £2.95/Pack**



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	0.27	14.95
CB4820	100M 3A White	0.27	14.95



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	0.38	21.95
CB4840	100M 3A White	0.38	21.95

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	0.50	28.95
CB4860	100M 6A White	0.50	28.95

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)

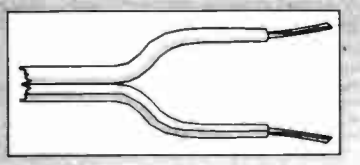
Code		Price/m	Price/reel
CB4870	50M 13A Black	0.90	29.95
CB4880	50M 13A White	0.90	29.95

INDEX

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

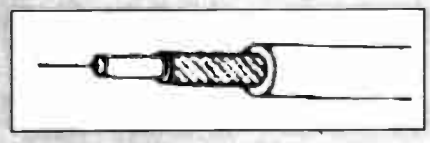
A very heavy duty twin cable with a 'figure 8' profile ideal for high power speaker connection suitable for power amplifiers up to 500W output. **CB4922** Figure 8 heavy duty 42/0.2. For high power audio systems. Max current 15A. White sheath 6x3mm with black polarity line. **42p/Metre; £22.95/Reel**

CB4924 Figure 8 heavy duty 79/0.2. Professional quality Max current 25A. Size 6x3mm. White sheath with black polarity line. **68p/Metre; £34.95/Reel**

Ribbon Cable

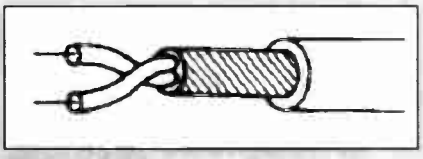
Parallel stranded conductors, easily split in any number of ways. 0.05 spacing. Red identification band on grey cable. 7/0.127. Conductors rate 1A 300V

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**



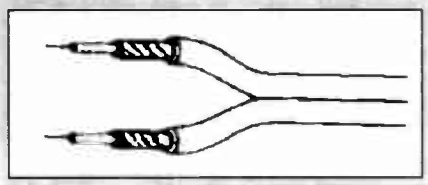
Screened Audio Single Core

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**



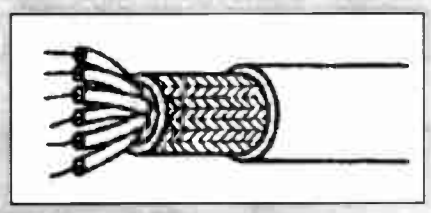
Microphone

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 7/0.2mm stranded conductors. Nominal conductor area 0.05m². Lap screened. Dims 4.0 x 2.0mm. Black. 100m reel. **24p/Metre; £12.95/Reel**



Screened Multicore

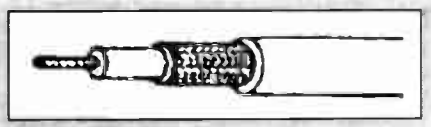
Screened multicore cable. All cores colour coded. Black outer sleeving. 100M reel.

CB4945 6 x 7/0.1mm. Nominal Conductor area: 0.05mm². Lap screen. O.D: 4mm. **40p/Metre; £19.95/Reel**

CB4950 10 x 7/0.13mm. Nominal conductor area: 0.09mm². Braided screen. O.D: 5.6mm. **46p/Metre; £23.95/Reel**

CB4960 15 x 7/0.13mm. Nominal conductor area: 0.09mm². Braided screen. O.D: 6mm. **64p/Metre; £32.95/Reel**

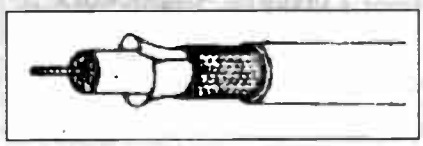
CB4965 25 x 7/0.13mm. Nominal conductor area: 0.05mm². Braided screen. O.D: 6mm. **76p/Metre; £37.95/Reel**



Coaxial

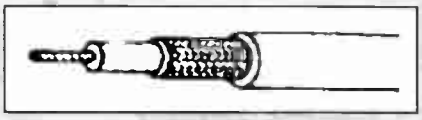
Low-loss UHF coaxial cable. 1/1.0mm conductor. Nominal conductor area: 0.78mm². 75Ω impedance.. Braided screen. Semi-air spaced. O.D 6.5mm. 100m reel.

Code	Colour	Price/m	Price/Reel
CB4970	Brown	**36p**	**18.95**
CB4975	White	**36p**	**18.95**



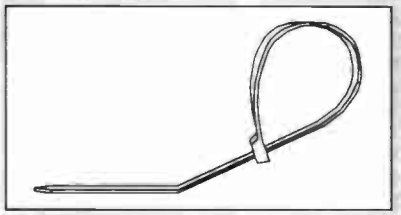
Satellite Cable

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. **36p/Metre; £17.95/Reel**



Natural Cable Ties

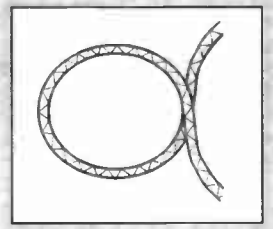
White nylon cable ties with a non-releasable ratchet lock action.

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

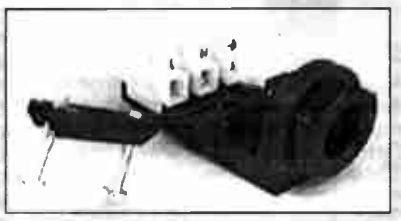
Self adhesive bases which will accept above cable ties. The base has a fixing hole of 5mm as an alternative.

Code	Size	Colour	Pk/20	100+
CB2760	19x19mm	Natural	**0.97**	0.35
CB2770	25x25mm	Natural	**1.57**	0.60



Spiral Cable Wrapping

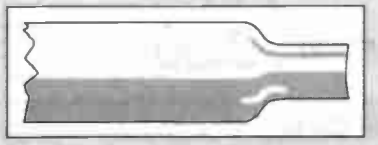
CB3780 Preformed binding which can be expanded by wrapping round cable forms. Natural colour. Supplied in 10m lengths. Diameter 6mm. Maximum diameter 50mm. **£1.86 per pack;** 10+ 1.05; 25+ 0.81



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
CP2B590PF	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 $10^{10}\Omega$
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 75×10^{-4} at 1kHz
Working Voltage	250V dc
Insulation Resistance	Greater than $10^{10}\Omega$
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

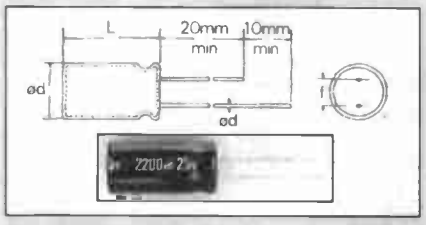
Tolerance	±20%
Working Voltage	250Vac
Climatic category	25/085/21 DIN 40040
Temperature range	-25 to +85°C

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.

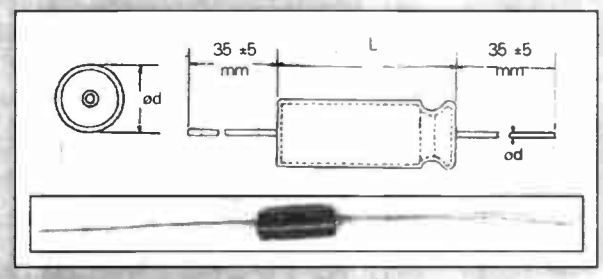
Case Code	L	D	f
A	11	5	2
B	11	6	2.5
C	12	8	3.5
D	12.5	10	5
E	17.5	10	5
F	18.5	13	5
G	20	13	5
H	25	13	5
I	26	26	7.5

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

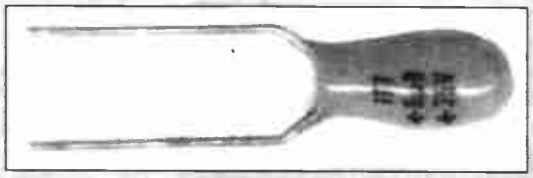
Miniature axial lead electrolytic capacitors manufactured to high technical and quality standards. All types are sleeved. Ripple current quoted is at 85°C

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

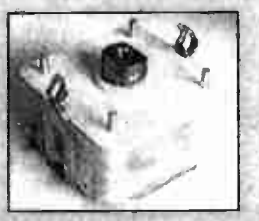
Tolerance	±20%
Tangent of loss angle	0.012max
Leakage current	0.04CV or 2µA whichever is greater.
Temperature range	-55 to +85°C

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	28p	0.21
CP2K22PF	2-22pf miniature film	32p	0.23
CP2K65PF	5.5-65pf miniature film	35p	0.25



Miniature Tuning Capacitor

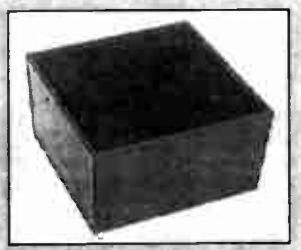
CP2K126PF A miniature tuning capacitor suitable for ZN414 circuits and crystal sets. Comprises AM sections of 126pF with trimmers and FM sections of 20pF with trimmers. Control shaft is a flatted 6mm diameter tapped with an M2.5 thread. Rotation 180°. Max. voltage 100V. Dimensions 20x20x12.5mm. **£1.25**

Jackson Variable Capacitors

CP2K500PF 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 1/4in. **£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

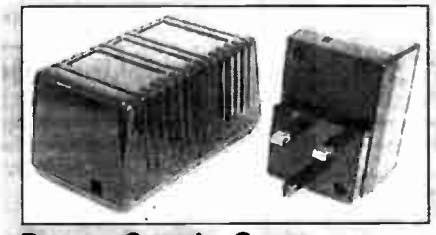
The TSU range of snap-in electrolytic PCB mount capacitors offers extremely high volumetric efficiency. These capacitors are ideal for all applications requiring high CV values and high voltage operation including switched mode power supplies. Snap-In terminals on a 10mm pitch for direct mounting into 2mm holes.

Code	Value	Voltage	1+	25+	100+
CP2I-16-4700M	4700µ	16V	1.88	1.20	0.96
CP2I-16-10000M	10000µ	16V	2.68	1.72	1.38
CP2I-35-4700M	4700µ	35V	2.61	1.67	1.34
CP2I-35-10000M	10000µ	35V	4.61	2.95	2.36
CP2I-63-1000M	1000µ	63V	2.17	1.39	1.11
CP2I-63-2200M	2200µ	63V	2.56	1.64	1.31
CP2I-63-4700M	4700µ	63V	4.47	2.86	2.28
CP2I-100-1000M	1000µ	100V	2.93	1.88	1.50

ABS Boxes

Professional quality versatile boxes for use where both costs 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.

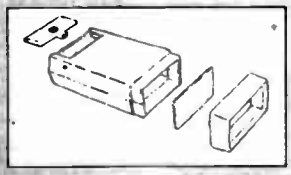
Code	External Dimensions	1+	25+	100+
CS4207	75x51x25	81p	0.58	0.45
CS4208	111x57x22	£1.01	0.70	0.56
CS4210	79x61x40	£1.54	1.07	0.85
CS4213	100x76x41	£1.70	1.18	0.94
CS4216	118x98x45	£1.93	1.35	1.07
CS4215	150x80x50	£2.47	1.71	1.37
CS4217	150x100x60	£2.77	1.92	1.54
CS4220	177x120x83	£3.83	2.67	2.13
CS4218	216x130x85	£5.89	4.10	3.27
CS4219	220x150x64	£4.44	3.16	2.53



Power Supply Cases

CS4310 ABS box with 13A pins in-built for a variety of different supplies. Overall size 75x50x50mm. **£1.28;** 25+ 0.97; 100+ 0.78

CS4320 Two part ABS box 115x60x57mm ideal for power supplies. **£1.26;** 25+ 0.87; 100+ 0.77

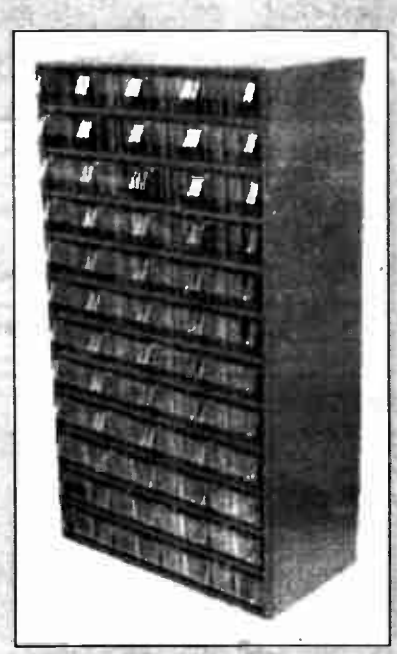


CS4330 Versatile case with built-in battery compartment. Case separates into two halves and front panel is removable. Ideal for DVM's or hand held equipment. Length 120mm, width 66mm, height 32mm. Battery compartment will take PP3. **£2.60;** 25+ 1.98; 100+ 1.58

Miniature Aluminium Boxes

A range of attractive aluminium boxes, finished in grey for a wide range of application 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 540x300x160mm, 48 plastic drawers, each drawer is divisible into a maximum of 6 compartments. Individual drawer size 155x70x37mm. **£37.95;** 4+ 28.04

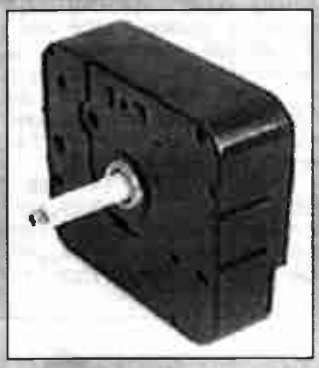
CS2442 Dividers in packs of 10. **£1.40;** 100+ 0.10

PRICES IN BOLD INCLUDE VAT; QTY PRICES IN LIGHT DO NOT

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

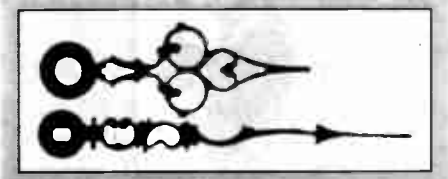
Code	Spindle Lengths H	M	S
CL3101	11.5	16.3	20.5
CL3202	6.0	11.5	15.5
CL3303	6.8	8.1	11.0

Hands

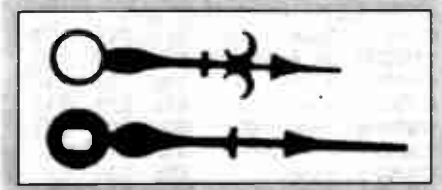
A selection of modern and traditional hands, all of which will fit either movement described.

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

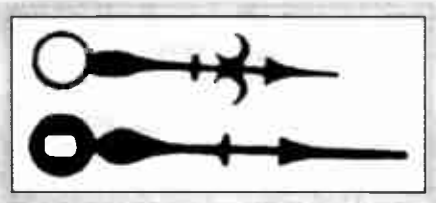
CL2430	60	80	Black	48p	0.31	0.24
CL2440	60	80	Brass	52p	0.34	0.26



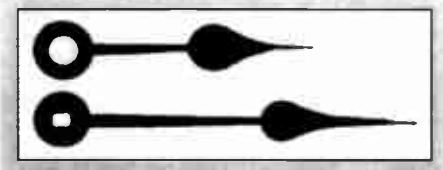
CL2450	47	68	Black	48p	0.31	0.24
CL2460	47	68	Brass	52p	0.34	0.26



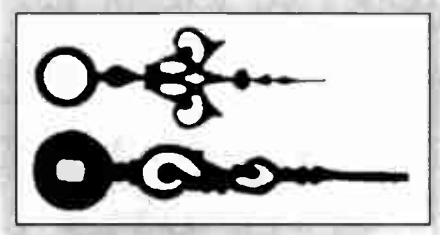
CL2470	34	46	Black	36p	0.23	0.18
CL2480	34	46	Brass	40p	0.26	0.20



CL2490	58	77	Black	50p	0.33	0.25
CL2500	58	77	Brass	54p	0.36	0.27

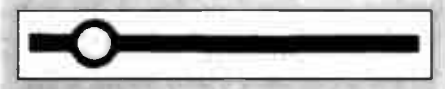


CL2510	53	75	Black	48p	0.31	0.24
CL2520	53	75	Brass	52p	0.34	0.26



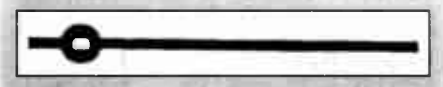
CL2530	35	44	Black	46p	0.30	0.23
CL2540	35	44	Brass	50p	0.33	0.25

Measured from spindle centre to end

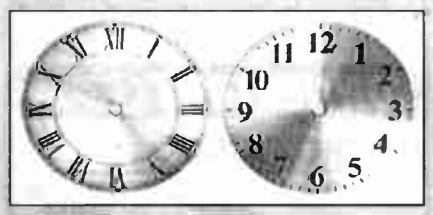


Second hands

Code	Length	Colour	1+	25+	100+
CL2550	60	Red	28p	0.18	0.14
CL2560	60	White	28p	0.18	0.14

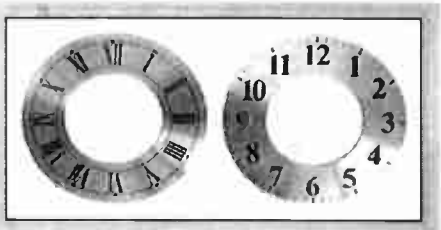


CL2570	80	Red	28p	0.18	0.14
CL2580	80	White	28p	0.18	0.14



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
CL2685	Brass	6"	Roman	£1.96	1.32	1.06

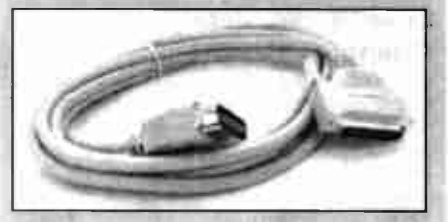


Chapter Rings

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.

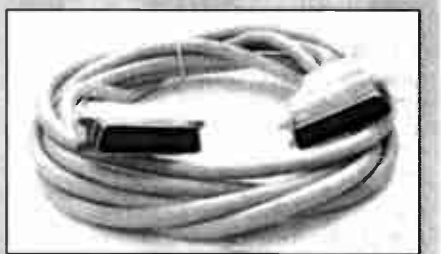
COMPUTER PRODUCTS



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
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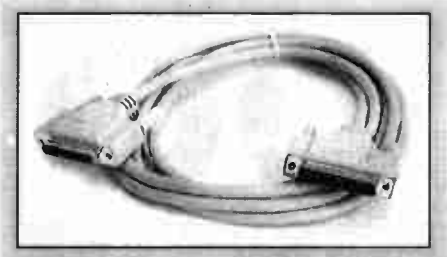
27 Park Road · Southampton · SO15 3UQ



RS232 Extension Cables

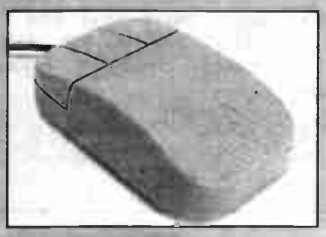
RS232 data cables completely screened end to end with 25 way 'D' connectors at each end. supplied in a variety of lengths in either male (plug) to male (plug) or male (plug) to female (socket) styles. Manufactured from 7/0.2 cable, sheathed in grey PVC with aluminium screen to minimise crosstalk and 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**

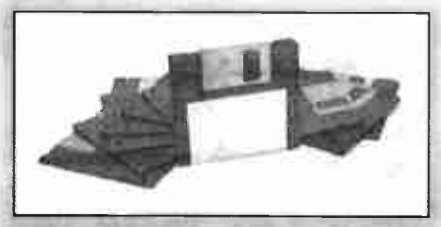


XT/AT Serial Mouse

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

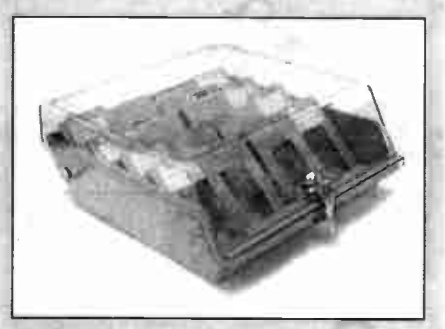
Mechanism	Optional encoder
Compatibility	Microsoft and MSC compatible
Dynamic Resolution	400DPI
Tracking Speed	500mm/second
Connector	RS232 9 way female
System Requirements	IBM PC XT/AT or compatible



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	1.02
CN2002	3 way cable plg	**£2.11**	1.22	0.92
CN2003	3 way chassis skt	**£1.08**	0.62	0.47
CN2004	3 way chassis plg	**87p**	0.50	0.38

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	1.09
CN2007	3 way cable plg	**£2.13**	1.20	0.90
CN2008	3 way chassis skt	**£2.66**	1.50	1.13
CN2009	3 way chassis plg	**£1.97**	1.11	0.84

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

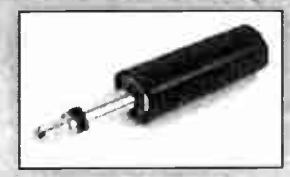
DIN Chassis Sockets

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 plg	**41p**	0.23	0.17
CN2034	3.5mm screened plg	**66p**	0.44	0.33
CN2035	3.5mm stereo plug	**81p**	0.46	0.35

Standard Jack Plugs

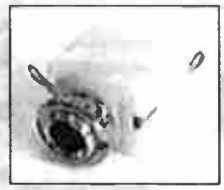
Standard insulated jack plugs of 0.25in nominal diameter. All types include strong black plastic barrels and integral cable protector sleeve. Solder termination.

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.

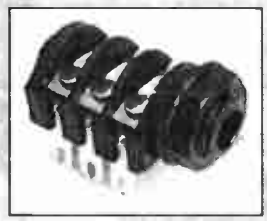
Code	Type	1+	25+	100+
CN2038	Screened plug	**84p**	0.49	0.37
CN2039	Screened stereo plg	**£1.09**	0.69	0.53



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

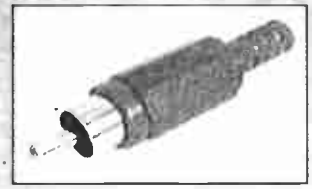
Chassis mounting jack sockets to suit jack plugs. Available with unswitched or switched contacts. Switched contact types have normally closed contacts which open upon insertion of the plug. Will accept a wide range of standard 0.25in plugs.

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.

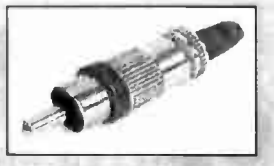
Code	Type	1+	25+	100+
CN2050	2.5mm	**32p**	0.20	0.15
CN2051	3.5mm	**32p**	0.20	0.15
CN2052	3.5mm stereo	**37p**	0.23	0.17
CN2053	Standard mono ¼"	**43p**	0.28	0.20
CN2054	Standard stereo ¼"	**48p**	0.30	0.22



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

CM2062 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).

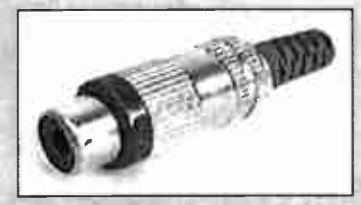
Code	Colour	1+	25+	100+
CN2072	Red	**£1.73**	1.18	0.95
CN2073	Black	**£1.73**	1.18	0.95

Phono Line Sockets

Insulated cable mounting phone 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

TEL: 01703 236363
FAX: 01703 236307
GREENWELD
27 Park Road · Southampton · SO15 3UQ

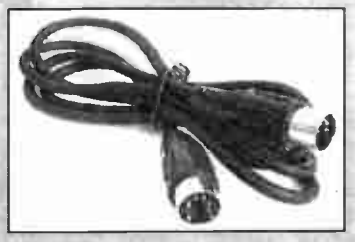


Screened Phono Line Sockets

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.

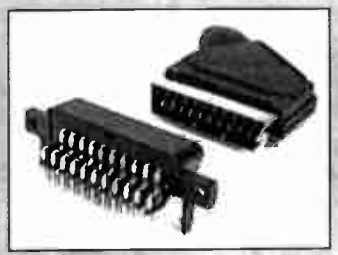


5pin 180 DIN plug to 5 pin DIN plug. Fully moulded construction employing four core screened cable. Overall length 1.5M, 3M or 5 metres.

Code	Type	Length	1+	50+
CN3101	DIN-DIN	1.5M	**£1.52**	0.86
CN3102	DIN-DIN	3M	**£2.30**	1.25
CN3103	DIN-DIN	5M	**£2.70**	1.43

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.

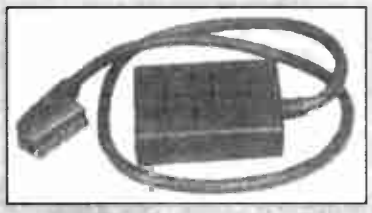
CN3105	Phono-Phono	1.5M	**82p**	0.43
CN3106	Phono-Phono	3M	**£1.36**	0.73
CN3107	Phono-Phono	5M	**£1.71**	0.90



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	0.37
CN2111	Scart PCB socket	**60p**	0.40	0.32

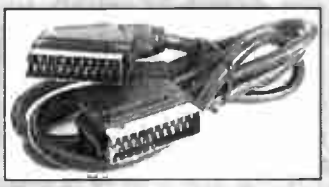


Scart Adaptor

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.

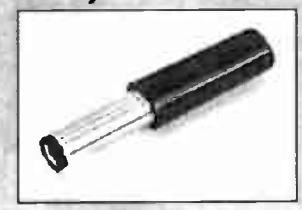


CN3113 Scart plug to Scart plug. Length 1.5M. **£3.50;** 10+ 2.18

CN3114 Scart plug to 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	0.28
CN2133	2.5mm	**44p**	0.35	0.28

Cigar Lighter Plugs

CN2137 Cigar lighter line socket for cigar lighter plug. **87p;** 25+ 0.49; 100+ 0.37

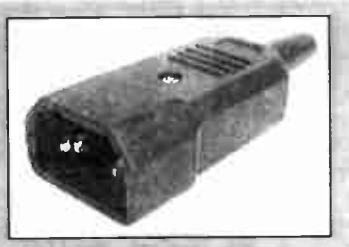
CN2135 Quality cigar lighter plug. **34p;** 25+ 0.19; 100+ 0.14

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

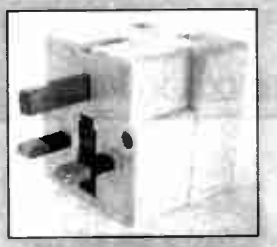


Rewireable Cable Plug

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+ 1.12**

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**

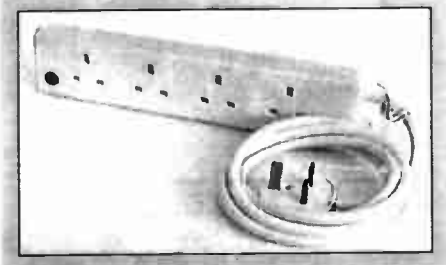


2 Way Mains Adaptor

CN2154 2 way adaptor. **£1.50; 25+ 0.80**

Bakelite 13A Mains Plugs

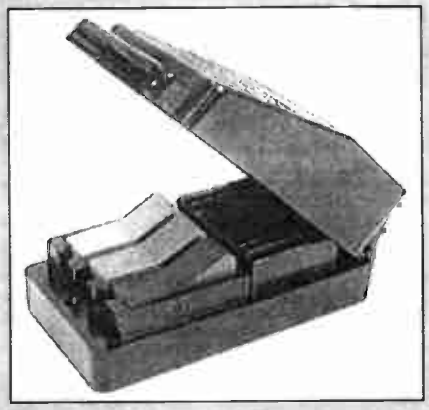
CN3150 13A plug fused at 13A. **64p; 20+ 0.40; 100+ 0.34**



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**

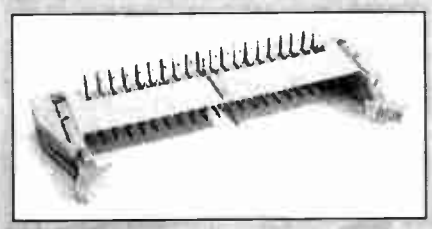


Quicktest - 13A Mains Connector

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**

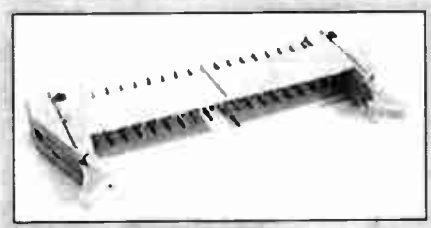
MULTIPOLE

IDC Connectors



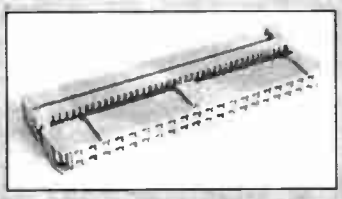
Right Angle PCB Plugs

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

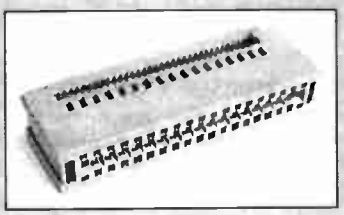
Code	Type	1+	25+	100+
CN2250	10 pin	**58p**	0.33	0.25
CN2255	20 pin	**71p**	0.41	0.31
CN2260	26 pin	**94p**	0.54	0.41
CN2265	34 pin	**£1.24**	0.72	0.54
CN2270	40 pin	**£1.63**	0.94	0.71



Cable Mounting Socket

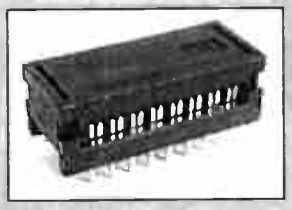
Cable mounting sockets which mate directly with the PCB mounting plugs. Complete with cable strain relief. Beryllium-copper contacts. Bump polarised.

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+
CN2350	20 way	**40p**	0.24	0.18
CN2360	40 way	**46p**	0.27	0.20



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

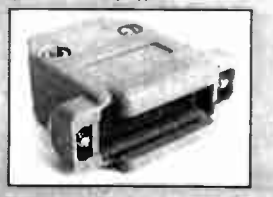
IDC 'D' Connectors

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 tow 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

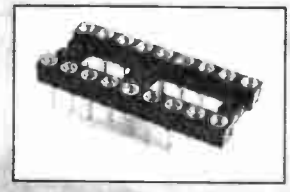
A range of ABS covers to fit all 'D' connectors listed. Features captive screw locks with long shanks (finger and screwdriver slots) and adjustable cable clamps. Can be fitted to connectors that have already been wired.

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

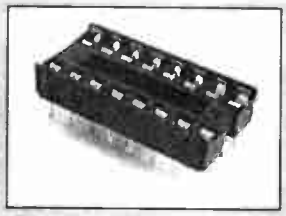
A low profile high-quality machined contact SIL socket. Moulded in black glass-filled flame retardant polyester. Supplied as a 20 or 32 way strip which may be broken down to the required number of ways. Temperature range -50 to +180°C.

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

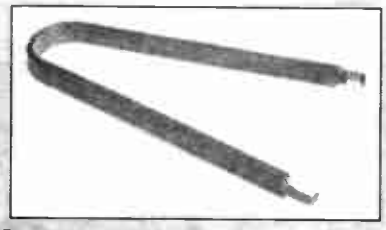
Code	Type	1+	Pk/10	100+	1k+
CN2615	8 pin	16p	£1.24	0.083	0.066
CN2620	14 pin	28p	£2.18	0.145	0.118
CN2625	16 pin	32p	£2.48	0.165	0.132
CN2630	18 pin	35p	£2.71	0.181	0.145
CN2635	20 pin	40p	£3.09	0.206	0.165
CN2640	22 pin	44p	£3.42	0.228	0.182
CN2645	24 pin	48p	£3.72	0.248	0.198
CN2650	28 pin	56p	£4.34	0.289	0.231
CN2655	40 pin	80p	£6.19	0.413	0.330



Low Profile DIL IC Sockets

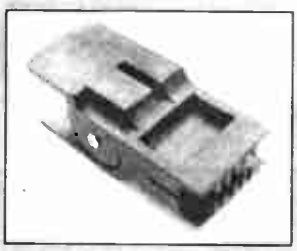
Low cost sockets with side-wipe contacts.

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



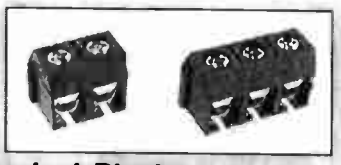
IC Extraction Tool

CN2760 Simple spring clip tool for easy extraction of integrated circuits. Suitable for use with ICs with up to 28 pins. Insulated handle. **70p**; 25+ 0.45



IC Extraction/Insertion Tool

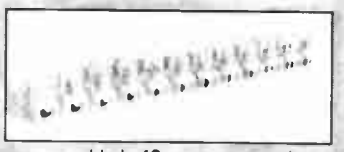
CN2770 A high quality spring loaded tool for use with 0.3in (8, 14.16.18 and 20 pin) devices. The tool may be for insertion or extraction of IC's. **£1.17**; 25+ 0.75



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

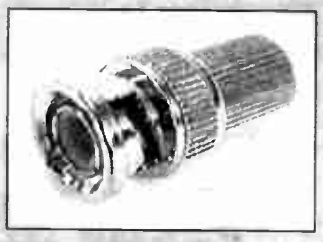
Code	Type	1+	25+	100+
CN2850	2A 95x16x13mm	50p	0.32	0.254
CN2855	5A 117x19x15mm	50p	0.32	0.254
CN2860	15A 133x25x18mm	88p	0.55	0.44
CN2865	30A 173x30x23mm	£1.72	1.07	0.86

RF/COAXIAL

BNC Connectors

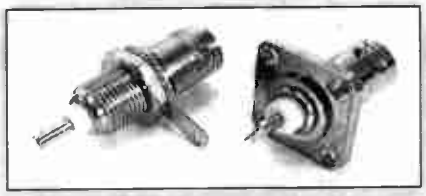
A range of quality constant impedance connectors with nickel plated bodies, PTFE insulator and silver plated brass contacts. Offered in either 50 ohm (accept RG58/U or Belden 9907 cable) or 75 ohm impedance (accepts RG59B/U cable).

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

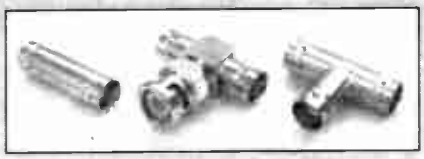
CN2872 Constant impedance high quality connector. Connection is made via screw connection for the signal and by crimp connection to the outer screen which also acts as a cable clamp. A soft moulded PVC cover covers the completed connector. 50 ohm impedance. Suitable for use with RG58C/U cable. **£1.44**; 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	

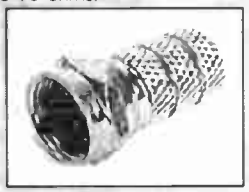
Code	Type	1+	10+
CN2880	Fixed 10:1	**£20.95**	14.39
CN2881	Switched 1:1, 10:1	**£21.95**	15.42
CN2882	Pk of 3 test hooks	**£6.95**	4.72
CN2883	Pk of 5 screw in tips	**£4.50**	2.90

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

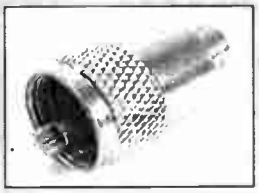
CN2885 A rapid assembly 'twist-on' plug for easy and fast termination to satellite TV cable type RG6/CT100. Bright nickel plated body. 75 ohm impedance. **22p;** 25+ 0.15; 100+ 0.12

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+ 0.14

F Adaptor

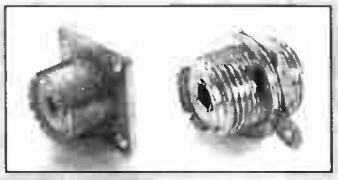
CN2887 An adaptor suited to mating two F plugs comprising two jacks back to back. Bright nickel plated brass body. 75 ohm nominal impedance. **25p;** 25+ 0.18; 100+ 0.14



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



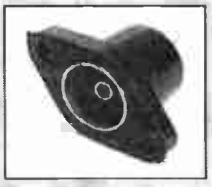
UHF Sockets

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	**97p**	0.65	0.52
CN2893	Round socket	**81p**	0.55	0.44

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

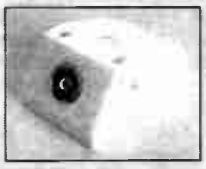
CN2895 Socket to suit above. Fits flush to chassis surface. Panel cut-out 13.2mm. Fixing centres 19mmx6BA. **28p;** 25+ 0.19; 100+ 0.15

Line Socket

CN2896 Free cable mounting socket to suit coax plug. Aluminium construction. Fully screened. **58p;** 25+ 0.40; 100+ 0.32

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

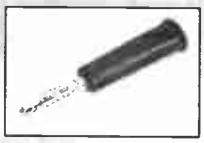
A range of insulated panel mounting 2mm sockets available in a wide range of colours. Nickel plated brass turned insert. Solder termination. Rated at 5A. Panel cutout 5.1mm.

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 stickable 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

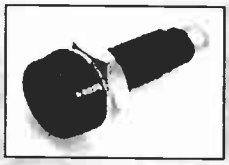
4mm plug with 4mm socket in the rear providing an in-line stacking facility. The lead wire is clamped in position by screw located at the bottom of the 4mm socket. Nickel plated brass insert with stainless steel plug spring. 10A rating.

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
CN2854	White	**75p**	0.50	0.40
CN2855	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	**22p**	0.15	0.12
CN2961	Blue	**22p**	0.15	0.12
CN2962	Green	**22p**	0.15	0.12
CN2963	Red	**22p**	0.15	0.12
CN2964	White	**22p**	0.15	0.12
CN2965	Yellow	**22p**	0.15	0.12

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.

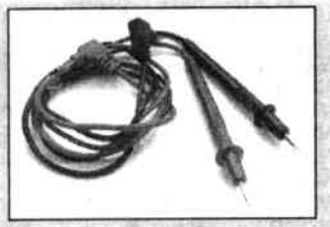
Code	Colour	1+	25+	100+
CN2973	Black	**9p**	0.06	0.045
CN2974	Blue	**9p**	0.06	0.045
CN2975	Green	**9p**	0.06	0.045
CN2976	Red	**9p**	0.06	0.045
CN2977	White	**9p**	0.06	0.045
CN2978	Yellow	**9p**	0.06	0.045

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+ 1.20

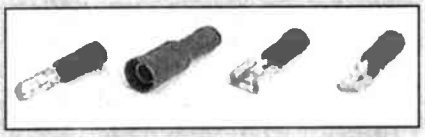
Microminiature Probes

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+ 1.15

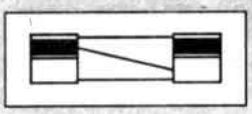


Crimp Connectors

Red sleeve (for cable up to 1.65mm dia), crimp connection supplied in packs of 10, 100, or 1000.

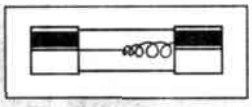
Code	Type	Pk of 10	100	1k
CN2990	Male bullet	80p	0.04	0.03
CN2991	Female bullet	80p	0.04	0.03
CN2992	Plain 0.25" blade	80p	0.04	0.03
CN2993	Insulated 0.25" receptacle	80p	0.032	0.026

FUSES



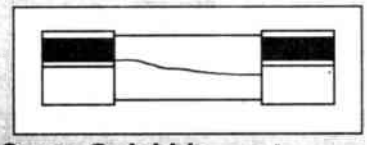
20mm Quickblow

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



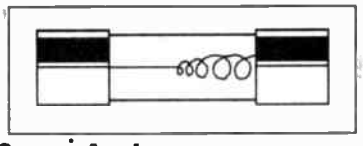
20mm Antisurge

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
FS2B8A	8A	18p	0.11	0.09
FS2B10A	10A	18p	0.11	0.09



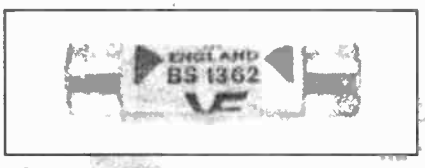
32mm Quickblow

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



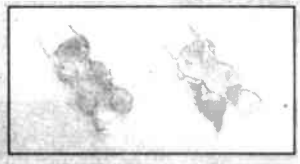
32mm Antisurge

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



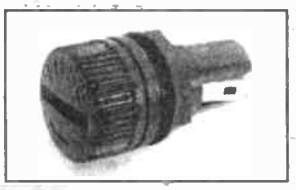
25mm (1") Plug Top

Code	Type	1+	10+	100+
FS2E2A	2A	16p	0.12	0.08
FS2E3A	3A	16p	0.12	0.08
FS2E5A	5A	16p	0.12	0.08
FS2E10A	10A	16p	0.12	0.08
FS2E13A	13A	16p	0.12	0.08



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

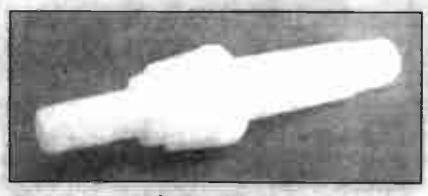
Low Profile 20mm Fuseholder

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

PRICES IN BOLD INCLUDE VAT; QTY PRICES IN LIGHT DO NOT

Finger Release 1¼x¼" Fuseholder

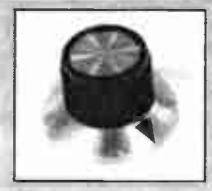
FS2040 A panel mounting 1¼x¼" finger release fuseholder moulded in phenolic resin. Maximum fuse rating 10A 250V AC. **55p**; 25+ 0.45; 100+ 0.36



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. **15p**; 25+ 0.10; 100+ 0.09

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	0.16
HW2420	Yellow cap	**30p**	0.20	0.16
HW2430	Green cap	**30p**	0.20	0.16
HW2440	Blue cap	**30p**	0.20	0.16
HW2450	Black cap	**30p**	0.20	0.16

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+ 0.16

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 ¼"	**£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	**£1.44**
HW2725	4BA	**£1.34**
HW2730	6BA	**£1.34**
HW2735	8BA	**£1.45**

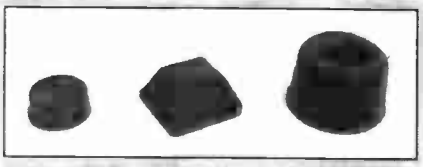
Hardware Packs

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	**38p**	0.025	0.019
HW2810	13mm	3.6mm	**48p**	0.031	0.024

Square Profile

Code	Width	Height	Pk/10	100+	1k+
HW2820	10mm	5mm	**48p**	0.031	0.024
HW2830	12.5mm	5.7mm	**52p**	0.034	0.026
HW2840	20mm	8mm	**92p**	0.06	0.046

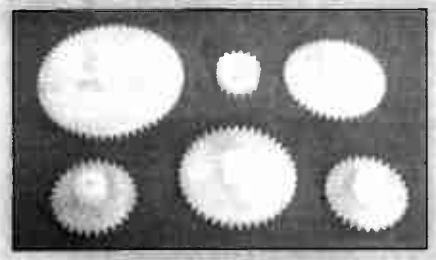
Screw On Feet

Moulded with a 3.5mm mounting hole. Black or grey finish, according to availability.

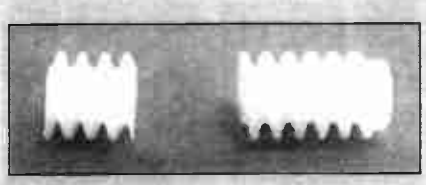
Code	Dia	Height	Pk/10	100+
HW2850	15.5mm	10mm	**£1.40**	0.09
HW2860	19mm	10mm	**£1.60**	0.10

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	32	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

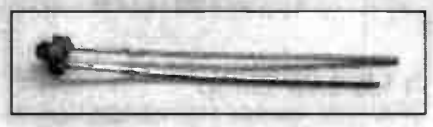
A range of 3 small motors operating on 1.5 to 4.5V with many applications including models, robotics and educational demonstrations.

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+ 0.40; 100+ 0.30

OPTOELECTRONICS



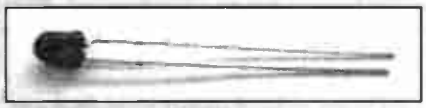
Miniature 1.8mm LED

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	2.5V	5V	2.0 at 10mA	30°	660
Green	30mA	2.2V	2.5V	5V	5 at 10mA	30°	565
Amber	30mA	2V	2.5V	5V	12.5 at 10mA	30°	625
Yellow	30mA	2.1V	2.5V	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	2.8V	5V	5@10mA	60°	625
Bright red	30mA	2V	2.5V	5V	50@10mA	60°	625
Green	25mA	2.2V	2.5V	5V	32@10mA	60°	565
Yellow	30mA	2.1V	2.5V	5V	32@10mA	60°	590
Amber	30mA	2V	2.5V	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°	625
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

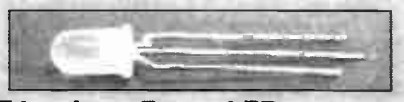
Code	Type	1+	100+	1000+
OP2205	Red	**10p**	0.05	0.035
OP2210	Bright Red	**10p**	0.05	0.035
OP2215	Green	**12p**	0.06	0.05
OP2220	Yellow	**12p**	0.06	0.05
OP2225	Amber	**12p**	0.06	0.05

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. **21p;** 25+ 0.13; 100+ 0.11

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	2.5V	5V	40@20mA	60°	625
Green	30MA	2.2V	2.5V	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. **25p;** 25+ 0.18; 100+ 0.15

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	2.5V	5V	90@20mA	60°	625
Green	30mA	2.2V	2.5V	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

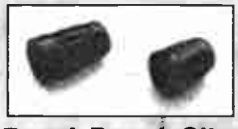
	I_f max	V_f typ.	V_f max	V_R max	Int at I_f mcd	View angle	Wave length
Red	50mA	9-12V	3.6V	0.5V	8@9V	120°	660
HE Red	50mA	9-12V	3.6V	0.5V	80@9V	120°	625
Green	50mA	9-12V	3.6V	0.5V	32@9V	120°	565
Yellow	50mA	9-12V	3.6V	0.5V	32@9V	120°	590

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	**14p**	0.09	0.07
OP2380	Recessed	**14p**	0.09	0.07

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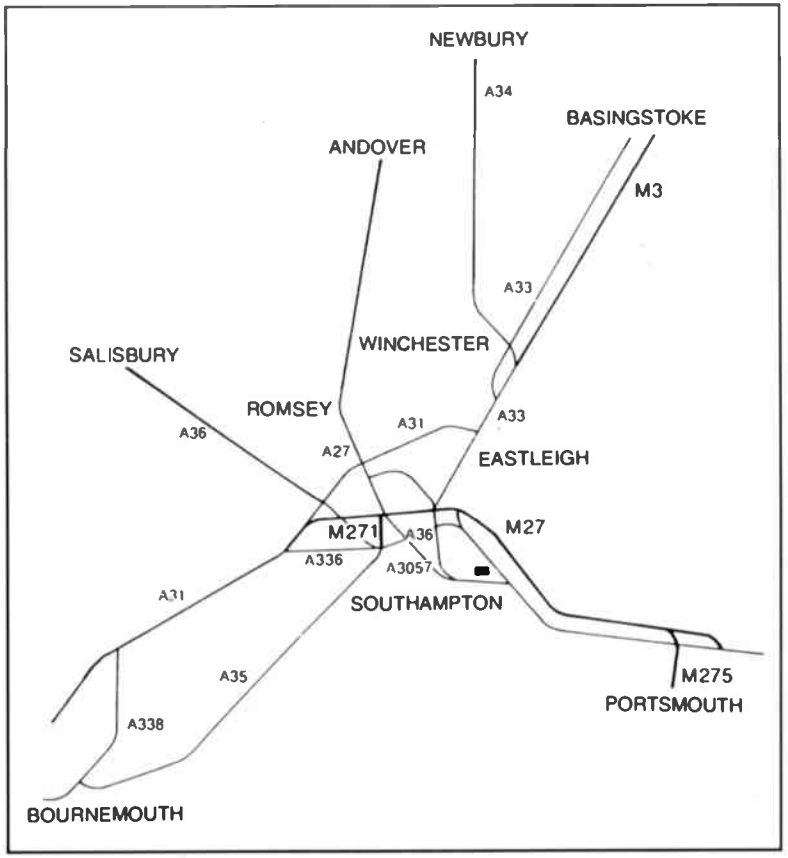

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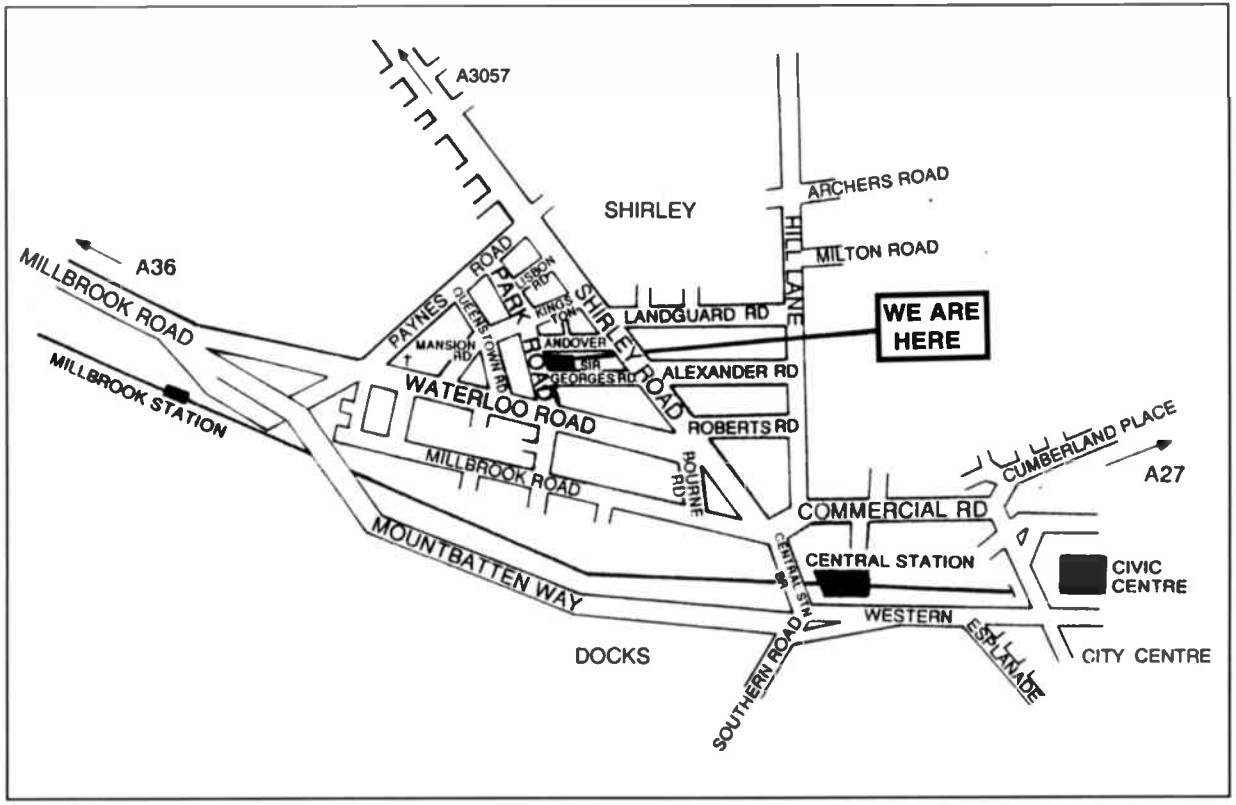


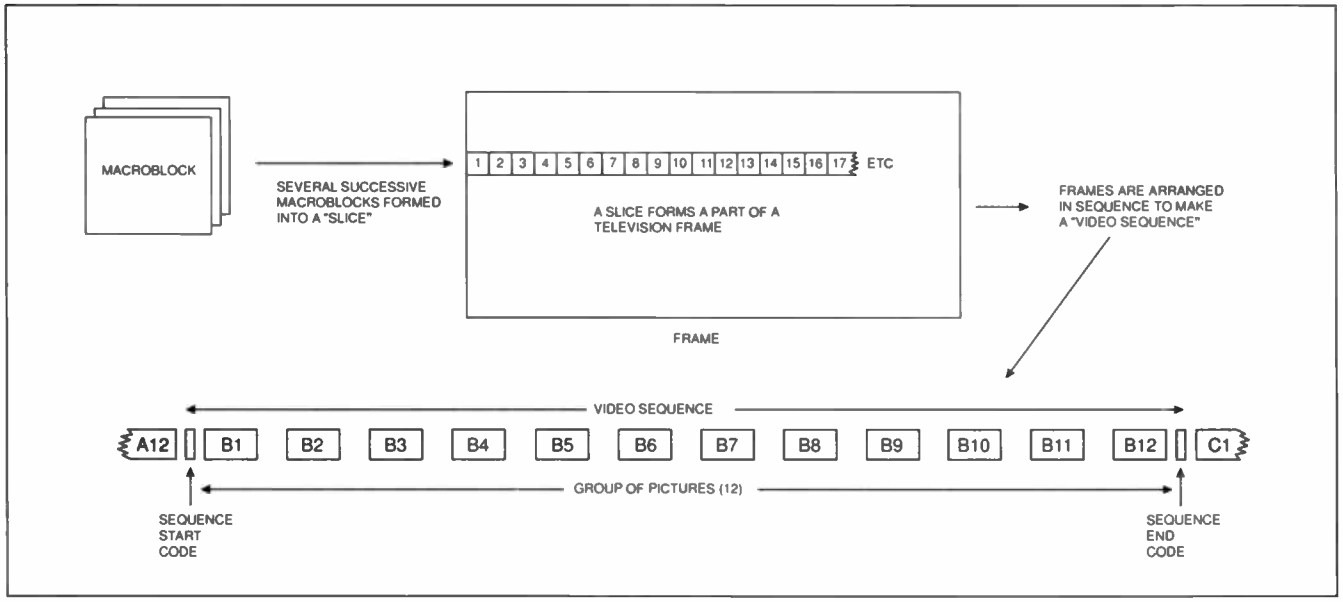


Fig. 4. A group of pictures.

number, are grouped together with appropriate identification codes and timing marks to form a video sequence. The group is a useful unit around which service identities can be determined and this makes for greater ease of editing and switching.

Next, the similarity of adjacent pixels within a frame is examined and a code sent to denote how many pixels have the same or very similar luminance and chrominance values. If, say, a whole line of picture has a luminance value of 0·6, Cr of 2·2 and Cb of 8·3, the process will say "Line 78, Pixel 1, Y =0·6, Cr =2·2, Cb =8·3, repeat 719 times".

SPATIAL REDUNDANCY

The third stage in Fig. 2 is termed Spatial Redundancy and only occurs within the boundaries of an individual frame. It is shown in expanded detail in Fig. 5. The process contributes further to the elimination of repetitive information. Further savings are made by using short codes for frequently-used code sequences and for timing and synchronising signals.

This is like the system used in Morse Code where the most frequently used letters of the alphabet have the shortest codes, for example "E" is simply a dot and "T" is just one dash, whereas "Z" is dah dah dit dit. In addition, large numbers of zeroes or ones can be re-coded, for instance *x* zeroes followed by *y* ones can be re-coded as (x, 0) (y, 1).

Large runs of zeroes are found at the end of data runs, and these are given short codes to signify the end of a data run instead. It all saves precious space, and the process is called Statistical Redundancy.

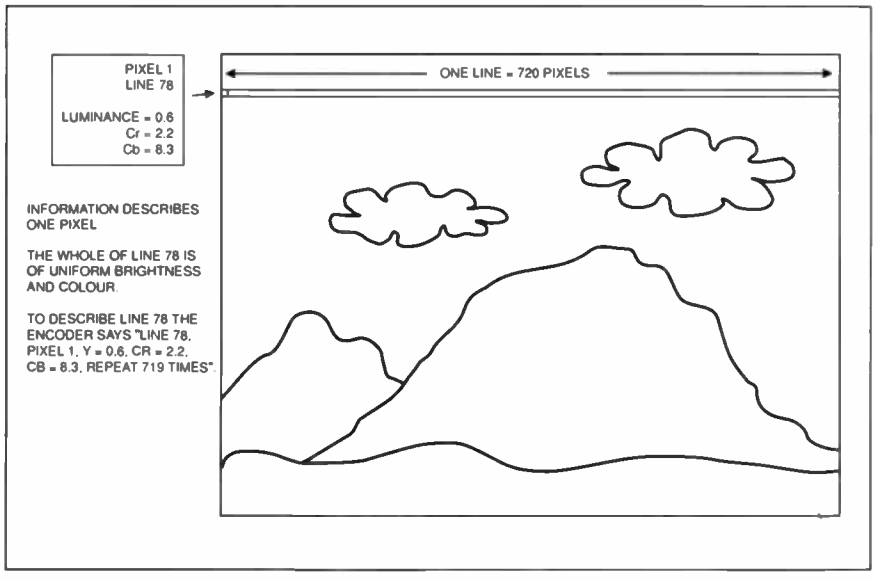


Fig. 5. Spatial redundancy.

The precise timings involved in television are an advantage when it comes to assessing the motion of a group of pixels which comprise part of a moving picture, for the accurate timing and precise positional information allows predictions to be made about blocks of pixels in motion. Macro-blocks are used for motion prediction, and the speed and direction can be calculated simply and a vector produced that describes the motion. The values of Y, Cr and Cb in macro-blocks in identical positions in successive frames can be compared and the differences used to generate a shorter code.

COSINE TRANSFORMS

Up to this point, the redundancy process is reversible, nothing of value has been lost. The next step in the sequence is a complicated mathematical process known as Discrete Cosine Transform. This is represented by stage four in Fig. 2, and expanded in Fig. 6.

The transformation is performed upon the numbers representing the luminance and chrominance values in the pixels of an 8 × 8 block. It is a conversion of the values from a time domain to a frequency domain.

It is somewhat akin to saying that a side of a square wave rises in 25 nanoseconds and that, in frequency terms, is 10 megahertz. This delivers a new set of whole numbers which are then quantised. That is to say, the numbers are "rounded up" or "rounded down" to the nearest step in a range of equal steps.

Supposing you have a set of steps that increment by 20 and you have to fit 47 into it, the nearest step is 40, so 47 is quantised to 40. If the next number in the range is 77, that is quantised to 80. The larger the steps (and the fewer), the larger the errors are. With the same numbers and steps of 5, 47 would be quantised to 45 and 77 to 75, so the closer the steps, the smaller the quantisation errors.

The quantisation process further reduces the amount of data that needs to be sent and in the MPEG encoder the quantisation process is a variable one, as will be seen later.

TRIPLE FRAMING

The MPEG process uses three types of frame (see Fig. 7), *I* for Intraframe, *P* for predicted frame, and *B* for bi-directional frame. The I frames are reference frames, they are not predicted or interpolated. An I frame is inserted into a group of pictures every twelfth spot, and serves to provide a reference for decoding to commence quickly – just under half a second. They are not subjected to the high degree of compression that B and P frames undergo.

The I frames allow channel surfers and the casual viewers who dip into and out of

viewing to get a picture almost instantly. In a twelve frame sequence, frames 3, 6, and 9 are predicted from the previous I frame with reference to the next I frame, and frames 1, 2, 4, 5, 7, 8, 10 and 11 are B frames; B is for Bi-directional because they are derived from I and P frames or P and P frames by interpolation. Again, much of the video data is carried over from the previous frame with changes signalled only, and often using abbreviated codes.

A full specification receiver would have enough memory associated with the MPEG2 decoder stage to store all three types of frame, but perfectly acceptable performance is achieved using only enough memory for two frames, I and P, and deriving the B frames in the receiver by processing.

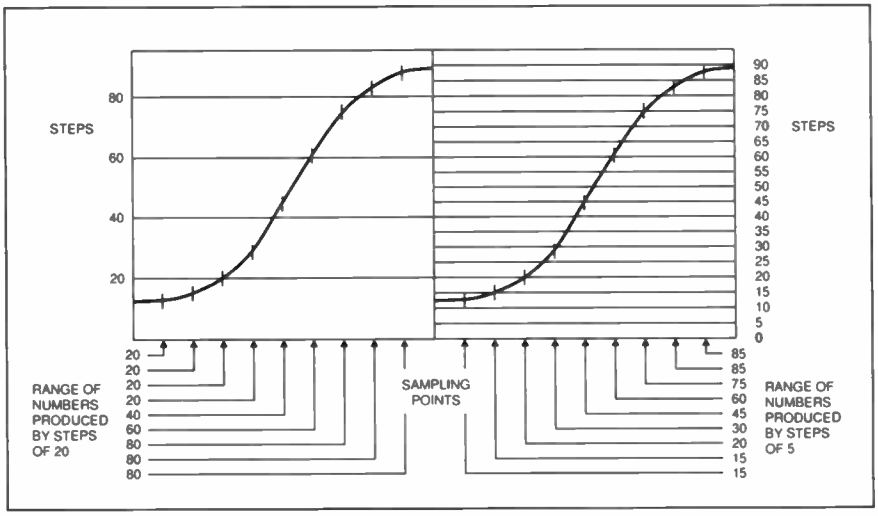


Fig. 6. Quantisation.

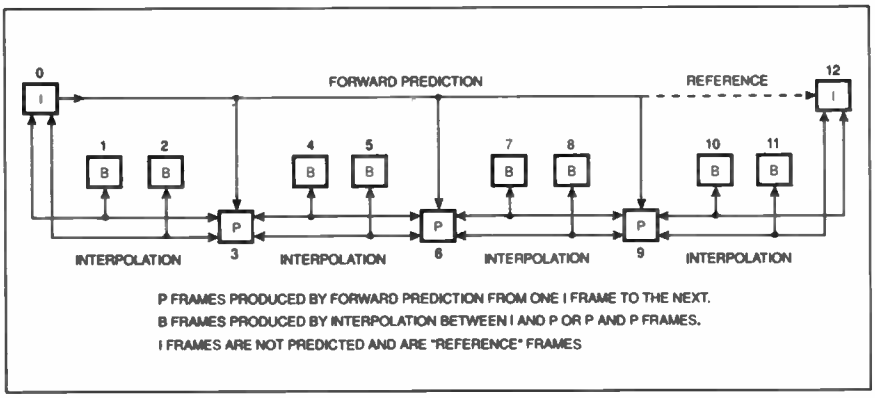


Fig. 7. MPEG frames.

PACKET ASSEMBLY

Compression of data has now passed the point of no return in the coding process. At this point in the proceedings the video data is assembled into packets, each data packet being a total of 204 bytes long, the construction of which is shown in Fig. 7.

At the head of the packet is a single byte sync word, usually hexadecimal 47 (47h). Then follow 187 bytes of data comprising the video or audio or accompanying data for a single service. At the tail end of the packet is a 16-byte checksum for use by the error correction system in the receiver. The 16-byte checksum at the end of each packet is used to determine its validity and, to aid error-correction, the data is passed through a Reed-Solomon cross-indexing system. This re-arranges the bits in each byte of data in the following fashion:

Bit Number: 8 7 6 5 4 3 2 1
Re-arranged as: 7 1 4 5 2 8 6 3

by the Reed-Solomon system.

This re-arrangement means that if a block of bits is obliterated by interference, for instance, the block is broken-up by restoring the bit-sequence to its original order, enabling the error-correction circuitry to operate more efficiently, e.g.:

Bit sequence: 7 1 4 X X X 6 3

received with 3 bits obliterated

Restored sequence: X 7 6 X 4 3 X 1

has the obliterated bits dispersed evenly throughout the byte. The system is used on CD recordings.

The individual packets of audio, video and data of a single service are strung together (Fig. 2, Variable Length Coding, stage 6) into a Packetised Elementary Stream, and into which are also inserted timing marks, called Presentation Time Stamps, that are used by the receiver to ensure that sound and picture are lip-synchronised. This is necessary because of delays to the video data in the many processes it has to undergo at the sending and receiving ends, particularly when any form of scrambling is also employed.

The data stream still has a variable bit-rate, and at this point it is passed into a Buffer stage (Fig. 2 stage 7) before the final multiplexing with other services. For this final stage, the data rate needs to be constant.

DATA RATE CONTROL

When the MPEG2 encoder encounters fast-changing and high-detail pictures, the data rate will be high to enable faithful re-creation of the pictures at the receiver. Because of this, there are occasions when the Buffer overflows because the incoming data is too great. When this occurs, the Data Rate Control between the Buffer and Quantisation stages (see Fig. 2 again), slows down the data rate by adjusting the quantisation process to a smaller number of steps with a greater gap between them. This reduction in performance is temporary and only finicky viewers will notice the passing degradation of picture-quality.

The elementary stream is now interwoven with elementary streams of other services into a final main stream called the Transport Packet Stream (see Fig. 8). Packets of audio, packets of video and packets of data are woven into one main stream in a random manner. The random nature of the interleaving, or multiplexing to give it the proper technical term, does not matter, for each packet carries an identification tag called Program Specific Information.

PSI allows the de-multiplexer in the receiver to sort out the packets into the separate services, as well as carrying information about the type of scrambling used, to what network the service belongs, and the Presentation Time Stamps.

There is a now a stream of packets of data from up to, say, four services multiplexed together. The Transport Stream will resemble the diagram of Fig. 9. This is the final form of the digital television bit-stream and it is passed to the transmitter as such.

MODULATION CHOICE

The final problem is the choice of modulation for the transmission, and for Satellite TV the choice is Quadrature Phase-Shift Keying, "QPSK". Fig. 10 explains this better than many words. QPSK uses two carriers of the same frequency, but the phase of one carrier, unmodulated, lags the other unmodulated carrier by 90 degrees. Four differing pairs of bits may be signalled by shifting the phase of each carrier by 90 degrees, or multiples of it. QPSK is used for NICAM TV sound.

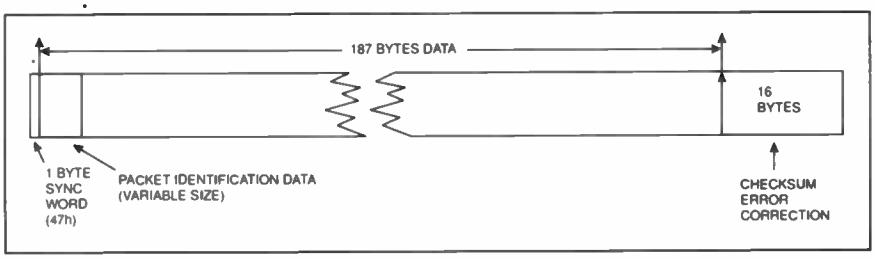


Fig. 8. MPEG data packet.

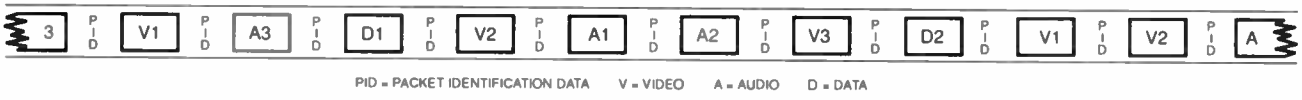


Fig. 9. Transport stream.

For Terrestrial Television on UHF, the choice is likely to be Orthagonal Frequency Division Multiplex, a very rugged transmission method ideally suited for the purpose. For Cable TV operators, the system will probably be Quadrature Amplitude Modulation. For all broadcasters, the coming of digital will be a godsend. For the Satellite broadcaster, the possibility of putting four good-quality transmissions on one transponder means cutting his transmission costs to a quarter of those currently incurred for analogue transmission, and the freeing-up of spectrum space will mean lower pressure on it as more would-be broadcasters clamour to go on the air.

Digital terrestrial transmissions would also be very cost-effective, since all four programmes we have at the moment could be broadcast on one frequency at one-tenth of the power currently used for one channel. Accountants and Greens would smile again.

Even for the Cable TV operator the way forward is digital, the ability to quadruple the current programme capacity of a network without new cables is almost unreal. The biggest nightmare for a cable operator is to have to replace the cable, there's so much of it and some is in places where it is difficult to access without incurring the wrath of road-users, pedestrians, local councils and home-owners.

The network equipment may need some improvement, but that is generally placed in accessible locations because it has to be serviced every now and then. So, the future is digital and it is coming fast. The advantages for the broadcasters are so great that it is they who will power the march towards totally digital broadcasting.

VIEWING CHOICE

What about the viewer? Digital broadcasting will allow the viewer more choice and a range of very different offerings to those enjoyed currently. In sport, four services on one carrier could be used, one for each camera at a sporting event, such as a tennis match or a football match. The cameras could be placed at the four corners of the stadium and give a choice of view selectable by the viewer at home or the receiver could display all four angles at once by splitting the screen into four.

Interactive TV is a distinct possibility, and the inclusion of a modem into the receiver would permit a return path via the local telephone network. You could even vote by this method, be it for Miss Wapping 1999 or the next parliamentary representative for your constituency! "Fine", you say, "but what about the picture quality?"

Digital TV is capable of superb studio quality pictures. To transmit these the bit-rate would be between 10 and 15Mbit/s. This would deliver a quality little different from that seen on a studio monitor. More channels on the same carrier would mean lower quality, down to VHS home video standard – but, of course,

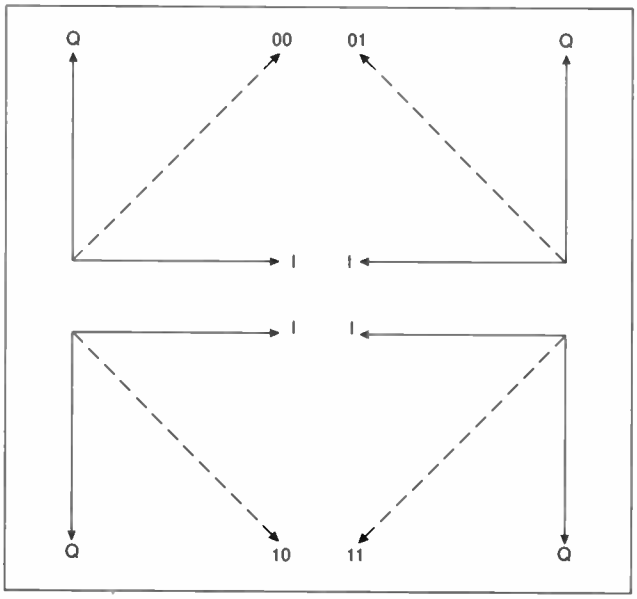


Fig. 10. Quadrature phase shift keying.

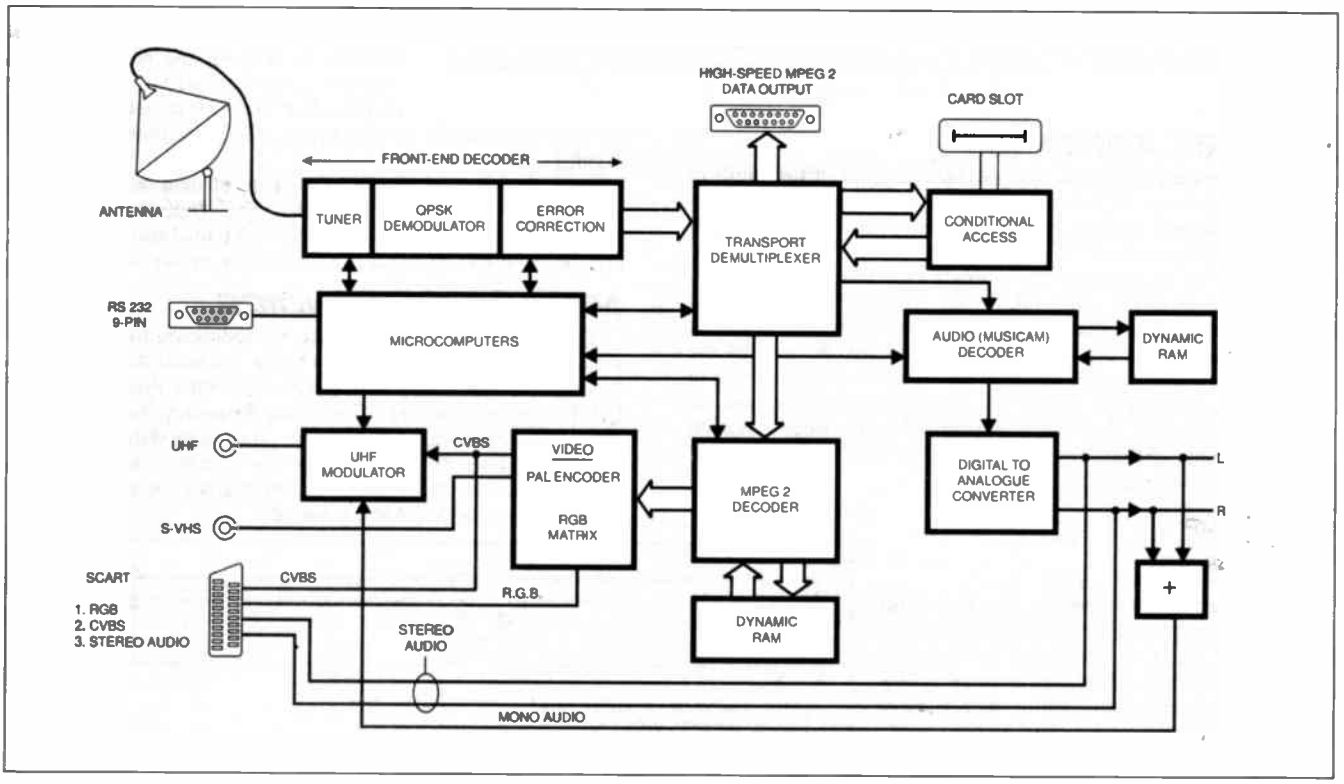


Fig. 11. Digital satellite receiver.

without dropouts and jitter. The bit-rate for this type of service would be 5Mbit/s and under, and possibly eight services could be squeezed into one carrier.

The problem with the lower bit-rates comes with total changes of scene and with fast-moving pictures with lots of fine detail. These situations require fast bit-rates and to accommodate them the quantisation process would be made "coarser", so that a temporary reduction in the definition would result. Viewers would have to know what to expect from a service by way of quality being traded for quantity.

DIGITAL SATELLITES

The Digital Satellite Receiver, a block diagram for which is in Fig. 11, is a totally new concept. The "front end" will vary according to the type of transmission, Satellite, Terrestrial or Cable, but the remainder will be the same as long as MPEG standards are used.

The transmission is demodulated in the front-end, and the data stream is error-corrected. From the error correction circuit, the data passes to the "Transport Demultiplexer" chip, a massive slab of epoxy borne on 160 pins. The Transport Demultiplexer chip recognises the various services and sorts them into separate streams, and separates the audio, video and supervisory data in each stream.

Audio data is demodulated in another monster i.c., converted to analogue form and passed to the auxiliary audio sockets and to the UHF modulator. The Presentation Time Stamps present in the audio packets are used to ensure tight synchronism between the picture and sound. A memory associated with the audio processor can delay the sound for up to one second.

Video data is processed in another LSI chip of many pins, the recovered data being used to build up the television picture in memory before it is read out, converted to analogue form and sent to the TV display section. A Satellite receiver will possibly convert the TV signal into the current PAL standard at the outset and employ a modulator to give the usual UHF output, but Composite Video, S-VHS and R-G-B outputs are all feasible.

THE FUTURE

Of course, many programmes will be scrambled to extract tolls for the pleasure of viewing the service – even the advertisements – as is the current practice! The descrambling process introduces a further delay to the complex video processing already encountered in the path through the receiver. This is the reason for the existence of the Presentation Time Stamps. Additional features are likely to be a data connector for accessing by a computer the on-board processors for diagnostic purposes or for re-programming the memories when system operating parameters require an up-date.

The provision of an MPEG2 data output is also likely, allowing the home computer to capture video "bites". The coming of digital broadcasting heralds interesting opportunities in the service and repair trade, though the feasibility of home construction recedes further with the degree of sophistication used in the design and construction of such circuitry.

Like it or not, Digital TV Broadcasting is the future!

SHOP TALK with John Becker

418MHz Remote Control System

The transmitter and receiver modules for the *418MHz Remote Control System* are available from **Radio-Tech Ltd. (☎ *01992 576107*)**. This well-respected *EPE* advertiser stocks the TXM-418-A transmitter and the SILRX-418-A receiver, and is offering them as a pair for the special price of £29.95, *including* VAT and P&P.

They are also offering the HT-12E serial encoder and the HT-12F serial decoder at only £2 for the pair, inclusive. Brian Back of Radio-Tech says that these special offers save you over 40% on the normal list price. All the other components should be available from your normal stockists.

MIDI MATRIX

Because the power supply module for the *MIDI Matrix* has to be compatible with the author's p.c.b. design, it recommended that it should be bought from **Electromail (☎ *01536 204555*)**, as part number 591-809. Although the rotary switches are shown in the circuit diagram as 1-pole 6-way types, you will find that you have to buy 2-pole 6-way and ignore the unused tags; they **must** be break-before-make types.

The 19-inch rack mounting case has a front panel measuring 483mm × 44mm and internal measurements of 432mm × 40mm × 293mm. It should be available from any supplier specialising in this type of enclosure, including **Maplin (☎ *01702 554000*)** and **Electromail**.

Opto-isolators 6N138 or 6N139 may not be commonly available from your local stockists but **Electromail** has both and **Maplin** stocks the 6N139 (look under *Optoelectronics*).

PUPPY PUDDLE PROBE

Well, it's a mixture of electronics and plumbing for the *Puppy Puddle Probe* (curious how the two technologies seem to mix in some *EPE* projects)! The electronic parts are all common-or-garden varieties and should be available from almost any component stockist. Most of the Probe bits will be found at any of the DIY-chain superstores, though you will have to nip into Halfords if you want the handlebar grip.

PIC-AGORAS

There is only one source for the FGM-3 magnetic sensor: direct from the manufacturer, **Speake & Co Ltd (☎ *0873 811281*)**. They are selling them at £14 each, plus VAT. You might also be interested to receive their general catalogue of sensors; ask them for one. If you want to write to them, they are at Elvicta Estate, Crickhowell, Powys, NP8 1DF.

Although not a specialised product, the 8-character 2-line l.c.d. module is not stocked by all the usual suppliers. **Electromail** stock the full-price ones, but you may find, though, that by shopping around "surplus" suppliers, you can pickup a bargain of the right type and at a much lower price; it must be HD44780-compatible.

Fully-programmed PIC16C84 microcontrollers are available from **Magenta (☎ *01283 565435*)** at £15.00 each inclusive of VAT, etc. (Thankyou Magenta). You will need to program in your own wheel size, however, as discussed in the text next month.

If you have TASM-compatible PIC-programming facilities, you can, of course, program your own chip. The software is available either on disk from the *EPE* offices (see *PCB Service* page), or from our Web site (see also *Net Work* page).

PRINTED CIRCUIT BOARDS

P.C.B.s for all this month's projects are, naturally, available from the *EPE PCB Service*, to which page you are referred!

Best wishes from John Becker; Dave will be back next month.

P.S. Always mention *EPE* when ordering parts for our projects (and at all other times too, if you would please!).

READOUT

John Becker addresses some of the other points you raise in your letters and phone calls.

SURPLUS BARGAINS

Dear EPE

I write to congratulate you on your Feb '97 issue. The feature on using intelligent l.c.d.s. was the key article for me. It also raised the question of obtaining surplus components at bargain prices. With so many bargains currently available, could you, perhaps, publish designs that are based upon them? I'd love to see a regular page (or more!) devoted to them.

Dave Jones, Llanelli

Often the problem with surplus items is that the supply is limited and by the time we have a project designed and published (remember that we have a "lead-time" which can run to several months), stocks of the surplus item on which it is based could well have become exhausted.

However, in instances where a surplus item is also readily available as a full-price product, then the situation becomes more feasible, as it is with the l.c.d. article you refer to. We'll keep your thoughts in mind. **JB**

SOURCING VALVES

Dear EPE

Would you know the address of the Mullard Valve company, or any other valve company? I need some technical data on EL34, EL84, ECC83 and ECC85, etc.

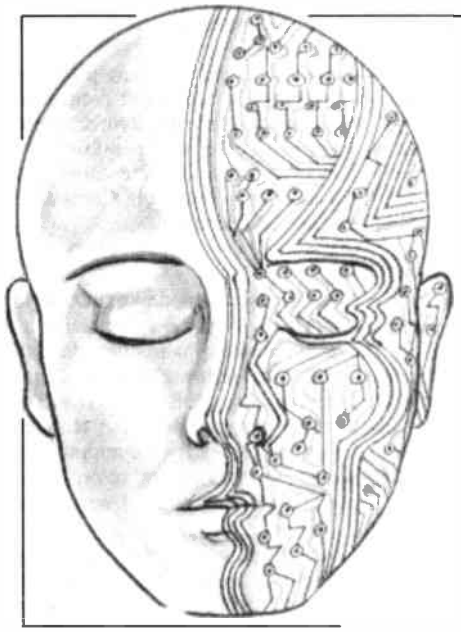
Sean Brennan, Co. Cork.

Mullard were absorbed by Philips many years ago and no longer make these valves. Some companies still in existence who do handle valves are:

Colomor Electronics, 170 Goldhawk Road, London W12 8HJ. Tel: 0181 743 0899. **Compelec**, 14 Constable Road, St Ives, Huntingdon, Cambs. Tel: 01480 300819. **Hesing Technology**, Cromwell Chambers, 8 St Johns Street, Huntingdon, Cambs. PE18 6DD. Tel: 01480 433156 **J. Birkett**, 25 The Strait, Lincoln, LN2 1JF. Tel: 01522 520767. **P.V. Tubes**, 104 Abbey Street, Accrington, Lancs, BB5 1EE. Tel: 01254 236521.

Your local reference library may also be able to obtain a copy of A.N. Ball's Radio Valve and Transistor Data, *which used to be published by Iliffe. I haven't seen a new edition for many years, but I always used to find it invaluable in those days when I practically heated the entire house with disposable valve heater energy! The last copy I have is the 9th edition of 1970. Libraries might be able to help get you a reference copy if you ask nicely.*

Browsing through magazine classified ads might also prove fruitful. **JB**



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!

Accurate Minutes Timer - for UV Sources

AFTER building an Ultra-Violet Light Box for producing p.c.b.s, a timer circuit was required which would operate the tubes for a pre-determined time. The circuit diagram shown in Fig. 1 was designed to produce accurate periods of between 1 to 12 minutes, and could also be used as a darkroom timer or similar.

The circuit uses the 50Hz mains frequency for its reference clock. The mains supply is stepped down by transformer T1, rectified before resistors R1/R2 feed the rectified signal to IC1a. The output of this is a 100Hz squarewave which is used to clock the binary ripple counter IC2 at pin 10.

The counter output is decoded by IC3a and IC3b such that one pulse is generated every minute. This pulse then clocks two ring counters (IC4, IC5) which are wired in series. The appropriate time is selected via the 12-pole rotary switch S2. Gates IC1b and IC1c form an SR latch and provides a power-on reset.

All the counters are disabled until Start switch S1 is closed, which sets the latch. With the latch set, transistor TR1 turns on which activates a power relay RLA. This is used to switch the load. When the counter reaches the required time, the output is inverted by IC1d to reset the latch and switch the unit off.

Duncan Boyd,
Blackburn,
West Lothian.

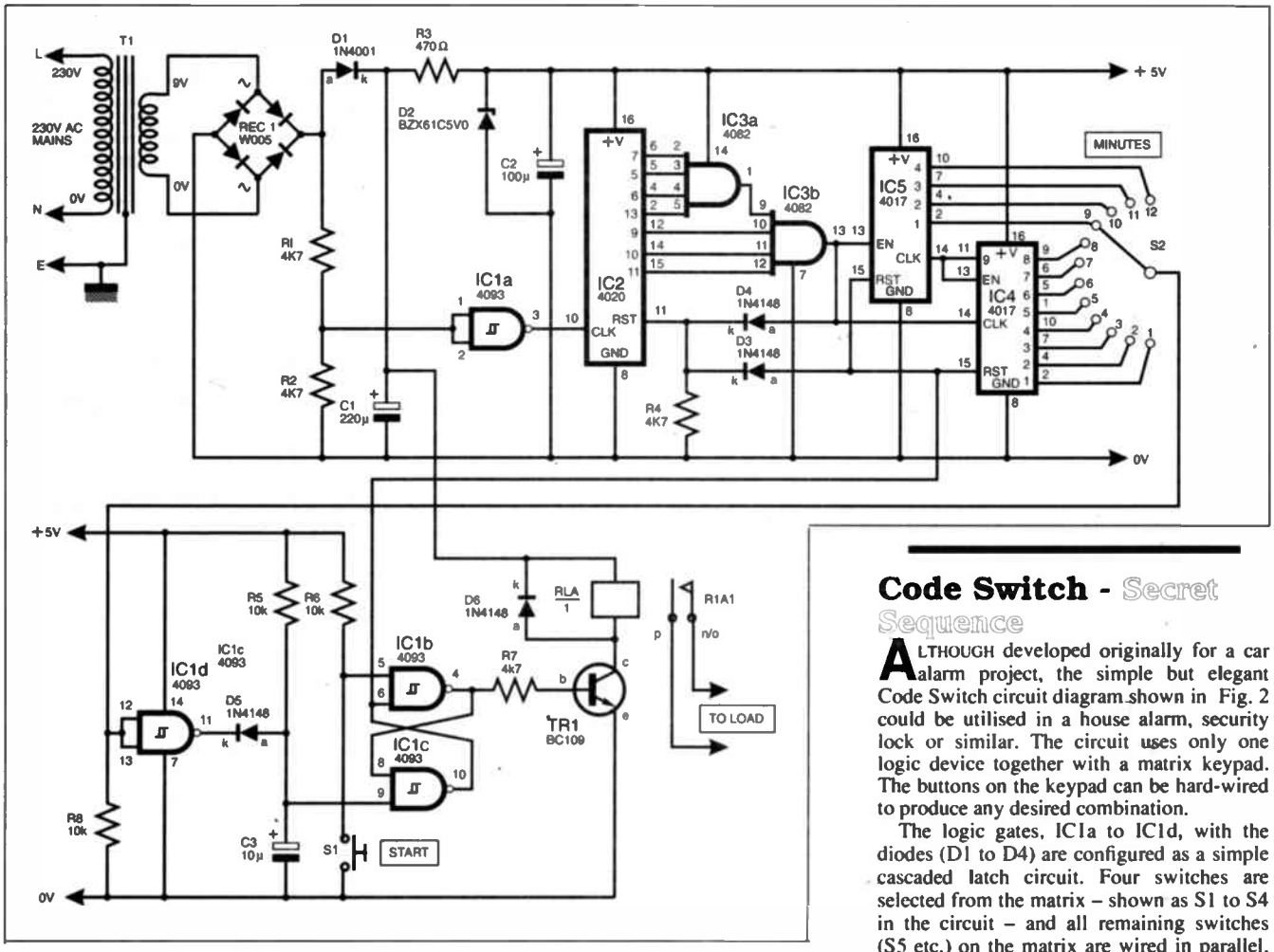


Fig. 1. Circuit diagram for the Accurate Minutes Timer.

Code Switch - Secret Sequence

ALTHOUGH developed originally for a car alarm project, the simple but elegant Code Switch circuit diagram shown in Fig. 2 could be utilised in a house alarm, security lock or similar. The circuit uses only one logic device together with a matrix keypad. The buttons on the keypad can be hard-wired to produce any desired combination.

The logic gates, IC1a to IC1d, with the diodes (D1 to D4) are configured as a simple cascaded latch circuit. Four switches are selected from the matrix – shown as S1 to S4 in the circuit – and all remaining switches (S5 etc.) on the matrix are wired in parallel, to act as "reset" switches.

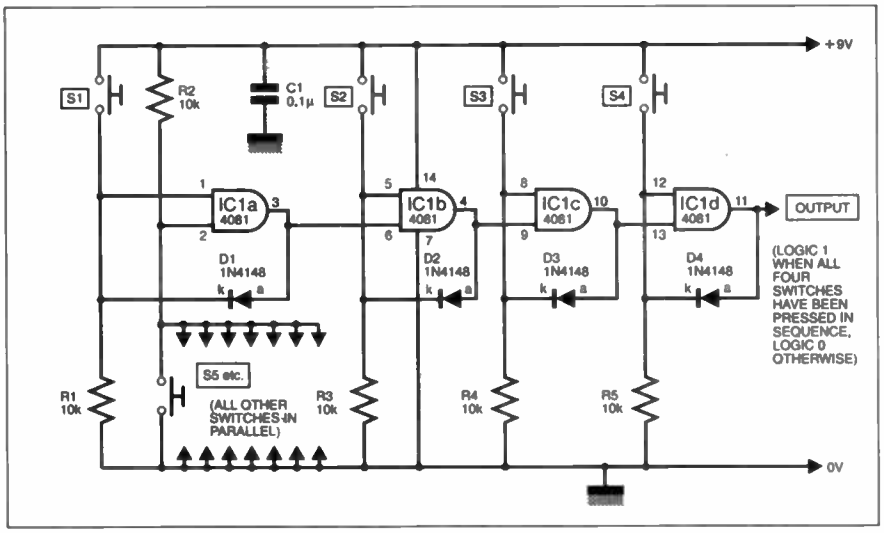


Fig. 2. The simple, but logical, circuit diagram for a coded-switch.

In this configuration the output can only go to logic 1 when switches S1 to S4 are closed in sequence. Any other combination will reset the circuit.

The Code Switch can operate from 5V to 15V d.c. and the output can be used to drive a relay or similar, via a buffer if necessary.

Duncan Boyd,
Blackburn,
West Lothian.

Inquizitor Quiz Master – I was first!

THE circuit depicted in Fig. 3 is an electronic "Quiz Master" which will determine who is the first to press a button in response to a question. Three contestants each have a pushswitch (S1 to S3) whilst the referee holds the "Reset" button S4. Closing S4 resets the flip-flops IC1a, IC1b and IC2a.

The pushswitches S1 to S3 are connected to the respective data (D) pins of each 4013 flip-flop, and one of three inputs of a 4075 triple-input OR gate (IC3). Each flip-flop drives an l.e.d. directly. When a contestant presses his/ her button, the corresponding D input to the flip-flop goes high. Therefore the OR gate output also goes high. This is wired to the SET (pin 6) pin of a fourth flip-flop IC2b, whose Q2 output (pin 1) goes high.

Thus a rising edge is sent to the clock inputs of the other three 4013 flip-flops, causing the data at their respective D inputs to be written to the outputs – a logic 1 to the winning flip-flop, and logic 0 to the other two. This means that the "successful" contestant will light their l.e.d. first, and if any other user presses their button, clocking of the flip-flops is disabled because pin 1 of IC2b is already high. No further button presses will be acknowledged until the circuit is reset at S4. IC4 is a 555-based oscillator which will also sound via LS1 whenever a button is pressed.

David Liddament,
Caversham,
Reading.

Fuse Tester – banishes confusion!

A very simple but useful tester for checking cartridge fuses, is shown in Fig. 4. It uses a tri-colour l.e.d. D1 to provide GO-NO-GO indication of a fuse's condition. When S1 is closed, the red l.e.d. will illuminate via R1 but if an intact fuse is placed across the touch contacts then the green l.e.d. chip will also glow, providing a yellow display.

The circuit can be hard-wired in a small plastic box with enough space to accommodate a PP3 battery for B1. A 5mm tri-colour l.e.d. was utilised for D1.

Mark McGuinness,
Clondalkin,
Dublin,
Ireland.

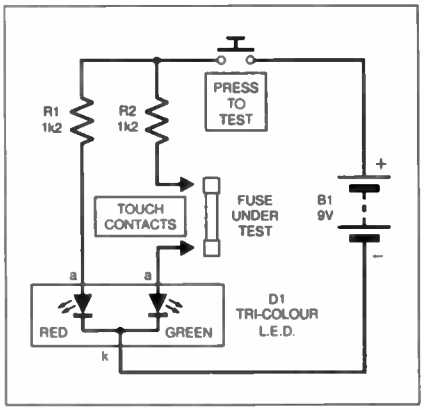


Fig. 4. There's no fuss with this fuse tester.

BE INTERACTIVE!

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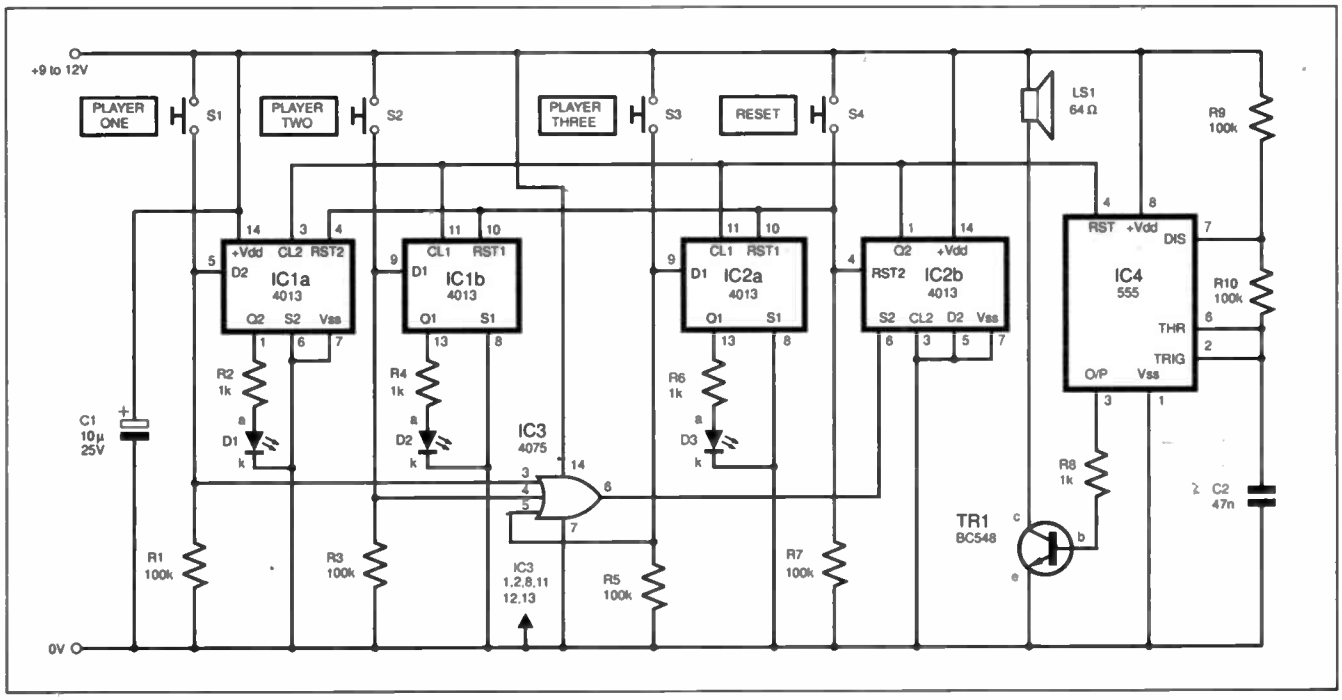


Fig. 3. Be master of the Inquisition with this Quizzical circuit diagram.

Constructional Project

PUPPY PUDDLE PROBE

DAVID SMITH

Treasure hunting takes on a new meaning with this "easy-build" detector.

WHAT'S got four legs, two eyes, resembles a bag of fluff, and leaks? That's right – a puppy. With springtime just about to arrive, many people will be contemplating the purchase of just such a quadruped to take "walkies".

However, it could be but a few hours before cries of "Ahh, isn't he a cute little bundle", change to "where is he/she and why hasn't *it* "asked" to go out for the last few hours?" If the puppy has been true to form, it will have delivered a little 'present' somewhere for his loving owners to discover!

The only way of finding this near invisible wet spot before it does any damage, is to place ones hand onto the carpet (palm down of course), and progress in a forward direction across the carpet making wide sweeping motions of a type not unlike those of a mine sweeper in a war zone. Then, on the cry of "Argghh!", you will have detected the infamous wet patch.

Alternatively, you could build the Puppy Puddle Probe described here. This does the job of finding those nasty little puddles for you. The actual probe consists of a pair of contacts, mounted at one end of a tube, which, when in contact with moisture, will cause an electronic circuit (mounted further along the tube inside a case) to trigger an alarm – thus indicating the presence of "a liquid".

CIRCUIT DESCRIPTION

The complete circuit diagram for the Puppy Puddle Probe is shown in Fig. 1. The purpose of the circuit is to detect the presence of animal urine on carpets or furniture, and then to sound an alarm.

This is achieved by the use of two, physically close conductive surfaces (mirror screws), which when bridged with moisture (urine), will allow current to flow to the base (b) of transistor TR1, a ZTX500. This is a *pnp* transistor which, in its normal quiescent state, is biased in the off position i.e. it does not conduct any current between its collector (c) and emitter (e).

DETECTION

When moisture is detected, the resistance between the two probe contacts reduces to only a few kilohms, which causes transistor TR1 to conduct and pass current between its collector and emitter. This current is then fed via resistor R2 to the gate (g) terminal of thyristor CSR1, turning it on. Current is then allowed to flow to both the piezoelectric warning device WD1 and the l.e.d. (light emitting diode) D1.

Once thyristor CSR1 has latched into its conductive mode, the only way to reset the circuit, is to stop current passing between the anode (a) and cathode (k) of the thyristor. This is accomplished by simply switching off the battery supply, via switch S1, and then switching it back on again in readiness for the next "detection"!

It was found on the prototype, that there was insufficient current taken by the piezoelectric sounder WD1 alone to cause latch-up of the thyristor, so l.e.d. D1 was added to the circuit. This l.e.d. was sufficient to cause a current of enough magnitude to flow through CSR1 to latch it into continuous conduction.

However, should you only require a momentary switching action from the thyristor, then you could try leaving the l.e.d. out of circuit. There is no guarantee that this mode of operation will work successfully in every case, owing to the wide electrical tolerances that some electronic components possess.

The use of a capacitor C1, effectively situated between the long probe wire and positive supply rail, prevents any spurious triggering of the device due to external interference.

BATTERY POWER

Power for the circuitry is derived from a PP3 type battery which will offer many hours of service due to the low quiescent current of only <0·1mA being taken. Because of the relatively long time between battery changes, careful consideration should be given to the fitting of a slightly more expensive PP3 type battery that would be less likely to leak.

CONSTRUCTION

Details of construction can be divided into two parts; these being the main control box, including the printed circuit board (p.c.b.), and the tubular assembly. Construction should start with the p.c.b. and case preperation, followed by the tubular and probe assembly.

The printed circuit board topside component layout, lead-off wiring details and full size underside copper foil

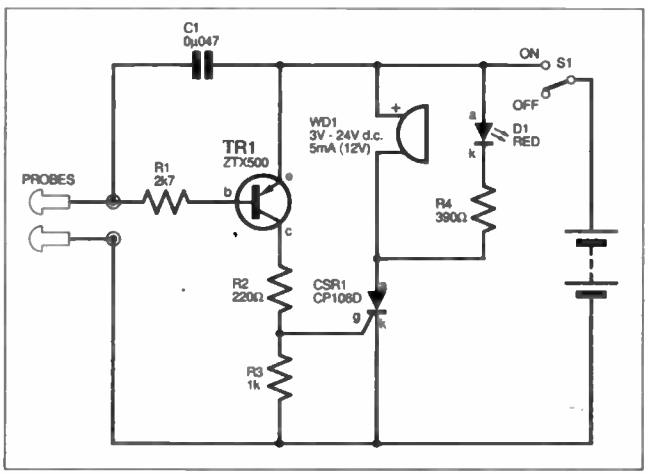


Fig. 1. Complete circuit diagram for the Puppy Puddle Probe.

master pattern for the Puppy Puddle Probe are shown in Fig. 2. This board is available from the *EPE PCB Service*, code 145.

Assuming the recommended size case is to be used, first check that the p.c.b. will fit neatly inside the case. Next, commence construction of the p.c.b. by soldering in place the six lead-off solder pins, Fig. 2. The only items not on the board are the On/Off switch S1, l.e.d. D1, battery and probe sensor.

The order in which the other components are mounted on the p.c.b. is not too critical, but it is advisable to fit the resistors and capacitor first, then the semiconductors and finally the sold-state sounder WD1. Make sure you double-check the pinouts of the transistor and thyristor before soldering in place. Also, check the polarity of the p.c.b.-mounting buzzer before installing on the board.

Once all the components have been mounted on the p.c.b. check for any "dry" solder joints or "bridges" between copper tracks. If everything seems in order, the board should be put to one side and the case preperation undertaken.

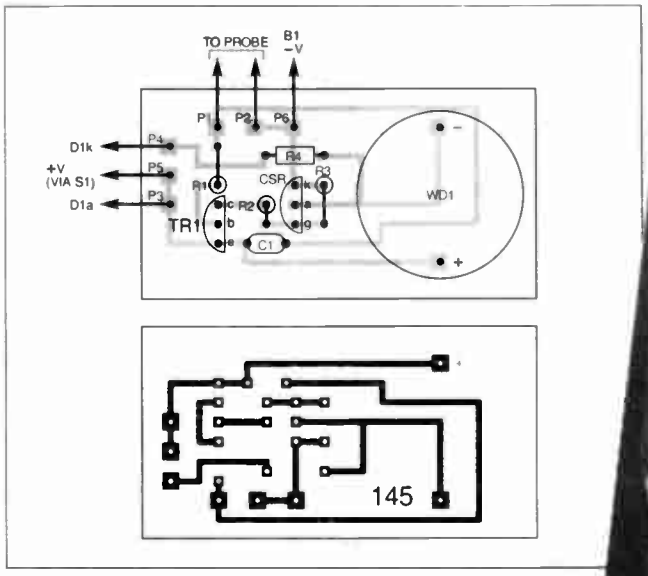


Fig. 2. Circuit board component layout and foil master.

Printed circuit board wired into the narrow case (left).

CONTROL BOX

We will now take a look at the construction of the control box. This is a standard plastic case (size 124mm × 32mm × 30mm) which houses the p.c.b., warning indicator l.e.d. and battery. Everything will fit neatly inside the specified box, but be aware that there is no room for manoeuvre.

Accuracy is essential during construction. However, it's worth the effort, as it offers a very neat way of containing all the electronics in a box that's only slightly wider than the plastic piping itself, see photographs.

One thing to remember though, is that you will have to assemble the various items in the correct order, otherwise you will find it impossible to fit some of the parts successfully.

Start by drilling all the necessary holes in the base of the box, followed by those at one end for the l.e.d. and on/off switch, see Fig. 3. Although the 5mm hole for the l.e.d. is simple enough to drill, cutting out the hole for the slider On/Off switch S1, is a little more tricky.

This will require the drilling of two 4mm holes side by side first of all. Next, you will have to shape these two holes into one oblong cutout by using a modelling knife to cut away all the excess plastic.

Be careful not to cut away too much plastic from around the holes. It's worth carefully marking the rectangular shape of the hole in pencil first and then cutting precisely to those marks.

Fit the two plastic pipe clips to the bottom of the box using countersunk bolts. These clips enable the case to be fastened securely onto the main pipe. Later, when the box is finished, you can either slide the clips onto the pipe from one end during assembly, or alternatively, push them gently onto the pipe.

The l.e.d. and miniature slider-switch can now be mounted in position at one end of the case. Use a plastic 5mm l.e.d. clip to mount D1. Once the case preperation is completed, this, together with the p.c.b., is also put aside awaiting completion of the tubular and probe assembly.

COMPONENTS

See SHOP TALK Page

Resistors

R1	2k7
R2	220Ω
R3	1k
R4	390Ω

All resistors 0·6W 1% metal film

Capacitor

C1	0μ047 resin-diped ceramic

Semiconductors

D1	5mm red light emitting diode
CSR1	CP106D 400V 2A thyristor
TR1	ZTX500 *pnp* silicon transistor

Miscellaneous

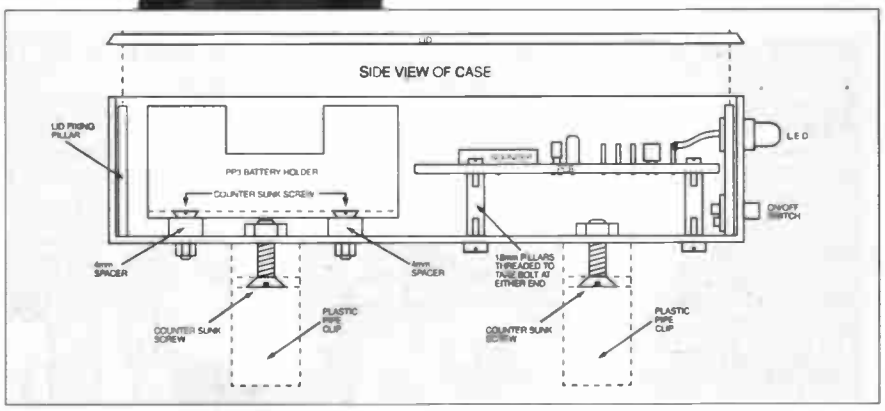
S1	sub-min. single-pole slide switch
WD1	3V to 24V d.c. low-profile, p.c.b.-mounting, solid-state buzzer

Printed circuit board available from the *EPE PCB Service*, code 145; plastic box, size 124mm x 32mm x 30mm; battery holder (PP3 type), with clips; 1·5m 4-core telephone cable (see text); multristrand connecting wire; 12mm (½") threaded spacer (4 off); 4mm spacer (2 off); solder pin (6 off); solder etc.

HARDWARE

Two metres 16·5mm p.v.c. overflow pipe; 135 degree angle bend joint (16·5mm overflow pipe joint); pipe clip for fixing 16·5mm overflow pipe (2 off); T-joint (16·5mm overflow pipe joint); p.v.c. cement; cycle handlebar grip; small block of wood, 10mm x 15mm x 50mm; solder tags (2 off); mirror screws, with caps (2 off); screws, nuts, bolts etc.

Approx Cost Guidance Only **£12** ***excluding hardware***



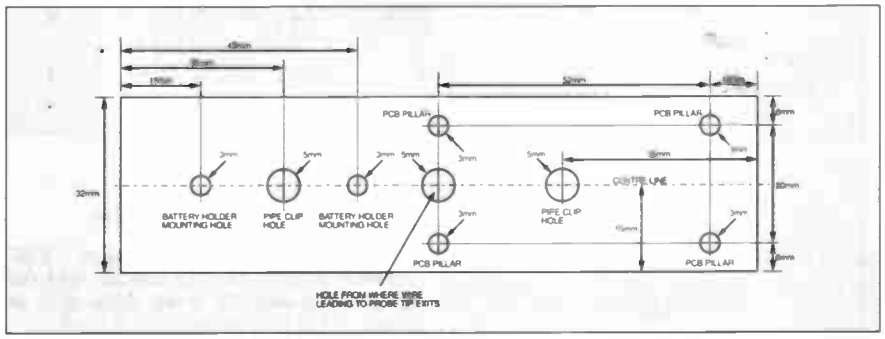


Fig. 3. Alarm box layout and base drilling details and dimensions.

TUBULAR ASSEMBLY

We now move on to the tubular body assembly, Fig. 4, and the sensor probe, Fig. 5.

The white p.v.c. tubing can be bought at most large DIY stores and is sold as 16·5mm overflow pipe. Unfortunately, this is normally sold in minimum lengths of two metres, which is somewhat longer than you need for the project. However, you may find a friendly DIY store manager who would be willing to cut a piece to length for you.

Regarding the dimensional lengths of the two pipes for the handle and stem, these are based on a person of average height operating the probe. There is no reason why the pipe could not be cut to another size, perhaps even making it very short so that a child could operate it for him or herself. After all, the puppy has probably been bought for them anyway and giving them that extra little bit of responsibility in hunting down their puppy's little "mistakes", may help them to realise the added responsibility one undertakes when a new member of the household arrives on the scene!

Referring to Fig. 4, cut the tubing to length using a small hacksaw. Take care to cut it squarely. Practice a few times if need be on a short length of spare pipe. Clean off any burred edges left by the hacksaw, using either sandpaper or a small file.

There are two tubular lengths of pipe, a shorter one of 130mm which forms the hand grip, and a longer, 935mm length which forms the main down-pole. Join these two pieces together using a 135 degree pipe joint as shown.

This angular bend should give a nice feel to the probe. Of course, a 90 degree pipe joint could be used instead, but the 90 degree angle when tried on the prototype, was found to be too severe for reliable and comfortable operation.

DETECTOR PROBE

At the bottom end of the probe is the detector assembly, see Fig. 5. This is made up from a piece of p.v.c. pipe in the shape of a letter "T".

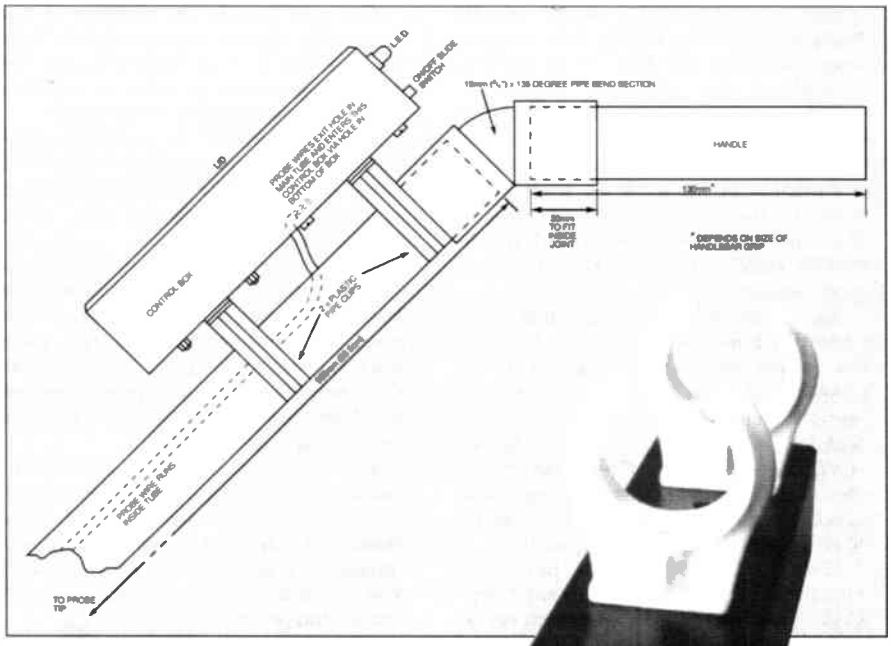


Fig. 4. Tube assembly and case mounting details.

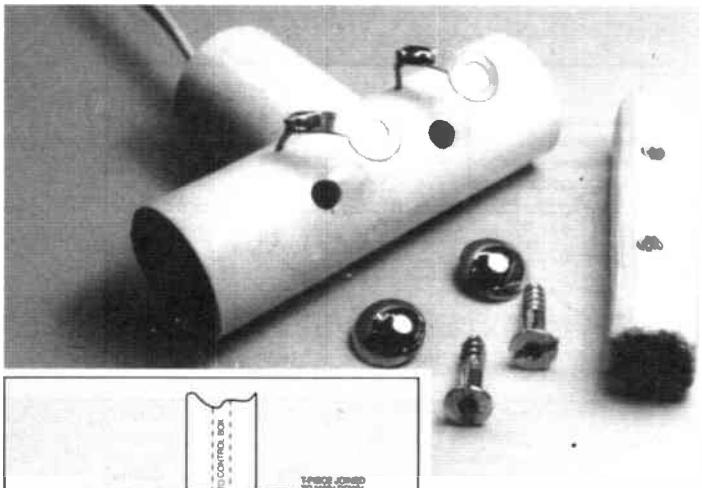
Alarm box ready to clip onto downpipe

On the underside of this T-piece are two mirror screws, situated in such a way that they make contact with the carpet when the probe assembly is held in a normal upright position. The mirror screws themselves pass through the plastic pipe and into a small piece of wood positioned inside.

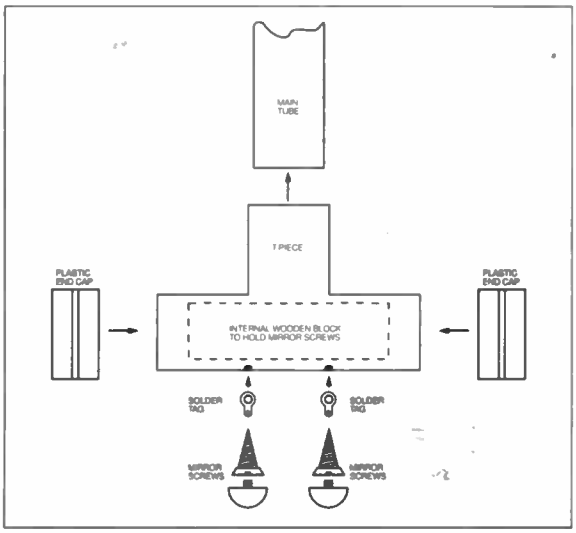
Each mirror screw also has a solder tag situated between the screw head and the pipe, onto which is soldered the two wires which lead back to the alarm box. However, before fitting the T-joint permanently to the main tube, thread the probe detector cable down through the stem pipe work.

Start at the hole drilled a few inches down from the top of the main pipe, passing the cable out of the bottom of the pipe and then through the T-joint. Allow yourself a sufficient amount of slack before cutting the wire to length. Should you then make a mistake whilst stripping the cable in readiness for soldering (and which of us hasn't in the past?), then you will have a little extra cable to play with.

On the prototype, 4-wire telephone cable was used. This offers both a lightweight and durable cable with the added advantage of having two, spare, unused wires should there ever be a problem in the future. However, the type of cable used is in no way critical to the functionality of the circuit.



Components required to make up the search head.



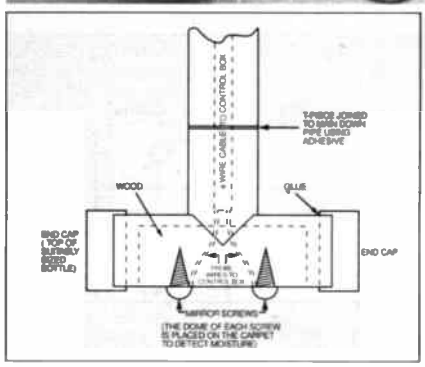
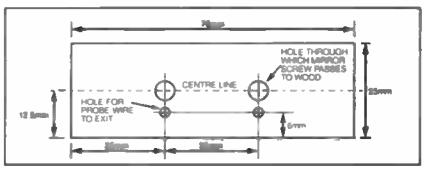


Fig. 5. Detector head assembly.

(Top right) component parts, (right) T-piece bottom drilling details and (left) assembled detector head. Note only two wires of the four-core cable are used.



Once you are happy with the overall length of the probe, pull apart the joints, apply a little glue to them, and reassemble them permanently, taking care to align all the pieces straight and true.

Finally, fit a bicycle handlebar grip to the top section of pipe. This will offer a more comfortable grip whilst operating the probe. It's hard to say which type of grip to buy for the best, as there are so many variations from which to choose.

The "puddle" detector is useful for searching under chairs.

FINAL ASSEMBLY

When fitting the battery holder in place, it should have two 4mm spacers fitted underneath. This will enable it to clear one of the two pipe clip fixing nuts see Fig. 3.

Next, fasten the four 12mm (½"), threaded fixing pillars to the base of the case, ready for the p.c.b., using short screws. However, before fitting the p.c.b. into the case, you will need to thread one end of the probe cable in through the hole especially made for it on the underside of the case and wire it to the board.

Likewise, wire up the PP3 battery connector and the wire leading from the On-Off switch S1 to the solder pin designated P5 on the p.c.b. Use heat shrink or PVC sleeving over all the connections in order to minimise the possibility of short circuits occurring.

Finally, having fitted the p.c.b. into the case, solder the l.e.d. leads directly onto the pins marked P3 and P4 in Fig. 2, taking care to observe the polarity of the light emitting diode D1.

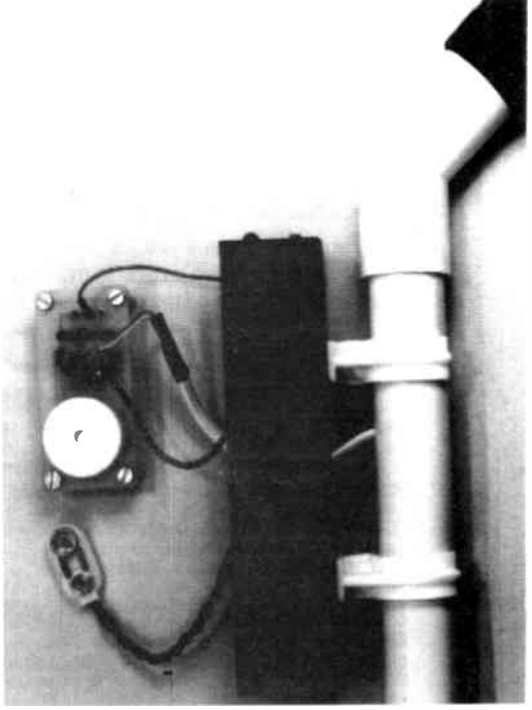
TESTING

Testing is quite straightforward really and the circuit should work by simply placing a dampened finger across the probe tip. Once the circuit has triggered, switch off and then on again to reset the device.

The ultimate test, of course, is to closely follow your new pet around the house for a while until the inevitable happens and then try out the device for real!

Animal urine can be very damaging to carpets and difficult to spot, especially when the carpet is heavily patterned and the urine has had a few minutes to soak in. Also puppies are very clever at finding the most inaccessible of spots to "operate" in.

One thinks, for instance, of the areas behind settees, and other heavy furniture. It is in these awkward and most difficult places to reach, that the Puppy Puddle Probe comes into its own. □



The alarm box clipped to the down-tube and the p.c.b. removed from the case.

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The Radio Amateur 2 Metre band from 144MHz to 146MHz allows local amateurs to keep in touch. Communication is either direct or via repeater stations located around the country. You can listen in with this superhet design which can be used in the car or from a mains supply.

PIC-A-TUNER

There was a time when music tuning accuracy was at the mercy of the individual's ability to "know" pitch, either "recalled" from memory, or imposed by a leading member of an orchestra – what note he or she regarded as being right was right as far as that group was concerned; it didn't matter too much, provided they all played the same tune on the same notes, whatever the absolute frequency! The use of mechanical tuning forks helped to keep things within a range of acceptability.

Electronics, however, has for many years allowed us to tune in relation to an absolute standard frequency of 440Hz, known as Concert A, all other notes being derived from that single frequency. Even 25 years ago, constructional projects for music tuners based on i.c.s were being published. But, sadly, some of the chips which used to be available have disappeared (the good old "AY" and "MK" series, for example), and their passing is grieved.

It's PICs to the rescue, though! With these simple but sophisticated microcontrollers, it's comparatively straightforward to produce an accurate tuner that listens to what frequency you are playing and tells you how far you are from the ideal note. It's especially easy to build one if someone else has already worked out the software program – enter the PIC-A-TUNER! It's all there: electronics, liquid crystal display and program. And, you've got a tactile keypad you can press for a few "Functions" as well; we'll disclose those next month!

GREAT EXPERIMENTERS

This fascinating new series describes the work of the major electrical and magnetic experimenters, the emphasis being on the fact that experimentation was, and is, a necessary requirement for the study of any science. The series covers the work of such famous experimenters as Gilbert, Galvani, Volta, Ampere, Ohm and Faraday etc.

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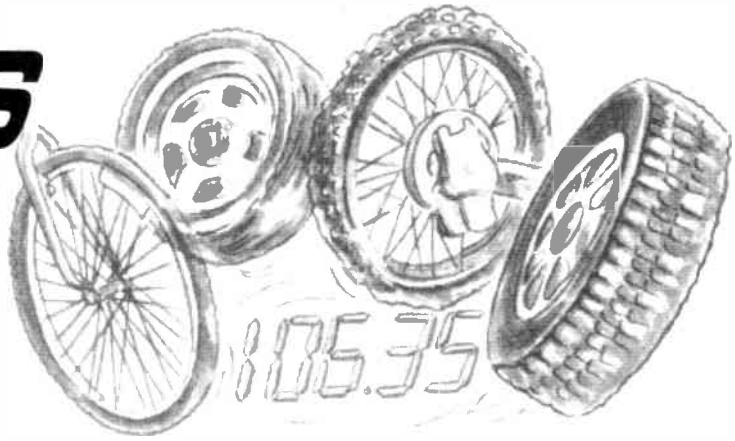
PIC-AGORAS WHEELIE METER



JOHN BECKER

Part 1

Flux-gate sensing and PIC microcontrolling combine to bring you the (nearly) ultimate in wheeled-distance measurement and display.

INSPIRED by the recently introduced FGM-3 magnetic sensor, and the author's desire to update an existing 6502-based bicycle computer, this design offers the opportunity to measure the distance covered by almost any wheeled vehicle, from a golf trolley to a bicycle and beyond. Wheel diameters up to about three metres can be catered for (. . . want to electronify your Penny-Farthing or Traction Engine?) at speeds of up to about 100 m.p.h.

The controlling heart of the design is the now-familiar PIC16C84 microcontroller, and its readout is on a readily available intelligent liquid crystal display (l.c.d.). Whilst the software is complex (though that needn't concern you), the design is simple to build and install.

Wheel rotation sensing is done using a magnetic field sensor in conjunction with a small magnet. The sensor is attached to the frame of the bike or other vehicle; the magnet can be secured to any convenient part of the wheel.

A further option is open to adventurous experimenters – you could, perhaps, be inspired to try modifing the design for use with sail-boards and the like!

As to the Title? There's a tale to tell, but we'll keep it short, at the end!

MAGNETIC SENSOR

Any type of magnetic sensor could have been the starting point for the design. All have their merits; all can have their problems. When contemplating the design of PIC-Agoras, though, it seemed an interesting idea to use the new FGM-3 magnetic field sensor from Speake & Co.

Its response has proved to be excellent and obviously has many other applications in which it can be used. Its only problem in this application was the need to convert the modulations of its frequency output to decoded single pulses.

The FGM-3 device is a very high sensitivity magnetic field sensor operating in the ±0·5 Oersted (±50 microtesla) range. Its operation is based on the flux-gate principle in which the strength of a magnetic field determines the frequency response of one or more coils.

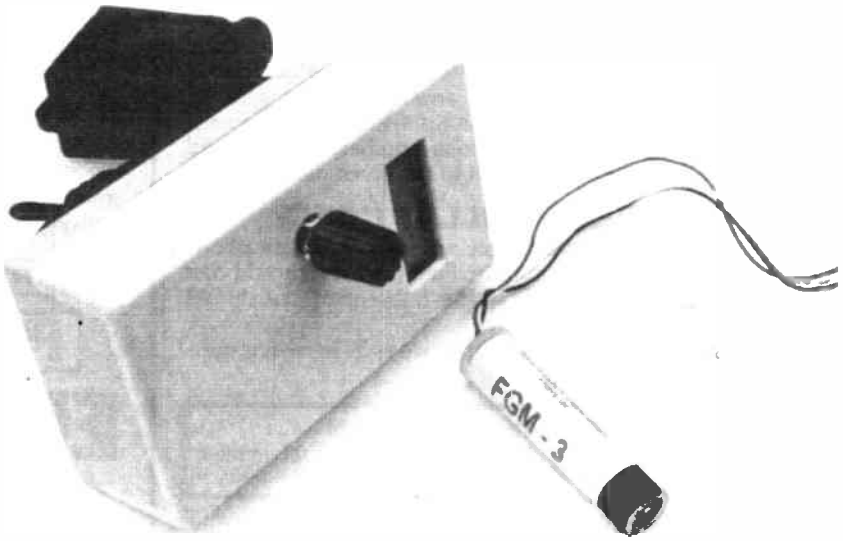
Flux-gates are commonly found in the miniature electronic compasses which are now in widespread use amongst the small-boat (and large) community. Go to any yachting chandler and you will probably see many examples.

In the past, flux-gates as ready-made individual components have not been available to the hobbyist electronic market. Regrettably, the precision with which the coils need to be wound does not allow them to be easily constructed in the average workshop. Certainly not in the author's, and he's tried! Thus it was with considerable interest that the FGM-3 was received.

SELF-CONTAINED

This device requires no adjustment on the part of the user. It is totally self-contained. The induction coil and all the frequency-generating electronics are enclosed in a tube about 65mm long by 16mm in diameter. The tube is transparent and looks like glass, though scraping it reveals that it is a plastic material. Its strength has not been put to the test (!) but it is probably wise to treat it with respect.

Three wires are the only connections that need to be made, two for power at 5V (7V absolute maximum), and one for the signal output. The output signal is a robust 5V rectangular pulse train whose frequency varies inversely with the magnetic field strength detected (giving a pulse period which is directly proportional to the field strength). This signal is ideally



Completed Wheelie Meter with FGM-3 magnetic field sensor.

suited to interfacing to a computer, or microcontroller, or other digital electronic circuit.

Typically, the frequency swing is from 50kHz to 120kHz for a field strength ranging between ±0·5 Oersted. You do not need to be concerned about field strengths in this application, however. Suffice to say that the frequency swing caused by moving a variety of small magnets past the sensor at several tens of millimetres distance is very detectable.

The sensitivity of the FGM-3 is such that even the earth's magnetic field can be detected, making the sensor usable in electronic compass applications. Be aware, though, that actually *designing* an electronic compass involves good knowledge of some quite high mathematics and the use of a microcontroller or similar which can cope with all the code involved!

The sensor's temperature sensitivity is excellent, at 0·003%/°C at 25°C.

The magnet chosen for use with the sensor was a small disc type removed from a plastic "fridge magnet" that typically holds kitchen notes to the side of a domestic fridge.

SENSOR INTERFACE CIRCUIT

First thoughts may suggest that since the FGM-3 outputs a well-shaped 5V pulse train, the changes in frequency when a magnet passes close by could be readily analysed by a PIC microcontroller. In principle, the PIC *can* be programmed to analyse them. The drawback is that it would need to spend most of its time analysing and not have much time to process the results.

There is *a lot* of processing to be done, as will be seen later. Consequently, an electronic interface is needed to do a bit of real-time pre-processing. We are not interested in the *actual* frequency of the pulse train. It is the *change* in frequency when the magnet passes that is of interest. All we need to know is whether or not the magnet is close or distant, a simple binary logic situation; Logic 1, the magnet is near; Logic 0, the magnet is distant, or vice-versa.

This conversion from frequency change to logic level could be done in several ways. Here it is done using a phase locked loop (p.l.l.) chip, the familiar CMOS 4046 device. The details in Fig. 1 show the frequency-to-logic conversion circuit diagram, the Sensor circuit.

The FGM-3 magnetic field sensor is shown as component X1, and the p.l.l. is IC1. The output from the sensor is fed into IC1's first phase comparator input, PCA IN at pin 14. The second phase comparator input is PCB IN at pin 3, which is coupled to the chip's voltage controlled oscillator output, VCO OUT at pin 4.

The basic oscillator frequency of the VCO is determined by the values of capacitor C1 and the joint action of resistors R2 and R3, plus preset potentiometer VR1. Variation in the voltage level on IC1 pin 9, VCO IN, causes the VCO output frequency to change accordingly.

Within IC1, circuitry compares the difference in phase between the two signals

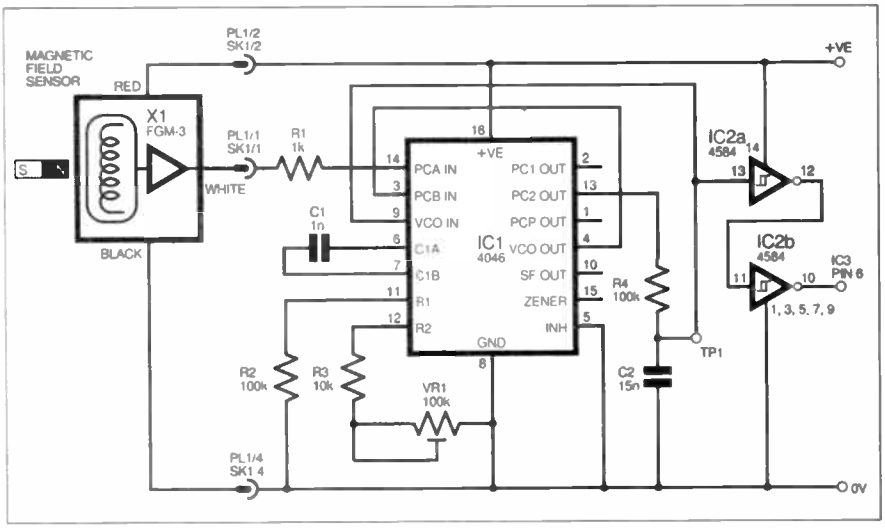


Fig. 1. Circuit diagram for the Sensor Interface frequency-to-logic section.

on the phase comparator inputs. Any difference in the phase causes a change in the voltage output at PC2 OUT, pin 13. Between them, resistor R4 and capacitor C2 smooth this output voltage and feed it back to the VCO IN input, pin 9. IC1 then does its best to change its VCO frequency and phase so that it equals that coming in from the sensor X1.

In this application, the VCO frequency range is set so that the sensor frequency and the VCO frequency never do need to match. Instead, the output voltage at PC2 OUT (pin 13) is forced to be at maximum when the sensor frequency is fast, and at minimum when it is slow. These maximum and minimum frequencies/voltages correspond to the magnet being close or distant to the sensor.

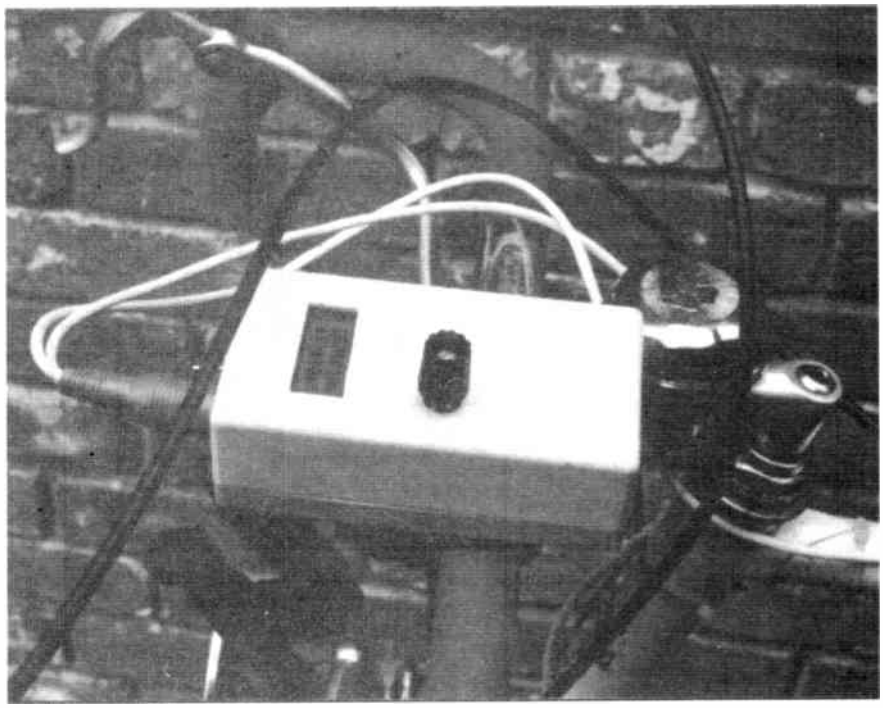
Converting the maximum and minimum voltages to cleanly changing Logic 1 and Logic 0 signals is done by the twin Schmitt inverter gates IC2a and IC2b. It is the output from IC2b pin 10 which provides the sharp logic level change which the microcontroller then needs to detect.

MICROCONTROLLER CIRCUIT

How the microcontroller processes the logic signal from the Sensor Interface will be discussed presently. Before it is, though, let's consider the general processing and display circuit in Fig. 2.

There are two active components in Fig. 2, the PIC16C84 microcontroller, IC3, and the intelligent liquid crystal display (l.c.d.), X3, which is based on the Hitachi HD44780 control chip. In-depth discussions of both these devices have appeared in previous issues of *EPE*: the l.c.d. module in February and March '97 issues (*How to Use Intelligent L.C.D.s*), and the PIC in several issues over the last year or so, notably February '96 (*Simple PIC16C84 Programmer*).

To briefly recap on the PIC16C84, it has one kilobyte (1KB) of EEPROM (electrically programmable read only memory) program memory, 64 bytes of EEPROM long-term data memory, and 36 volatile general-purpose data registers (SRAM – static random access memory). There are



PIC-Agoras Wheelie Meter installed on the handle-bars of a bicycle.

two bidirectional ports, the 5-bit Port RA and the 8-bit Port RB. The device includes its own master clock generator (oscillator) whose frequency is set externally either by a quartz crystal network or an *RC* (resistor/capacitor) network. There are four modes of clock operation:

RC Resistor/capacitor oscillator

XT Standard crystal oscillator

HS High speed crystal/resonator

LP Power saving, low frequency crystal

For this application, the XT mode is used with a 3·2768MHz crystal, X2, in conjunction with capacitors C3, C4 and resistor R8.

Also included in this microcontroller are a Watchdog Timer (WDT), and an edge-sensitive interrupt pin at Port INT/RB0 (pin 6). Program memory can be loaded serially while in-circuit, Port CLK/RB6 (pin 12) being the clock input, and Port DIO/RB7 (pin 13) the serial data input.

When not in use for loading program data, both the latter pins are available for normal data input/output.

To set the device into program loading mode, input $\overline{\text{MCLR}}$ (pin 4) has to be set to a voltage of between +12V and +14V. This input also serves as the Reset line, being taken to 0V to activate the in-chip reset routines. Normally, it is held at about the same positive voltage as supplies the chip's power, between +4V and +6V.

Switches S2, S3 and S5, resistors R6, R16, R17 and R9, and diode D2 are all associated with the programming mode and will be discussed when programming is described.

MODE SELECTION

Switch S4 is a panel mounted rotary 4-bit binary switch of which only the first three bits are used, providing eight modes (16 lines of display) that can be set via Port pins RA0, RA1 and RA2. The software program constantly monitors these pins and takes the appropriate action depending on the mode selected.

The modes are:

0 Show trip elapsed time and distance in kilometres

1 Show current speed and trip average speed in kilometres

2 Show trip peak speed and absolute distance since unit's first use, in kilometres

3 Show trip elapsed time and distance in miles

4 Show current speed and trip average speed in miles

5 Show trip peak speed and absolute distance since unit's first use, in miles

6 Show number of wheel rotations detected per second and average per 10 seconds

7 Reset all trip counters to zero

Switch S4 has only one pole (P), consequently only the selected "way" (pin 1, 2 or 4) can be held at a specific logic level via the pole. To keep the unselected pins at a known logic level requires them to be held at that level via biasing resistors, in this case R13 to R15.

The pole of the switch is put under program control, via Port pin DIO/RB7 (13). Only when the switch needs to be read is this line taken high. At all other times it is held low.

DISPLAY MODULE

The l.c.d. module X3 has two lines each of eight groups of display pixels (a 2-line 8-character unit). As discussed in *EPE* Feb '97, any of the module's internal library of alphanumeric characters and other symbols can be routed to any of the 16 display positions under software control.

Routing the data to be displayed from the microcontroller IC3 to the l.c.d. X3 requires the data code to be set up on the l.c.d. data pins and the appropriate toggling of two control lines, RS and E (pins 4 and 6). The l.c.d. can be operated in 8-bit or 4-bit mode. In the latter mode, data is only applied to data pins D4 to D7 (pins 11 to 14), pins D0 to D3 (pins 7 to 10) being left unconnected.

Data can be sent to the module either as Control commands or Character display data. The Control commands available are numerous, and can include such things as which line and pixel area the characters are to be displayed at; where the cursor sits; whether data is to be scrolled and in what direction; etc. To set Control command mode, line RS is taken to Logic 0. Setting RS to Logic 1 puts the display into Character transfer mode.

Control and Character data transfer are actioned when line E is taken low, to Logic 0.

There is a third control line, R/W (pin 5), This controls whether the l.c.d. is to receive data (Write mode, Logic 0), or supply it back to the outside world (Read mode, Logic 1). In this application, only Write mode is required, so the R/W pin is tied to the 0V line.

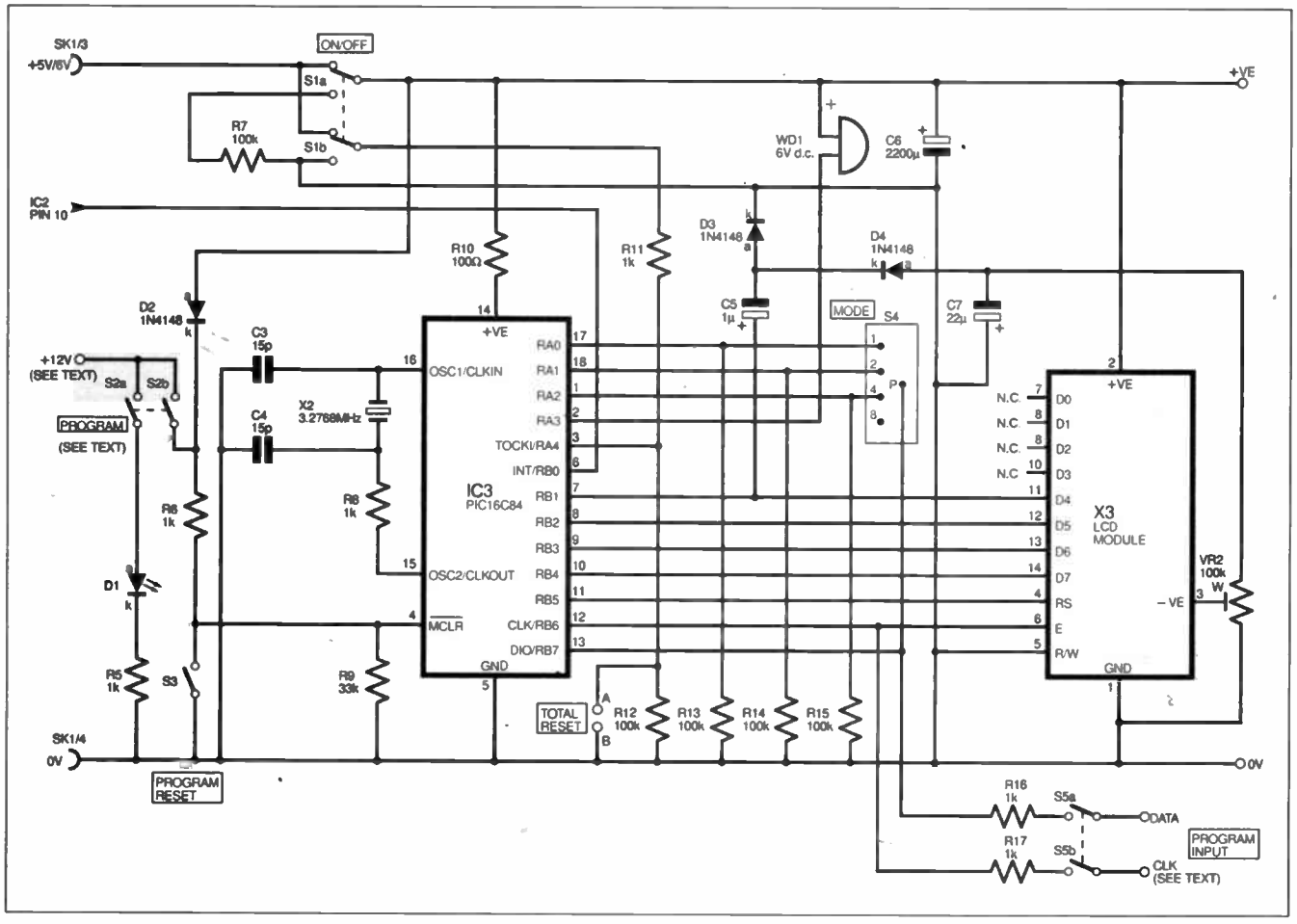


Fig. 2. Circuit diagram for the general Processing and Display stages of PIC-Agoras.

The l.c.d. module needs a negative voltage for screen contrast biasing. A simple negative inverter circuit is used, comprising capacitors C5, C7, diodes D3, D4, and preset potentiometer VR2. When IC3 is not actually transferring data to the l.c.d., Port RB1 (pin 7) is programmed to constantly toggle this line up and down. The resulting waveform is a.c. coupled by C5, negatively rectified by D3 and D4, and smoothed by C7. Preset VR2 sets the negative bias voltage for the desired screen contrast.

(The need for this negative bias is much bemoaned! Why couldn't the manufacturer allow this version of the l.c.d. to be biased to the 0V line instead, as is the case for other versions?)

AUTOMATIC SAVING

The PIC-Agoras system has been designed and programmed so that at the moment of switching off its power (by switch S1), the program automatically stores the current trip data – time elapsed, distance covered and peak speed – into the chip's EEPROM data memory. Next time the unit is switched on, this data is automatically recalled. You can thus go off for refreshments during a trip without wasting battery power!

While the unit is switched on, capacitor C6 (having a fairly high value) is held charged at close to full battery voltage level. Port pin TOCKI/RA4 (pin 3) is held high via resistor R11, and IC3 itself is powered via R10.

When S1 switches off the battery, IC3 and the display are powered by the charge held in C6. Port TOCKI/RA4, though, is immediately biased to a Logic 0 level via switch S1b. The program responds to this logic change and immediately jumps into the data-save routine. This routine is speedy and is completed before the charge on C6 has decayed below the voltage at which IC3 can continue to function.

Resistor R12 prevents TOCKI/RA4 from being indeterminately biased at the moment when the pole of S1b shifts between its other two contacts (it is a break-before-make switch, a make-before-break switch would cause the battery to be shorted to 0V by S1b during this transition).

NO CONFUSION

Resistor R7 continues to discharge C6 to a zero volts level after IC3 has ceased to function. A couple of minutes or so should be allowed to elapse before switching the unit on again. Failure to do this could confuse the microcontroller if its supply voltage from C6 has not fallen sufficiently and the chip is still being powered at an acceptable level. Such confusion could interfere with the EEPROM data storage values, and prevent the program restarting when power is switched on again.

The purpose of resistor R10 in IC3's positive power line is to limit the current it tries to draw from C6 during power-down.

Much thought and experimentation were put into the automatic saving problem, but no better solution could be envisaged. The reason for wanting automatic storage at switch-off was to overcome human memory loss!

Working data totals are held in volatile memory since there is a finite limit of times that the EEPROM data memory can be written to (typically 1,000,000 times). Consequently, it cannot be used as an active writable working memory during normal high-speed processing.

Obviously, then, a mere human would have to remember to switch the unit to another mode in order to store the trip data prior to switching off; an action all too easy to forget after a lengthy, tiring ride!

RESETTING BY CHOICE

It *is* possible to store the trip data by a switched action if you prefer. Switch S4 Mode 7 is the Reset mode. Switching to this mode triggers a 10-second countdown timer routine, during which Port RA3 activates the warning buzzer, WD1, accompanied by a display of the countdown seconds remaining. (The buzzer also "beeps" when power is switched off.)

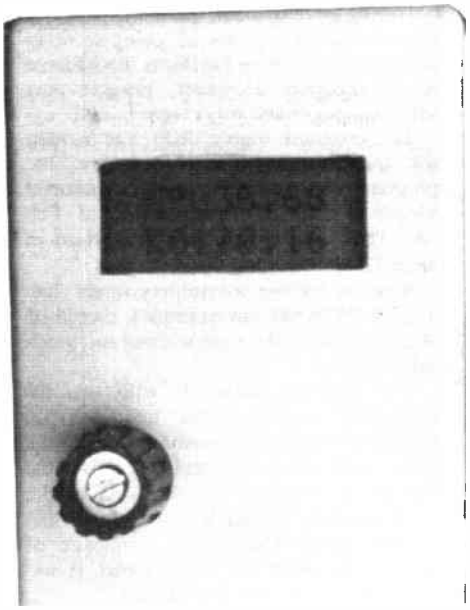
At the end of the countdown, the EEPROM trip-data storage routine is actioned; current trip data is stored into the EEPROM memory and running totals (distance covered since first-ever use of the unit) are updated. The ordinary working memory areas for the trip are then reset to zero. Normally, this routine is selected at the start of a trip.

During the countdown, Reset mode can be aborted so that if you inadvertently switch to it you can switch to another mode without updating the EEPROM and resetting trip data.

The buzzer is included to give adequate warning that Reset mode has been selected. Switching out of Reset mode resets the countdown timer so that next time this mode is selected, the count period is again set to start from 10 seconds.

TOTAL RESET

There is a further Reset facility provided, the ability to totally reset *all* the totals in the EEPROM memory back to zero. For data safety reasons, this facility is not accessible from outside the unit, which needs to be opened. In the circuit diagram of Fig. 2 are two points alongside



Completed display unit showing readout window and Mode switch.

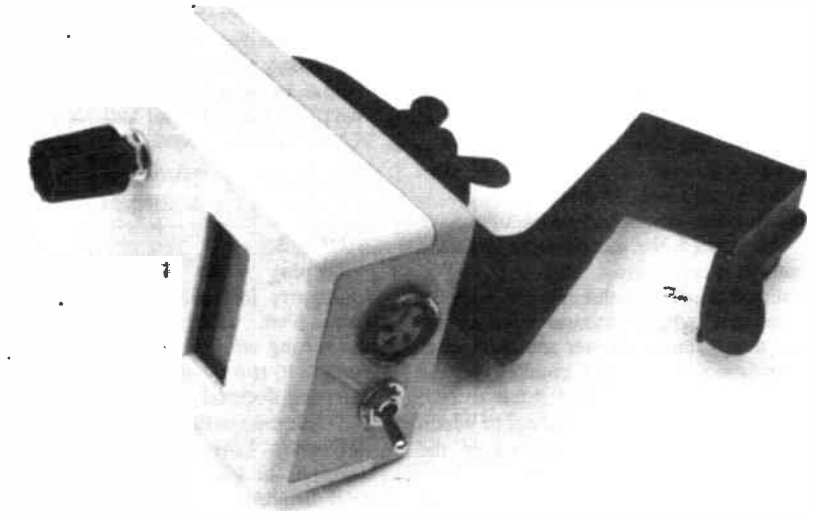
resistor R12 marked *A* and *B*. With the unit's power switched off, these two points should have a link wire soldered across them, connecting Port TOCKI/RA4 to the 0V line.

The power is then switched on and during the program's initialisation routine, the fact that Port TOCKI/RA4 is held low will be detected by the software. The program then jumps to the Total Reset routine, zeroing all EEPROM data memory locations. The program then goes into a catatonic state, refusing to do anything further.

Following Total Reset, power should be switched off and the *A* – *B* link removed. The unit can now be closed up, switched on again and used in the normal way.

SOFTWARE

The controlling software program is *complex*! Indeed, it's too complex to describe in detail, so only a brief run-down can be given. It is also lengthy, occupying nearly all available program memory locations (three bytes to spare!).



Finished control unit showing power/signal socket, on/off switch and cycle mounting clamp.

During development, there was actually concern that it was not all going to fit in and that one or more functions would have to be dropped. However, programmers love challenges and ways were found!

The program source code was written for assembly by TASM software, the program discussed in the earlier mentioned *Simple PIC16C84 Programmer* of Feb '96. That code is available as advised in *Shop Talk*.

Readers having assemblers other than TASM (MPASM, for example), should be able to translate the code without too much difficulty.

The program starts off with two initialisation routines. The first sets up various parameters in memory and on the Ports, and retrieves stored data from the EEPROM memory. The other is for the l.c.d. module, setting it into 4-bit 2-line control mode. During this sequence of events, the need for Total Reset is examined and actioned accordingly.

The main program now starts, from within an interrupt detection loop. This looped routine examines the status of an internal timer and that of the internal register on Port INT/RB0 (pin 6). This is the line that is connected to the final output of the Sensor circuit at IC2b pin 10.

If a wheel rotation has been detected (an internal register flag is automatically triggered without program intervention), two wheel-count counters are incremented. The maximum pulse count rate is 25Hz (25 wheel revolutions per second).

TIME - OUT

If the time-out flag of the timer has not been set, the program remains in the interrupt loop. If the flag has been set, which automatically occurs every 1/25th of a second, the first elapsed-time clock counter is incremented and the program jumps to the main calculation and display routine.

The first procedure in this routine is to read the value of the first elapsed-time counter. If it has received 25 pulses (= one second), the elapsed seconds, minutes and hours counters are incremented appropriately. If the time reaches 24 hours, all four elapsed-time counters are reset to zero. (An actual time of day clock facility is not included.)

Each time the seconds counter reaches a multiple of 10 seconds, the second wheel rotation counter has its information transferred to an averaging counter. The count value is also compared against a peak value counter; if the present count is greater than the peak value already stored, the peak value becomes the present count and stored in EEPROM memory.

When these 10-second procedures have been completed, the second wheel rotation counter is reset to zero.

Every *one* second, though, the contents of the first wheel rotation counter are added to a distance counter and then reset. Incrementing the distance counter is quite a complicated process since it has to take into account the size of the wheel to which the rotation count refers. Setting of the wheel size value is covered later.

Wheel size is stored in two bytes as part of the program itself. The data is retrieved by two sub-routine calls, one for each byte.

The wheel size value and the one-second rotation count are multiplied together and stored in three dedicated registers as a 24-bit binary number. This value represents the distance travelled during the present trip.

MODE STATUS

The program next reads the status of Mode switch S4. The route that the program now takes depends on the Mode detected, but all routes are accompanied by an updating of the display screen in some manner.

In any Mode, though, only one line of the l.c.d. is updated at a time. The program alternates between the two lines, and this alternation occurs every 25th of a second, so the data is effectively always seen as a real-time value. Each line of the display has eight bytes of data sent to it, which comprise an appropriate mixture of alphanumeric characters and blanks. These bytes are sent as a consecutive sequence of 16 nibbles (2 nibbles = 1 byte) as required by the 4-bit l.c.d. control mode.

The Mode procedures and displays are as follows:

MODE 0

Display Line 1: Trip elapsed time routine. Converts seconds, minutes and hours data from its 3-byte decimal storage format to 8-byte l.c.d. display format with colon and decimal point inserted; 24-hour clock.

Display Line 2: Trip distance in kilometres routine. Converts distance data from 3-byte binary format to 8-byte l.c.d. display format, to two decimal places of accuracy, inserting decimal point and identity letters KD (Kilometres/Distance).

Typical display: 01:23.05
KD031.53

MODE 1

Display Line 1: Current speed in kilometres routine. Evaluates speed from 10-second wheel rotation counter average data, converting answer to 8-byte l.c.d. display format, to two decimal places of accuracy, inserting decimal point and identity letters KV (Kilometres/Velocity). The 10-second averaging of the rotation count helps to smooth out small distracting variations in the displayed answer caused by the rate of the sampling process.

Display Line 2: Average speed in kilometres routine. Evaluates average speed from distance and elapsed time data, converting answer to 8-byte l.c.d. display format, to two decimal places of accuracy, inserting decimal point and identity letters KA (Kilometres/Average).

Typical display: KV047.31
KA022.79

MODE 2

Display Line 1: Peak speed in kilometres routine. Evaluates peak speed from peak wheel rotation count data, converting answer to 8-byte l.c.d. display format, to two decimal places of accuracy, inserting decimal point and identity letters KP (Kilometres/Peak).

Display Line 2: Total distance (ever covered) in kilometres routine. Evaluates total distance covered from current distance travelled and previous absolute distance travelled as held in EEPROM, converting answer to 8-byte l.c.d. display format, to two decimal places of accuracy, inserting decimal point and identity letter K.

Typical display: KP053.73
K0431.53

MODE 3

Display Line 1: Trip elapsed time routine. Identical to Mode 0, Line 1.

Display Line 2: Trip distance in miles routine. Follows kilometre conversion routine of Mode 0 Line 2, then converts answer to miles equivalent in 8-byte l.c.d. format, to two decimal places of accuracy, inserting decimal point and identity letters MD (Miles/Distance).

Typical display: 01:23.05
MD014.24

MODE 4

Display Line 1: Current speed in miles routine. Follows kilometres conversion routine of Mode 1 Line 1 then converts answer to equivalent miles value in 8-byte l.c.d. format, to two decimal places of accuracy, inserting decimal point and identity letters MV (Miles/Velocity). One kilometre is taken as five-eighths (5/8) of a mile (in all Modes 4, 5, 6 calculations).

Display Line 2: Average speed in miles routine. Follows kilometres routine of Mode 1 Line 2 then converts answer to equivalent miles value in 8-byte l.c.d. format, to two decimal places of accuracy, inserting decimal point and identity letters MA (Miles/Average).

Typical display: MV029.56
MA014.24

MODE 5

Display Line 1: Peak speed in miles routine. Follows kilometres routine of Mode 2 Line 1 then converts answer to equivalent miles value in 8-byte l.c.d. format, to two decimal places of accuracy, inserting decimal point and identity letters MP (Miles/Peak).

Display Line 2: Total distance (ever covered) in miles routine. Follows kilometre routine of Mode 2 Line 2 then converts answer to equivalent miles value in 8-byte l.c.d. format, to two decimal places of accuracy, inserting decimal point and identity letter M.

Typical display: MP033.58
M0269.70

MODE 6

Display Line 1: Current wheel rotation count during one second routine. Converts immediate wheel turns count to 8-byte l.c.d. format, inserting letters TL (Turns/totaL), three blanks and three digits. The count value is that since the last reset of the counter and so is seen to increment from zero to total one-second count, and then back to zero, and so on. A useful routine when aligning sensor and magnet on the vehicle.

Display Line 2: As for Mode 6 Line 1, but is an averaged value for ten second period, with prefix letters TA (Turns/Average).

Typical display: TL 005
TA 018

MODE 7

Display Line 1: Visual warning of RESET countdown in progress with seconds remaining count displayed; buzzer sounds. Remains at zero count and buzzer

continues to sound until Mode is changed.

Display Line 2: As for Mode 7 Line 1.

Typical display: RESET! 7
RESET! 7

ARITHMETIC

Most of the above Mode routines use repeated accesses to multiplication and division routines, which not only are too difficult to explain briefly, but also *extremely* lengthy, consuming much of the 1KByte program space available. Regrettably, PIC microcontrollers do not have these routines built into their command structure and so they have had to be written as blow-by-blow sub-routines. What a hassle!

Writing the routines proved how accustomed one can become to programming languages which *do* have the routines built in – with the 80486 and even the much earlier 8086 microprocessors, for example, programmers have a much easier time of it in this respect, though without some of the other benefits that a PIC microcontroller can offer.

POWER SUPPLY

It is intended that this design should be powered by a "heavy duty" 6V battery; a supply between 4V and 6V is acceptable. The *absolute maximum* is 7V and this must NOT be sustained or exceeded.

Current consumption at 5V is approximately 14·5mA.

CONSTRUCTION

Full details of the printed circuit board (p.c.b.) assembly and wiring to other components are shown in Fig. 3, as is the track layout for the copper foil pattern. This board is available from the *EPE PCB Service*, code 141.

If you do not intend to program your own PIC16C84 (see later), or if you already have a PIC programmer, then resistors R5, R16 and R17, l.e.d. D1, switches S2, S3 and S5, and computer connector PL2 can be omitted. Similarly, you can ignore further references to any aspect relating to on-board programming of IC3.

Experienced constructors will, of course, assemble the p.c.b. in whatever order they like. Other readers may prefer to follow the order in which the author assembled his prototype:

First, insert the link wire shown above IC3, and then the i.c. sockets. Do not try to save money by omitting the latter; it is much easier to just pull out an i.c. rather than have to unsolder it, should you ever need to replace it.

Next, insert the resistors and diodes, followed by the preset potentiometers and the capacitors. Note that capacitor C6 and preset VR2 are mounted on the rear of the board (trackside). Mount crystal X2 so that it lies horizontally above capacitor C3 and resistor R14. Now insert 1mm terminal pins where needed for connecting wires to off-board parts. Finally, solder in switch S4.

Make doubly-sure that the polarity of the diodes and electrolytic capacitors are observed, as well as the orientation of switch S4 (check this with a meter if you are not sure, though it should be marked underneath).

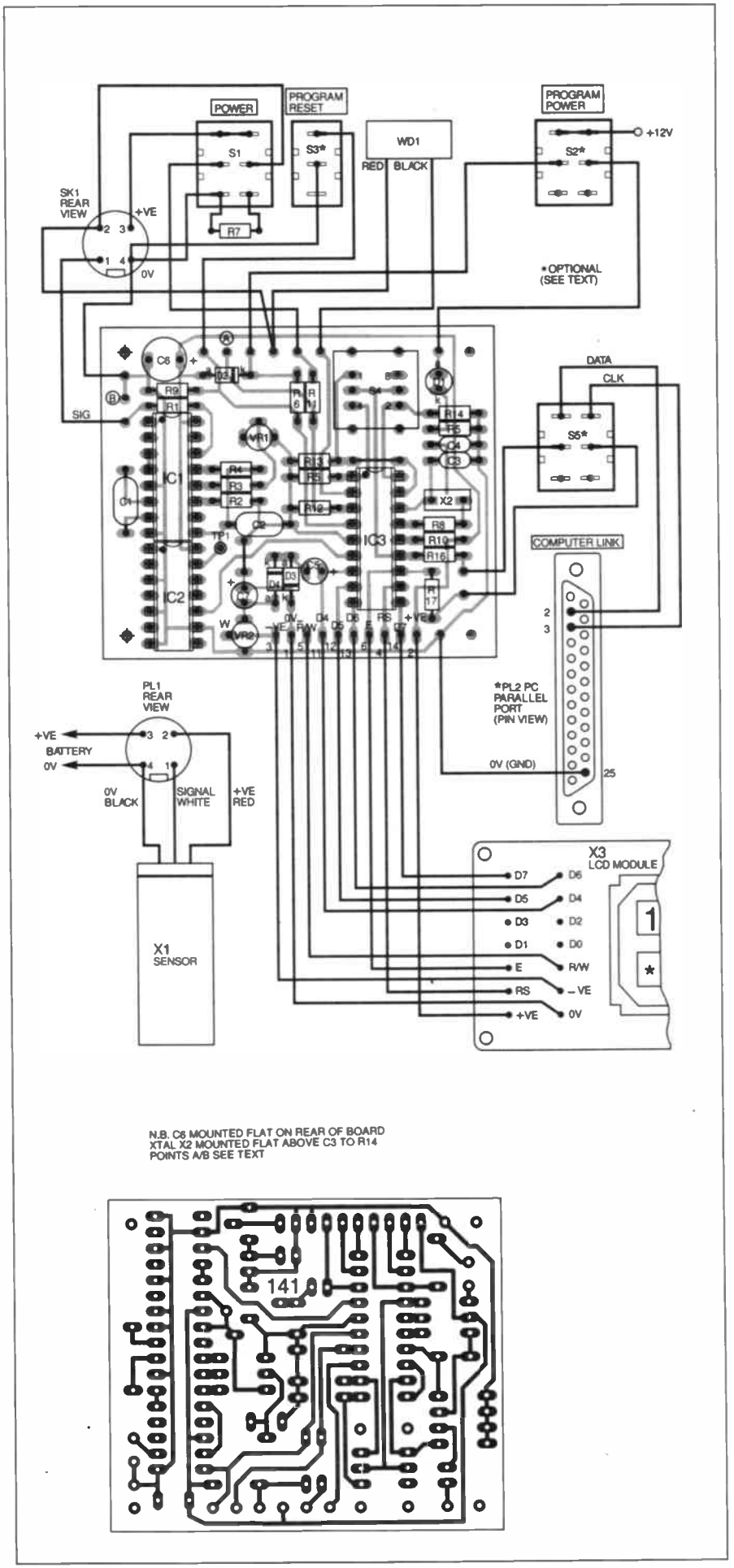
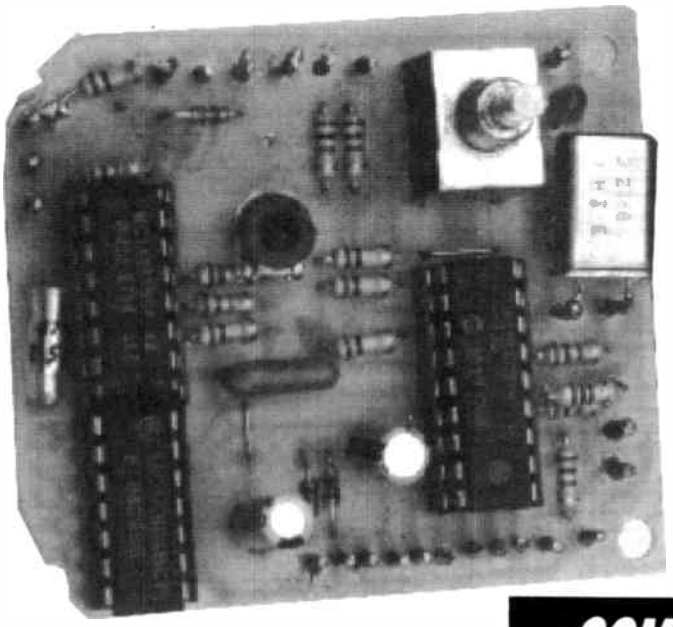


Fig. 3. Printed circuit board component layout, interwiring and full size copper foil master for PIC-Agoras. Note that C6 and VR1 are mounted on the track side of the p.c.b.



Layout of components on the prototype printed circuit board.

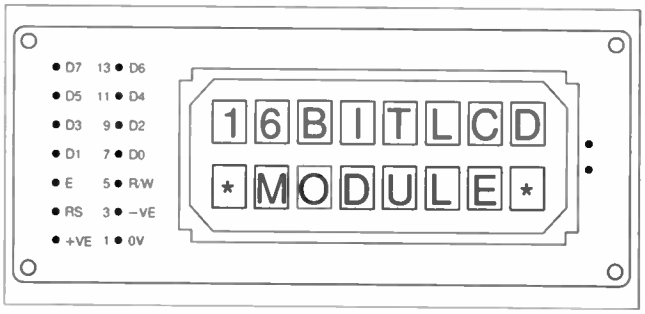


Fig. 4. Pinout information for the l.c.d. 2-line 8-character module.

CASE DRILLING AND FITTING

Before wiring the p.c.b. to anything else, drill out the lid of the recommended case to accept the mounting bush of switch S4. The l.c.d. requires an oblong cut out in the lid, cut so that only the display area is visible. The time-honoured technique of multiple perimeter hole drilling is suggested for this, pushing out the unwanted section and filing down the edges to full smoothness.

Drill out one end of the other part of the case to accept socket SK1 and switch S1. Ultimately, this end of the case will be at the same end as the display.

The l.c.d. module in the prototype was not bolted to the case. Fortuitously, its width made it a snug fit between the side walls of the case. The buzzer was then stuck to one wall with double-sided adhesive tape immediately above the l.c.d., so holding the latter in position.

The p.c.b. is secured inside the box by means of switch S4's bush and nut assembly. It may be necessary to trim the board's corners.

WIRING-UP

Before you mount the l.c.d., buzzer and p.c.b., carry out all the inter-component wiring. Keep leads fairly short but long enough so that you can manipulate things during the process. Connect the wires to their terminal pins at the *rear* of the p.c.b.; with the l.c.d., push the tinned ends of the wires through its p.c.b. holes and solder them on the display side.

If you are going to program your own PIC16C84, now wire-up switches S2, S3 and S5, and the three wires to computer connector PL2. The latter wires should be long enough so that PL2 can be plugged into the parallel printer port of your PC-compatible computer. The author's wires were about two metres long and no problems were experienced with data transfer.

Temporarily wire the FGM-3 sensor to DIN plug PL1, using the sensor's own leads. Also connect the battery-clip wires to this plug. Connect switch S2 to a +12V (or up to +14V) power supply. From this supply also make a 0V connection to SK1 pin 4. Observe the correct polarity of all these connections.

COMPONENTS

See SHOP TALK Page

Resistors

R1, R5, R6, R8, R11, R16, R17	1k (7 off)	
R2, R4, R7, R12 to R15	100k (7 off)	
R3	10k	
R9	33k	
R10	100Ω	

All 0·25W 5% carbon film

Potentiometers

VR1, VR2	100k min. round cermet preset (2 off)

Capacitors

C1	1n polyester
C2	15n polyester
C3, C4	15p polystyrene (2 off)
C5	1µ radial elect. 63V
C6	2200µ radial elect. 16V
C7	22µ radial elect. 16V

Semiconductors

D1	red l.e.d. (see text)
D2 to D4	1N4148 signal diode (3 off)
IC1	4046 phase locked loop
IC2	4584 hex Schmitt inverter
IC3	PIC16C84, pre-programmed, see text

Miscellaneous

X1	FGM-3 magnetic field sensor
X2	3·2768MHz crystal
X3	2-line 8-character l.c.d. module (HD44780 compatible)
S1	min d.p.d.t. toggle switch
S2, S5	min. d.p.s.t. toggle switch (3 off)
S3	min. s.p.s.t. toggle switch
S4	4-bit binary, rotary switch
PL1	4-pin DIN line plug
PL2	25-pin parallel printer port connector
SK1	4-pin DIN chassis socket
WD1	6V active buzzer

Printed circuit board, available from the *EPE PCB Service*, code 141; 14-pin d.i.l. socket (2 off); 16-pin d.i.l. socket; collet knob for S4 (3·2mm shaft) and coloured insert; min. 2-way terminal block; small disc magnet; heavy-duty 6V battery and clip; 1mm terminal pins; 2-tone plastic case, 120mm × 66mm × 30mm (l × w × h); cable ties; connecting wire; solder, etc.

***Approx Cost Guidance Only* £39**
excl. programming parts

FIRST CHECKS

Leave all the i.c.s out of their sockets for the moment and *do not* plug PL2 into the computer.

Thoroughly check all your soldered connections, both on the p.c.b. and on all other parts, preferably using a close-up magnifying glass.

When satisfied, plug PL1 into SK1, switch off programing switches S2, S3 and S5. Switch on both the normal 5V/6V supply and the 12V programming supply.

Referring to the circuit diagrams in Fig. 1 and Fig. 2, take a few readings around the p.c.b. to check that the positive supply is reaching the parts that it should, e.g. IC1 pin 16, IC2 pin 14, IC3 pin 14, l.c.d. (X3) pin 2, and IC3 pin 4. At the latter pin, the voltage will be about half a volt below the 5V/6V supply line voltage due to the presence of diode D2 and resistors R6 and R9.

If you have an oscilloscope, check that there is an output frequency signal from the Sensor at IC1 pin 14.

Switch off the main power supply switch S1 and switch on Program switch S2. Immediately check that the +12V supply *is not* reaching IC3 pin 14. (If it is, diode D2 is in the wrong way round; switch off and change it.) The l.e.d. D1 should light up and IC3 pin 4 should now be at the 12V level. Switch on Reset switch S3 and check that IC3 pin 4 is now at the 0V level.

Switch off both power supplies, insert all three i.c.s., observing the usual static-prevention precautions. Perform the above tests again from the beginning. An oscilloscope check at IC3 pins 15 and 16 should confirm that the clock generator around crystal X2 is functioning (only a scope can confirm this easily). At present, unless you are using a pre-programmed IC3, it is unlikely that the l.c.d. screen will show any detail, remaining totally blank.

SENSOR CHECKING

The Sensor circuit can be checked without IC3 having been programmed. Tape the sensor X1 to the workbench and connect a multimeter to test point TP1. Set the meter to a 5V d.c. (or greater) range.

Pass a small magnet back and forth past the sensor and observe the meter response as you do so. It will be found that a greater response is likely to occur nearer to one end of the sensor than the other, depending on which side of the

magnet faces the sensor. Note these facts in some way on both items (e.g. sticky label or Chinagraph pencil).

While passing the magnet, experiment with various settings of preset VR1 and jot down the resulting observed voltage differences. Don't be too fussy about these tests since more accurate setting up will be done once everything is mounted on the vehicle and its wheel.

However, you should establish that there are magnet positions and settings of VR1 which cause the output from IC2b pin 10 to swing between logic level extremes (0V and +5V).

SOFTWARE DIFFERENCES

There is a slight difference in the software for those who are doing their own programming and that supplied in the pre-programmed chips. The difference allows home-programmers to preset the wheel size from within the software. Pre-programmed chips can only have the wheel diameter set externally, by the user, via a signal generator. This is due to the complexities of having chips pre-programmed commercially to meet individual wheel diameter requirements.

In the software for the pre-programmed chips, diameter parameters can be set according to the frequency fed into the unit from the signal generator. These parameters are stored in the EEPROM data memory, and not in the program memory.

Home-programmers may use either technique. For the latter method, the software is used without modification. For the preset internal method (which, it has to be said, is the simplest way if you have the equipment), the following changes must be made:

Delete source code lines 173 to 175:

```
PAGE1
BCF TRISA,3
PAGE0
```

Delete source code lines 191 to 195:

```
btfss PORTA,3
GOTO WHEEL
PAGE1
BCF TRISA,3
PAGE0
```

Delete all source code lines from 1301 to 1317 inclusive. You MUST retain the final line of the software (.end)

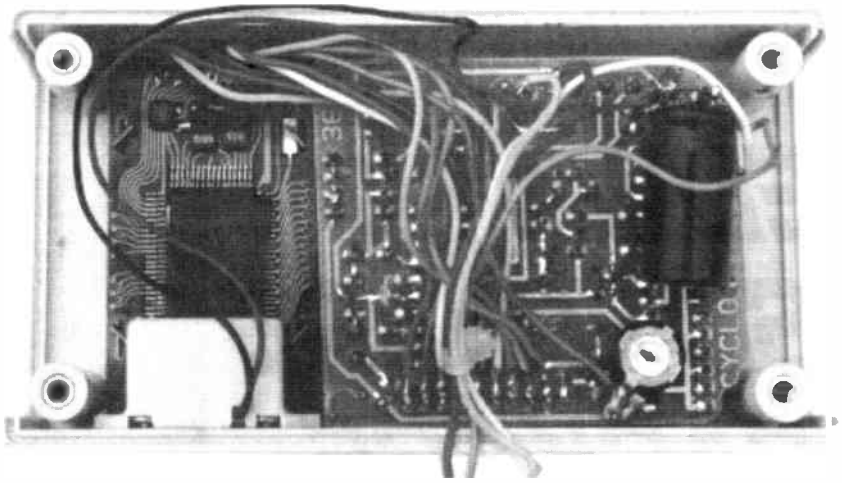
All 'comments' following the colon (;) in all the above deletion lines (not shown here) should also be deleted.

Source code lines 295 and 296 must be reinstated by deleting the colon (;) immediately in front of them (they are inoperative in the unmodified software):

```
SIZE1: retlw 45
SIZE2: retlw 56
```

There must be no blanks in front of these commands.

Having modified the lines via a text editor, such as the MS-DOS 'EDIT' software found on most recent PCs, save the software as an ASCII file (NO formatting commands specific to many word processors must be contained in this file). The software is then ready for assembly.



Layout of components in the interior of the case. The buzzer holds the display module in place.

SOFTWARE PROGRAMMING

Assuming all is well, IC3 can be programmed on-board by the computer. Load the software into the computer via an appropriate PIC16C84 software assembly program (e.g. TASM). The software must have been assembled as a binary file with extension *.com*. Plug connector PL2 into the parallel printer port.

The PIC16C84 first needs to be initialised with its basic operational parameters. Switch on Reset switch S3 (Reset mode). Switch on S2 (Program mode – l.e.d. on). Switch on Program Input switch S5, connecting the PIC to the computer's printer port. Switch off Reset switch S3. Run the initialisation routine provided with the PIC programming software package, and at the computer screen prompts:

Set the Clock for crystal XT mode (up to 4MHz)
Set Watchdog Timer OFF
Set Power-on-reset ON

The programming software may advise different orders of switching the Reset and Program switches, if so, follow its instructions. Note, though, that any switch numbers referred to in the programming software are unlikely to correspond to the switch numbers of PIC-Agoras.

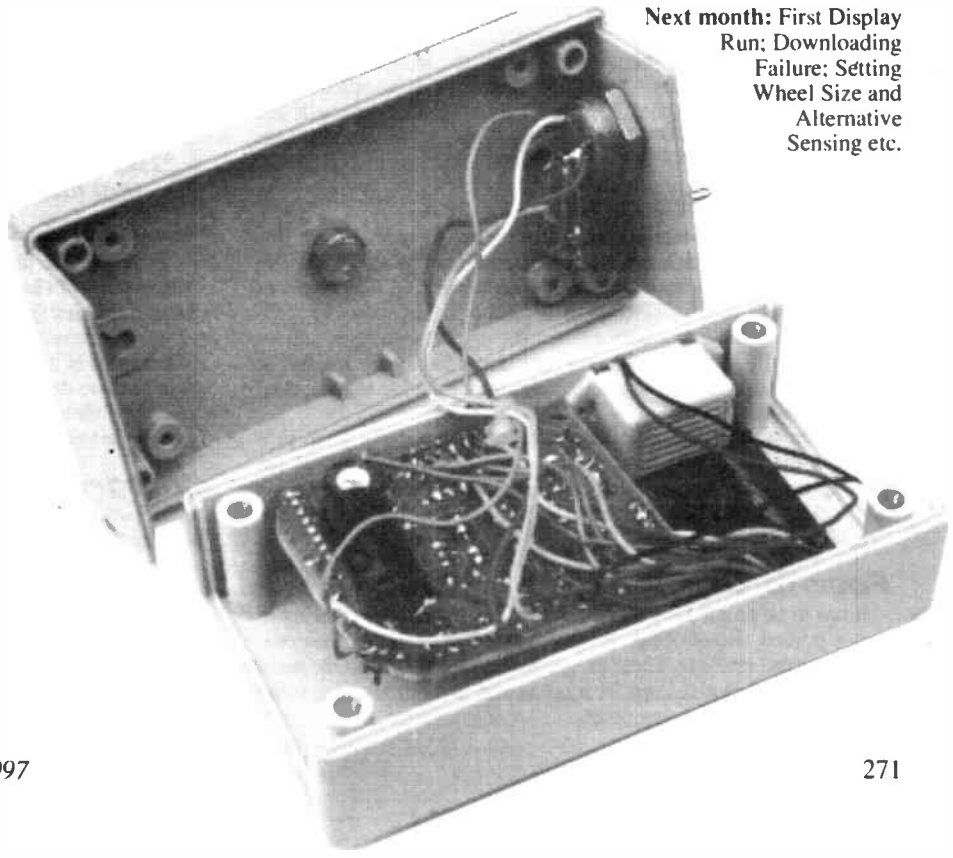
Having completed the initialisation, the main software can be downloaded to the PIC16C84. Assume for the moment that the wheel size data has already been set to the required value. If it has not, don't worry, it can be done later and the PIC can be reprogrammed with the revised software. You can reprogram the PIC at least 100,000 times if you wish, and probably more. The default wheel size values are those used by the author, for a 27·5 inch diameter wheel.

Leaving Program switch S2 on, again set Reset switch S3 on, and then off. Run the downloading software package and follow screen prompts (also following any switch setting requirements, if different).

When downloading is complete, as advised on-screen, switch on S3, switch off S2, switch off S5, in that order.

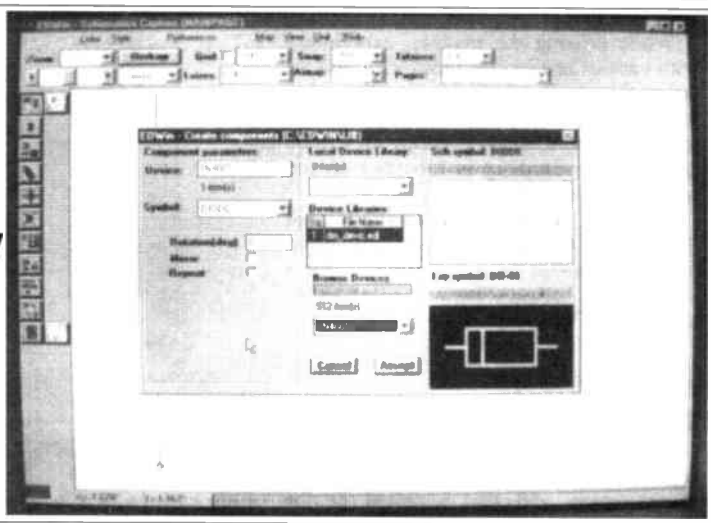
Set Mode switch S4 to Mode 1 (fully anti-clockwise if the switch rotation is lugged; if it's not, just guess, no harm will come).

Next month: First Display Run; Downloading Failure; Setting Wheel Size and Alternative Sensing etc.



Special Review

EDWIN NC SOFTWARE PACKAGE



ROBERT PENFOLD

An electronic design software package that carries a "professional spec." at a reasonable non-commercial price.

It is rather more than a p.c.b. design program, it is basically four programs merged into one.

AT ONE time it was quite normal for printed circuit design programs to cost a four figure sum, and a few of these programs actually made it into five figures. Eventually, some good low cost (about £100) programs came along, and the market changed dramatically. After some "jockeying for position", what were once up-market programs had a zero removed from the price, and became much more affordable.

These days a printed circuit design program has to offer some advanced features in order to command a four figure price tag. Typical up-market features include advanced autorouters, circuit simulators, and a high degree of automation so that boards will virtually design themselves!

EDWin is an "all singing, all dancing" electronic design program for PCs that costs some £2990 plus VAT in its normal guise. It is now available for "non-commercial use" at the relatively modest VAT inclusive price of £114. It is therefore available to home users and students at the lower price.

The non-commercial version includes all the features of the full product, but there is only one printed manual. This is called "Getting Started", and is about 80 pages long. The other manuals are supplied on the CD ROM, and there is the usual built-in help facility.

Heavy Weight

You need a reasonably powerful computer in order to run this program. The minimum requirement is an 80386 based PC having at least eight megabytes of RAM, a VGA screen, 40 megabytes of free hard disk space, a CD ROM drive, and a mouse.

It will run much better with a faster PC, an SVGA screen, and 16 megabytes of RAM. The program runs under Windows 3.1, 95, or NT. Obviously a Windows-compatible output device is needed in order to produce hard-copy.

The two-stage installation process involves running a setup program on the CD ROM first. This places a limited version of the program onto the hard disk, but running a further setup program on the 3·5 inch floppy disk converts the "crippled" program into the "real thing."

Four-To-One

It has to be pointed out from the start that EDWin is rather more than a printed circuit design program, and it is basically four programs merged into one. These programs are accessed from the main program, which is also used for loading and saving files, plus some other general housekeeping tasks.

From, the main program you can access schematic capture, board layout, circuit simulation, and post-processing programs. The latter is largely about producing files and documentation concerned with printed circuit manufacture, and is of limited interest to the home user.

Further programs are accessed from the four sub-programs. For example, the board layout program gives access to two autorouters. Including Windows, you sometimes find yourself working four program layers deep!

Operation of the programs largely follows normal Windows practice. There is the usual menu bar at the top of the screen, and a status line at the bottom. The latter tells you what the program is doing, what it expects you to do, etc.

A vertical tool bar is normally to be found down the left hand side of the screen, and the "tools" provided change depending on the program in use, and the selected function within that program. For example, the "tools" for editing components are somewhat different to those used for editing tracks. This gives a large number in total, but placing the pointer over a "tool" icon results in its function being indicated on the status line.

"There seems to be nothing else in this price range that has the range of features available from EDWin."

In general the programs are reasonably easy to use. This software seems to be of German origin, but the text in the main programs has been translated into English.

The general scheme of things when drawing boards or schematics is to use the "EDIT" menu to select the type of object you wish to deal with (component or track for example), and then use the "tools" to actually draw and edit objects. Dialogue boxes pop-up as and when necessary.

Integrated Circuits

If you wish to work that way, the programs can be fully integrated, operating from the same data base. This way of doing things has advantages, but it is inevitably quite complex. If you take the fully integrated approach, the normal first step is to draw the circuit diagram using the schematic capture program.

The circuit has to be drawn using what are called "devices" in EDWin terminology. A "device" is not just a circuit symbol, but also electronic data for the component (the value of a resistor for instance), plus physical connection and outline details.

AVAILABLE OPTIONS

EDWinNC Basic: Schematics, PCB Layout with Basic Autorouter and Postprocessing, Max. 100 component database and 500 symbol Device Library.	£49.00
The **De Luxe 1** version has the above, but also includes Professional Libraries and *unlimited* database components.	£79.00
De Luxe 2 is the same as the basic version, but with Professional Libraries and adds Mix-mode Simulation.	£79.00
De Luxe 3 all the above plus the Arizona Autorouter.	£114.00
Options: Professional Libraries	£24.00
Professional Database (Unlimited components)	£24.00
Mixed mode Simulation	£24.00
EDSpice Simulation	£49.00
Arizona Autorouter	£24.00
Thermal Analysis	£19.00

Post and Packing £5.00 UK. Overseas £10.00 for CD-ROM version (3½" disks add extra £10.00)

Prices include VAT

Multiple logic gates complicate matters as they appear as several circuit symbols, but only one component on the circuit board. However, there are facilities that can handle this, including some automatic help.

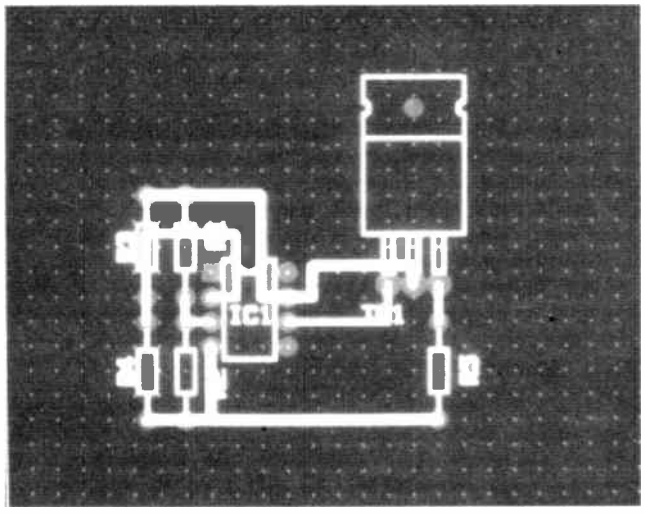
Having drawn up a circuit using "devices", it can then be loaded into the board layout and simulator modules. If we take the layout program first, this provides facilities for both manual and automatic board design, or a combination of the two. With the manual approach, the user places predrawn symbols onto the screen, and then draws tracks between the pads.

There is a useful array of tools for manually editing the board layout, and there is no difficulty in moving components, rerouting tracks, etc. I have not actually tried it, but if "devices" are used when designing the board, it is possible to produce the circuit diagram from the circuit board, rather than vice-versa.

Programs designed to operate using schematic capture or net list input (a text file containing a list of components and interconnections) are often rather cumbersome when used as straightforward electronic drawing boards. EDWin is not the easiest of programs to use in this fashion, but it is by no means the worst either. Tasks such as moving and rotating components, changing track widths, etc. are easily accomplished, and I do not think there would be any problems in designing large boards manually.

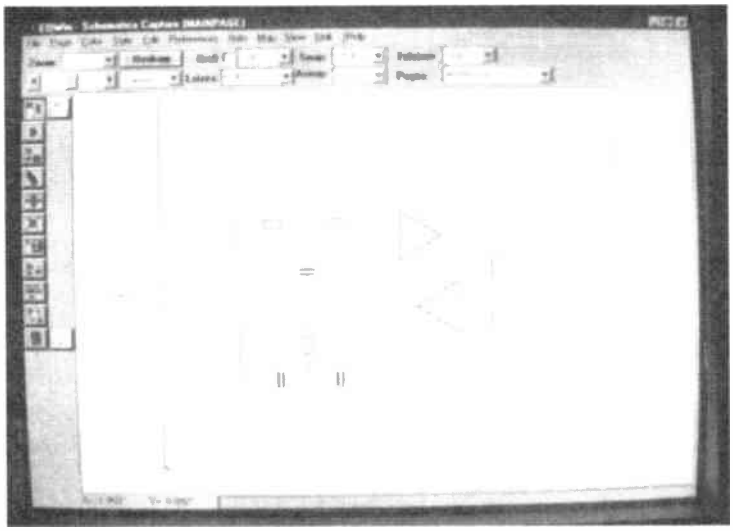
Keeping it Tidy

For a slightly more automated approach, you can place the components on the board, draw a "rats nest" of interconnections, and then use one of the autorouters to tidy things up and produce properly routed tracks. The standard autorouter is augmented by a more advanced "Arizona" autorouter. They apparently use rip-up and retry methods, and the "Arizona" autorouter additionally uses "shove" techniques. In other words, it will move an existing track that gets in the way, rather removing and rerouting it.



The beginnings of a design in the layout editor at a close-in zoom level. This can be used as a fully manual p.c.b. drafting program.

"We have become used to software prices falling as markets become saturated, but at its non-commercial price of £114 EDWin still rates a great bargain."



The schematic capture program with a 50Hz notch filter circuit loaded. Note one of "EDWin's" many toolbars at the left hand edge of the screen.

Provided the programs were given realistic component placement and design rules they always produced 100 percent routing in my tests. Quite good single-sided designs can be produced if you are prepared to use thin tracks and small clearances.

Taking automation to EDWin's limits, you load the interconnection data produced using the schematic capture program, and then use the auto-placement feature to position the components on the board. One of the autorouters can then be used to route the tracks.

In this way it is possible to produce printed circuit board designs fully automatically, and surprisingly rapidly. However, you will not necessarily end up with a particularly neat design. Auto-placement tends to work better with digital circuits than with linear types.

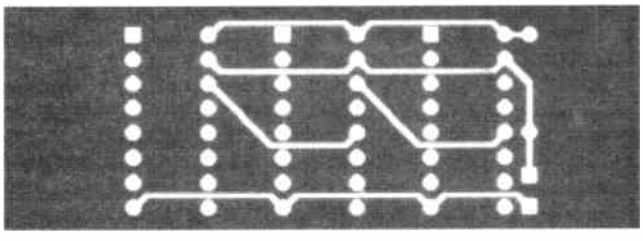
Virtual Circuits

The simulator is of the mixed mode variety, which means that it can handle linear circuits, digital circuits, or a mixture of the two. Circuit simulators are fine for circuits that are based on operational amplifiers, transistors, and simple logic devices, but tend to be impractical for many modern circuits that are based on special integrated circuits that cannot be easily modelled.

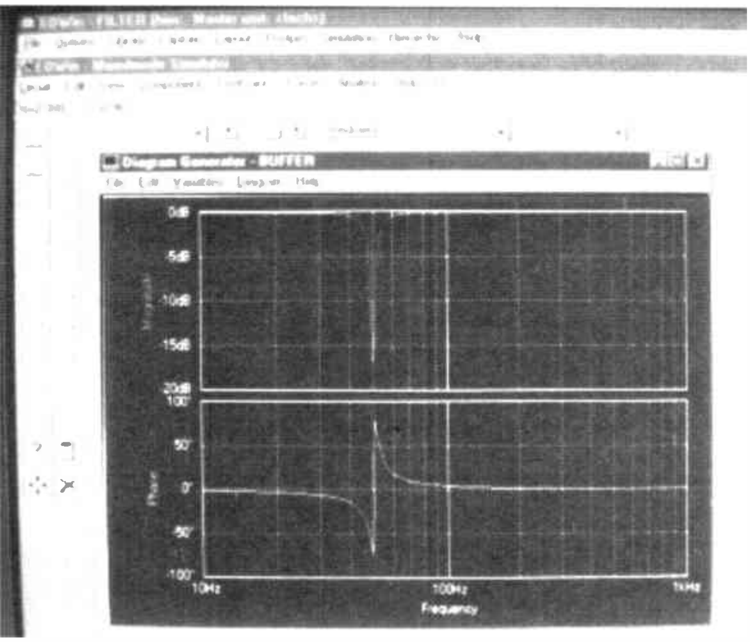
I only tried the EDWin simulator with linear circuits, and it seems to work well with designs that do not use any exotic components. It will provide the usual a.c. sweep, producing graphs showing frequency and phase response. Unlike some other simulators, it provides sensible frequency scaling and graphs that are easy to interpret.

The simulator can also handle d.c. bias levels, transient response, and there is a pop-up digital multimeter that can be used to measure voltage, differential voltage, or current. You simply "click" the mouse at the appropriate test point on the circuit diagram, and the relevant voltage or current is displayed on the virtual multimeter.

With digital circuits, the multimeter can act as a logic probe, showing the logic state at the selected test point. The circuit



A simple three-stage decade counter, routed as a single-sided board by the "Arizona" autorouter. This took two passes plus a third to mitre the corners of the tracks.



An a.c. sweep in the mixed mode circuit simulator. This shows the phase and frequency responses for a 50Hz notch filter.

simulator is clearly a complex piece of software in its own right, and like the other main programs of EDWin, cannot be fully described in a review such as this.

Library Editor

There is actually a fifth piece of software available via the main program, and this is the library editor. This is inevitably rather complex to use, since each "device" requires a very detailed description. This is really the weakness of the schematic capture approach to things.

Provided you only use the supplied library of "devices" things remain relatively straightforward (there are many thousands of devices in the library). At some stage, though, you may have to start editing your own "devices", and things then become rather more difficult. It is easy to end up spending more time defining devices than drawing circuits, designing boards, and actually making the finished project.

It is possible to produce some quite complex component outlines using the library editor, but in common with most printed circuit design programs, it is rather cumbersome compared to general CAD and illustration programs. The lack of a comprehensive printed manual is a big disadvantage with software as complex as this. Matters are complicated by the fact that a few functions do not seem to operate in quite the manner described in the on-line help.

Mastering the library editor could take a substantial amount of time and effort.

Summary

If you require a simple and easy to operate program that can be used to quickly draw up printed circuit boards, EDWin is probably not the best choice. If you require something more challenging, EDWin has a lot to offer.

In fact, there seems to be nothing else in this price range that has the range of features available from EDWin. It has virtually infinite "play value", but this is not to say that it is a "toy" program. It is a sophisticated piece of software that will provide excellent results.

We have become used to software prices falling as markets become saturated, but at its non-commercial price of £114 EDWin still rates a great bargain. However, there are one or two drawbacks that should not be overlooked.

In order to run well, a fairly powerful PC is required, and a reasonably well specified PC is needed in order to run this software at all. While it is nice to have the full version of the program rather than a cut-down amateur variant, it means that you are faced with a steep learning curve.

If you have a limited amount of spare time you may never get to grips with EDWin. On the other hand, if you have the time and are prepared to put in the effort, EDWin will deliver the goods and no doubt provide countless hours of fun.

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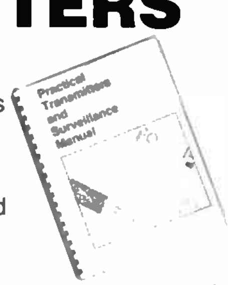

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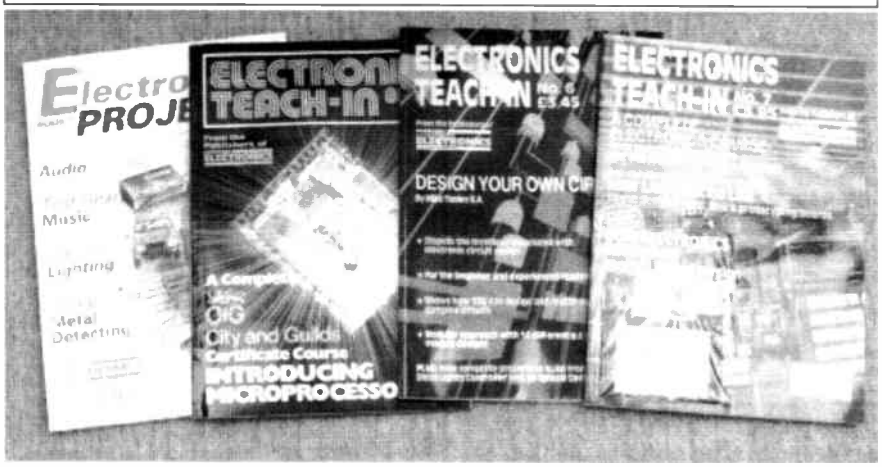

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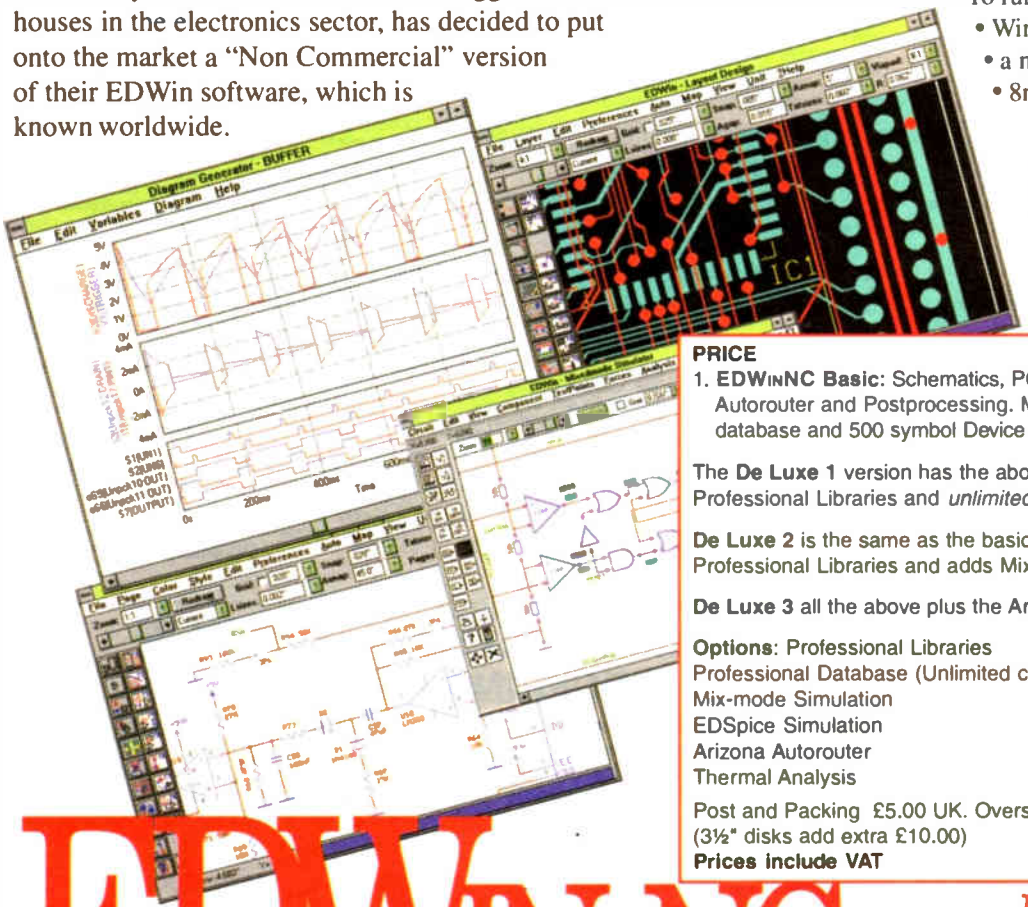

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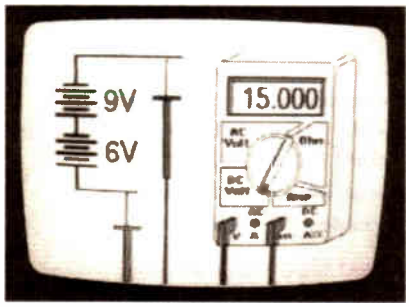

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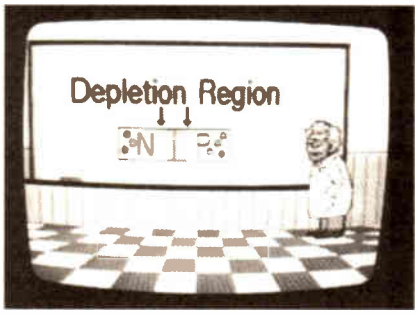
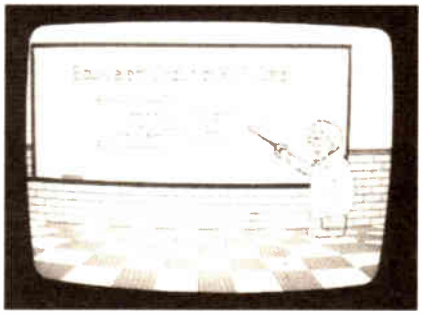


VT403 58 minutes. F.M. Radio Part 2. A continuation of f.m. technology from Part 1. Begins with the detector stage output, proceeds to the 19kHz amplifier, frequency doubler, stereo demultiplexer and audio amplifier stages. Also covers RDS digital data encoding and decoding. **Order Code VT403**

MISCELLANEOUS

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

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



Each video uses a mixture of animated current flow in circuits plus text, plus cartoon instruction etc., and a very full commentary to get the points across. The tapes are imported by us and originate from VCR Educational Products Co, an American supplier. (All videos are to the UK PAL standard on VHS tapes)

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FOX REPORT

by Barry Fox

HEARING AIDS AND CELLPHONES

When I do radio phone-in programmes I always get at least one call with an interesting question I can't answer. So I go away and check for the next week. Sometimes the information is well worth a wider audience. Here are a few loose ends recently tied up.

Banks, Post Offices, theatres and public service HQs often have an induction loop system for the hard of hearing. The loop couples at low frequency with a hearing aid. Some telephones have a socket for an amplified headset. So is there a cellphone that works in the same way?

The short answer is no. Cellphones, especially digital models (GSM, Orange, Mercury One-2-One) churn out so much interference that they upset a hearing aid. So it seems unlikely that they can ever work with an induction loop.

But most modern cellphones have a port which can connect to a hands-free system for a car. Motorola sells an earpiece and throat mic that will connect to the port on some of its cellphones, instead of a hands-free car kit.

RECORDING TELECOMS

Another caller asked whether it is now illegal to record a telephone call. The question is prompted by recent adverts on radio, TV and in newspapers, which warn (even boast) that all calls to the company will be recorded. This disclaimer was itself prompted by a clarifying statement put out by the DTI in July about changes which came into force in September. These changes concern the licences under which the telephone services operate under the Telecommunications Act 1984.

Emergency services, like the police and ambulances, can record all calls without warning the caller. Business, like banks, insurance companies and stockbrokers, can record calls but must make "every reasonable effort" to warn the caller. Hence the new rash of adverts.

Private individuals, such as journalists investigating a sensitive story, can tape without warning. In theory they should use only an acoustic or inductive coupler. In practice these can give poor results and no-one is going to know if the taper uses a direct connection to the phone line. But the direct connection must be via an isolation box or the ringing and DC voltages that routinely pass down a phone line may damage the recorder. Inexpensive isolators are sold in the USA and Japan, but not in the UK.

NAGGING REDIALING

A third caller asked about "naggers", as sold in the USA. A nagger is a phone which continually redials a busy or engaged number until it answers. Until recently they were banned in the UK because the regulations set by the BABT, British Approvals Board for Telecommunications, gave the makers of phones and fax machines a choice of four complicated options. Cut short, these required the automatic re-dialler to space calls by at least three minutes, or make only three attempts at one minute intervals. The reason given was that naggers clog BT's network.

Guernsey Telecom, in the Channel Islands, recently introduced a service called Ringback which has proved very popular. Press "5" when you get an engaged tone. Ringback then keeps checking the busy number, calls you back when it is free and sets up the call.

In November BT introduced its own Ringback service in the UK. The only difference is that BT charges 10p per call.

Incidentally GT found that Ringback clashes with call waiting, because Call Waiting does not return a conventional engaged tone. UK users will now discover the same problem.

This, and BT's 10p surcharge, makes nagger phones all the more attractive. They cost nothing extra to use. And the good news is that BABT has now relaxed its rules, as a first step towards harmonisation on nagging throughout Europe.

New phones and faxes can make up to 15 attempts at a call, spaced at five second intervals. The first nagging phones are due in the shops soon. They will not be as useful as American models which dial until eternity, with no delay. But they are a whole lot better than the clumsy restrictions we have been stuck with so far.

ENACTING COMMONSENSE TELECOMS

The English Advisory Committee on Telecommunications, is a quango, set up to advise telecoms watchdog Oftel. I had never heard of ENACT until it announced that "consumers are concerned about call queuing systems".

Too true. A company answers calls promptly, but then plays a recorded announcement and lo-fi music while keeping the caller holding on the line until someone is ready to talk. And all the time the caller is paying for the call.

The Microsoft Network helpline even has the cheek to play a recording which says the delay is caused by the unexpected popularity of MSN and the latest version of the Internet Explorer software.

So what does ENACT advise? The quango's catchy name certainly implies some hope of useful action.

Chairman Moira Black says, "Adoption of good practice could soon put things right".

So how does Ms Black's ENACT propose to improve practice? "People should write to the managing director of the company concerned". If firms do not then improve their queuing system, says Ms Black, "people will start hanging up".

Has Ms Black or anyone else in ENACT ever owned a PC? If they did, they would know that the people who phone computer helplines have no choice but to hang on. They have bought a system, or subscribed to a service, that does not work properly and there is no printed manual to refer to. The company works on the Microsoft principle that users should use online help, or if they can't get on line they should phone the helpline.

Anyone who follows Ms Black's advice will forfeit the chance of getting their PC working again.

Who sets up these advisory committees, and who picks their staff? Can I be on a few please?

MICE, MATS AND 3M

Do you use a PC on a sliding shelf mount? If you do, you know the problem. The shelf is not wide enough to take a PC keyboard and a mouse pad, side by side. But if you put a mouse pad under one side of the keyboard, its thickness throws the keyboard off-balance.

3M has the answer with the Precise Mousing Surface. This rather fancy name describes a small sheet of plastics material, with a microscopically fine structure of tiny peaks and valleys on the surface. You cannot see them, but you can feel them as a rough surface. This lets a mouse grip the plastics firmly. But the mat is so thin that it will slide under one side of a keyboard without making it lopsided.

The only down side is the price. 3M talks a lot of guff about "patented microreplication technology" to justify a retail tag of over £9. My bet is that either 3M will drop the price, or a competitor will come up with something very similar.

Remember that ordinary mouse pads used to sell for several pounds a time. Now they are given away, often as advertising material.

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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), PIC Disassembler (unpublished).

The disk (order as "PIC-disk") is available from the *EPE PCB Service* at £2.50 (UK) to cover our admin costs (the software itself is *free*). Overseas £3.10 surface mail, £4.10 airmail. Alternatively, the files can be downloaded *free* from our Internet FTP site: **ftp://ftp.epemag.wimborne.co.uk.**

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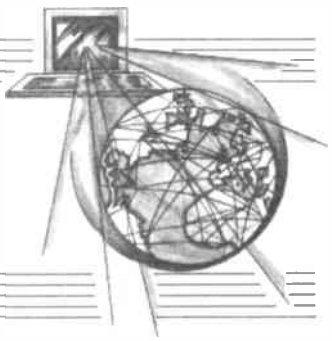

ALAN WINSTANLEY

OUR web site is a busy place these days, and a brief analysis of our WWW statistics tells us that the number of visitors to our pages (**http://www.epemag.wimborne.co.uk**) has now reached record levels! Recently added to our site include the application information for TENS users (**./aecctens.htm**) which was written in conjunction with the AECC, Bournemouth, to accompany last month's *Simple Dual Output TENS* project. This tells you how and where to apply TENS electrodes to help counter many types of pain. An all-text version is destined for the FTP site.

Also, the *EPE Basic Soldering Guide* is now available on-line (**./solderfaq.htm**), to help novices and students to choose the right soldering iron, and then to master the correct soldering technique. Many hundreds of users have already downloaded it, and you are free to use it for personal or educational purposes. An on-line version of the *1996 Constructional Project Index* is also new (**./idx1996.htm**), where you can browse the A-Z of all our 1996 projects; additionally, an on-line "Please Take Note" is hyper-text-linked into the index, so you can check the few corrections and amendments published during the year. This will always be kept up to date.

Meantime, over at our FTP site (**ftp://ftp.epemag.wimborne.co.uk**), you will find the new *text-only* version of the *EPE Basic Soldering Guide*. Look for the document **solder.txt** in the **/pub/docs** sub-directory. Also newly uploaded are the relevant files for the *PIC-Agoras* project. Open the **/pub/PICS** folder and then navigate to the *PIC-Agoras* sub-directory, and download the file within. Easy!

Fans of *Ingenuity Unlimited* will now find a document called **ing_unlt.txt** in the **/pub/docs** sub-directory, which gives you some hints and tips when considering submitting an item to the famous *Ingenuity Unlimited* column. A printed version is available by sending an SAE to the Editorial offices (UK only).

Y2K and the Year 2000

As previously highlighted on our news pages, the year 2000 is an event which, in computer circles, has struck terror into the heart of many computer systems operators. The problem is that a lot of older software and machinery cannot recognise the year 2000. Indeed, personal computers themselves will struggle, because the built-in CMOS real time clock of older computers cannot roll over to the year 2000; instead they may revert to 1980 in what has become known as the "Y2K" phenomenon. All around the world, there are Y2K user groups and clubs of businessmen banded together struggling to ensure that their data systems won't be brought to their knees after midnight on 31 December 1999.

In the personal computer market, anything from older class AT PC's through to Pentium machines could be affected, and my own older 486 PC suffers from the Y2K flaw (as readers of my own *Home Page* will know) whilst a new machine I own, is fine. As you can imagine, all E-mail, news and files are date-stamped and due to Y2K, older systems will force themselves back to 1980, causing chaos in larger commercial systems.

One way to test the hardware clock on a DOS-based machine is to exit any running software and go to the DOS prompt. If you have any concerns at all, then you should back-up all valuable data. Then check the date/time format of your machine and type:

```
C:\DATE 12-31-1999
C:\TIME 23:59
```

(you may need to reverse the date format, depending on your system), and then switch off for more than one minute. Power on and reboot to the DOS prompt. Check the date again. It should hopefully be 01-01-2000, but if it displays 01-04-1980 then you have the Y2K problem. Furthermore, the year 2000 is a leap year, so your clock should also "understand" 02-29-2000! Reset the clock and date again, to today's values, and re-boot.

Whilst the latest Pentium-powered machines and all Macintoshes take the millennium rollover in their stride, it is all too easy to forget that there are still legions of older machines in regular use, especially in developing countries where funds are tight. There are also plenty in use in less demanding tasks, for example my 486 acts as a good printer server.

What appears to be a solution to the Y2K problem comes in the form of **year2000.zip**, a patch for which I have obtained permission to upload to our FTP site. This file is now available in the **/pub/software** sub-directory and is free for personal use.

Year2000.zip hails from Tom Becker of RighTime Inc., Miami USA, whose web site at **http://www.RighTime.com** deals with this looming problem. You are advised to check the latest issue from RighTime's web site, but the version on our FTP site is currently the most recent. The program takes only 700 bytes in residence, and executes from your **autoexec.bat** file and works in OS/2 and DOS through to Windows 95. It is extremely easy to use and it uses a cute algorithm to detect the date as reported by your system's hardware clock, and fool your system into thinking that the New Millenium has arrived!

On test, **Year2000.com** loaded quickly during boot-up and worked perfectly on test, and you are urged to download the zip file, even if only to read **year2000.txt** after unzipping it. This file gives you the precise details of the Y2K bug and how RighTime sets about curing it. You may also find it interesting if you have an Award BIOS on your system.

Interesting Links

As always, to save you time, the following links are ready-made for you to click on the Net Work page of our WWW site. On the Y2K theme, try pointing your browser at **http://www.mitre.org/research/y2k/** for an introduction to the Y2K problem. Computer makers' compliance statements are also available on the same site. More Year 2000 links are on **http://www.year2000.com/y2klinks.html.**

My thanks to reader Owen Coughlan who suggests for audio fans, **http://users.aol.com/jorman/schems.html** (an impressive on-line collection of circuits for audio and effects fans) and **http://www2.gist.net.au/~aek/circuits.htm** which contains more circuits and links, including one to Dolby Laboratories at **http://www.dolby.com.**

Into Stepper Motors?

Http://www.doc.ic.ac.uk/~ih/doc/stepper started with a bulk supply of old disk-drive steppers, and makes interesting reading. Meanwhile, Dan Thimm has started an excellent web site called "*Robots, Rockets and Electronics*", dedicated to those who enjoy electronics, offering some simple projects on-line at **http://unix.newnorth.net/~dthimm**. Be patient while Dan's Electronic Experimentation Emporium downloads!

The new "*Electronics Resource Directory*" is a free, comprehensive listing of over 500 web sites for electronics enthusiasts and engineers. See **http://www.netins.net/showcase/elab/r-home.html/.** Finally, **http://home.sprynet.com/sprynet/lar01/nicad.htm** is a web site concerning Ni-Cad battery charging, and contains the author's personal observations and advice on caring for rechargeable Ni-Cads.

See you next month for more *Net Work*. My E-mail address is **alan@epemag.demon.co.uk**. My Home Page is **http://ourworld.compuserve.com/homepages/alan_winstanley.**

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Advanced 3-Way Stereo Active Cross-Over, housed in a 19" x 1U case. Each channel has three level controls: bass, mid & top. The removable front fascia allows access to the programmable DIL switches to adjust the cross-over frequency: Bass-Mid 250/500/800Hz. Mid-Top 1.8/3/5KHz, all at 24dB per octave. Bass invert switches on each bass channel. Nominal 775mV input/output. Fully compatible with OMP rack amplifier and modules.

Price £117.44 + £5.00 P&P

STEREO DISCO MIXER SDJ3400SE ★ ECHO & SOUND EFFECTS★

STEREO DISCO MIXER with 2 x 7 band L & R graphic equalisers with bar graph LED Vu meters. **MANY OUTSTANDING FEATURES:- including Echo with repeat & speed control, DJ Mic with talk-over switch, 6 Channels with individual faders plus cross fade, Cue Headphone Monitor. 8 Sound Effects. Useful combination of the following inputs:- 3 turntables (mag), 3 mics, 5 Line for CD, Tape, Video etc.**

Price £144.99 + £5.00 P&P SIZE: 482 x 240 x 120mm

PIEZO ELECTRIC TWEETERS - MOTOROLA

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.**

ibl 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.

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FREQUENCY RESPONSE FULL RANGE 45Hz - 20KHz

***ibl* FC 12-100WATTS (100dB) PRICE £159.00 PER PAIR**
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SPECIALIST CARRIER DEL. £12.50 PER PAIR

OPTIONAL STANDS PRICE PER PAIR £49.00
Delivery £6.00 per pair

IN-CAR STEREO BOOSTER AMPS

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

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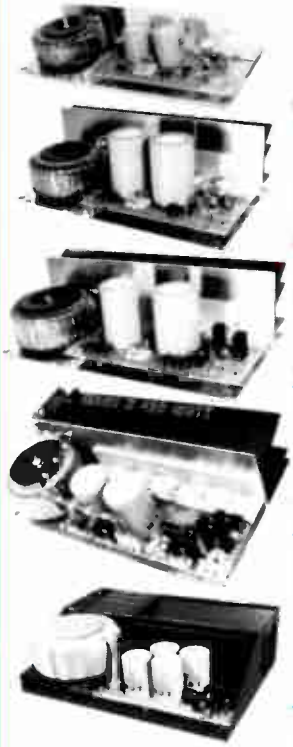
OMP MOS-FET POWER AMPLIFIER MODULES

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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LARGE SELECTION OF SPECIALIST LOUDSPEAKERS AVAILABLE, INCLUDING CABINET FITTINGS, SPEAKER GRILLES, CROSS-OVERS AND HIGH POWER, HIGH FREQUENCY BULLETS AND HORNS, LARGE (A4) S.A.E. (60p STAMPED) FOR COMPLETE LIST.

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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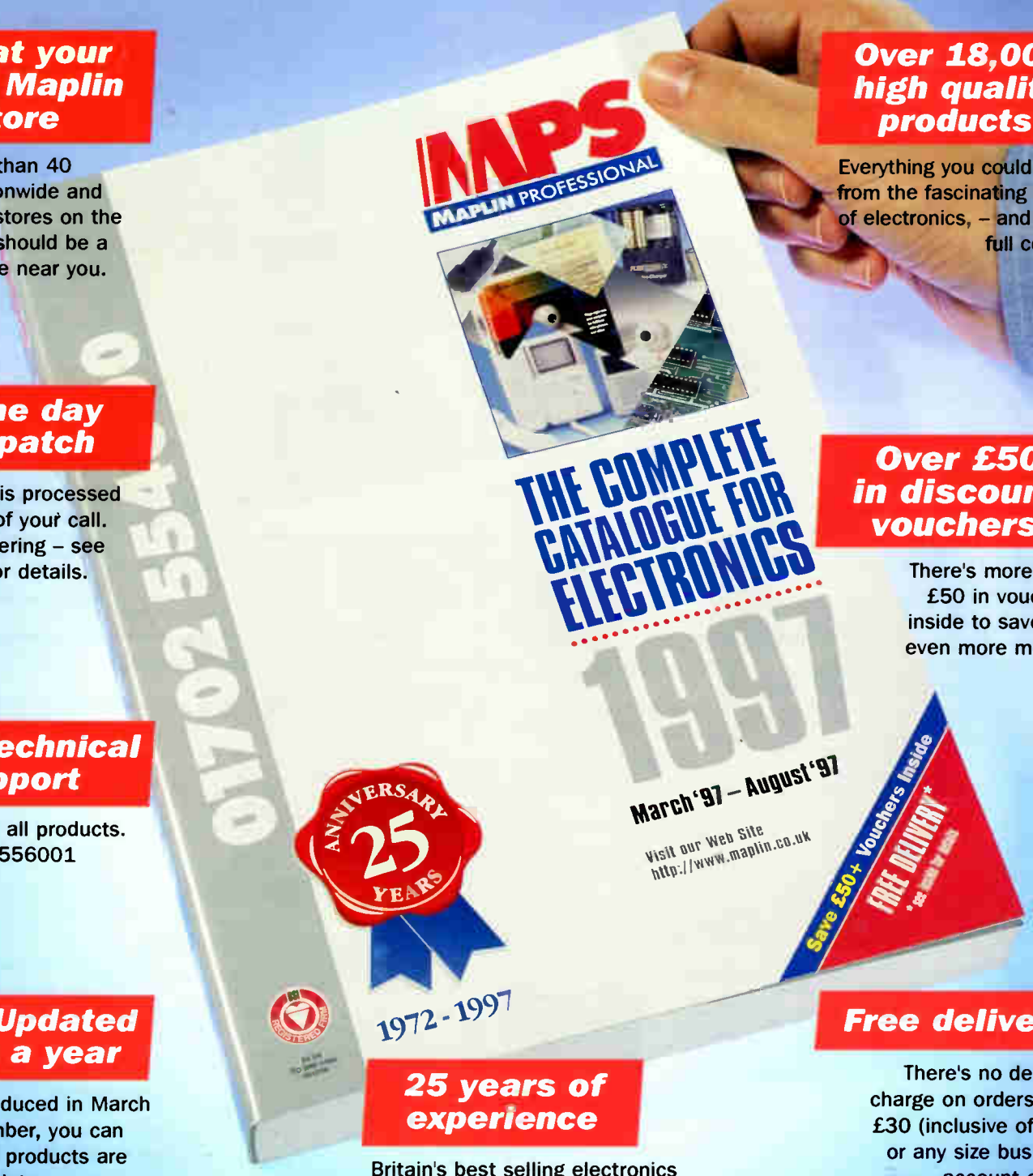

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