EVERYDAY
PRACTICAL
ELECTRONICS

OCTOBER 1997

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Even if it cannot possibly go wrong it still will

THE No.1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

PLUS New Technology Update – Circuit Surgery
Interface – Ingenuity Unlimited – Innovations

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

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

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

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

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

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

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

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

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

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

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

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

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

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

NEW LOW COST VEHICLE TRACKING TRANSMITTER KIT £29 range 1 5-5 miles, 5,000 hours on AA batteries, transmits info on car direction, left and right turns, start and stop information. Works with any good FM radio. £29 ref LOT101a

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

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

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

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

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

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

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

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

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

Could be adapted for laser listener, long range communications etc Double beam units designed to fit in the gun barrel of a tank, each unit has two semi conductor lasers and motor drive units for alignement. 7 mile range, no circuit diagrams due to MOD, new price £50,000? us? £199. Each unit has two gallium Arsenide injection lasers, 1 x 9 watt, 1 x3 watt, 900nm wavelength, 28vdc, 600hz pulse frequency. The units also contain an electronic receiver to detect reflected signals from targets. £199 for one. Ref LOT4.

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

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

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

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

HIGH POWER DC MOTORS, PERMANENT MAGNET

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

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

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

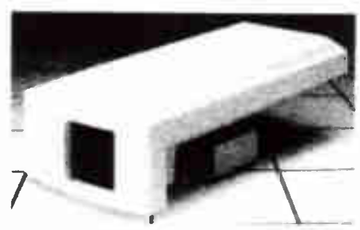
AA NICAD PACK Pack of 4 tagged AA nicads £2 99 ref BAR34

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

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

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

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



COLOUR CCTV VIDEO CAMERAS BRAND NEW AND CASED FROM £99

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

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

A MAGNET THAT LIFTS 33 KILO'S!

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

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

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

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

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

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

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

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

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

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

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

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

***NEW MEGA POWER VIDEO AND AUDIO SENDER UNIT.** Transmits both audio and video signals from either a video camera, video recorder, TV or Computer etc to any standard TV set in a 500m range! (tune TV to channel 31) 12v DC op. Price is £65 REF: **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 price is £18 REF EF62 (kit) Transmits to any FM radio. Built and tested version now available at £45 ref EXM34

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

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

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

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

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

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

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

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

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

SECOND GENERATION NIGHT SIGHTS FROM £748

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

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

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

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

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

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

WIND GENERATORS 380 WATT

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

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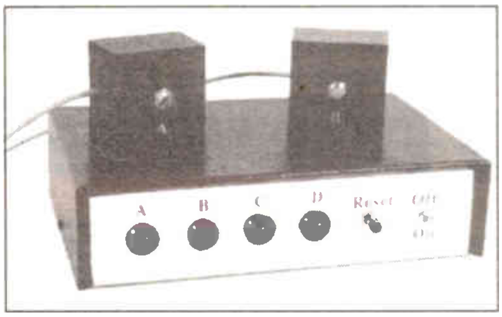

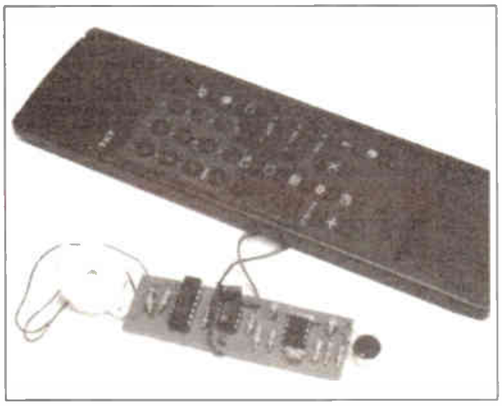

Projects and Circuits

Series and Features

Regulars and Services

Our November '97 issue will be published on Friday, 3 October 1997. See page 682 for details.

£1 BARGAIN PACKS – List 1

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

1 x 12V Stepper Motor. 7·5 degree. Order Ref: 910.
1 x 10 pack Screwdrivers. Order Ref: 909.
2 x 5 amp Pull Cord Ceiling Switches. Brown. Order Ref: 921.
5 x reels Insulation Tape. Order Ref: 911.
4 x 14mm Bull-races. Order Ref: 912.
2 x Cord Grip Switch Lamp Holders. Order Ref: 913.
1 x DC Voltage Reducer. 12V-6V. Order Ref: 916.
1 x 10 amp 40V Bridge Rectifier. Order Ref: 889.
Lightweight Stereo Headphones. Moving coil so superior sound. Order Ref: 896.
2 x 25W Crossovers. For 4ohm loudspeakers. Order Ref: 22.
2 x NiCad Constant Current Chargers. Easily adaptable to charge almost any NiCad battery. Order Ref: 30.
18V-0-18V 10VA mains transformer. Order Ref: 813.
2 x White Plastic Boxes. With lids, approx. 3" cube. Lid has square hole through the centre so these are ideal for light operated switch. Order Ref: 132.
2 x Reed Relay Kits. You get 8 reed switches and 2 coil sets. Order Ref: 148.
12V-0-12V 6VA mains transformer, p.c.b. mounting. Order Ref: 938.
1 x Big Pull Solenoid. Mains operated. Has ½" pull. Order Ref: 871.
1 x Big Push Solenoid. Mains operated. Has ½" push. Order Ref: 872.
1 x Mini Mono Amp. 3W into 4 ohm speaker or 1W into 8 ohm. Order Ref: 495.
1 x Mini Stereo 1W Amp. Order Ref:870.
15V DC 150mA p.s.u., nicely cased. Order Ref: 942.
1 x In-Flight Stereo Unit is a stereo amp. Has two most useful mini moving coil speakers. Made for BOAC passengers. Order Ref: 29.
1 x 0-1mA Panel Meter. Full vision fact 70mm square. Scaled 0-100. Order Ref: 756.
2 x Lithium Batteries. 2·5V penlight size. Order Ref: 874.
2 x 3m Telephone Leads. With BT flat plug. Ideal for 'phone extensions, fax, etc. Order Ref: 552.
1 x 12V Solenoid. Has good ½" pull or could push if modified. Order Ref: 232.
3 x In-Flex Switches. With neon on/off lights, saves leaving things switched on. Order Ref: 7.
2 x 6V 1A Mains Transformers. Upright mounting with fixing clamps. Order Ref: 9.
2 x Humidity Switches. As the air becomes damper, the membrane stretches and operates a micro switch. Order Ref: 32.
4 x 13A Rocker Switch. Three tags so on/off, or changeover with centre off. Order Ref: 42.
1 x Suck or Blow-Operated Pressure Switch. Or it can be operated by any low pressure variation such as water level in tanks. Order Ref: 67.
1 x 6V 750mA Power Supply. Nicely cased with mains input and 6V output lead. Order Ref: 103A.
2 x Stripper Boards. Each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc. Order Ref: 120.
12 Very Fine Drills. For PCB boards etc. Normal cost about 80p each. Order Ref: 128.
5 x Motors for Model Aeroplanes. Spin to start so needs no switch. Order Ref: 134.
6 x Microphone Inserts. Magnetic 400 ohm, also act as speakers. Order Ref: 139.
6 x Neon Indicators. In panel mounting holders with lens. Order Ref: 180.
1 x In-Flex Simmerstat. Keeps your soldering iron etc always at the ready. Order Ref:196.
1 x Mains Solenoid. Very Powerful as ½" pull, or could push if modified. Order Ref: 199.
1 x Electric Clock. Mains operated. Put this in a box and you need never be late. Order Ref: 211.
4 x 12V Alarms. Makes a noise about as loud as a car horn. All brand new. Order Ref: 221.
2 x (6" x 4") Speakers. 16 ohm 5 watts, so can be joined in parallel to make a high wattage column. Order Ref: 243.
1 x Panostat. Controls output of boiling ring from simmer up to boil. Order Ref: 252.
2 x Oblong Push Switches. For bell or chimes, these can switch mains up to 5A so could be foot switch if fitted in pattress. Order Ref: 263.
50 x Mixed Silicon Diodes. Order Ref: 293.
1 x 6 Digit Mains Operated Counter. Standard size but counts in even numbers. Order Ref: 28.
2 x 6V Operated Reed Relays. One normally on, other normally closed. Order Ref: 48.
1 x Cabinet Lock. With two keys. Order Ref: 55.
6½ 8Ω 5 Watt Speaker. Order Ref: 824.
1 x Shaded Pole Mains Motor. ¾" stack, so quite powerful. Order Ref: 85.
2 x 5 Aluminium Fan Blades. Could be fitted to the above motor. Order Ref: 86.
1 x Case, 3½ x 2¼ x 1¾ with 13A socket pins. Order Ref: 845.
2 x Cases. 2½ x 2¼ x 1¾ with 13A pins. Order Ref: 565.
4 x Luminous Rocker Switches. 10A mains. Order Ref: 793.
4 x Different Standard V3 Micro Switches. Order Ref: 340.
4 x Different Sub Min Micro Switches. Order Ref: 313.

BARGAINS GALORE

INSULATION TESTER WITH MULTIMETER. Internally generates voltages which enable you to read insulation directly in megohms. The multimeter has four ranges, AC/DC volts, 3 ranges milliamps, 3 ranges resistance and 5 amp range. These instruments are ex-British Telecom but in very good condition, tested and guaranteed OK, probably cost at least £50, yours for only £7.50 with leads, carrying case £2 extra, Order Ref: 7.5P4.
THIS INSTRUMENT but slightly faulty – you should be able to repair it. We supply circuit diagram and notes, £3, Order Ref: 3P176.
12V 10A SWITCH MODE POWER SUPPLY. For only £9.50 and a little bit of work because you have to convert our 135W PSU. Modifications are relatively simple – we supply instructions. Simply Order PSU Ref: 9.5P2 and request modification details. Price still £9.50.
MEDICINE CUPBOARD ALARM. Or it could be used to warn when any cupboard door is opened. The light shining on the unit makes the bell ring. Completely built and neatly cased, requires only a battery. £3, Order Ref: 3P155.
DON'T LET IT OVERFLOW! Be it bath, sink, cellar, sump or any other thing that could flood. This device will tell you when the water has risen to the preset level. Adjustable over quite a useful range. Neatly cased for wall mounting, ready to work when battery fitted, £3, Order Ref: 3P156.
VERY POWERFUL MAINS MOTOR. With extra long (2½") shafts extending out each side. Makes it ideal for a reversing arrangement for, as you know, shaded pole motors are not reversible, £3, Order Ref: 3P157.
SOLAR PANEL BARGAIN. Gives 3V at 200mA. £2, Order Ref: 2P324.=

£1 SUPER BARGAIN 12V axial fan for only £1, ideal for equipment cooling, brand new, made by West German company. Brushless so virtually everlasting. Needs simple transistor drive circuit, we include diagram. Only £1, Order Ref: 919. When we supply this we will include a list of approximately 800 of our other £1, bargains.

LIGHT DIMMERS. On standard plate to put directly in place of flush switch. Available in colours, green, red, blue and yellow, £2.50, Order Ref: 2.5P9.
45A DOUBLE POLE MAINS SWITCH. Mounted on a 6" x 3½" aluminium plate, beautifully finished in gold, with pilot light. Top quality, made by MEM, £2, Order Ref: 2P316.
DON'T STAND OUT IN THE COLD. Our 12m telephone extension lead has a flat BT socket one end and flat BT plug other end, £2, Order Ref: 2P338.
20W 4 OHM SPEAKER. £3, Order Ref: 3P145. Matching 4 ohm 20W tweeter on separate baffle, £1.50, Order Ref: 1.5P9.

LCD 3½ DIGIT PANEL METER
This is a multi-range voltmeter/ammeter using the A-D converter chip 7106 to provide 5 ranges each of volts and amps. Supplied with full data sheet. Special snip price of £12, Order Ref: 12P19.

TELEPHONE EXTENSION WIRE. 4 core correctly colour coded, intended for permanent extensions, 25m coil, £2, Order Ref: 2P339.
PHILIPS 9" HIGH RESOLUTION MONITOR. Black and white in metal frame for easy mounting. Brand new, still in maker's packing, offered at less than price of tube alone, only £15, Order Ref: 15P1.
HIGH CURRENT AC MAINS RELAY. This has a 230V coil and changeover switch rated at 15A with PCB mounting with clear plastic cover. £1, Order Ref: 965.
ULTRA THIN DRILLS. Actually 0.3mm. To buy these regular costs a fortune. However, these are packed in half dozens and the price to you is £1 per pack. Order Ref: 797B.
YOU CAN STAND ON IT! Made to house GPO telephone equipment, this box is extremely tough and would be ideal for keeping your small tools in, internal size approx. 10½ x 4½" x 6" high. Complete with carrying strap, price £2, Order Ref: 2P283B.
ULTRA SONIC TRANSDUCERS. Two metal cased units, one transmits, one receives. Built to operate around 40kHz, price £1.50 the pair, Order Ref: 1.5P4.
POWER SUPPLY WITH EXTRAS. Mains input is fused and filtered and the 12V DC output is voltage regulated, intended for high class equipment, this is mounted on a PCB and also mounted on the board but easily removed, are two 12V relays and Piezo sounder. Price £3, Order Ref: 3P80B
MAINS ISOLATION TRANSFORMER. Stops you getting "to earth" shocks, 230V in and 230V out, 150W, £7.50, Order Ref: 7.5P5, and a 250W version is £10, Order Ref: 10P97.
MAINS 230V FAN. Best make "PAPST", 4½" square, metal blades, £8, Order Ref: 8P8.
2MW LASER. Helium neon by Philips, full spec., £30, Order Ref: 30P1. Power supply for this in kit form with case is £15, Order Ref: 15P16, or in larger case to house tube as well, £18, Order Ref: 18P2. The larger unit, made up, tested and ready to use, complete with laser tube, £69, Order Ref. 69P1.

10% FREE
If you order ten of an item we will add an eleventh one free.

AIR SPACED TRIMMER CAPS. 2-20pf, ideal for precision tuning UHF circuits, 4 for £1, Order Ref: 818B.
MODEM AMSTRAD FM240. As new condition but customer return so you may need to fault find, £6, Order Ref: 6P34.
AMSTRAD POWER UNIT. 13.5V at 1.9A or 12V at 2A encased and with leads and output plug, normal mains input, £6, Order Ref: 6P23.
80W MAINS TRANSFORMER. Two available, good quality, both with normal primaries and upright mounting, one is 20V 4A, Order Ref: 3P106, the other 40V 2A, Order Ref: 3P107.
PROJECT BOX. Size approx. 8 x 4 x 4½" metal, sprayed grey, louvred ends for ventilation otherwise undrilled. Made for GPO so best quality, only £3 each, Order Ref: 3P74.
SENTINEL COMPONENT BOARD. Amongst hundred of other parts, this has 15 i.c.s, all plug in so do not need soldering. Cost well over £100, yours for £4, Order Ref: 4P67.
15W 8 OHM 8" SPEAKER & 3" TWEETER. Made for a discontinued high quality music centre, gives real hi-fi and only £4 per pair, Order Ref. 4P57.
WATER PUMP. Very powerful, mains operated, £10, Order Ref: 10P74.
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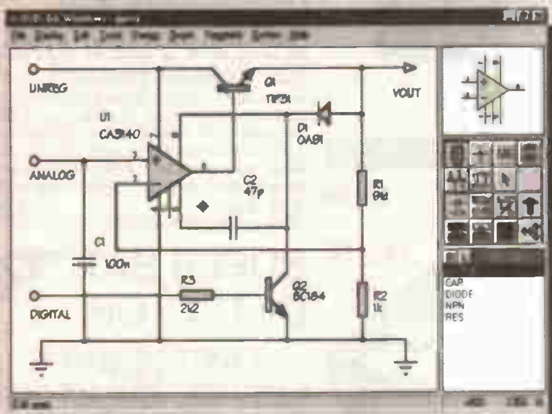

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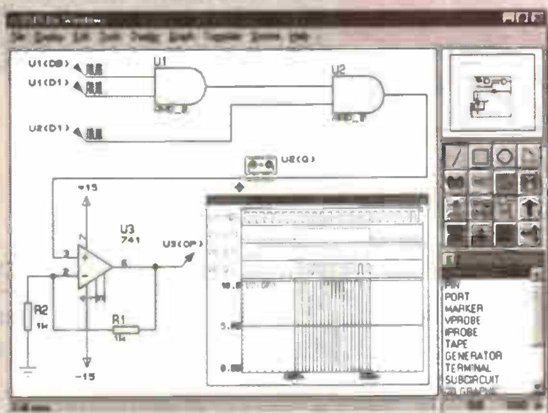

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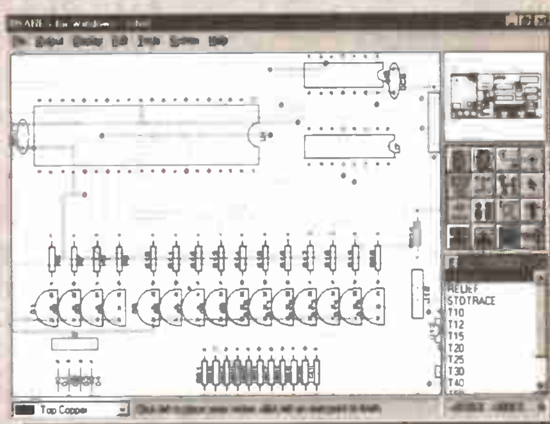

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EWW January 1997

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NO ONE KNOWS

It's interesting to hear from friends in industry that on most projects nowadays no one person fully understands how every part of a system is designed and operates. Systems have become so complex that specialists are required for each part of the design and only a full design team could explain the total project in detail. As systems like Digital TV become more and more complex in nature no doubt the design teams will expand in numbers in proportion to the level of complexity. One begins to wonder if a knowledge of basic electronics will continue to be relevant to design engineers in general.

Maybe a chip designer will need to understand some basics but, more likely, just individual gate or device behaviour. Once you get to the level of connecting and programming microprocessors to perform various tasks is Ohms Law relevant or necessary? We take the view that a sound understanding of basic principles can never do any harm and since most examination syllabuses start at the "current flow" level it seems that industry and universities also continue to share that view.

EDUCATED

Whatever your level of interest we will, over the coming months, be running special features to cover various design approaches. Our regular and now famous *Teach-In* series kicks off in the November issue and will cover basic electronics. It has been specifically written to cover the City and Guilds Digital Electronics syllabus (726) but will be of value to GCSE and A Level students and also to those interested in electronics in general, even if you don't want to partake of a formal qualification. In short, it should be of value to everyone who wants to understand basic electronics principles. A team of writers from Hull University, co-ordinated by Alan Winstanley, is busy producing all the material.

On the other hand, for those who want to program their own chips to perform various tasks, we will also be presenting a series of *FREE* supplements covering PIC programming; *PIC–Tutor* is a practical step-by-step guide to understanding and using PIC instruction codes. The course builds, in easy practical stages, to the programming of a PIC as a dedicated burglar alarm – an alarm which will operate exactly how you tell it to. With PIC programming you can build in all the little quirks you fancy into your own system, and even change them at a later date if you feel the need.

The series employs a hands on approach with a simple development p.c.b. so that you can start by making your PIC flash a single l.e.d. and finish with a fully operational programmed system. Written by our own Technical Editor, John Becker, we believe this will be the best introduction to this fascinating subject yet published. Watch out for further announcements on this series.

Mike Kenward

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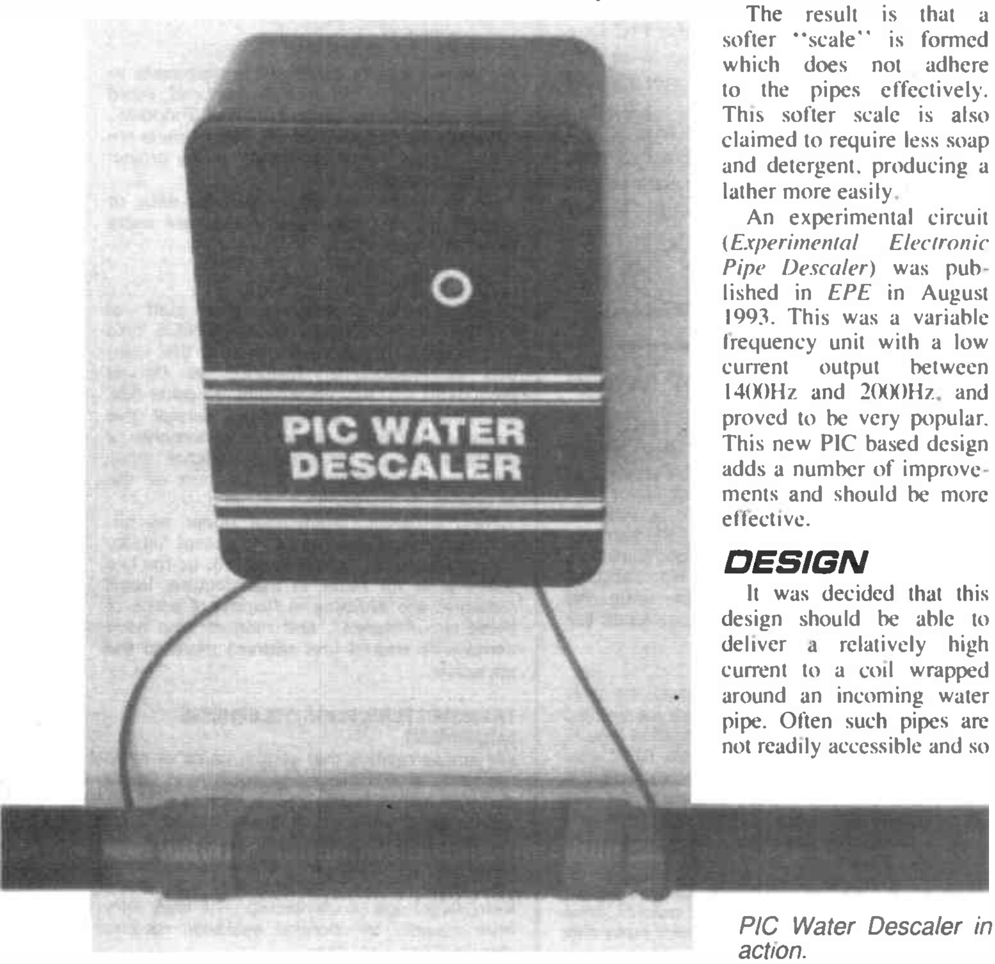
PIC WATER DESCALER

MARK STUART

Treat your water to the low-cost power of a microcontroller to reduce the level of scale build-up around your home.

A NUMBER of commercial Pipe Descalers are presently available. The simplest type consists of a small magnet which is strapped around the pipe, whilst others are more intricate and usually involve wrapping one or more coils of wire around the pipe and connecting them to a control box that delivers a fixed or variable frequency output voltage and current.

These devices are claimed to prevent new scale forming and gradually to encourage existing scale to dissolve back into the water and be flushed from the system. The exact chemical mechanism is not clear, but it seems that subjecting the water to a fixed or variable magnetic field alters the way in which the dissolved salts crystallise.



PIC Water Descaler in action.

The result is that a softer "scale" is formed which does not adhere to the pipes effectively. This softer scale is also claimed to require less soap and detergent, producing a lather more easily.

An experimental circuit (*Experimental Electronic Pipe Descaler*) was published in *EPE* in August 1993. This was a variable frequency unit with a low current output between 1400Hz and 2000Hz, and proved to be very popular. This new PIC based design adds a number of improvements and should be more effective.

DESIGN

It was decided that this design should be able to deliver a relatively high current to a coil wrapped around an incoming water pipe. Often such pipes are not readily accessible and so a compromise was necessary to have sufficient turns to be effective, without being too difficult to wind.

A single layer coil of 55 turns of 1/0·6 wire was chosen for a 15mm copper pipe. This will be the standard for most houses. Other dimensions of pipe can be accommodated by varying the number of turns to use a similar length of wire.

To ensure that the ideal frequency would be present for at least some of the time, a swept frequency drive was used, with the frequency continuously cycling from 1200Hz up to 14kHz and back. This range is convenient as it allows standard audio techniques to be used.

To keep construction simple the component count was kept low by using i.c.s throughout, and a separate double-insulated "plug-in" power supply to ensure electrical safety. To allow the circuit to be checked, a monitor l.e.d. was incorporated, along with an audible indicator that allows the actual current through the coil to be verified.

CIRCUIT DESCRIPTION

The full circuit diagram for the PIC Water Descaler is shown in Fig.1, together with the pinout information (Fig.2) for the PIC12C508 microcontroller IC2.

The incoming supply voltage passes via diode D2, which protects against reverse polarity, to the input terminal of the 1A voltage regulator IC4 where it is reduced to 5V. This simple arrangement protects the circuit components and allows a wide range of *unregulated* power supplies to be accommodated.

The ideal supply provides 8V at 250mA. Higher voltages can be used but will increase the temperature of IC4 accordingly. A small heatsink is recommended for voltages of 10V or more.

If a regulated supply is available, then a direct 5V connection can be made to the circuit, and IC4 removed – note though that there will not be any reverse polarity protection in this case.

Capacitor C5 ensures the stability of IC4 if the power supply lead is a long one, and C4 decouples the 5V supply. Additional decoupling is provided for IC2 by resistor R2 and capacitor C1.

The a.c. descaling signal is generated by IC2 which is a pre-programmed PIC12C508 microcontroller chip. The program code generates a variable frequency output signal sweeping up and down between 1200Hz and 14kHz.

A pre-programmed chip for this project is available from Magenta so that the project can be built without any programming knowledge. The use of microcontrollers is becoming commonplace – even in simple projects such as this. A look at the circuit published in 1993 shows that eight components are used to generate the descaling signal where the present circuit uses just three and provides a more complicated output. The circuit also uses less board area and requires less assembly work.

The output from IC2 is a square wave swinging from 0V to 5V. This is reduced in amplitude by the potential divider action of resistors R3 and R4 to a more suitable level to drive IC3. Capacitor C2 removes the d.c. component of the signal and C3 reduces the high frequency component and rounds the edges of the square wave.

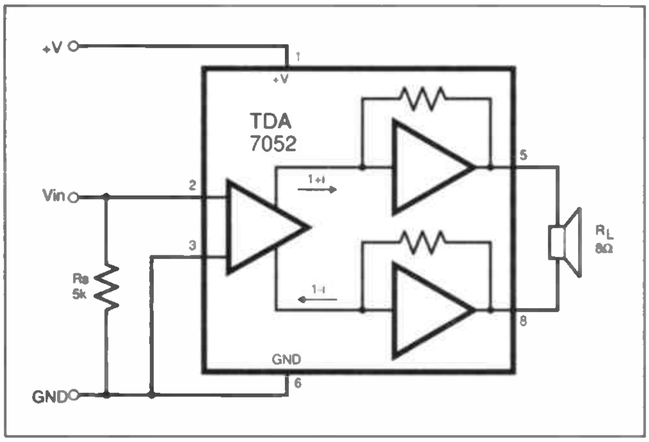


Fig.3. Internal structure of the TDA7052 audio power amp.

POWER OUTPUT

An audio amplifier with a "full bridge" output is formed around IC3. The internal circuit, which consists of two amplifiers driven in antiphase is shown in Fig. 3.

The output from IC2 has been programmed to have a short pause after each frequency sweep, so that the l.e.d. will appear to flicker. As the pauses are very short, this will appear only as a very brief "glitch" but will give an indication that the program is running correctly.

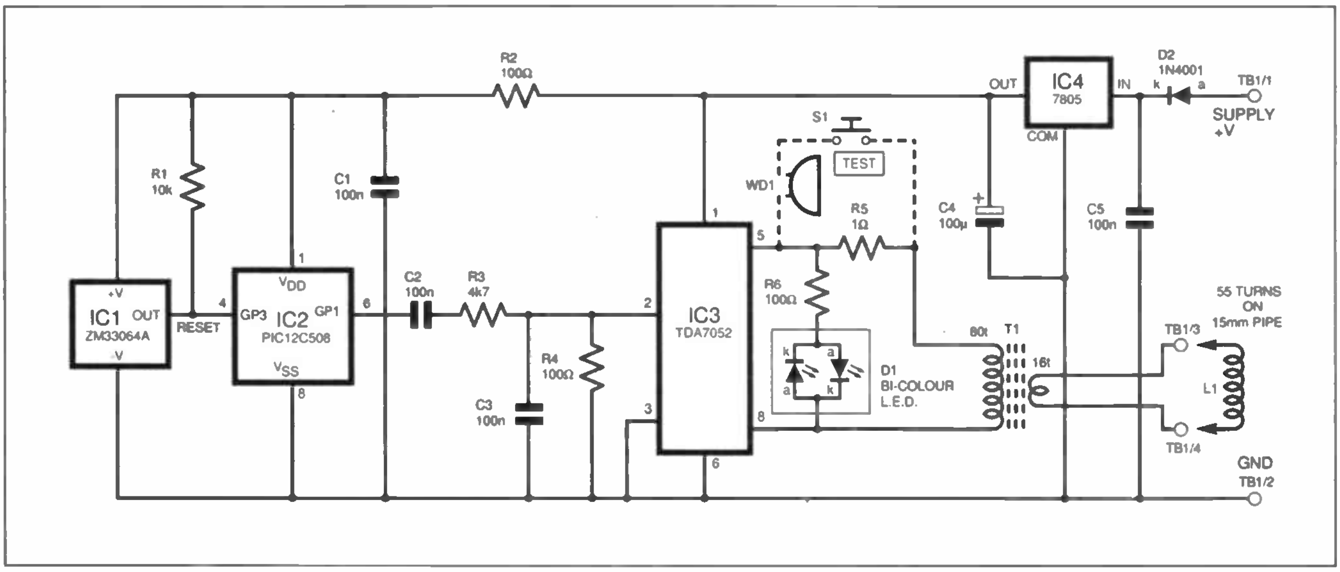


Fig.1. Complete circuit diagram for the PIC Water Descaler. The power supply for the circuit is taken from an unregulated plug-in "mains adaptor". The ideal supply provides 8V at 250mA. Components shown "dashed" are optional for testing.

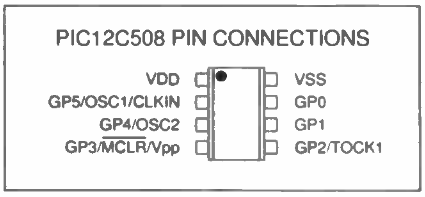


Fig.2. Pinout details for the PIC12C508 microcontroller.

RESET

A small 3-pin device, IC1, monitors the supply voltage and holds the microcontroller "reset" pin low until the supply exceeds 4·6V. This ensures that IC2 starts and runs its program correctly and is shut down if the supply voltage falls for any reason.

This component can be left out provided the supply voltage is always switched on "cleanly". In practice, there may be occasional surges in the supply voltage which could "crash" the program. This would not be a problem in some applications, but in an unattended circuit such as this it is possible that a crash could go unnoticed for weeks, during which time the circuit would be ineffective.

This device has been chosen because it is happy working at low supply voltages, and because it can deliver a substantial output current. It also has internal over temperature and short circuit protection.

The coil around the pipe has a very low resistance – less than 0·5 ohms. In the earlier design, the current was limited to a few milliamps by a series resistor, and no attempt was made to optimise the coupling. In this design it was decided that plenty of current would be provided to have as much effect on the water as possible.

A coil matching transformer T1 has a turns ratio of 5:1 and raises the impedance of the coil by the square of the turns ratio, so that the output of IC3 sees an impedance of 12 ohms. This is a very effective matching method, and results in a current of 1A flowing in the coil.

MONITORING

The output voltage from IC3 drives a red/green bi-colour l.e.d. D1 via current limiting resistor R6. This should glow *orange* when a square wave output is being delivered. If a *fault* occurs in IC3 it may glow red, or green.

A second monitoring option is provided by a piezo sounder connected across resistor R5. This will reproduce the audio frequency output provided there is sufficient current flowing through R5 to drop an appreciable voltage.

If the water pipe coil L1 is disconnected for any reason, the output load will have been removed and the output current will fall so that the residual voltage drop across R5 is very small and the resulting output practically inaudible. With the coil connected, current flow increases the voltage across R5 resulting in a clearly audible output.

A small push-to-make switch (S1) can be fitted if audible monitoring is to be used frequently. In practice the coil is unlikely to become disconnected, and so this feature may be left out, or just used for setting up.

The current consumption of the circuit is approximately 250mA when running normally. If the coil is disconnected this falls to 25mA or so depending upon the frequency.

CONSTRUCTION

The PIC Water Descaler circuit is built on a small printed circuit board (p.c.b.) which slides into p.c.b. guide slots in the recommended case. This board is available from the *EPE PCB Service*, code 170.

Before fitting any components check that the board fits correctly into the case, and if necessary file the ends slightly. The incoming power supply and outgoing water pipe coil connections are made to a 4-way p.c.b. mounted terminal block TB1. A small notch should be cut in the edge of the case so that the wires can pass freely.

A full size underside copper track master pattern, together with the topside component layout, is shown in Fig. 4. A d.i.l. socket should be used for IC2, but *not* for IC3 which relies on heatsinking via its pins to the copper track area on the p.c.b.

Voltage regulator IC4 stands up on the board, and can be fitted with a small heatsink if a higher power supply voltage is to be used. A small strip of aluminium 15mm × 40mm or so will be adequate.

Fit the resistors, capacitors, and the socket for IC2 first, taking care to identify the negative lead on capacitor C4 and to fit the i.c. socket with its pin 1 identification the right way round. Reset generator IC1 should be fitted with its body profile as shown in Fig. 4. Diode D1 has its cathode (k) end identified by a silver band which should be fitted to match the line shown in Fig. 4.

The bi-colour l.e.d. D1 should be fitted directly onto the board and bent over 90 degrees so that it lies over the edge by 5mm as shown in Fig. 5. It should then fit into a corresponding 3mm diameter hole drilled in the lid or bottom of the case. A small piece of Blu-tak stuck inside the case lid or bottom can be used to show an impression of the l.e.d. and so indicate the drilling position when the board is slid into the case p.c.b. guides.

As D1 is a bipolar l.e.d. it can be fitted either way round. It is driven by a.c. and so will light red in one direction and green in the other giving a sort of yellow/orange appearance. It really doesn't matter which polarity gives red and which green.

OUTPUT TRANSFORMER

Ferrite pot-core transformer T1 must be correct for this circuit to operate correctly. It is made up from a coil former, winding wire, two ferrite cores/cups, and a pair of spring clips that hold the completed assembly together.

The 80-turn primary is wound first. Winding is much easier if a suitable spindle – such as a pen or pencil – can be found, over which the former can be held.

Use 28s.w.g. enamelled wire and wind in neat layers as far as possible. There is no need to insulate between layers, but it can make the winding very neat if each layer is finished with thin insulating tape before winding the next one. When 80 turns have been wound finish the winding in the same slot as the start, and twist the two ends loosely together.

The secondary winding is 16 turns of the same wire wound over the primary winding starting and finishing in the opposite slot from the primary. The turns ratio is not critical so don't unwind the primary if you can't remember whether there are 79 or 80 turns!

When the windings are complete, bend over the ends of the secondary so that you can tell them from the primary, and fit the two core halves into the former. Align the core halves and carefully press the spring clips into position to hold the whole assembly together.

Cut the winding ends down to 30mm from the core and strip the insulation from the end 10mm. The enamel can be stripped with heat from a soldering iron, but it is helpful if some enamel can be removed first by drawing the wire between a folded piece of fine abrasive paper.

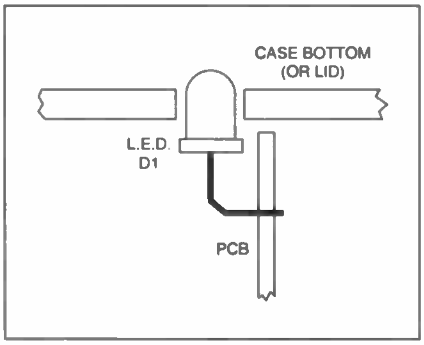


Fig.5. Mounting the l.e.d. at right angles to the p.c.b. to align with case viewing hole.

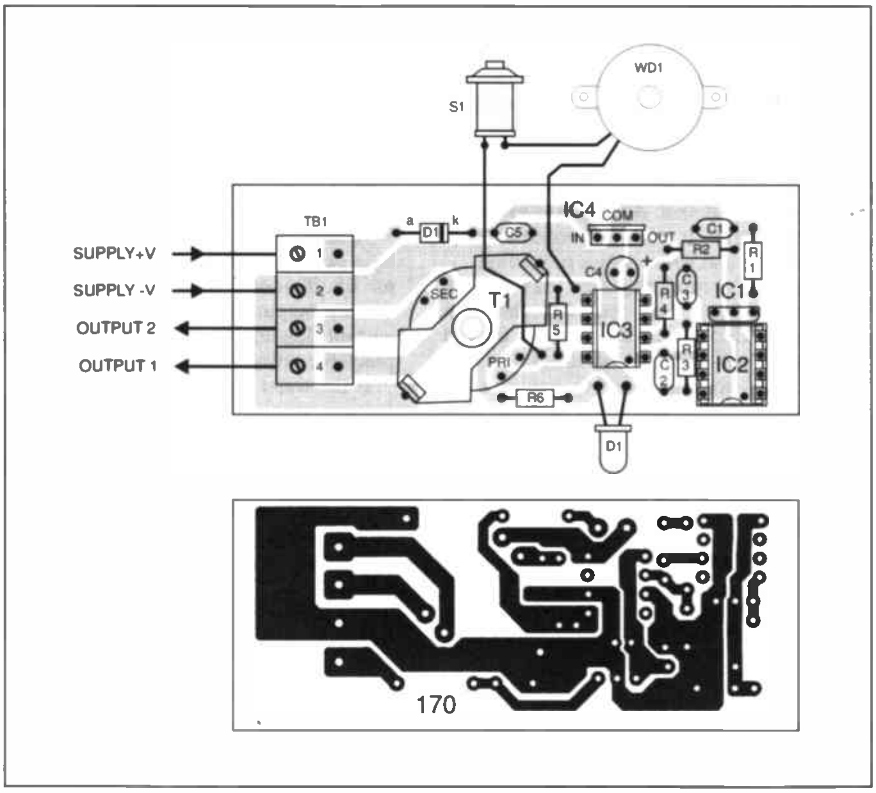


Fig.4. Printed circuit board component layout and full size copper foil master for the PIC Water Descaler. The piezo sounder and pushbutton switch are optional components.

COMPONENTS

See SHOP TALK Page

Resistors

R1	10k
R2, R4, R6	100Ω (3 off)
R3	4k7
R5	1Ω

All 0·25W 5% carbon film

Capacitor

C1, C2, C3, C5	100n polyester 63V, 5mm lead spacing (4 off)
C4	100µ radial elect. 10V

Semiconductors

D1	3mm bi-colour l.e.d.
D2	1N4001 50V 1A rect. diode
IC1	ZM33064A 4·6V reset generator
IC2	PIC12C508 pre-programmed microcontroller (see text)
IC3	TDA7052 audio power driver
IC4	7805 5V voltage reg.

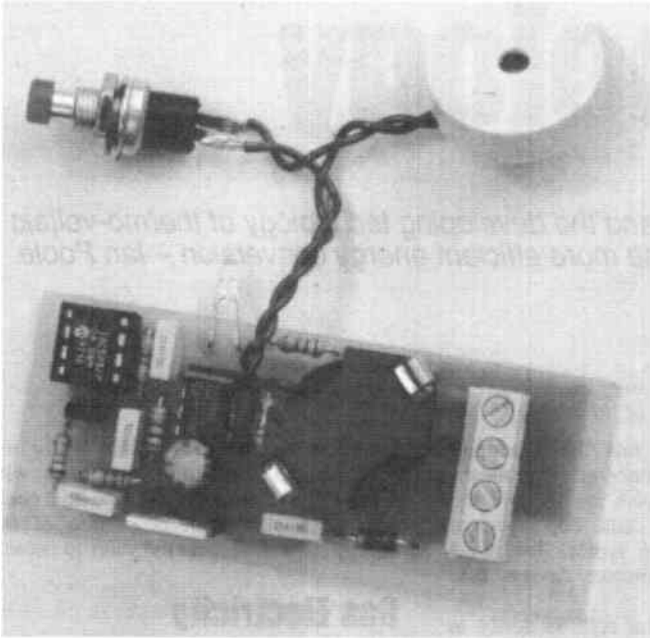
Miscellaneous

T1	ferrite pot-core output transformer: bobbin – 4322 021 38461 and clip – 4313 021 03960 (Philips). Core N41 (Siemens) – see *Shoptalk*
WD1	piezoelectric sounder (optional)
S1	pushbutton switch, push-to-make (optional)
TB1	4-way, p.c.b. mounting, connecting block

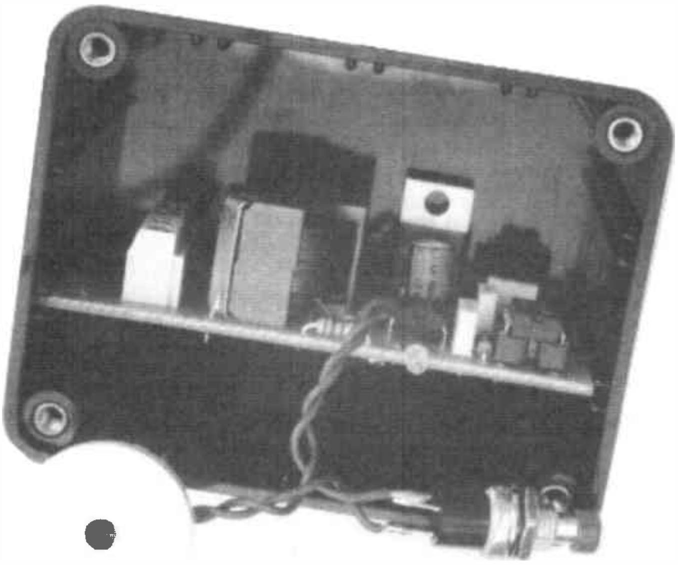
Printed circuit board available from *EPE PCB Service*, code 170; plastic case, size 80mm x 60mm x 40mm approx.; 8-pin d.i.l. socket; 28s.w.g. enamelled copper wire for output transformer (see text); length of 1/0·6 standard insulated wire for water pipe coil (see text); solder etc.

Plug-in unregulated power supply (mains adaptor) – see text.

Approx Cost Guidance Only £25 excluding plug-in PSU



Completed circuit board showing positioning of components. Note the l.e.d. leads have been bent 90 degrees to the p.c.b.



Finished printed circuit board slotted into the small plastic case. The test switch and piezo sounder can be sited remotely from the case.

The transformer is fixed to the board by the two pins on the spring clips. Make sure it is the right way round, so that the primary and secondary windings are in the correct positions to be threaded through their connecting holes on the board.

Thread through the wires, leaving 10mm of free wire above the board and then solder the tinned ends to the connecting pads. The polarity of each winding is not important – just make sure that the primary and secondary have not been mixed up.

The use of a piezo transducer for monitoring is optional. Simply connect any suitable transducer in series with a push-to-make switch across the two p.c.b. connecting points provided. The transducer and switch can be mounted in or on the Descaler case, or remotely in a more convenient place.

TESTING

The circuit is relatively simple, has only has one function, and so should be easy to test. Before testing, inspect the board carefully for dry joints, solder bridges, and incorrectly placed or polarised components.

Beware! Some types of solder have conductive flux residues which must be cleaned off – this seems to be more of a problem lately as solder manufacturers have sought to eliminate certain chemicals from their fluxes and have added others!

Standard rosin flux Multicore solders are generally OK, and their residues can be left in place without any difficulty. If in doubt, check the type of solder, and clean the copper side of the board with washing-up liquid and water, and make sure that the board is thoroughly dry before continuing.

The Descaler should first be checked without connecting a water pipe coil, and without inserting IC2. Begin by applying a power source and check for 5V on the output of IC4. Any supply from 8V upwards should give the correct output.

An input of less than 8V will give a lower voltage output as the regulator will not function correctly. A benefit of using this type of voltage regulator is that it incorporates over-temperature and short-circuit protection.

Next, check the output pins (5 and 8) of IC3. These should both sit at half of the supply voltage, and so there will be zero volts across the primary of T1 and l.e.d. D1 will be off. Pin 2 of IC3 will be held at 0V via resistor R4.

As the supply voltage is correct, the output of the "reset" device IC1 should be turned off and so the voltage at pin 4 of the socket for IC2 should be pulled up to 5V via resistor R1. The circuit current at this stage should be between 5mA and 15mA.

PIPED SOUNDS

If all is well so far, switch off, allow a few seconds for capacitor C4 to discharge, and plug in programmed microcontroller IC2. Switch on and check that the supply voltage is still correct and that the l.e.d. is now on.

An audio check can be made by connecting the piezo transducer across the two output terminals TB1/3 and TB1/4. The circuit should be producing a rising and falling high pitched tone. Note that as the microcontroller generates the different pitches by altering numbers in counting registers, the pitch will be varying in small increments and will sound "notchy".

If there isn't an output, check that pin 4 of IC2 is being pulled up correctly, and that IC1 is the right way round. Resistor R2 in the supply line will protect IC1 and IC2 from damage if they have been fitted incorrectly.

Once everything is running, check the supply current which should be between 10mA and 20mA. A high current reading will result if transformer T1 has been fitted with its primary and secondary windings interchanged.

The water pipe coil L1 should now be wound around the pipe. Take care, and remember to leave enough spare wire to connect to the Descaler p.c.b. Circuit matching has been optimised for 55 turns of 1/0·6 standard insulated connecting wire wrapped in a single layer around a 15mm copper pipe with 300mm flying leads.

If the Descaler cannot be mounted close to the pipe, it is possible to extend the leads, but the current flow will be reduced. Using thicker extension leads will help, but it is better by far to mount the unit close to the pipe, and extend the power supply cable – up to five metres or so should be possible without any reduction in performance.

When the water pipe coil is connected to the Descaler the supply current will rise to around 250mA and IC3 will become slightly warm. The optional piezo sounder, connected across resistor R5, should produce a low level audible output, which will stop if the coil becomes disconnected.

SOFTWARE SOURCING

This project uses the 12C508 PIC, a fairly new addition to the Microchip range, and has been pre-programmed by Magenta Electronics so that the Descaler can be built by anyone without prior knowledge of programming. See *Shoptalk* for details.

Readers who wish to program their own PICs can acquire the software either on a 3·5 inch disk from the *EPE* editorial office or download it from our Web site (there is a nominal charge for the former, but the latter is Free – again see *Shoptalk* page). The Web site file is in the sub-directory **/PICdescaler**.

USE

Once completed and installed, the PIC Water Descaler should be switched on, checked, and left to get on with the job. The gradual descaling and prevention of new scale formation should begin immediately.

Note that the Descaler is supposed to work not by altering the amount of lime in the water, but by modifying its properties. The only way to see if it is effective is by observing the formation (or hopefully, lack of formation) of scale over a period of time.

We look forward to hearing of the results achieved by constructors of this project.

New Technology Update

Solar cells, and the developing technology of thermo-voltaic cells, promise more efficient energy conversion – Ian Poole reports

THERE is increasing concern about the amount of energy we are using. People wonder what will happen when all the oil runs out. Then there are "green" questions relating to the pollution which burning fossil fuels brings. Nuclear power also brings its problems.

Even if there were no risks when running nuclear power stations, the spent radioactive fuels have to be disposed of in a manner which does not harm the surroundings. This is, of course, very difficult and some say it cannot be done satisfactorily.

To overcome these problems, people are looking more towards natural forms of energy. Large windmills are cropping up in a number areas to harness energy from the wind. Energy can also be harnessed from the tides. Then there is a colossal amount of energy received each day from the sun.

Measured in kilowatts per square metre, we would have an almost limitless source of energy if it could be harnessed efficiently. Even in Great Britain, where the weather may not seem sufficiently sunny, solar energy could be used to provide much of our needs.

Even now, solar cells are being used increasingly. Units requiring small amounts of remote power often use solar energy as a source of electrical power. Satellites are totally reliant on this source of energy, often having large wing-like arrays to catch the maximum amount.

Today's direct broadcast satellites require large amounts of power to enable sufficiently strong signals to be broadcast for reception by domestic equipment and small antennas.

The problem with solar energy is that solar cells are expensive and low in efficiency. To overcome these problems a number of developments are taking place.

Principle of Operation

Semiconductor solar cells contain a *p-n* junction and, when these cells absorb sunlight, photons reach the *p-n* junction and release electrons from their bonds to create electron-hole pairs. These drift across the *p-n* junction under the effect of an electric field created by the doping in and around the junction. The movement of the holes and electrons constitutes a current which can be used in an external circuit.

In order to be able to produce even a small amount of power, the silicon between the surface of the device and the actual *p-n* junction must absorb as little light as possible so that the maximum amount reaches the junction. This means that very thin top layers are used in the construction of these cells. Top layers of only one micron are typical for some of the highest performance devices (see Fig.1).

Manufacture of solar cells is costly in view of the accurate requirements and the sheer size of the devices. Compare the area of silicon required with some of today's v.l.s.i. chips which are less than a centimetre across and can cost many pounds. Solar cells need to have as much area as possible if they are to be able to produce sufficient power.

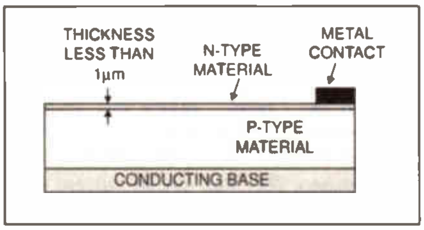


Fig.1. Construction of a typical solar cell.

Improvements

One of the problems with using sunlight as a source of power is that it contains the full spectrum of colours. Normally the design of a solar cell has to be optimised for a particular wavelength.

When a wavelength is received which is not optimum, the efficiency of the cell is reduced. This occurs because the junction has what is called a band-gap. Light entering the structure has to have sufficient energy to enable the hole-electron pairs to cross the gap. If there is insufficient energy in the photon of light, then no energy is converted.

To overcome this problem, a new structure has been produced and this is able to accept light over a much wider band of wavelengths. By having a number of much smaller band-gaps, energy can be converted from a much wider range of wavelengths and energy levels.

The structure currently has to be made from gallium arsenide, but it is hoped to be able to transfer to silicon as technology boundaries are pushed back. It is also expected that significant improvements can be made in the area of efficiency.

Currently, the best silicon cells are able to give efficiencies of around twenty per cent. This new process is expected to give more. Possibly it will not be long before it becomes cost effective for use to cover our southern facing roofs with solar cells. Estimates are that this could produce a significant proportion of our energy requirements in the years to come.

Gas Electricity

In another development, the energy from natural gas is being converted more efficiently into electricity. Natural gas is one of the cleanest burning forms of fuel creating a relatively small amount of pollution. Today many power stations burn this form of fuel and convert it into electricity. This is achieved by using the gas to heat water, converting it into steam. The steam powers a turbine, which drives the generators that produce the electricity.

The generators themselves are relatively efficient, converting over 90% of the mechanical energy they receive into electricity. However, the turbines are very much less efficient, as are other methods of converting heat energy to other forms of more usable energy.

Thermo-voltaic Cells

In one project, initially aimed at producing an economically powered car, major strides are being made in improving efficiencies. The work is based around the development of a thermo-voltaic cell. The cells are manufactured using indium gallium arsenide and closely relate to the photo-voltaic cells used for the conversion of sunlight.

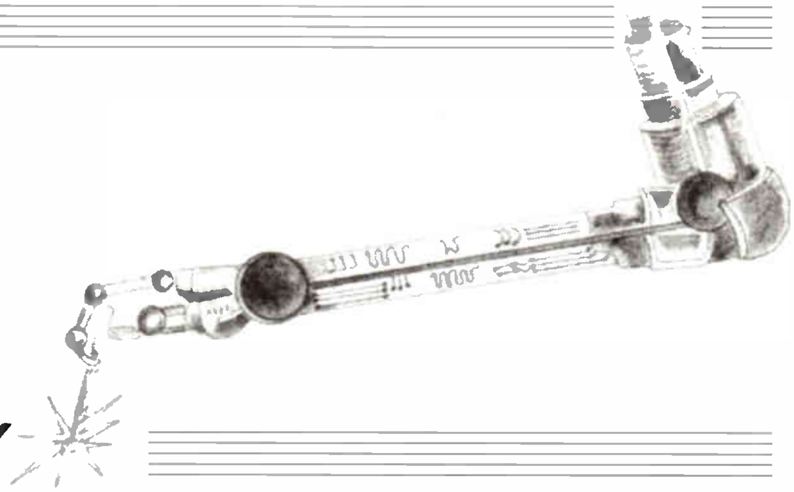
Unlike photo-voltaic solar cells, these thermo-voltaic cells are tailored to operate at a much lower temperature. The sun's rays have a source temperature of 6000°K, whereas the temperature of the flame used to irradiate the thermo-voltaic cell is only about 1500°K.

To be able to convert the energy of the flame efficiently to electrical energy, the cells must have a much smaller band-gap to allow the electron-hole pairs to be generated. By using indium gallium arsenide, it is possible to convert the energy of the flame far more efficiently than if a more conventional solar cell had been used.

To generate the electricity, the cells have to be carefully mounted. In experimental models, the gas is burnt inside a silicon carbide tube. The flame is very close to the cells and this means that the power density received by the cell is much more than that received from the sun. This too enables the efficiency to be improved.

Regular Clinic

CIRCUIT SURGERY



ALAN WINSTANLEY

***This month we take the lid off (and peek inside) counters in a digital extravaganza, we also follow up on mains earthing topics. Some new supplier information is included – and we announce our major new educational series,* Teach-In '98.**

DIGITAL counting is one field which yields a healthy crop of readers' letters. This month, we start a two-part low-down on the fundamentals of using digital counter chips. Ian Bell of the Department of Electronic Engineering at the University of Hull (fresh from counting bats – see last month) offers guidance on implementing counting techniques using digital technology. Next month Ian continues the discussion with specific applications and hopefully resolving a few readers' queries along the way.

Counter Jargon

Counters are very important types of digital "building block" which occur in almost all digital systems (e.g. the program counter in the CPU of your PC). They can also form the heart of many interesting projects for the electronics hobbyist. There are a number of different types of counter available as i.c.s in the 7400 and 4000 series logic families. The larger catalogues include pinouts of most chips, and manufacturers' Data Books are useful for more advanced constructors. In order to describe digital counters, it helps to know some "counter-jargon" first.

Clock: This is the input which makes the counter count; it is *negative edge triggered* if the counter counts when the clock changes from logic 1 to logic 0, and *positive edge triggered* if the counter counts when the clock changes from 0 to 1 (see Fig. 1). A pulse has both a positive and a negative edge, but each type of counter only responds to *one* of the edges to ensure that pulses are counted correctly, at different points for the two types of clocking.

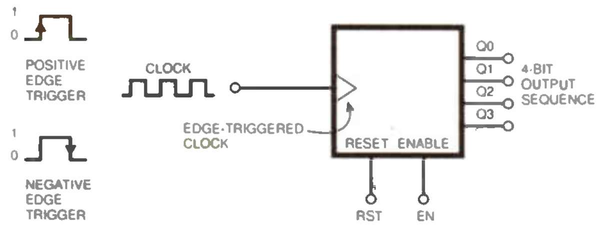
The CMOS 4017, 4022 and 4029 (more later) are unusual in that they have both a negative and a positive edge clock; either may be used as long as the other is constant at the appropriate level. Some "bi-directional" counters (ones which can count up or down) have separate clocks for the two directions.

Number of States: This tells you how many different steps the counter can go through. So a counter which could count from 0 to 15 would have 16 states (remembering that zero is included as one state).

Each time the counter receives a suitable clock pulse, it changes from the current state to the next one in the sequence. Most counters go back to the first state when they are clocked in the last state in their sequence.

Number of Bits: A "bit" is short for a binary digit. The number of bits tells you how many outputs the counter has available with which to indicate the current count value. A "4-bit" counter has four outputs, labelled Q0 to Q3 (sometimes, you see Q1 to Q4 instead.) In some cases, for example the 4040, not all the counter's outputs are actually available on the chip's pins. (See *Circuit Surgery*, March 1997.)

Fig.1 (right). Anatomy of a simple digital counter.



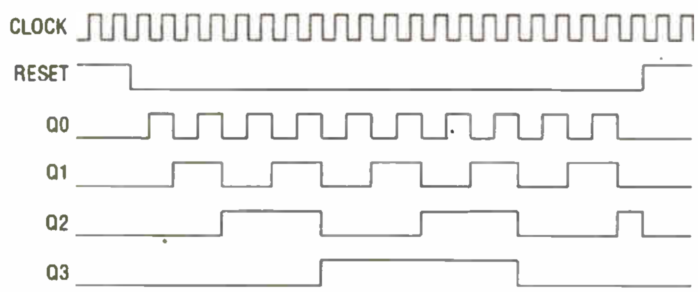


Fig.2. Example 4-bit binary counting waveforms (negative edge triggered).

Table 1: 4-bit Binary Counting Sequence

Q3	Q2	Q1	Q0
0	0	0	0
0	0	0	1
0	0	1	0
0	0	1	1
0	1	0	0
0	1	0	1
0	1	1	0
0	1	1	1
1	0	0	0
1	0	0	1
1	0	1	0
1	0	1	1
1	1	0	0
1	1	0	1
1	1	1	0
1	1	1	1

Coding: This is the relationship between the states and the output bits. That is, each state that the counter must correspond to a particular set of 0s and 1s on its output. This sounds complicated but it can be explained by some examples.

Binary Counter

An n-bit binary counter has 2^n states corresponding to all possible n-bit binary numbers. For example, a 3-bit binary counter has $2^3 = 8$ states, with each state corresponding to one of the binary numbers from decimal 0 (000) to decimal 7 (111).

state 0 output 000	state 4 output 100
state 1 output 001	state 5 output 101
state 2 output 010	state 6 output 110
state 3 output 011	state 7 output 111

Each time the counter is clocked, it cycles through all the states in sequence (0, 1, 2, 3, 4, 5, 6, 7, 0, 1, 2, 3 . . . and so on). Example devices include:

4-bit: 7493, 74161, 74163, 74293, 4516, 4520 (dual counter), 40161, 40163 and 40193
7-bit: 4024
8-bit: 74590, 74591, 74592 and 74593
12-bit: 4040. (The 4020 is 14-bit binary counter but only 12 of the bits are available at the outputs.)

How a 4-bit (four binary digit) count develops is shown in Table 1. If you like, a binary "1" is added to Q0 on the right-side (the least significant bit) with each successive clock pulse. Remember that 1 + 1 in binary is 10 (nought, carry one).

The 4-bit sequence will cycle through 16 steps as shown, and then repeat. The output waveforms are represented in Fig.2; in that example, counting only occurs when the reset pin is low at logic 0.

BCD Counter

Binary Code Decimal counters have 4-bit outputs and 10 states. The outputs correspond to the binary numbers from decimal 0 to decimal 9 – a Binary Coding of a Decimal number (hence BCD). See Table 2.

Example devices include: 4510, 4518 (dual), 40160, 40162, 40192, 7490, 74160, 74162 and 74290. A number of such counters can easily be cascaded to count large numbers in decimal, however the 4534 provides five decades on one chip.

Ring Counters

In their basic form, Ring Counters have n states and n outputs, with one output "active" for each state. So a 4-bit (4-state) ring counter's outputs would go through the following sequence: 0001, 0010, 0100, 1000 . . . and then repeat. Or 1110, 1101, 1011, 0111 . . . and then repeat.

This type of coding is sometimes called "one-hot" or "1-out-of-n" (in this example 1-out-of-4) coding. Note that the "hot" output may be either logic 0 or 1, depending on the device used.

It is particularly useful for controlling sequences of events. If you use the outputs to drives l.e.d.s or other indicators or lamps (arranged in order) you produce a "chaser display" such as the famous *Knight Rider* car's lighting effect!

Example devices include the very popular 4017 which has a "1-of-10" coded output, and the 4022 has a "1-of-8" output. We'll be looking at the 4017 in more detail next month.

Frequency Dividers

In their basic form, Frequency Dividers have n states and one output. The output pulses once each time the counter cycles through the n states. Thus if the clock frequency is f, the output frequency is f divided by n. Some devices have multiple outputs for different values of n, or provide facilities for setting different values of n (programmable frequency dividers).

Examples of frequency dividers include the 4018 which can divide by any number from 2 to 10, although for some divisions an external AND gate is needed. The 4059 is more sophisticated and can provide any division from 3 to 15,999 without external components.

In fact, all counters can be used as frequency dividers using the appropriate output, for example the 4017 will act as a divide by 10 and the 4022 as a divide by 8. Binary counter outputs provide frequency division by powers of 2 (2, 4, 8, 16 etc.). You'll notice this in Fig.2, comparing the input clock frequency with the four output frequencies.

You may come across other types of counter and output coding, for example the 7492 is a divide-by-twelve (12-state) counter with a 4-bit binary-coded output (counts 0 through 11). The 7490 and 74196 can be configured to give a bi-quinary code output or BCD. The 4029 has a mode control input to select between binary and BCD counting.

Dual Devices

Some counter chips are "dual" devices which conveniently contain two counters, for example the 74393 and 4520 dual 4-bit binary counters and the 4518 dual BCD counter. The 4060 contains an RC/crystal oscillator circuit as well as a 14-bit binary counter, with bits 5 to 14 available (see *Circuit Surgery*, March 1997). The 4521 is similar, but with a 24-bit counter. Now let's return to more "counter jargon".

Table 2: Binary Code Decimal sequence – four bits, representing decimal 0 to decimal 9.

Q3 (8's)	Q2 (4's)	Q1 (2's)	Q0 (1's)	Decimal equivalent
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9

More Jargon

Reset: This is a control input which forces the counter into a particular state (and therefore a particular output code). Usually the Reset makes the counter go to the state representing a count of zero.

Binary and BCD counters usually reset to all zeros on their outputs, whilst Ring counters reset to the active output at the beginning of the sequence. Many counter chips have *asynchronous resets* – they reset as soon as the reset is applied, but some such as 74162, 74163, 74668, 40162, and 40163 have a *synchronous* reset which waits until the next clock pulse occurs.

Up/Down Counters: Some counters can step through their state sequence in either direction, that is, they can count both *up* and *down*. There are two ways of controlling the direction – firstly to use a direction control input (as the 74168, 74169, 74190, 74191, 4029, 4510 and 4516); secondly to use two separate clocks (one for up and one for down) (as in the 74192, 74193, 40192 and 40193).

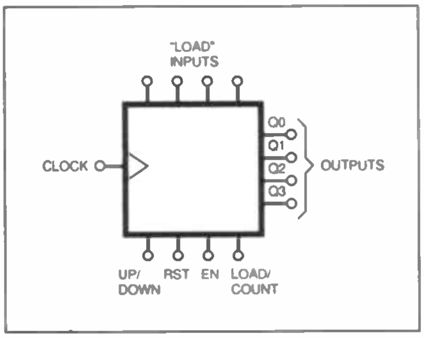


Fig.3. Control pins of a typical presettable counter.

Presettable Counters: Some counters enable us to "load" a value into them. They will then count from this value next time they are clocked in "count" mode. Often a *control input* is used to select either load or count (e.g. 0 = load, 1 = count) and the clock either transfers the input data to the outputs (or counter state) or makes the counter count, depending on the mode input. Examples include: 4029, 4522, 4526, 74160, 74161, 74162, 74163, 74196 and 74197. Fig.3 summarises these features.

Stop/Start

Enables and Clock gates. It is often necessary to start and stop counters either under direct human control (e.g. via a simple switch), or using a signal from

CIRCUIT THERAPY

Circuit Surgery is your column. If you have any queries or comments, please write to: Alan Winstanley, *Circuit Surgery*, Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset, BH21 1PF, United Kingdom. E-mail **alan@epemag.demon.co.uk.** Please indicate if your query is not for publication. A personal reply cannot always be guaranteed but we will try to publish representative answers in this column.

some other part of the circuit. The most obvious way that springs to mind is to use an AND gate as in Fig.4. The clock signal will pass through to the counter when the "enable" pin is high. This technique is called *gating* a clock.

Simple clock gating works but is not without its dangers. If the control (enable) goes low briefly while the clock is high, an extra count will occur, as shown in the waveforms. In many applications it is important to make sure that this cannot happen.

Many counter chips have an enable input, so an external AND gate is not required. In some cases the internal circuitry is also simply a gate, but others have more sophisticated enable circuits, for example the 74163 counter has a synchronous enable control.

We'll continue our counter extravaganza in next month's *Circuit Surgery*, when we will deal with several readers' questions – how to cascade counters, how to drive displays, and how to generate random numbers. Bingo!

Ian Bell, Department of Electronic Engineering, University of Hull.

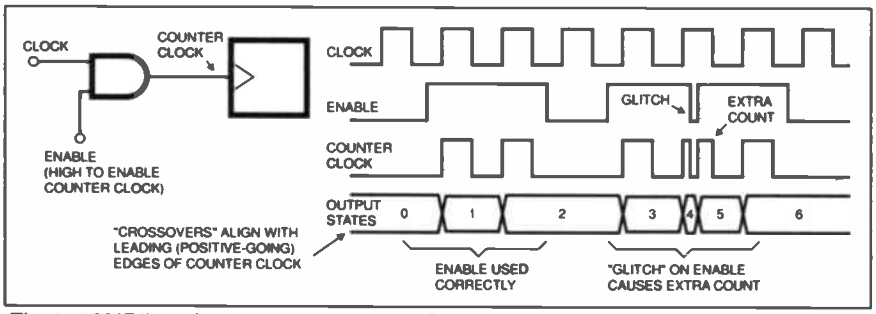


Fig.4. "AND" gating a counter clock. Care is needed to avoid spurious counter clocks from being introduced by "glitches" on the ENABLE input.

Back Down to Earth

My mention of mains earthing (June 1997 issue) prompted requests from ***Ron Hargreaves*** in Bridlington and ***K.C. Toh*** of Malaysia asking me to return to the subject of the need for a mains "earth".

The question originally posed was, *why not just provide an insulated Live and Neutral supply, and omit the earth altogether?* After all, the only way you could then obtain a shock, would be to touch both the mains Live and Neutral wires at the same time!

The fundamental answer seems to be: *copper wire.* The earth is used by the power companies as a "return" for their electrical supply, then in the overall (and simplified) scheme of things, they just need to deliver a supply to your region using *one* copper conductor rather than *two*, and they physically use the ground as the return path back to the power station (or sub-transformer). If you look at it on a national scale then, in effect, one side of the mains electrical supply is already earthed "at the power station end" of things.

The downside is that your human body is in constant physical contact with the common return for your domestic mains feed: *the ground.* Ordinarily this is totally safe until a live mains wire contacts your body, in which case you will have the full mains potential (240V r.m.s. = 339V peak) across you. *Hence, if you are unfortunate enough to touch any mains live voltage, you will receive a potentially fatal shock because current will travel through your body to earth, en route back to the power station. Power will always attempt to find its way to earth.*

Protection

The only protection possible is to ensure that the equipment is "double insulated" in the first place - manufacturers design-in safety by moulding plastic insulating materials to make it virtually impossible for you to come into contact with the mains supply in everyday use. You will observe the double-insulated symbol (two concentric squares) used on the vast majority of consumer electronics which use a *two-conductor* power cord.

Things are different, though, in the case of, say, an electric heater which cannot be double-insulated. If a mains wire simply came adrift or the insulation failed deep inside the appliance, then you would have to be pretty unlucky to touch it and receive an electric shock. A simple internal short-circuit would blow the fuse. But if the wire touched the *steel* case and *that* became live, then if you touched the cabinet, you would be electrocuted because you are (usually) earthed, and current will then flow through *you* to earth.

By ensuring that the steel case is hooked directly to a good, strong earth (using the green/yellow wire of a UK mains 3-core cable), this provides a very low-resistance path for the current as it tries to return to ground and then back to the power station. Thus the mains supply will be shorted out, a large current will flow through the *Earth wire* rather than your body, and this will melt a fuse or open a trip-switch, disconnecting the supply.

It should be remembered that there are still many ways of suffering accidental electrocution – in one widely reported tragedy in the UK, a person was fatally injured whilst standing on an [*earthed*] domestic copper water pipe and testing some wiring for a fault. Touching a live wire caused massive electrocution as the current passed straight through him to the grounded water pipe. *Never* think of earthing as being *complete* protection against electric shock – it's far from it.

Found At Last

Remember my request to locate a source for the SP8629 frequency divider/prescaler chip (*EPE* May 1997)? Two readers pleaded for a supply of these versatile but obsolete chips. We think we turned up trumps – thanks to ***S.N. Mahendra*** in Chennai, India who claimed to have several and offered to barter with the readers. I've put the readers in touch.

Maplin South Africa

Steve Wilson, who is Director of Maplin (South Africa) Pty. Ltd., contacted me to offer help to our many loyal readers in the Republic, who may have difficulty obtaining parts. Steve tells me:

I noted in your July issue that one of your South African readers was having problems obtaining certain electronic components. I thought you'd like to know that Maplin South Africa can supply all items as per the Maplin catalogue.

We hold stock of popular items here in SA and a weekly air shipment from the UK means that even UK stock items can be delivered to any customer in South Africa within a matter of days. Our catalogue is available from CAN (the South African equivalent of WH Smith!).

EPE readers can contact us at P.O. Box 1846, Somerset West, 7129, RSA. Tel. (021) 8515123 (Enquiries/Help desk); 8515124 (Orders). Fax 8515127.
E-mail **maplin@iafrica.com.**

Announcing Teach-In 98

Regular readers will remember our *Teach-In '93* series which covered GCSE and "A" Level Electronics. This series proved to be highly popular (the *Teach-In Mini Lab* and *Micro Lab* test and development units are still available by mail-order from Magenta Electronics, see their advertisement elsewhere in this issue).

Also, the series is still available in book form, along with a PC demo floppy disk, as *Teach-In No. 7*, from our *Direct Book Service* (see separate listing). The book is actually used with correspondence courses and forms an ideal general all-round introduction to electronics for students and hobbyists.

The new *Teach-In '98* series focuses on the requirements of the City & Guilds 726 syllabuses related to Information Technology: specifically, an *Introduction to Digital Electronics*. After a broad introduction to basic electronics terminology, we will be describing digital systems and more advanced techniques, culminating in an item of test equipment which embodies all the principles described in the series. We will also sprinkle in some extra-syllabus material pertaining to real life, as likely to be experienced by the rookie technician or apprentice electronics engineer entering industry or higher education!

Team Effort

Teach-In '98 is written for beginners as well as more experienced readers. The series is in fact a joint effort, the "Teach-In Team" comprising Rob Miles, Ian Bell (already known to many for helping out at the *Surgery*) and Dr. Tony Wilkinson, all lecturers at the Department of Electronic Engineering at the University of Hull, with myself tagging along for fun and free biscuits, as usual.

The Team will also offer support to readers, both by traditional mail and E-mail, so you can be sure of confidence-boosting and reliable help when you need it most. Be sure to enrol from Part One, starting in the November issue!

Next month: Continuing Ian's discussion on digital counters; Schade's Graphs revisited; silver solder, and more!

Innovations

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

PATENTLY SPEAKING

Competitors adopt cooperation rather than litigation in the flat loudspeaker arena. Barry Fox presents the evidence.

TWO companies have been claiming patent rights on a similar new approach to flat panel loudspeaker technology. Both NXT (New Transducers Ltd., which is part of the Verity Group alongside Mission) and Noise Cancellation Technologies Inc. of the USA, let the panel vibrate freely, rather than clamping the sides and making it work as a piston. The two companies have now agreed to cross licence their patents, rather than fight each other in court.

NXT built on a chance discovery by the Ministry of Defence; while working on noise-cancellation in aircraft the MOD found its panels worked as loudspeakers. NXT bought the rights, made the idea work in hi-fi and has already licensed Sir Norman Foster and Partners to make architectural speaker panels and NEC to make thin speakers for laptop computers.

When launching the NXT concept, in September 1996, Verity's chief executive and chairman, Farad Azima, admitted that there might be patent disputes. Soon after, NCT started to make noises about its patents on noise-cancellation panels for automobiles.

On 1 April, NCT and NXT signed an agreement whereby each can use each other's patents and each will pay the other royalties. This cross licence creates a powerful patent pool which the two companies can exploit. If they had fought each other in court they could well have invalidated each other's patents, and thus left the field open for competitors to copy the technology without paying royalties to either company.

NXT is also paying NCT an upfront fee of $3 million, in recognition of the fact that it has more scope for exploitation. Each company has offered the other the chance to buy its shares at favourable rates.

TINA'S ARRIVED!

AN upgraded version of TINA, the popular software package for the design and simulation of analogue, digital and mixed-mode electronic circuits, has been announced.

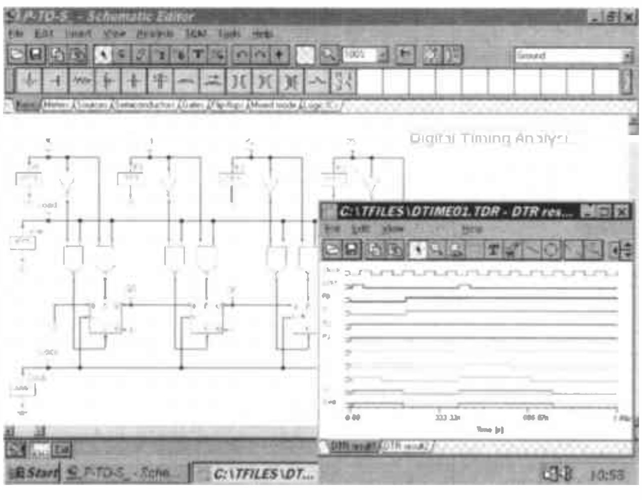
TINA (Toolkit for Interactive Network Analysis) built its reputation on the basis of providing sophisticated design and analysis performance at a reasonable price. It has been widely accepted by electronic designers around the world.

The new version, TINA*plus*, includes many new features. These include faster algorithms, new component models and an immediate mode for testing circuits while they are being constructed. There are now over 4000 components, including comprehensive TTL and CMOS ranges. Various tools and hotkeys make circuit construction simple. There is a powerful range of analysis tools, including a.c., d.c., transient and Fourier, stepped digital, digital timing, noise and pole zero.

In addition to sophisticated diagrams, a full range of analogue and digital virtual instruments is included: function and analogue generators, multimeter, oscilloscope, x-y recorder, signal analyser and logic analyser. Components can be imported/exported in SPICE format and there are comprehensive DTP functions to allow text and drawings to added.

TINA*plus* is available at an introductory price of £199. Upgrades for existing TINA users are £99. Site licences are available.

For more information, contact Tandem Technology Ltd., Dept EPE, Breadbare Barns, Clay Lane, Chichester, W. Sussex PO18 8DJ. Tel: 01243 576121. Fax: 01243 576119. E-mail: 101626.3234@compuserve.com. Web: www.tina.com.



Vintage Comms Fair

THE National Vintage Communications Fair takes place on Sunday 26 October 1997 at Hall 11, N.E.C. Birmingham, 10.30am to 4pm, tickets on the door £5.

The fair features vintage radio and broadcasting, classic valve audio and hi-fi, early telephones and P.O. equipment, gramophones, phonographs and recordings, film and TV, electrical/mechanical antiques and collectables.

For more information, tel: 01392 411565.

Videosender Clampdown

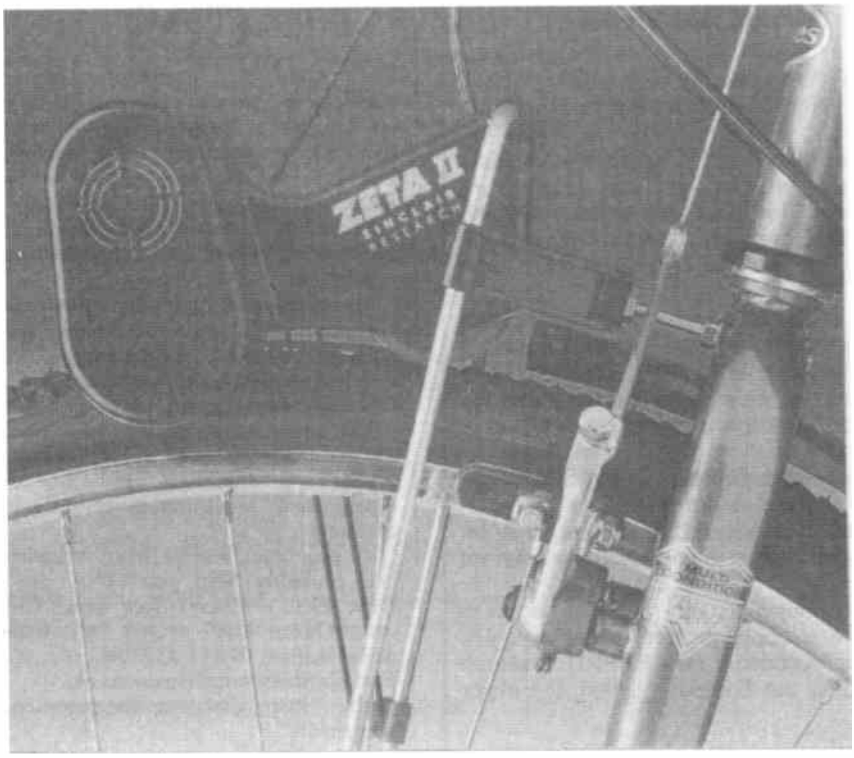
VIDEOSENDERS are now outlawed under a Parliamentary Order which came into effect on 1 September '97. The devices, which can transmit pictures from a video recorder to a separate TV elsewhere in the house, cause interference to other people's broadcast reception and can affect nearby frequencies used by the emergency services. Their use is already illegal, but under the new regulations, possession, sale, import and manufacture will also be prohibited. Breaches of the new Order will attract a maximum fine of £5,000 plus forfeiture of the equipment.

Members of the public are, therefore, strongly advised not to purchase a videosender, and anyone currently in possession of such a device should consider disposing of it.

For more information, call the Department of Trade and Industry on 0171 211 0470.

We note that one of our advertisers – A.L. Electronics (see page 728) can now supply a legal, type approved, transmitter/receiver type video sender system working in the 1·39GHz band.

SINCLAIR RIDES HIGH



By Alan Winstanley

SINCLAIR Research has announced the successor to its ZETA (Zero Emission Transport Accessory) in the form of ZETA II, a revamped electric motor drive system which fits most bicycles to provide power assistance for those times when you find pedalling hard going.

The previous shoebox-sized ZETA weighed in at ten pounds and was fitted over the rear wheel, as Sir Clive demonstrated to me at the National Cycle Show when launched. It used pretty standard technology and retailed at £144·95 and subsequently sold some 15,000 units worldwide, says Sinclair, although in the context of two million cycles sold in the UK alone every year, this is not a tremendous figure.

ZETA II is a restyled and re-engineered power unit which uses a new pulley-mounted belt drive system fitted over the front wheel. It incorporates a new lightweight rare earth 168W motor unit which is now separated from the 12V 7Ah sealed lead acid battery pack; recharging takes 14 hours from flat.

Sinclair claims it will provide half the power needed to propel a 10-stone rider up a 1-in-12 hill at 8 m.p.h. (12·9 k.p.h.). With no head wind, and without any pedalling assistance it can propel the "typical cyclist" up to 12·5 m.p.h. (20 k.p.h.) for around five miles (8 kms) – or 10 to 15 miles (16 to 24 kms) with added pedal power. It is roughly 17 per cent lighter than the old design, at 8·2 lbs. (3·75 kgs).

Power transmission is offered by a drive belt via a reduction gearbox. The belt can be flicked down onto the tyre tread directly when needed for use, and a new pulley system adjusts the drive belt pressure on the tyre automatically for greater efficiency and a smoother ride, claims Sinclair. ZETA II will fit any wheel size between 16 to 27 inches diameter, including folding bikes. The motor can be secured with a cycle lock, and the battery pack is removable and luggable.

In the UK it can be used legally by anyone aged 14 or over, without a road fund licence or driving licence. Running costs are quoted as a penny per recharge, the battery being good for about 500 recharges. Spare batteries are available. Selling at £95 + £5 p&p, the Scottish-built unit comes with all fittings and will be available initially by mail-order from Sinclair Research Ltd., Dept. EPE, Vector Services Division, 13 Denington Road, Wellingborough, Northants NN8 2RL. Tel: 01933 279300.

Pinning Down VCR Security

Japanese company Sharp will soon launch a new VCR with a clever security feature. Barry Fox reports

EXISTING anti-theft VCRs rely on a PIN which must be entered before the machine will work. Owners find it inconvenient to enter a PIN every time they want to use their VCR. They either forget their PINs or write them down near the VCR, negating any security benefit.

When the new Sharp VCR is first used, the new owner enters the home post code, using the remote control keypad. At the same time the owner enters a secret Personal Identification Number of their own choice. The Post Code and PIN are stored in an EPROM, of the type used to store the channel tuning settings.

The EPROM holds its memory even when the VCR is disconnected from the mains power supply. But whereas the VCR can be re-tuned to different reception frequencies at any time, the Post Code can only be changed if the user first enters the secret PIN. So rightful owners can re-program their Post Code if they move house, or sell a VCR secondhand. A thief does not know the PIN, so cannot change the entry. Nor can anyone who has bought a stolen VCR. Removing the EPROM is no help, because it stops the VCR working altogether.

Whenever the VCR is used, it briefly displays its home Post Code on the screen. Unless a thief foolishly tries to sell goods in the same street from which they were stolen, the VCR will always display a Post Code which signals a previous owner in a different location. This warns a prospective buyer to beware, and to ask for the PIN which only the legitimate owner can provide.

The police need now only switch on a recovered VCR to see where in the UK it came from and then check reported burglaries in that area. Prices for the new VCRs start at £180.

B.A.E.C. PHONES

APPARENTLY the British Amateur Electronics Club had incorrect committee member telephone numbers in their last newsletter, a matter which carried over into our *Innovations* page of August '97. The phone number for J.F. Davies, the Secretary, is now quoted as 01606 883742.

MINI DRILLING

MINICRAFT'S new P3 precision cordless tool is compact, versatile and seems ideal for all those small DIY and hobby tasks. The tool has plenty of power and torque to drill in wood, plastic, ceramics, glass and light metals, and to cut, polish, grind and engrave.

Its features include: 3 × NiMH 3·6VDC power; 9,500r.p.m. no-load speed; usage time approx. 25 mins; chuck: keyless, 0·4mm to 3·2mm; fan-cooled motor; twin ball-bearing drive shaft; 25 accessories; sturdy carrying case; overnight plug-in charger. it fits the Minicraft drill stand MB540.

For more information, plus a free catalogue and list of stockists, call Minicraft on 0700 646 427238

Not So Holy Grail?

Delight for some, consternation for others – low cost CD copying is on its way, so reveals Barry Fox.

PHILIPS has sent shock waves through the record industry by promising what it calls the "Holy Grail" in time for Christmas - a £500 recorder that copies music onto blank CDs.

The IFPI (International Federation of the Phonographic Industry) complains "There have been no discussions between the hardware and software industries. The piracy implications are immense. This is a combination of old and new, CD-R (write-once), on which there have been discussions between the hardware and software industries, and CD-RW (erasable) on which there have been no discussions.

"We have already agreed that CD-R will have a recording identification device (which stores the recorder's unique number on the disc as it makes a recording) and it may be that this will be included in CD-RW. But there have been no discussions. It is of great concern to us. Now there is a lot of sudden panic which may turn out to be unnecessary. For the time being we can only wait and see."

Philips says the new recorder will be "fully compatible" with the 500 million Audio CD players already in use. But this is true only for recordings made on blanks that do not erase. Recordings made on erasable CDs will play only on next year's CD players, with AGC for the laser reader to cope with the different reflectivity of CD-R and RW discs.

The Philips announcement is timely. The music industry has just begun to subject all available audio watermarking and copyright control technologies to rigorous, independent tests. The tests are under a new ESPRIT research project called Muse which is jointly funded by the European Union, the major record companies and their trade bodies.

TECHNICAL BOOKS AND CDS

THE name of Mauritron Technical Services is synonymous with in-depth stocking of a huge variety of service manuals, books and other technical publications. The latest edition of their catalogue, number 31, is likely to contain the essential information you are looking for on almost any electronic equipment.

Its categories highlight information for computers, monitors, ham radio, military surplus, office equipment, satellite receivers, semiconductors, TVs, test equipment, audio, video recorders, valves and vintage wireless. New to this are edition are CD-ROMs numbers 5 and 6 (MP-352 and MP-353) which cover computer monitor service manuals.

If you want service info, Mauritron can probably help you. They are at Dept. EPE, 8 Cherry Tree Road, Chinnor, Oxon OX9 4Qy. Tel: 01844 351694. Fax: 01844 352554.
E-mail: sales@mauritron.co.uk.
Web: http://dialspace.dial.pipex.com/mauritron/.

VULKANISM

"CORDLESS soldering iron and precision heating tool breaks new ground in portability and application versatility", is the caption of the press release received about VulKan, MS Manufacturing's new gas-powered product.

Gas catalytic soldering irons have been produced before, but the VulKan P200, it is claimed, draws and builds on best practice to deliver true second-generation performance. New levels of flexibility stem from its exceptionally low weight – around 25 per cent lighter than alternatives – and from higher heat output: 135W maximum.

The range of attachments includes 15 tips, which optimise the tool for soldering, cutting, slicing, heating, igniting, shrinking insulation, melting, shaping and may other uses; wow!

As those familiar with gas power will affirm, the method produces a carbon dioxide-rich atmosphere around the tip which minimises oxidization, making it ideal for repairing dry joints, etc.

For more information, contact BS Manufacturing Ltd., Dept EPE, Strawhall Industrial Estate, Carlow, Ireland.
Tel: +353 (0)503 41340. Fax: +353 (0)503 40363.
E-mail: mediplas@iol.ie. Web: www.wordsun.com/mp1

Maplin Powering-Up

MAPLIN, the specialist electronics retailer, seems intent on increasing its influence in the wider world of marketing electronic products. The company has recently recruited Neal Turner to fill the newly created post of Sales and Marketing Director. Neal was previously with Farnell Components as Director and General Manager responsible for sales and marketing in the UK and Eire.

His brief is to grow the trade mail order business by capitalising on Maplin's recognised product range specialisations – computer components and peripherals; cables and components; tools and test equipment; sound and vision, and the hobbyist range.

"Maplin occupies a unique position in the electronics sector, distributing through a mix of retail stores and the catalogue", said Neal. "Maplin serves the hobbyist and the industrial consumer with the same level of professionalism. I am looking forward to contributing to the company's continued growth."

Seven new stores are planned by Maplin before the end of the year, necessitating a major drive to recruit store managers and senior retail staff.

May the Force Stop You

ACCORDING to a recent report in *BBC Top Gear* magazine, an astonishing new weapon against car theft is being trialled. The idea came about following a US Department of Defence experiment that went wrong. During trials of new non-lethal weaponry following the Gulf War, a Tomahawk missile fitted with an electromagnetic pulse (EMP) generator was fired into the desert.

When the trials team went to go home, none of their cars worked as the EMP blast had killed their electronics. Now San Diego defence firm SAIC is trialling a car immobilisation system which can be used by police to fire mini EMPs at stolen vehicles as they speed past. Who foots the bill for the rightful owner's dead electronics, we wonder, and what if people nearby are wearing heart pace-makers?

Sounding-out Adverts

ABOUT time too – for years advert sound has invariably been far too high, now they're doing something about it! – Barry Fox has the details.

AFTER 35 years of complaints from viewers, Britain's TV stations are finally able to install new digital technology which lets them judge whether commercials are too loud. Channel 4 is the first station to buy a subjective loudness meter, designed by Pearson Television (formerly Thames TV) under contract from the Independent Television Commission, and built by British electronics company Michael Stevens and Partners. The ITV stations are now evaluating the equipment. So is the BBC, which also now receives complaints about intrusive adverts for its own station and programmes.

Commercial TV was launched in the UK in 1955 and by 1960 viewers were saying that the commercial breaks sounded louder than the programmes. The problem has got worse as producers use new audio technology to hammer home their message.

SQUASHED DECIBELS

Compressors squash the natural peaks in music and speech, while at the same time boosting the quieter passages. So the sound is consistently loud. Another technique, pioneered in the 1960s by the Tamla Motown studios in Detroit, uses filters and compressors to divide the audio frequency spectrum into many narrow bands and pack as much energy into each one as possible. So the natural sound pattern of music is distorted and spread evenly over the whole frequency spectrum. One voice is then allowed to peak at a carefully chosen frequency so that it cuts through like a knife.

The overall effect is to make commercials sound very loud, and punchy, especially when broadcast after a quiet musical programme, old black and white movie, quiet nature programme or subtle drama. Conventional sound level meters measure only the energy peaks in the sound, so cannot indicate subjective loudness.

SUBJECTIVE METERING

In 1993 the British Audience Research Board questioned 3000 TV listeners, and found clear evidence that "substantial proportions of viewers" thought adverts were too loud. John Emmett, now research and development manager of Pearson Television, had tried to quantify subjective loudness while at Thames Television, so the Independent Television Commission gave PTV £5000 to finalise the design for a standard meter.

Emmett played test tapes of commercials to forty families, asking them to grade the sound from quiet to loud. The results were then compared to the sound pressure level peaks in the test sound. This produced a formula for relating the apparent loudness of sound heard from a TV set to the electrical energy in the signal leaving the TV studio.

In 1995 PTV made a few sample meters and asked TV studios to test them. The final design is now being manufactured by Michael Stevens. The meter costs £2475 and is an electronic circuit which connects between the sound mixing desk in the TV studio and the TV screen which the engineer uses to monitor the picture quality.

The circuit superimposes vertical bar graphs over the TV picture, like coloured thermometers at each side of the screen. One bar displays the electrical peak level of the signal, measured in dB, while the other shows a loudness scale in arbitrary *L* numbers. Channel 4 has bought the first batch of eleven production models and the BBC and ITV are evaluating the next batch.

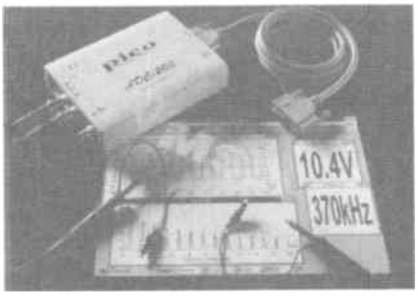
Broadcast regulations limit the peak sound level to "6", to prevent overloading the transmitters or receivers. There is no rule book yet on loudness, so engineers at Channel 4 are currently using the meters to try and establish an acceptable value for *L*, as the maximum loudness before viewers complain. First tests suggest that the loudness scale should also be kept below "6".

NOVICE COURSE

A 20-WEEK Novice Amateur Radio Course starts on 6 September at Nuffield House Community Association Radio Group, Nunsfield House, 33 Bolton Lane, Alvaston, Derby. The Group holds a City and Guilds examination centre certificate and the course will end with the C&G exam in March '98.

The course is free to members. The membership fee is £14 per year.

For further information, contact the tutor, Frank Whitehead G4MLL, 18 Bath Road, Mickleover, Derby DE3 5BW. Tel: 01332 512080. The Group itself can be contacted on tel: 01332 755900, E-mail: nharg@dial.pipex.com, Web: http://dspace.dial.pipex.com/nharg/.



NEW PICOSCOPE

PICO Technology's new ADC 200-100 virtual instrument combines a 100MS/s dual channel oscilloscope with a 50MHz spectrum analyser at, say Pico, a fraction of the cost of comparable instruments.

The latest model in the popular ADC 200 range offers all the functionality of a normal benchtop scope together with all the advantages of connection to a PC-compatible computer, such as the ability to annotate, save and print waveforms. Other benefits are context-sensitive help and the ability to copy and paste waveforms straight into a word-processor. In applications such as education and training, where groups of people have to see the screen at once, the use of a PCs colour screen provides a vast improvement over a benchtop scope display.

Advanced facilities provided by the software include simultaneous views of scope, spectrum analyser and meters, plus displays of both live and reference signals in the same window. It also features two trigger modes to capture intermittent one-off events.

The ADC 200-100 is priced at £549, complete with cables and power supply. For more information, contact Pico Technology Ltd., Dept. EPE, Broadway House, 149-151 St Neots Road, Hardwick, Cambs CB3 7QJ. Tel: 01954 211716: Fax: 01954 211880. E-mail: post@picotech.co.uk. Web: http://www.picotech.com/.

Also see our Special Offer on page 719.

WET 'N WILD

It may not be "pure" electronics, but it sounds fun, and so we mention it (!):

Wet 'n' Wild water theme park in North Shields has recently adapted one of their mid-range flume rides using Arcom Control System's bus-based boards to offer rider interaction by means of in-ride pressure pads and sensors, all controlled by custom software, supplied by Orchard Software of Kidderminster.

Riders travel along with 150 gallons of water a minute, taking the place of the ball in the popular arcade game Pinball! The idea is hit as many green pads along the route as you can, avoiding the red ones. Once out of the tube, the score is calculated in relation to hits and ride duration.

For more information, contact Arcom Control Systems Ltd., Clifton Road, Cambridge CB1 4WH. Tel: 01223 411200. Fax: 01223 410457. E-mail: sales@arcom.co.uk.

FREE

NEXT MONTH

GREENWELD 1998 CATALOGUE

Greenweld's new catalogue, hot off the press, will be presented FREE with next month's issue. Packed with a wide range of electronic components, tools, test gear, etc., the 1998 catalogue should be of interest to all readers.

TEACH-IN '98 NEW

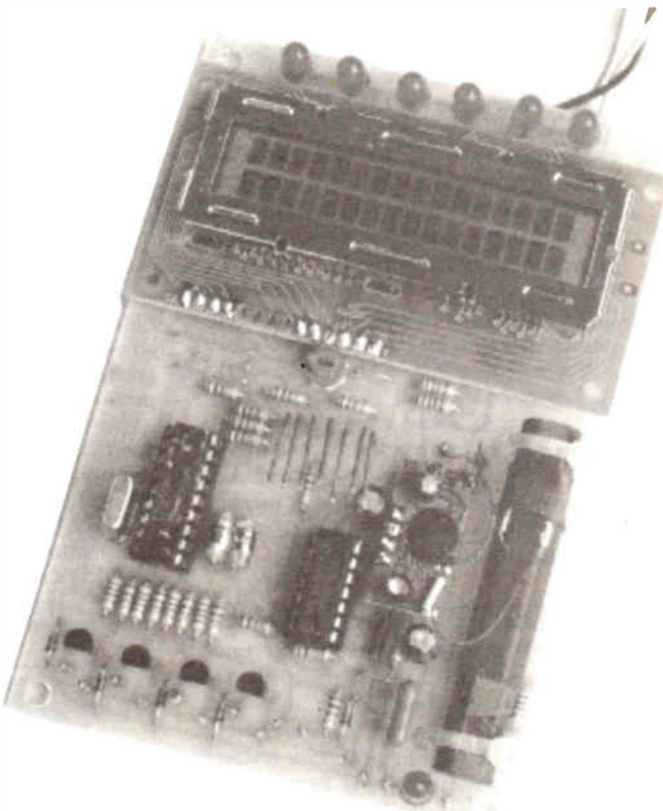
If your background knowledge of electronics is shaky, non-existent or just needs refreshing then our new Teach-In '98 *series is for you. Authoritatively written to follow the City & Guilds 726 Digital Electronics syllabus it will, in fact, also apply to GCSE, A Level and BTEC students as well as those who simply want to learn for their own benefit.*

The series introduces some novel analogies to get the concepts of electronics across and will, we believe, set a new standard for the practical study of electronics.

Don't miss the start of this important series.

EPE TIME MACHINE –

The Project Of The Future



- ★ *Millenium countdown clock – counts down in seconds to the start of the year 2000*
- ★ *Automatically corrected time from Rugby radio time signal – no setting – no adjustment – ever*
- ★ *Automatic leap year and summer time adjustment*
- ★ *Provides four individual, keypad presettable, versatile timers – two with two on/off periods for each day of the week, and two with two on/off periods repeating daily*
- ★ *Shows time (hours, minutes and seconds), day of the week and date (day, month and year)*
- ★ *After 2000 it will start counting down to 2100*
- ★ *Compact design with no setting-up required*

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NOVEMBER ISSUE ON SALE FRIDAY, OCTOBER 3

REMOTE CONTROL FINDER

BART TREPAK

Give a little whistle and your lost handset will reveal its hiding place!

Most televisions (as well as videos, satellite receivers and audio systems) now come with a remote control handset which can be used to change channels, volume settings, brightness and all the other basic functions of the TV, as well as, in some cases, more advanced functions such as Teletext.

With all these functions available from the handset, it is understandable that manufacturers often do not duplicate the controls on the set itself, so that the only "control" to be found on the television is the On/Off switch. Others limit these "on set" functions to perhaps channel Up/Down and Volume controls, which are usually hidden away behind a flip-down panel and comprise switches more fiddly to operate than those on the handset itself.

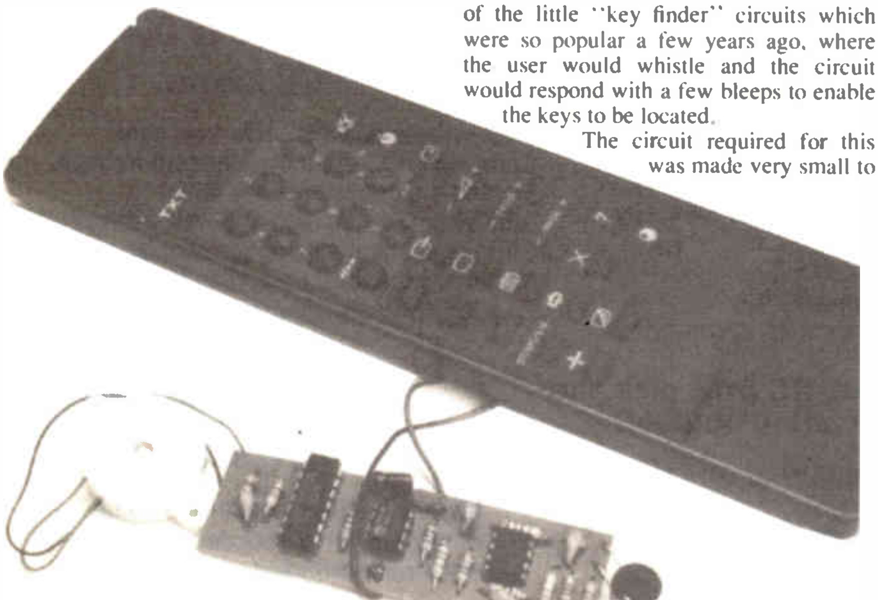
This does not, of course, present a problem when the handset is to hand but, unfortunately, these devices have a habit of disappearing just when they are needed and sometimes even for days on end. The viewer is then unable to adjust the brightness or volume and, worse still, is forced to watch all the adverts instead of using the opportunity provided by the commercial break to check what is on the other channels, or even the latest share prices.

REMOTELY FOBBED OFF?

It occurred to the author that the best solution to this problem would be a device that would emit a signal to enable the user to locate the missing handset. In view of the usual "hiding places", this would necessarily have to be an audio signal. The audio signal would, of course, need to be switched on remotely when the handset needed to be found, but another remote control for the remote control was going a bit far! Besides, what if *that* remote control could not be found?

An ideal solution would have been one of the little "key finder" circuits which were so popular a few years ago, where the user would whistle and the circuit would respond with a few bleeps to enable the keys to be located.

The circuit required for this was made very small to fit into a key fob and consisted of a piezo microphone/speaker, a special integrated circuit which included an amplifier, and a small battery.



The chips used in these "key finders" had a common input/output pin so that the microphone, a piezoelectric element, also functioned as the loudspeaker. The input pin, upon receiving a whistle signal, would switch to an output mode and play a little tune.

Unfortunately, the particular chips which were used in self-locating key fobs have disappeared from the component catalogues. Luckily, though, the author had the foresight to buy up a large number of similar devices for just such an eventuality.

These chips differ slightly in that they have a separate output which just changes state each time a whistle is detected. In this case a separate microphone and sounder must be used and the circuit modified somewhat.

Most remote control handsets consist of a fairly large box, the dimensions of which are dictated mainly by the thickness of the battery and the size of the keyboard. Besides these two items, the only other contents of this box are an integrated circuit and half a dozen other small components. This should leave plenty of room to fit a miniature microphone insert, a small circuit board and a buzzer.

Provided the circuit can be made small enough and with a low enough current consumption, it can be powered by the battery fitted to the handset, without the necessity of attaching another box and battery to it. The circuit described here fits this requirement and should be suitable for fitting into all but the thinnest of handsets.

WHISTLE SWITCH CHIP

The best way to understand the circuit is to examine the workings of the main whistle detector chip, the UM3763. The manufacturer is not very explicit about how the circuit works, but it contains an input amplifier, a clock oscillator and a frequency sensing circuit, together with an output stage suitable for switching an l.e.d. or a small motor or, indeed, a buzzer.

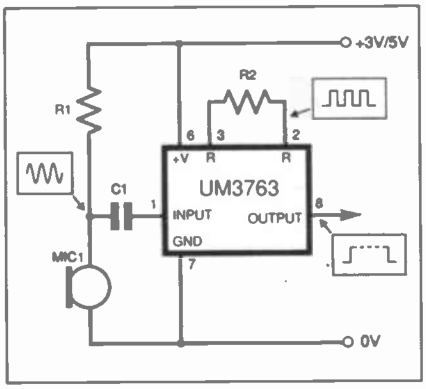


Fig.1. Basic UM3763 circuit.

In use, the circuit is configured as shown in Fig.1. A microphone is connected to the input and the clock frequency is set to about 15kHz by resistor R2.

The output switches each time that 256 cycles of a sub-frequency of between 1/10th and 1/15th of the clock frequency (i.e. between 1kHz and 1·5kHz) are received. This gives the circuit a good immunity from ordinary sounds which may fall briefly into this band.

The frequency band to which the circuit responds can be changed very easily by simply altering the value of the clock resistor (R2) so that higher or lower whistle frequencies can be accommodated.

The UM3763 was, in fact, designed for use in toys where the output stage would switch a motor on at the first whistle and off again at the second, so it is not ideally configured for a "key finder" application.

First of all, the gain of the input amplifier, while adequate for controlling toys or models, is not really high enough when the microphone is likely to be situated under a cushion or down the side of your sofa. An additional high gain amplifier is required.

On the output side, we now need to drive a piezo sounder for a short time every time a whistle is detected, so the latched output circuit needs to be modified.

CURRENT LIMITING

A careful eye must also be kept on the supply current as this circuit will be on continuously in this application. It must, therefore, consume a minimum of current in the stand-by mode so that its addition to the remote control handset will not result in having to change the batteries every other day!

It is also important to ensure that the output always switches itself off and cannot be left on permanently. The low supply voltage also results in a low output volume which could be further muffled should the unit be hiding under a cushion.

To get around these problems, without having to use fancy circuits to increase the volume, a piezo buzzer has been used. These have a built-in oscillator and are optimised to obtain the maximum sound level from the piezo element even when the supply voltage is limited.

Even so, the basic output sound level would be quite low. To make it more distinctive and the unit easier to find, the buzzer is pulsed by an additional oscillator circuit.

EXCLUSIVE

To save having to switch the oscillator off when the unit has been found, and to ensure that it cannot be left on inadvertently, the output of the whistle switch must be made momentary so that it will return to the off state after a pre-determined period.

At first sight, an ordinary monostable circuit could give a positive-going pulse of a few seconds duration and then return to zero each time the output of the whistle switch i.c. went high. This would appear to fit the requirement but, in fact, would not be suitable.

Following the first whistle, the output of the UM3763 would indeed go high and remain in this state, during which time the monostable output would also go high, switching on the oscillator (and buzzer) and then, after the monostable period, the output would go low again, switching off the buzzer.

The next whistle, however, would only cause the UM3763 output to go low, but, since the monostable is triggered only by positive-going pulses, its output would remain off for this transition and no sound would be produced. The circuit would, therefore, only respond to every other whistle, which is not quite what is required.

One answer to this problem is to use an XOR (exclusive-OR) gate, the truth table for which is shown in Fig.2.

EXCLUSIVE OR GATE

INPUTS A	INPUTS B	XOR OUTPUT
0	0	0
0	1	1
1	0	1
1	1	0

Fig.2. Exclusive OR function.

There are several ways in which an XOR gate can be regarded. First of all, it can be considered to be a digital comparator since the output only goes low when the inputs are at the same logic level, but remains high when the inputs are different. It can be used, therefore, to determine if two binary digits (bits) are equal and, by using more gates, to compare two binary numbers (bytes).

Another way of looking at this function is to consider input B (or A) as a control input. When this control input (B) is low, the output follows the input (A) and goes high when A is high and low when A is low.

When the control input B is taken high, however, the output becomes the inverse of A and goes high when A is low and low when A is high. Consequently, the gate can also be used as a programmable logic inverter/buffer.

DELAY GATE

Because an XOR gate's output only goes high if the two input levels are different, by feeding both inputs from the same output source, but delaying one slightly, the circuit will generate a pulse each time that the output level changes state. A simple XORed delay circuit is shown in Fig.3.

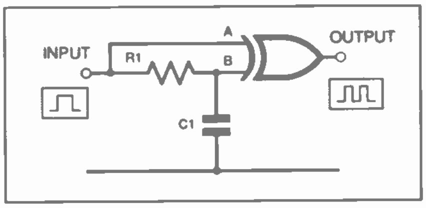


Fig.3. Basic frequency doubler.

When input A first goes high, input B remains low because capacitor C1 is discharged. Since both inputs are now at different logic levels, the output of the gate will go high. Capacitor C1 then begins to charge via resistor R1 and when the voltage level on C1 has reached about half of the supply voltage, input B will be at logic high.

With both inputs now high, the output will go low again. Only during the time interval between input A and input B going high, will the input logic levels be different and the output of the gate high. The same reasoning is also true if the input to the circuit changed from logic high to low, so that each time a change in the input occurs, the circuit will produce a positive pulse at the output.

The duration of this pulse will depend on the values of R1 and C1 and, as the high input impedance of CMOS devices allows a relatively high value of resistor (many megohms) to be used, pulses of a few seconds can be easily realised even with relatively small value capacitors.

This circuit is connected to the output of the whistle switch in the final circuit to control the oscillator and will, therefore, switch the buzzer on for a few seconds each time the UM3763 output changes state.

XOR OSCILLATOR

Two other XOR gates are used to make a low frequency oscillator to switch the buzzer on and off and so generate a pulsed tone. The circuit is shown in Fig.4.

The oscillator is enabled (switched on) by causing the gates to function as inverters when the control input is taken high. When the control input is low, the gates do not invert the signal and oscillation stops.

There is a slight problem here in that the final output state is not well defined and could end up either high or low, depending on the state of the oscillator when the enable signal is switched off. Consequently, if the buzzer were to be connected between the gate's output and one of the supply rails, it could result in the buzzer sounding continuously when the enable signal went low.

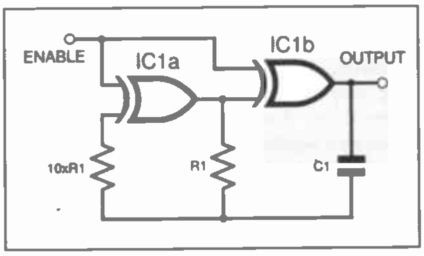


Fig.4. Gated XOR oscillator.

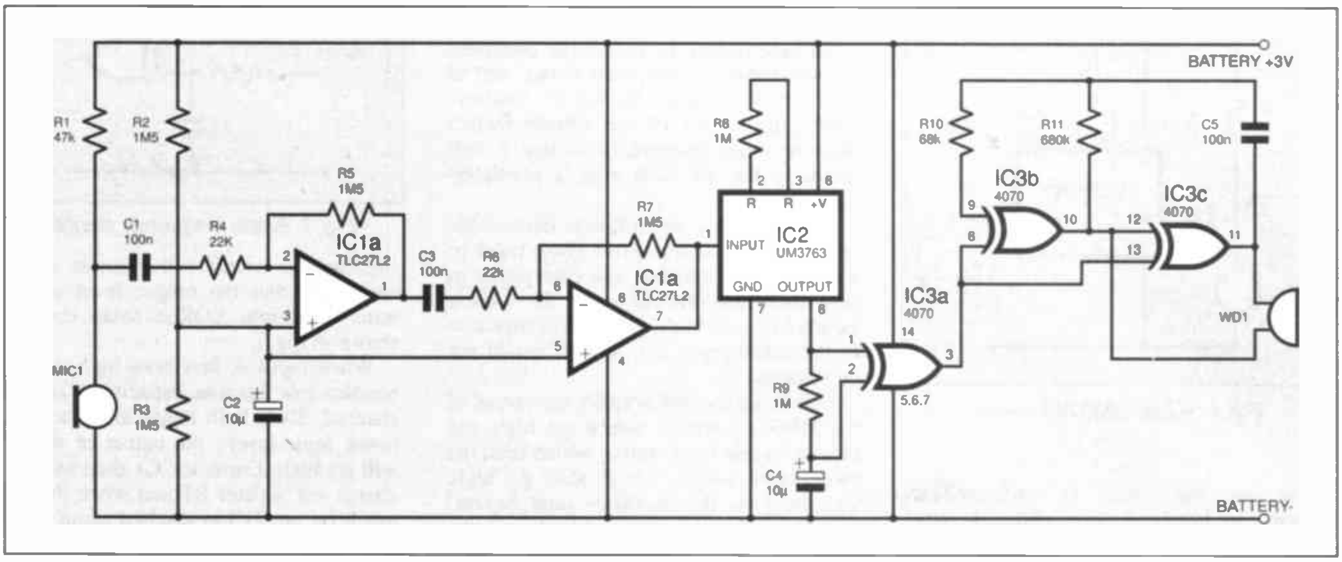


Fig.5. Full circuit diagram for the TV Remote Control Finder.

This problem is overcome by connecting the buzzer between the outputs of the two gates. When the oscillator is disabled, the gate ceases to invert and both input and outputs assume the same voltage levels, turning off the buzzer.

When the circuit is oscillating, the output voltage is always the opposite to the input and the buzzer operates when the voltage across it has the correct polarity to enable the internal circuit to work. The buzzer cannot be damaged during the periods of reverse polarity since the voltage/current levels are very low.

COMPLETE CIRCUIT

The complete circuit diagram for the Remote Control Finder is shown in Fig.5 and the various circuit blocks should now be readily identifiable.

Whistle signals are picked up the electret microphone MIC1, which is biased by resistor R1. Electret microphones are much smaller than piezo or crystal types but have an internal amplifier so that R1 must be included for correct operation.

The microphone is the main element responsible for current drain in this circuit and, for this reason, the value of R1 should be made as high as possible. The manufacturer specifies a minimum value of one kilohm (1kΩ) for this but no maximum value is given.

A number of specimens were tried and all worked well with values of 47kΩ, at which value the total current for the circuit was about 90µA. It may be necessary, though, to decrease this value in order to ensure reliable operation.

The signal is fed to a two-stage amplifier built around IC1, which provides a high gain and boosts the weak microphone signals to around 2V peak-to-peak, suitable for feeding to the whistle detector, IC2.

The 3V supply, together with the low current requirement, limits the type of op.amp which can be used as the input amplifier. The good old 741 or its near cousins would be totally unsuitable.

The dual TLC27L2 was felt to be the best choice as it is reasonably inexpensive, operates at 3V and, being a CMOS device, draws only 10µA per amplifier. Note that this chip is also available as TLC272 and TLC27M2, which are high and medium bias versions. Whilst these give superior a.c. performance (not needed in this circuit) it is at the expense of higher supply current. Consequently, the L version is the preferred choice.

A similar range of op.amps designated TLC252 is also available which is guaranteed for operation down to 1V, but there is probably not much point in using these (more expensive) chips since, by the time the battery voltage has dropped to this level, the other chips will have ceased working and the handset will probably not be of much use even if it could be found!

Whistle frequencies should not be made much higher than about 1·5kHz because, at the high gain levels required, the gain of the TLC27L2 begins to drop above this frequency.

Whistle detector IC2 responds to input signals which are within a band of frequencies as determined by the frequency of the chip's internal oscillator. With the component values shown, this is around 15kHz but may easily be altered by changing the value of resistor R8.

The output of IC2 changes state each time it detects the correct frequency and IC3a converts this level change to a pulse having a duration of about 10 seconds.

COMPONENTS

Resistors

R1	47k
R2, R3, R5, R7	1M5 (4 off)
R4, R6	22k (2 off)
R8, R9	1M (2 off)
R10	68k
R11	680k

See SHOP TALK Page

Capacitors

C1, C3, C5	100n ceramic (3 off)
C2, C4	10µ miniature radial elect. 16V (2 off)

Semiconductors

IC1	TLC27L2 dual op.amp
IC2	UM3763 whistle switch – see *Shoptalk*
IC3	4070 quad XOR gate

Miscellaneous

MIC1	electret microphone
WD1	active buzzer, low voltage

Printed circuit board, available from the *EPE PCB Service*, code 168; connecting wire; solder, etc.

Approx Cost Guidance Only £12

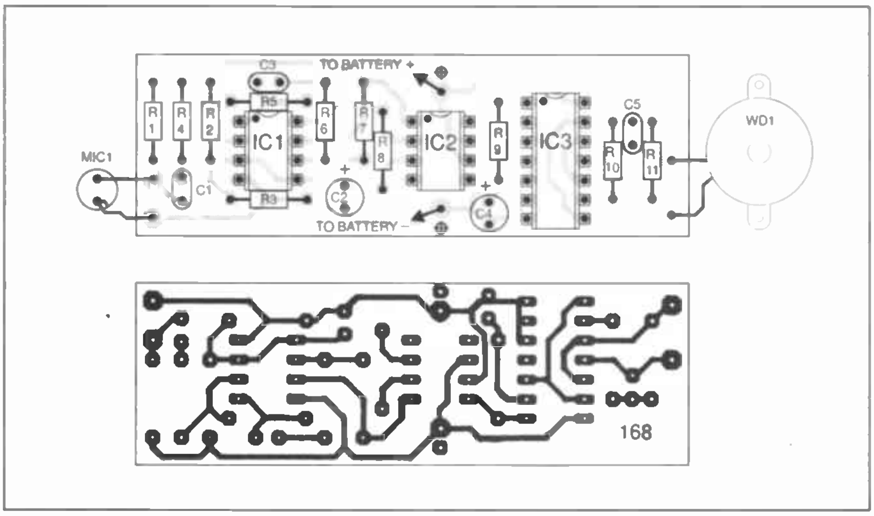
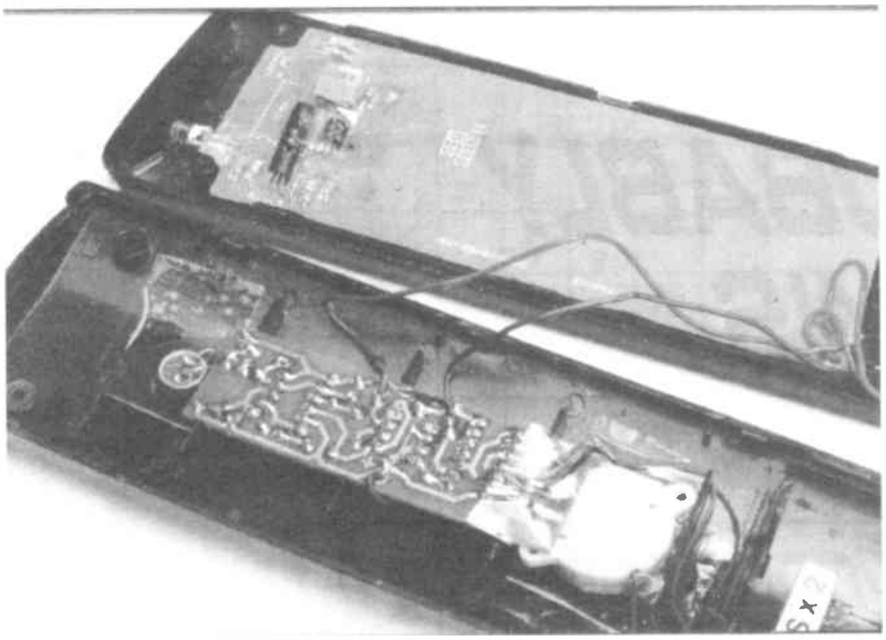


Fig.6. Printed circuit board component layout and full size underside copper foil track master pattern for the Remote Control Finder.



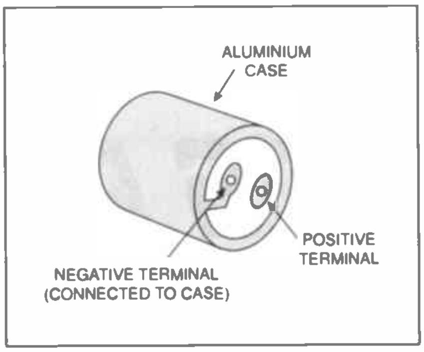


Fig.7. Electret microphone insert.

Both the microphone and the buzzer are mounted off the board. Since the buzzer has fairly long leads this gives greater flexibility in its positioning relative to the p.c.b.

Note that the buzzer also contains its own circuit but, since the output driving it is alternating, it may be connected to the circuit without regard to polarity.

which enables the oscillator built around gates IC3b and IC3c to operate. Between them, both outputs of these gates drive piezo buzzer WD1.

The standby current of the UM3763 is approximately 20µA at 3V, whilst that of IC3 is almost unmeasurable as CMOS devices only draw significant current when they are switching.

CONSTRUCTION

Since space is almost certainly going to be at a premium, it is best to construct the circuit on the recommended printed circuit board. This board is available from the *EPE PCB Service*, code 168.

Layout details for the p.c.b. are shown in Fig.6. The board is about 2·5cm wide and 7·5cm long and, when populated, around 1cm high, so it should fit inside most TV remote control handsets.

It is as well to check the handsets first, however, before purchasing components for this project. Some handsets may appear to have plenty of space, but when opened are found to have intricate internal mouldings for supporting the keyboard or strengthening the enclosure, although it may be possible to remove some of these.

It should be mentioned that remote control handsets are designed primarily with a view to their final appearance and ease of assembly and not necessarily for disassembly. Many, therefore, contain fixing screws hidden beneath self adhesive facia panels or in the battery compartment.

Cases are often specially moulded to clip together and these can be easily broken if excessive force is used to try to dismantle them. Care should be taken to try to ascertain how the case is held together rather than using brute force to dismantle it.

Apart from this, no special precautions other than those normally observed when fitting CMOS devices need be taken. However, although sockets for the i.c.s are desirable, their use may increase the height of the assembly beyond an acceptable limit so this should be checked before deciding whether or not to use them. Obviously, miniature components, especially capacitors, must be used throughout.

The microphone specified normally comes without leads so these have to be soldered carefully to its back. It is important to connect the microphone to the circuit with the correct polarity and the negative terminal is connected to the metal body of the component (see Fig.7).

If it is not clear which terminal is which, a multimeter set to low resistance or continuity will soon reveal which terminal is connected to the case. The leads may be made from discarded resistor leads and connected to the board as shown.

WHISTLE TEST

Suitable power supply connection points on the remote handset should be found by examination, using a voltmeter. Having connected the p.c.b. to the unit, it may be tested by whistling, whereupon it should respond with its own signal. If it does not, try whistling at different frequencies to ascertain the correct tone required.

If all is well, the circuit should be mounted within the handset and secured by means of double-sided adhesive tape, either to the box lid or the keyboard printed circuit board which normally offers a large flat unobstructed area. The buzzer should be mounted in a similar manner.

After drilling two small sound inlet/outlet holes in the case for the microphone and buzzer, the handset may be re-assembled. Take care to ensure that the components or p.c.b. do not interfere with the operation of the remote control by shorting or touching other components inside the case. If there is any likelihood of this, insulate the circuit with a few strategically placed pieces of insulating tape.

You will now have the luxury of knowing that the Remote Control Handset, which previously appeared to have a mind of its own, will now tell you where it is hiding – unless of course it decides to wander even further afield and out of earshot altogether!

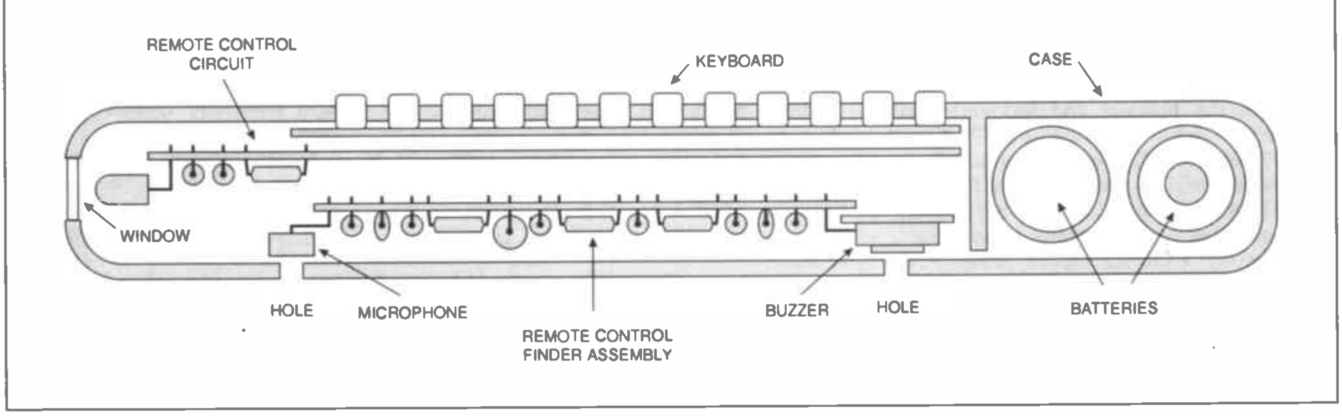


Fig.8. Typical installation in a remote control handset.

IT'S PROBABLY MURPHY'S LAW

BARRIE BLAKE-COLEMAN

When exposed to scientific scrutiny, Murphy's Law acts to prevent its own disclosure.

THE all too common outcome of a seemingly predictable chain of events is catastrophe. The more you attempt to avoid it, the worse it appears to get. Thus has *Murphy's Law* been recognised.

We surmise that the Murphy Syndrome occurs too frequently to be pure chance, though reason counsels otherwise. Is Murphy's Law a satanic malevolence, an unseen and fiendish conspiracy to create chaos? Or is this interpretation of adverse phenomena irrational and more properly explained in the simple innocence of probability theory?

Though light-hearted, this article expects to challenge current beliefs. In this last respect, readers are forewarned that it is written and structured so as to be convincing. Readers who believe they discern disingenuity, non-sequiturs and syllogisms are invited to rebut – if appropriate.

INFAMOUS LAST WORDS

Murphy's Law is concisely epitomised by Captain E. J. Smith, commander of the *S.S. Titanic*, who was heard to utter the memorable words, "Icebergs? So what! She's unsinkable ain't she?" just a short while before the bottom of his ship was ripped open.

An amusing source for the Law of Murphy is the fictional and luckless Edsal Murphy – born (supposedly) 1852 (died – 1922 and 1923!) though establishing an authentic origin is more difficult. Burns, in 1786, observed that "*the best laid schemes of mice and men are prone to go awry*", whilst the Victorian satirist James Payn noted that:

I never had a piece of toast,
Particularly long and wide,
But fell upon the sanded floor,
And always on the buttered side.

According to some historical sources (e.g. Macquarie), Murphy originated as an incompetent character in wartime US Navy training cartoons. Another reference (Berry) quotes a certain inept mechanic at Cape Canaveral. More credible authorities (e.g. *Concise Oxford*) cite George Nichols, a Northrop project manager, who in 1949 developed the idea of designing components which were impossible to fit incorrectly.

"Is Murphy's Law a Satanic malevolance . . . ?"

The initiative supposedly came from a remark by Captain E. Murphy (of the Wright Field Aircraft Laboratory) that electrodes used in rocket sled trials (designed for testing rapid de-acceleration in pilots) were invariably wired incorrectly, as too aircraft valves with a choice of similar connecting ports. This led to the observation that "If there are two or more ways of doing something, and one of them can lead to catastrophe, then someone will do it!"

The fact that a "failsafe" design was needed is implicit in Murphy's Law – it became formalised by common consent as "*Even if it cannot possibly go wrong, it still will*".

The *Law* is not universally recognised as Murphy's Law, being variously regarded, in a more general form, as *The Law of Continuous Misery*, and sometimes as *Sod's Law*, *Bodes Law* or *Fingles Third Law*, though this latter is obscure.

Nevertheless, each version essentially articulates the same sentiment, that occurrences in life appear to be imbued with a malevolent influence, a definite inclination to thwart, confound, confuse, baffle, block, hinder, obstruct, burden, hamper and generally screw up all the things we want to do.

Instances of Murphy's Law abound and are now so axiomatically ingrained in the engineering and scientific community that the majority will nod vigorously when confronted with other peoples experiences. As expounded in other treatises, special and general forms exist, typically:

1. If a circuit cannot fail, it will
2. A fail-safe circuit will destroy others
3. Any wire cut to length will be too short
4. A device selected at random from a group having 99 per cent reliability will be from the one per cent group
5. A dropped tool will land where it can do the most damage (also known as the Law of Selective Gravitation)
6. Tolèrances will always accumulate adversely
7. Interchangeable parts won't
8. If a prototype functions perfectly, subsequent production units will malfunction
9. The last mounting screw will be the one that shears off
10. The more innocuous a design change, the more profound its effect
11. Any error incorporated into a calculation or design will operate in a direction able to create the maximum damage
12. Constants aren't – variables won't (all constants are variables)
13. In any computation, the figure that is most obviously correct will be the source of error
14. A patent application will be preceded by one day (week or month) by another independent worker who will then abandon his own application as unworkable

OPPOSITION BY INANIMATE OBJECTS?

So often have utterly improbable events created havoc that there has grown up a general consensus that animate and inanimate objects are subject to supernatural influences which sneer at the usual laws of physics and chance. Indeed, the fact that everyone knows that bread always(?) drops butter side down was the subject of a quasi-serious investigation in a past *QED* TV programme.

Not unexpectedly, the "experts" demonstrated that in the controlled dropping of jam covered bread, no malevolent influence existed and that the two possibilities, jam down or jam up, were equally likely events. In short, Murphy's Law was a fallacy – empirically bankrupt, an observational misnomer.

Unfortunately, these conclusions from the "experts" were in no way convincing. Those watching could have been forgiven for feeling that just maybe the test conditions were themselves the subject of Murphy's Law.

If the Law holds, it applies wherever attempts are made to quantify, or acquire with some certainty, the factors necessary for the Law itself to apply. In these circumstances the Law will act to prevent itself being exposed. A mocking parallel of Le Chatelier's (or possibly Heinsenberg's) principle.

UPPER-CRUST

Notwithstanding the old adage about "those convinced against their will, hold to their opinions still", few critical observers thought the demonstration a rigorous test of the phenomena (with the proviso that it wasn't easy to do in any circumstances). Skeptical experts – with an unwavering faith in statistical analysis – were clearly not looking beyond the very simplistic manifestation they thought Murphy's Law underpinned.

Dropping jam covered bread is all very well, but what does it imply? Was it really a real world simulation of how Murphy's Law works? Of course it wasn't!

We know (don't we?) that the jam only hits the floor when the bread is dropped outside a Murphy "continuum", in other words, our experience tells us that the moment we deliberately drop jam covered bread in a controlled way over fixed a time frame (i.e., say I drop jam covered bread at 10 second intervals for ten hours) the laws of chance (probability) and statistics immediately apply. Otherwise, by the hypotheses above, Murphy's law would definitely be validated.

If, however, the time frame is "discontinuous" and this is the day when other Murphy factors are concentrating (you have an important meeting and are wearing a brand new suit) then dropping the bread/toast on your lap is on the cards, and it will tend to do so jam/butter side down!

"The best laid schemes of mice and men are prone to go awry"

This latter example is actually a far too mundane version of the Murphy syndrome. More typical is watching a spring loaded cog shoot from the mechanism under repair, skim across the table, launch itself into mid-air, ricochet off a milk bottle and bounce off the kitchen window into the sink.

Similarly, dropped screws, the ones irreplaceable in a mechanism, bounce off umpteen surfaces and then disappear into the most inaccessible crevice. As cog and screw disappear, we are left in awe at the impossibility of it all. "Couldn't have contrived that in a month of Sundays", we muse to ourselves trying to work out what quirk of fate, ballistics and position had calculated everything so perfectly for the fateful trajectory.

PARANOID

This then, essentially sums up the problems we face in elucidating the elusive quality of Murphy's Law. We see virtually unique events which are so beyond contriving, so improbable, that its audacity leaves us staggered (and, understandably, a little paranoid).

Deliberately pitching cogs at the table, in the hope of striking bottle and kitchen window, will never (in our lifetime) cause a dimensionally inappropriate cog to be lost from sight down the centre orifice of a plug hole; will it?

As we think on matters, we juxtapose several factors. The first is that the loss of the cog is an extremely improbable event. The next that it isn't the first time this kind of thing has occurred. Then we are struck by the relative ratio of two states, that is, the likelihood of the proposed event (fitting the cog) versus the chances behind the resultant mishap.

Similarly, and without attempting to exactly quantify things, we can see that the number (or frequency) of improbable pathways contained in the event is in stark contrast to the direct probability of the event itself. In short, we are left with the proposition that a procedure with a most probable outcome, carrying a high probability of success, resulted in a uniquely improbable and very unfavourable result.

However, the fact that we experience such statistically unfavourable events *not* infrequently means either that other (dark?) forces are involved, or that these improbable occurrences are in themselves somehow favoured. What we are saying then, and the reason Murphy's Law is generally admitted, is that we will tend to observe events with infinitely small probabilities taking place with a numerically disproportionate frequency. In short, we have to ask what is the probability of regularly witnessing, initiating or participating in, a highly improbable (near impossible) event?

To consider this, we need to look harder at the basis and theory of probability, a field of endeavour described by the French mathematician Laplace as "common sense reduced to calculation".

THE EVENT ISN'T THE ISSUE

As a point of interest, it all started with gambling. In 1654 the Chevalier de Mere (notorious gambler and amateur mathematician), proposed to the celebrated mathematician Blaise Pascal a problem concerning the "division of stakes in a game of dice" if the players had to abandon the game before its conclusion.

Pascal communicated the query to Pierre de Fermat (nowadays also notable not only for probability theory but also for his *Principle of Least Time*), and the study of probability began. However, for all its power, it remains riddled with contradictions. Treating the theory of probability as an exact methodology is dangerous – it deals with determining uncertainties, not strictly the opposite.

Intuition is important. Say two college students agree to flip a coin and let it land as it will. Heads they go for a beer, tails they watch TV, and if the coin stands on edge they study.

Common sense told them that they would be spared the necessity of studying. Indeed, they were gambling effectively only on two favourable possibilities; they were instinctively employing innate probability analysis. Given all previous experience concerning coin behaviour, it was unlikely that it would land (and stand) on its edge.

POSSIBLE

If p is the expectation that tails will appear, then (assuming no bias) there is the same chance, p, that heads will

appear. If we are certain that *either* heads or tails will appear, then the value of *certainty* is $2p$, expressing the probability that any event which is bound to occur will occur.

If we now assign certainty as 1, then $2p = 1$ and the probability of heads is 1/2 and the probability of tails is 1/2. To sum up, each event is equally likely. The same is true of our previously cited slices of jam covered bread. The idea that it could stand on edge is simply not considered!

But what if we *do* consider the edge possibility? Suppose that the number of ways in which a certain event can happen is h and the number of ways it can fail to happen is f. Suppose, further, that both possibilities are equally likely. Then the probability that the event *will* happen is:

$h/(h+f)$

and the probability it will *fail* to happen is:

$f/(h+f)$

and the probability that it will happen, or fail to happen, is:

$h/(h+f)+f/(h+f)=(h+f)/(h+f)=1$

That is, the chances that it will happen or fail to happen is a certainty. Now, we have agreed (?) that the coin cannot stand on edge but must fall with either heads or tails showing. That is, the number of ways in which the coin can stand on edge is 0 and the number of ways this can fail to happen is 2 (i.e. heads or tails). Therefore the probability that the coin will stand on edge is (in this scenario at least) 0/2, or 0.

IMPOSSIBLE

This leads us to consider that the *probability of the occurrence of an impossible event* is 0, and the *probability of the occurrence of an event which is certain* is 1 and that the *probability of the occurrence of a doubtful-yet-possible event* is some value between 0 and 1.

It dawns on us, perhaps, that the coin example is too idealistic, too trite. Concede that there is a finite possibility that the coin will land on its edge – this is the real world. So we write the probability of occurrence as some very small fraction, *fr*, over 2. The ratio of the two dominant, but equally likely, events (heads or tails) will be numerically vast compared to the edge probability *fr*.

Our college students knew they faced a finite risk of having to study, but they were gambling very much with the odds against it happening.

Intuition tells us that the longer a statistically determined event has failed to happen, the more probable becomes its occurrence. (Fruit machine players believe this). Conversely, though it may be an absolute rule that in a fruit machine the odds remain fixed each time the sequence starts, by definition, if the odds on a certain improbable event (jackpot) are finite, each such improbable event, as it takes place, is viewed as taking the re-occurrence of the same event further away. Yet this, on a strict statistical basis, is wrong – it could as easily happen next time round.

Likewise, we might reason conversely, that the failure of a statistically predictable (and normally distributed) event to occur over time brings the likelihood of occurrence closer. We would be very surprised (though it is equally probably) if all the predicted events occurred at the end of time. But, unlikely as it is, this could happen. Nevertheless, in terms of Murphy's Law this is the point where dry calculation loses touch with reality. In the real world, shear statistical probability is just one factor amongst other effects and influences.

Back to our cog (above). The numerical ratios are arguably a reflection on the possibility of unlikely events occurring often. In terms of occurrence, the number of situations in which we find ourselves throughout our lives means that we are continually becoming players in improbable events.

In terms of a perception of time and circumstances, very unlikely events appear to happen regularly to some people. Sometimes, we intuit that it is far too often! Just like the coin, we know life can land on its edge and that this remote possibility will happen only when we are least prepared, or equipped, to handle it.

Can we conclude anything from this?

Only that our lives are not wholly measured by chance, nor are we prone to be the victims of an ill-fated jinx. The more we do, the greater the opportunity for becoming an unwilling participant in a Murphy scenario.

Murphy occurrences, and our perception of them, increase in direct proportion to circumstances and our ability not to be able to cope with them – a fact with which we are all acquainted. Fate rules. We have only limited control over the conditions which optimise factors governing Murphy's Law.

So, let us try to formalise Murphy's Law as an empirical statement. The possibility of a Murphy occurrence *(Mo)*, through the coincidence of any one of n different events of improbability *(p~)* able to take place over a given time span *(t)* is:

$$Mo=t(n\,\Sigma p{\sim})$$

(Σ = summation of single event $p{\sim}$ terms). Now Cp approaches 1 as n and t are increased and $p{\sim}$ becomes more finite (increasing to 1). Time is important because event sequences are invariably time dependent, thus as t becomes vanishingly small Mo vanishes accordingly. Likewise, the absence of an event or event sequence over unit time means that a multiplier reduces to zero and accordingly Mo is zero. As $p{\sim}$ increases positively over unit time so too does the value for Mo but this may be countered by a reducing value for t (time span).

This restates Murphy's Law in a way which denies any supposed demonic intervention, and accounts for the more pragmatic aspects.

The message is simple, i.e. there is a high risk of the occurrence of highly improbable events – but they may not always be negative. However, as regards chains of adverse occurrences and unfavourable events, they can and do appear to cluster.

Hence, the explanation is not, as advocated by some, *that a large number of improbable outcomes leads to the certainty of an improbable outcome*, but that in Murphy's Law it is the improbable (inexplicable) outcome which tends to be probable!

The two statements are not tautological since, in the first instance, a Murphy occurrence would mean that any observer insisting that an outcome was so uncertain (i.e. certain to be improbable) that the result could not be predicted, would be demonstrably wrong! Likewise, in a field of likely outcomes, Murphy dictates that the outcome is not predictable.

Murphy will, by definition, confound. It suggests that the improbable is favoured – in a nutshell, *there is a high probability that a highly improbable event will occur, or the chances of participating in an improbable event are high.*

This doesn't imply that improbable events are themselves made intrinsically probable; rather, their occurrence is. We distinguish between the implicit improbability of an event in itself, and the likelihood of such events occurring.

BIASED CONCLUSION

As a final comment, some observers will hotly deny Murphy's Law, because it implies bias in the laws of chance – they rightly insist that probability is just that, and cannot be violated, without realising that Murphy's Law implies no such thing, since each Murphy event has its own statistical identity. That is to say, a Murphy is not removed from the statistical environment.

"Even if it cannot possibly go wrong, it still will."

Others avoid acknowledging any contradiction by insisting that we be reminded that adverse events are as equally probable as favourable ones, again misunderstanding the basic Murphy dictum. (Forgetting, for instance that getting it right is one critical path requiring control, getting it wrong is a plethora of pathways independent of control).

Some find refuge in fatalistic acceptance, yet others refuse the evidence of their own experiences and, entirely unflustered by misfortune, simply ignore it altogether. Pragmatists, on the other hand, recognise that it will get you in the end and plan accordingly. [ ]

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MULTI-STATION QUIZ MONITOR

ROBERT PENFOLD

A low-cost method of assuring you have fair play when playing your favourite panel game

THIS project is a monitor for television style quizzes where the first person to press his or her pushbutton is given the first opportunity to answer the question. The unit has four large light emitting diodes (l.e.d.s), one for each contestant.

When a contestant operates their pushbutton switch, the relevant light switches on and the other three contestant's lights are then blocked. Once switched on, a light remains on until it is reset by the Quiz Master, and the unit is then ready for the next question to be asked.

The circuit is powered from a six volt battery, and due to its low standby current consumption, an extremely long battery life is obtained.

Although featured here as a four contestant system, it can be easily extended to cater for a larger number if required. In theory at any rate, there is no limit to the number of stages that can be added to the circuit.

SYSTEM OPERATION

On the face of it, this is an application that is well suited to standard logic techniques, and which requires no more than a few logic gates. It is not that difficult to obtain the desired effect using standard logic techniques, but in practice this usually seems to produce a rather overcomplicated end result.

Also, conventional logic circuitry tends to be a bit restrictive, making the addition of extra stations difficult or impossible. This is an application where "home spun" methods can offer simplicity and greater versatility.

The circuit finally devised is a logic circuit of sorts, but it is not based on CMOS or TTL logic integrated circuits. Instead it utilizes silicon controlled rectifiers (s.c.r.s or thyristors) and a simple diode gate.

An s.c.r. is a three terminal device like a transistor, but it can only be used as an electronic switch. It is either switched on or turned off, with no intermediate states. The block diagram for the low cost Multi-Station Quiz Monitor is shown in Fig.1.

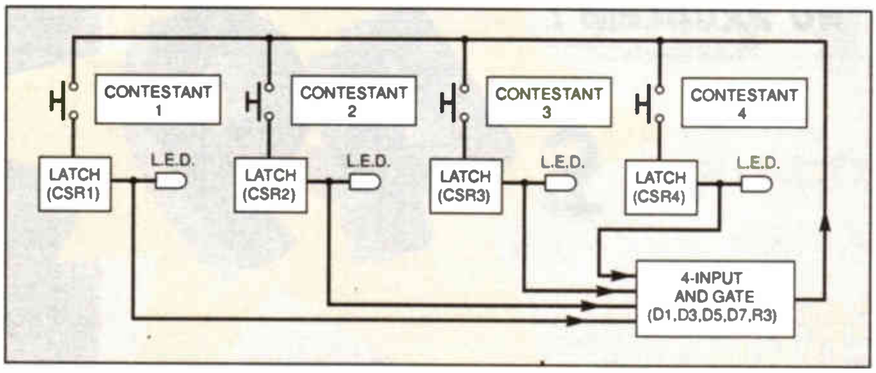


Fig.1. Block diagram for a 4-station Quiz Monitor.

The latches are actually the s.c.r.s. Unlike a transistor, once a thyristor (s.c.r.) has been biased into conduction it remains switched on even if the input current is cut off. It can only be switched off again by reducing the output current to a low level.

Each thyristor drives a l.e.d., and is activated via a pushbutton switch. Therefore, once a pushbutton switch has been activated, the relevant l.e.d. will switch on and remain on even if the switch is released.

LOCK-OUT

An essential feature of any quiz monitor is an automatic blocking of all the other indicator lights as soon as one of the lights has been switched on. This leaves no doubt as to which contestant pressed his or her button first.

In this case the automatic blocking is obtained by feeding the pushbutton switches from the output of a 4-input AND gate. The inputs of the gate are fed from the outputs of the latches.

The output of an AND gate is *high* (1) if all of its inputs are *high* (i.e. input 1 ***and*** input 2 ***and*** input 3 ***and*** input 4 are high), but *low* (0) if *one* or more of the inputs are *low*. It is from this that the AND name is derived.

The outputs of the latches are normally high, but go low when activated. Therefore, under standby conditions all four inputs are high, and the output of the gate is high as well. If one of the pushbutton switches is operated, the output of the appropriate latch will go low, and its l.e.d. indicator light will switch on.

With one input of the gate now low, the output will go low as well. This cuts off the bias current to the input of the latch that has been activated, but its l.e.d. remains switched on. On the other hand, operating one of the other pushbutton switches will now have no effect, since the output of the gate is low, and no bias current will be provided to the latch.

It only takes about a microsecond (a millionth of a second) for a thyristor to switch on. This rapid switching makes it possible for the unit to switch on the appropriate l.e.d. even if two pushbutton switches are operated almost simultaneously.

In theory, it is possible for two or more l.e.d.s to be switched on simultaneously, but this is virtually impossible in practice.

CIRCUIT OPERATION

The full circuit diagram for the Multi-Station Quiz Monitor appears in Fig.2. This consists of what are essentially four identical stages. Fig. 3 shows alternative jack plug and socket connections for the Contestant switches S1 to S4.

If we consider the first Contestant stage, based on thyristor CSR1, this drives l.e.d. indicator D2, and resistor R4 sets the l.e.d. current. When D2 is switched on there is a total voltage drop of almost three volts across CSR1 and D2 itself, giving a little over three volts across R4 and a current flow of about 15mA.

This is high enough to give good brightness from D2, but is comfortably within the 20mA maximum rating for most l.e.d.s. It is also high enough to ensure that once CSR1 has been triggered it remains switched on. A current flow of 5mA is sufficient to ensure that a C106D thyristor (s.c.r.) remains switched on.

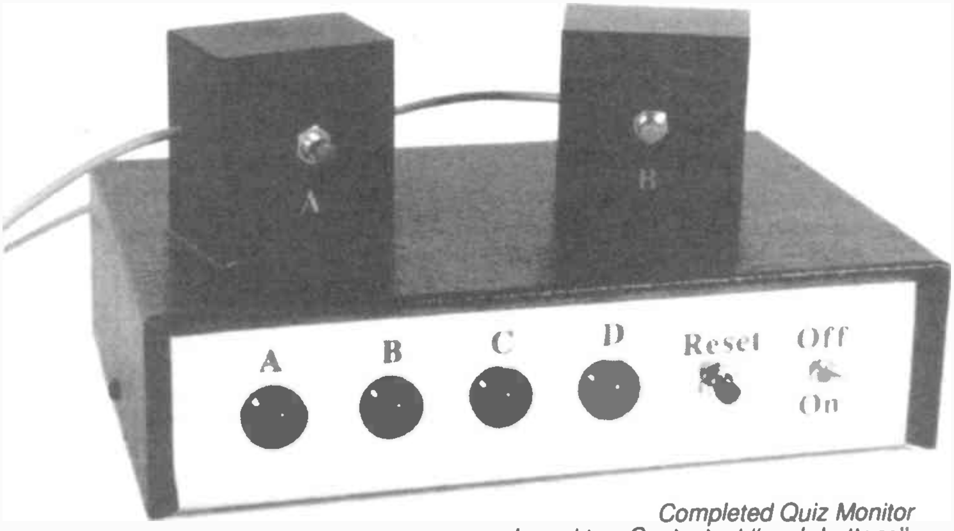
When pushbutton S1 (Contestant 1) is closed, CSR1 is provided with a small gate current via resistors R3 and R1. A maximum current of 500µA is needed to trigger a C106D thyristor, but the sensitivity of "real" C106Ds seems to be quite high. The problem seems to be more one of preventing unwanted triggering rather than getting devices to trigger into conduction.

Resistor R2 is needed to prevent problems with stray pick-up of electrical noise causing unwanted triggering. The values of R1 and R3 have been made quite high to ensure that the automatic lock-out works properly once one of the thyristors has been triggered.

The AND gate is comprised of diodes D1, D3, D5, D7 and resistor R3. If (say) CSR3 is switched on, the current flow through diode D5 and CSR3 pulls the lower end of R3 to a low potential of one volt or so. This gives an inadequate trigger current for one of the other thyristors if a pushbutton is operated, and gives the required lock-out of the other buttons.

MASTER RESET

A toggle switch S6 is the normal On/Off switch, and this could be used to reset the unit. It is just a matter of switching off the supply, and then almost immediately switching it back on again.



Completed Quiz Monitor console and two Contestant "push-buttons".

In practice, it is easier if the unit is Reset using a separate pushbutton switch, and this is the purpose of switch S5. This switch is a *push-to-break* type, rather than the more normal push-to-make type.

Normally S5 connects the power to the circuit, but if it is briefly operated, power is momentarily cut off from the circuit. This reduces the current through the active thyristor to zero, and switches it off.

Although the current consumption of the circuit is around 15mA when an l.e.d. is switched on, it is extremely low indeed the rest of the time. In fact only minute leakage currents flow, and the standby current consumption should be no more than a few microamps. The average current consumption is therefore quite low, giving a very long operating life from each set of four HP7 size batteries.

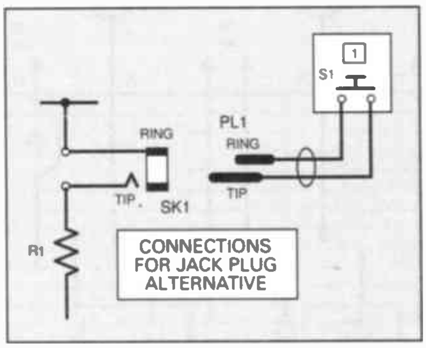


Fig.3 Jack plug and socket alternative arrangement for Contestant switches.

EXPANSION

If a greater number of l.e.d.s/push-buttons are required, the circuit is easily expanded. It is just a matter of adding an extra stage for each additional indicator l.e.d. and switch.

In other words, for each additional stage duplicate S4, R11 to R13, CSR4, D7, and D8. The "breadboarded" prototype worked properly using eight stages, but the circuit should function properly using many more than this.

CONSTRUCTION

The stripboard component layout, underside copper break details and wiring for the Multi-Station Quiz Monitor are shown in Fig.4. This board measures 44 holes by 19 copper strips.

This is not a standard size, so cut the board to size using a hacksaw, cutting along rows of holes rather than trying to cut between them (which is not practical due to the narrow gap between rows). This usually gives rather rough edges, but they are easily filed to a neat finish.

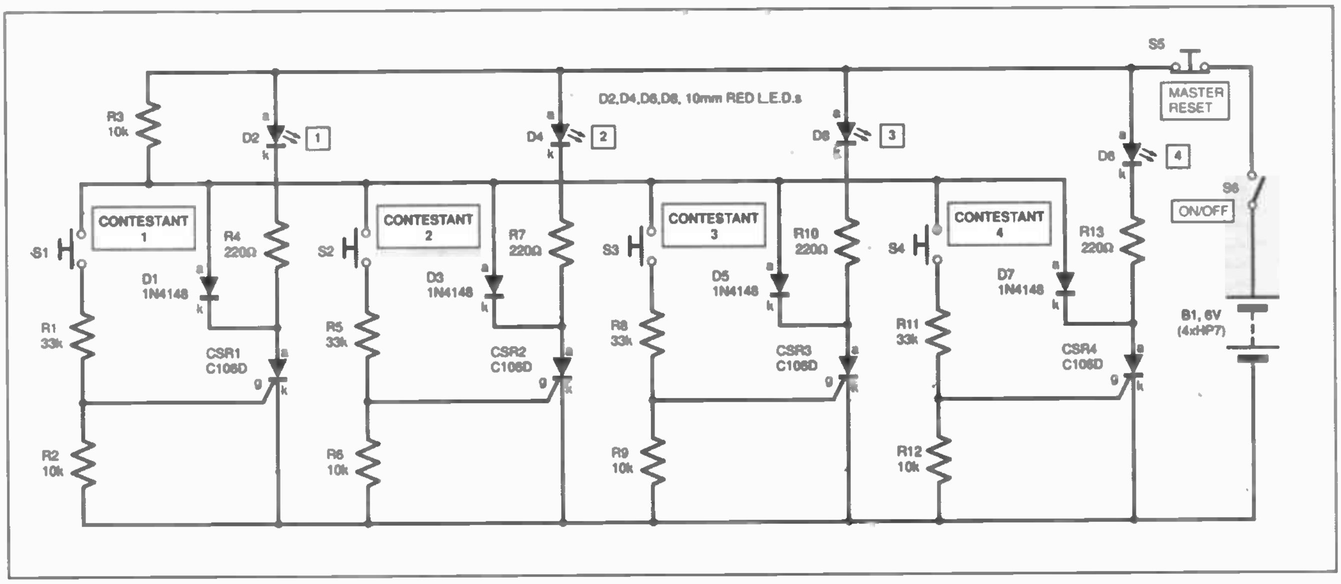


Fig.2. Complete circuit diagram for the Multi-Station Quiz Monitor. Note Reset switch S5 is a press-to-break type.

The two mounting holes in the board are drilled next, and these are 3·2mm in diameter. Do not forget the twelve breaks in the copper strips. These can be made using the proper tool, or a twist drill of about five millimetres in diameter makes a good substitute.

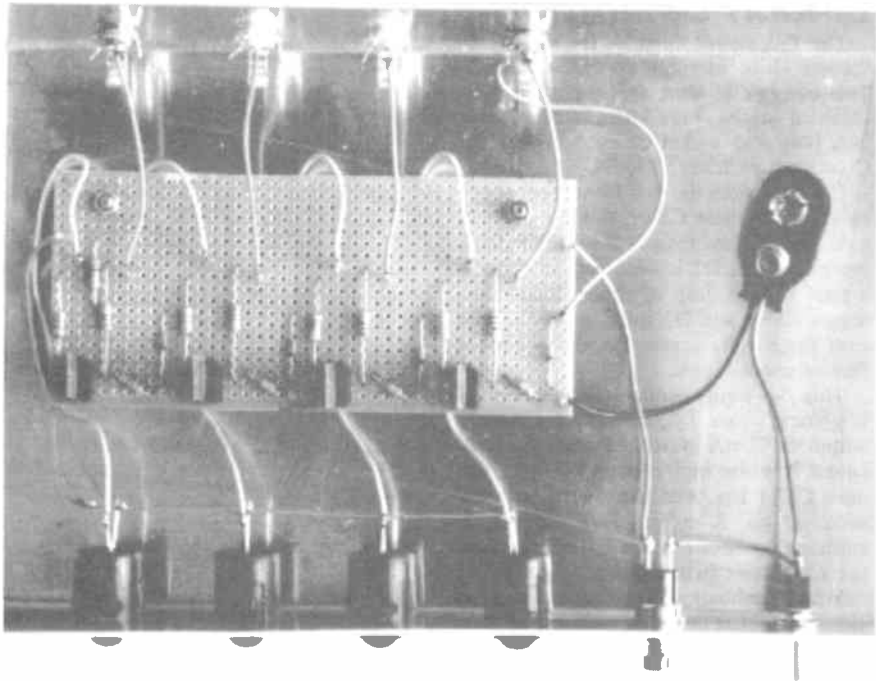
The board is now ready for the components to be fitted. It is advisable to fit the resistors first, and single-sided solder pins at the points where connections to the switches and l.e.d.s will be made. Then fit the diodes and thyristors, taking care to fit them the right way round.

CASE DETAILS

A medium size metal or plastic box should accommodate this project. A plastic box is likely to be the cheaper option, but some l.e.d. holders seem to be something less than fully compatible with the thick panels of plastic cases.

The prototype is housed in an inexpensive metal instrument case, with switches S5, S6, and the four l.e.d.s mounted in a single row along the front panel. The general layout is in no way critical though, and any reasonably practical layout is acceptable.

The circuit board is mounted on the base panel of the case using metric M3 or 6BA screws. If a metal case is used it is



General component layout and interwiring inside the finished Multi-Station Quiz-Monitor control console. Being a metal case, only a single lead is needed for the open style, jack socket "ring" (earth) connections as they are linked together via the metal rear panel.

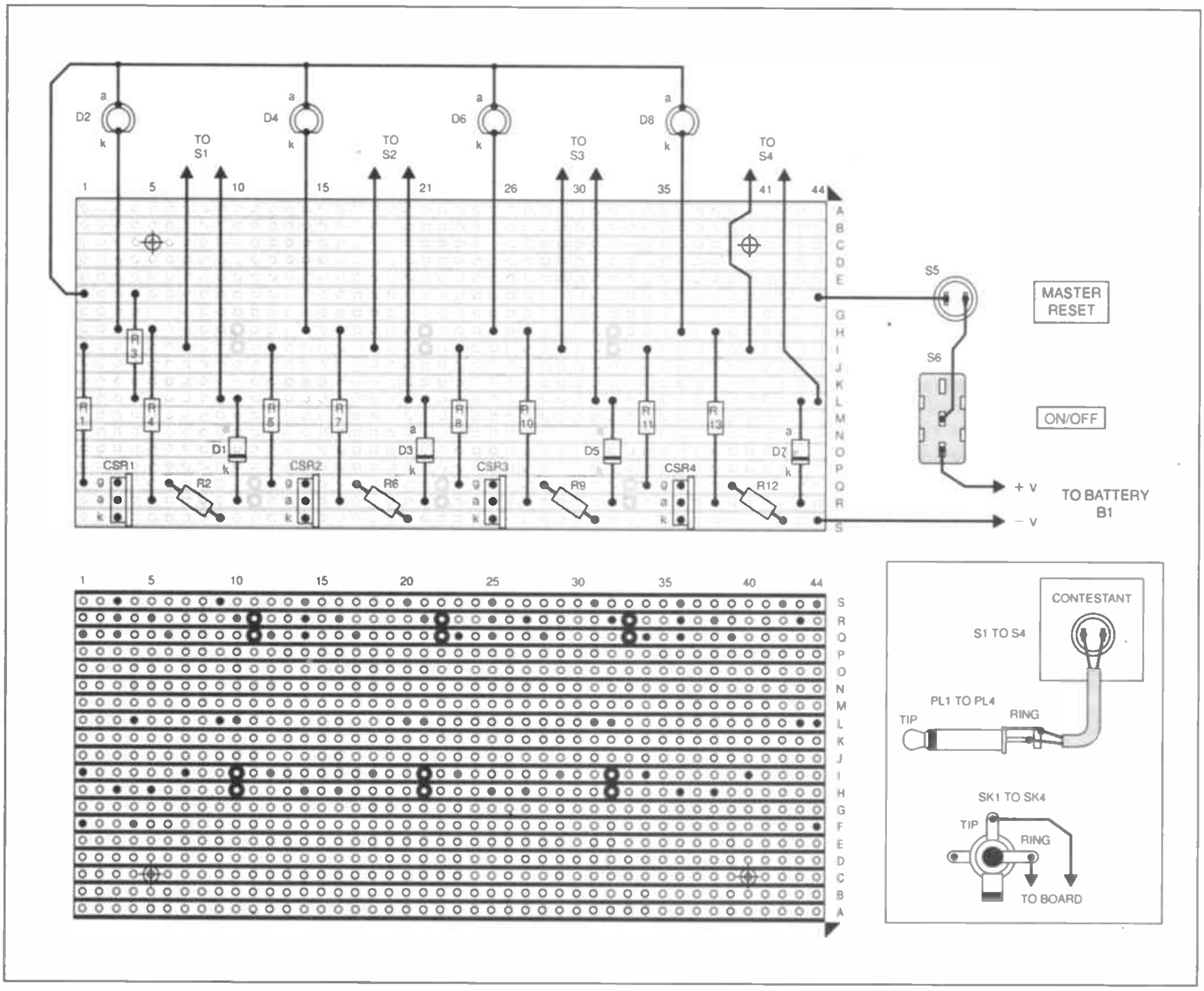


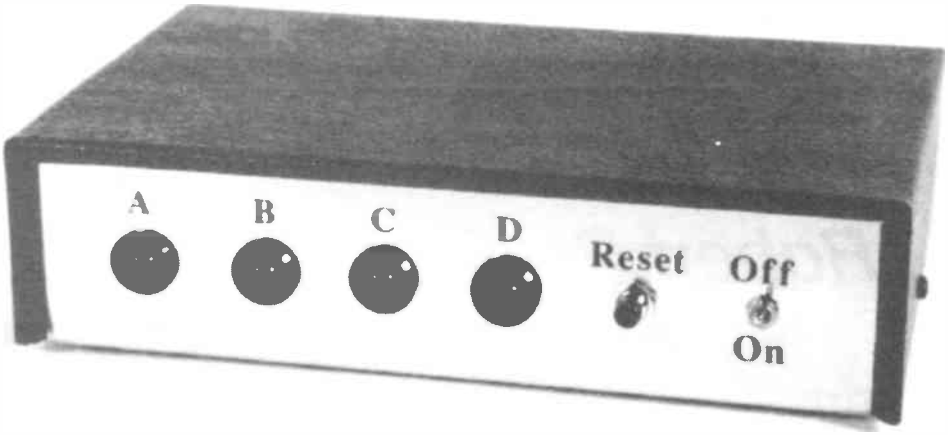
Fig.4. Stripboard component layout, interwiring details and underside copper tracks showing the necessary breaks in the strips. The preferred wiring to the jack sockets and plugs is shown inset.

essential to include spacers at least 6mm long to keep the connections on the underside of the board clear of the metal case.

DISPLAY L.E.D.s

Large high efficiency l.e.d.s of 8mm or 10mm diameter are ideal for this application. However, it is probably best to avoid the ultra-bright types that produce a very narrow beam. A high brightness type that is visible over a very wide angle is likely to give much better results.

Ordinary 5mm l.e.d.s are just about adequate, but it is not advisable to use l.e.d.s any smaller than this. Whether you use ordinary l.e.d.s or the "jumbo" variety, the cathode (k) lead is normally indicated by that leadout wire being the shorter of the two. Also, the cathode lead is usually indicated by a "flat" on that side of the encapsulation of the l.e.d.



Jumbo l.e.d. display on the front panel of the prototype Quiz Monitor. The display numbers have been replaced with "station" letters on this model.

COMPONENTS

Resistors

R1, R5, R8, R11	33k (4 off)	
R2, R3, R6, R9, R12	10k (5 off)	
R4, R7, R10, R13	220Ω (4 off)	

All 0·25W 5% carbon film

See SHOP TALK Page

Semiconductors

CSR1 to CSR4	C106D 400V 5A thyristor (4 off)
D1, D3, D5, D7	1N4148 silicon signal diode (4 off)
D2, D4, D6, D8	10mm red l.e.d. (4 off)

Miscellaneous

S1 to S4	push-to-make, momentary action switch (4 off)
S5	push-to-break momentary action switch
S6	s.p.s.t. min. toggle switch
B1	6V battery pack (4 x HP7 size cells in holder)

Metal instrument case or large plastic box, size approx. 200mm x 130mm x 50mm; plastic "potting" box size 73mm x 48mm (4 off); 0·1 inch matrix stripboard having 44 holes by 19 copper strips; 10mm l.e.d. holder (4 off); battery clip; screened audio lead (about 8 metres); 3·5mm jack plug and socket (4 off each – see text); connecting wire; single-sided solder pins; solder, etc.

Approx Cost Guidance Only £20 excluding batteries

TRIGGER SWITCHES

Contestant switches S1 to S4 are mounted in small plastic boxes. "Potting" boxes are a good choice, as these are about the right size, are reasonably tough, and are quite cheap. They have open bases, but this is of no real consequence.

Each switch is mounted centrally in the top panel of its box, and an entrance hole for the connecting cable is drilled in one side of the box. It is not essential to use screened cables to connect the switches to the main unit, but a thin screened audio cable is probably the most practical choice.

Any reasonably thin twin-cable should be satisfactory though. If necessary, the connecting cables can be several metres long.

JACK IN THE BOX

The rear panel of the master case can be drilled with four entrance holes for the leads from the pushbutton switches, with the leads then being connected direct to the component board. If the case is a metal type the holes should be fitted with grommets to protect the cables.

A neater method is to link the Contestant switches to the circuit board via four plugs and sockets, such as 3·5mm jack plugs and sockets. This makes it easier to set up the equipment, and to store it away when it is not in use, and gives reduced risk of getting the cables into a major tangle. The drawback of this method is that the plugs and sockets will increase the cost of the project by a few pounds.

If you use open style jack sockets and a *metal* case, remember that the earth (ring) tags of the sockets will be connected together via the case. It is then only necessary to connect the earth tag of *one* socket to the anodes of D1, D3, D5, and D7, using a single lead to the stripboard (*L*44) – see photograph. The "tip" tags connect to resistors R1, R5, R8, and R11.

With *insulated* sockets, both switch leads from the board must be connected to *each* socket, and it does not matter which way round each pair of leads is connected.

IN USE

After a final check of the wiring, switch on and check that each pushbutton switch will operate its l.e.d., and that once an l.e.d. is activated the other l.e.d.s are blocked. It is just possible that one of the pushbutton switches will fail to operate its l.e.d. due to an inadequate gate current to the relevant thyristor (s.c.r.).

Lowering the value of the 33 kilohm (33k) gate (g) feed resistor for that stage should cure the problem. For instance, if l.e.d. D6 fails to light or is reluctant to do so, reduce the value of resistor R8 to about 15k (kilohms). □

INTERFACE

Robert Penfold

1Hz to 32kHz FREQUENCY METER INTERFACE

THE PREVIOUS *Interface* article featured a three range Digital Audio Frequency Meter Interface for PCs, and in this article we continue with an improved, single range Frequency Meter Interface that covers frequencies from one Hertz to 32767 Hertz (32·767kHz). In some respects this circuit is similar to the one described previously, but the gate pulse is generated using software timing and an output line of the printer port, rather than via a monostable.

Only one range is provided, but by using a 16-bit counter this covers slightly more than the full audio range. The accuracy obtained does not equal that of a digital frequency meter (d.f.m.) having crystal controlled timing, but the accuracy compares well with that of analogue frequency meters. It is more than adequate for many purposes.

Doubling Up

Like its predecessor, this unit requires a PC equipped with a bi-directional printer port so that the eight data lines can be used as inputs. In this case we actually require 16 data inputs to read the counter, but it is not difficult to double the number of input lines using some additional hardware.

The circuit diagram of Fig.1 provides the required 16 into eight multiplexing. IC2 and IC3 are octal tristate buffers which have their outputs connected to the computer's data inputs via resistors R1 to R8. These are needed to provide current limiting before the printer port is set up for bi-directional operation, when the data lines will operate in the output mode by default.

The tristate buffers are controlled from the auto line-feed output of the printer port, but IC2 is controlled via an inverter (IC1). A high control signal therefore connects the least significant byte through to the printer port, and a low control signal couples the most significant byte through to the port.

Signal Processing

Signal processing and gate stages of the circuit are shown in Fig.2, and are virtually identical to those used in the original design. The only difference is that the monostable has been omitted, and the gate (IC4a) is controlled direct from the strobe output of the printer port. A minimum input level of about 150mV r.m.s. is needed to operate the trigger circuit, and the input impedance of the circuit is 250 kilohms.

A 16-bit binary counter is provided by three 4024BE seven stage counters (see Fig. 3) wired in series to provide what is actually a 21-stage counter. However, only the first 17 stages are actually utilized, with the first 16 of these being read via the circuit of Fig.1.

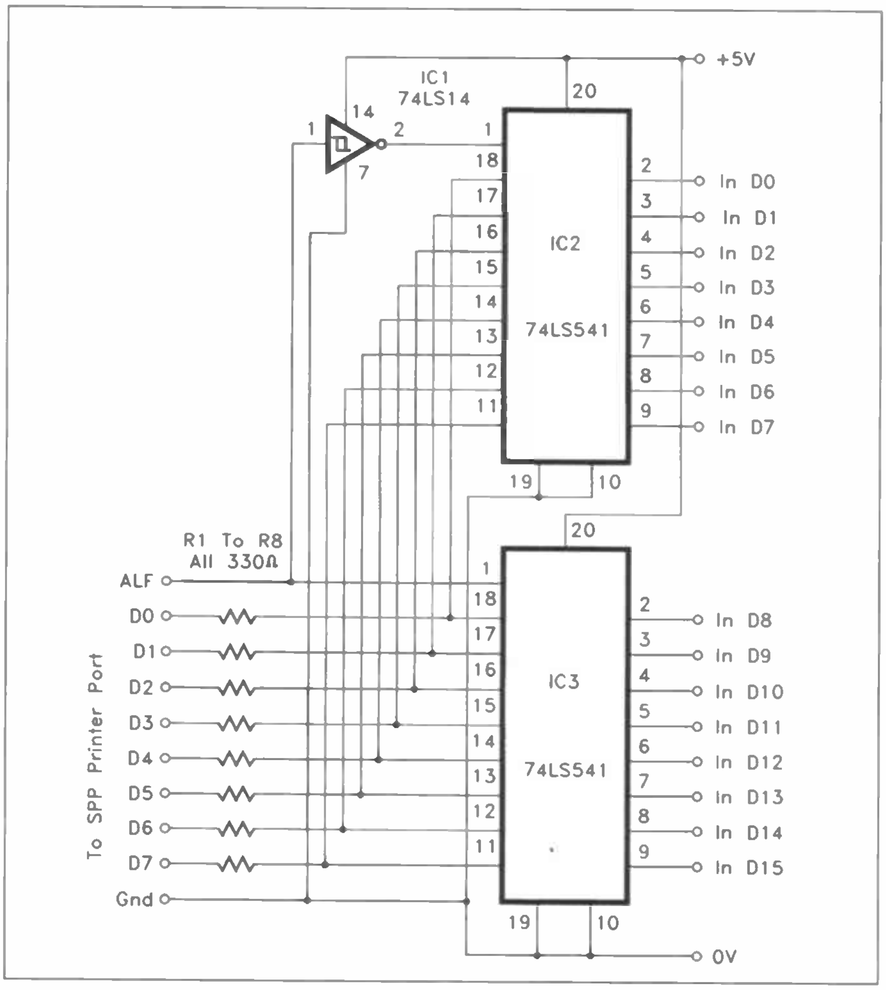


Fig. 1. Circuit diagram for the 16-bit input port section.

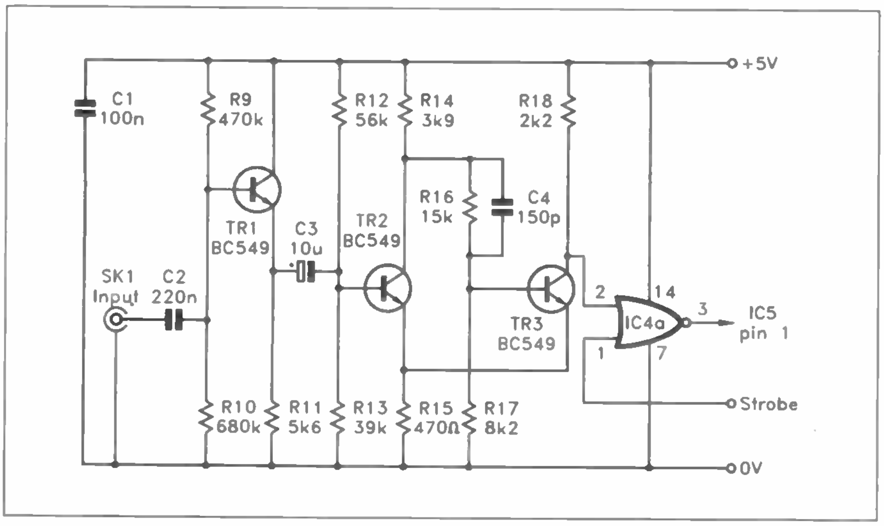


Fig.2. Circuit diagram for the signal processing and gate stages.

The 17th stage is used to provide an overflow warning. If an overflow occurs, the 17th output goes high and sets the simple latch based on IC4b and IC4c. The output of the latch is monitored via the Busy handshake input of the printer port. The Initialise output of the port is used to reset the counter and the latch before a reading is taken.

Listing 1: Frequency Meter Program (GW BASIC)

```
10 REM AUDIO FREQUENCY
   METER PROGRAM
20 REM FOR PC WITH
   BIDIRECTIONAL
   PRINTER PORT
30 CLS
40 OUT &H37A,32
50 OUT &H37A,36
60 OUT &H37A,32
70 T = TIMER + 2
80 OUT &H37A,33
90 IF TIMER < T GOTO 90
100 OUT &H37A,32
110 IF (INP(&H379)) <
    128 THEN GOTO 230
120 LOCATE 5,30
130 LB = INP(&H378)
140 OUT &H37A,34
150 HB = INP(&H378)
160 HB = HB * 256
170 F = LB + HB
180 F = F/2
190 F = F * .99
200 F = F\1
210 PRINT F "HERTZ"
220 GOTO 40
230 LOCATE 5,30
240 PRINT "OVERLOAD        "
250 GOTO 40
```

Connecting Up

Connection details for the printer port are provided in Fig.4. Connections to the port are made by way of a male 25-pin D-type connector.

Of course, the Frequency Meter interface should work with any eight-bit input port that can also provide two handshake outputs and one input. However, the software will obviously require a substantial amount of modification if a different input port is used.

Software

The very simple GW BASIC listing provided here is all that is needed in order to get the system functioning correctly. This program requires the Interface to be connected to printer port one (LPT1:), but it should work just as well with port two if the port addresses are amended accordingly.

The first step when taking a reading is to set the printer port to the input mode and to reset the counter. This is the purpose of lines 40 to 60. A gate pulse must then be generated, and the pulse length used has to be something of a compromise. The timing of the pulse is handled by the GW BASIC TIMER function, which has a resolution of 10 milliseconds.

In order to obtain good accuracy it is necessary to use a fairly long gate pulse, but a really long gate time is undesirable as readings would be taken at a very slow rate. It would also limit the unit to a rather low maximum input frequency.

A gate period of two seconds is a good compromise which gives reasonably frequent readings together with an accuracy which will normally be within one percent. All the TIMER function does is to return the number of seconds that have elapsed since midnight.

The timer is read at line 70, the returned value is then incremented by two, and the result placed in variable "T." Line 80 "opens" the gate, and line 100 "closes" it again. In between these, line 90 provides the two second delay by looping until the value returned by the TIMER function is greater than the value stored in variable "T".

The input port is read at lines 130 to 150, and the two eight-bit bytes are placed in variables "LB" and "HB", which contain the least and most significant bytes. The two bytes are merged into a single 16-bit value by multiplying "HB" by 256 and then adding this value to "LB."

As the gate period is two seconds rather than one second, the value from the port is divided by two in order to obtain the frequency in Hertz. The gate period will actually be slightly more than two seconds because it takes a short while for the computer to terminate the gate pulse once the timing loop has been completed.

With something like a 200MHz Pentium PC the error this produces is likely to be so small as to be insignificant. With a slower computer such as a 75MHz Pentium machine the measured frequency might be as much as one per cent higher than the actual input frequency.

Line 190 is used to reduce the value read from the interface by one per cent, and line 200 then strips off any decimals.

If you are using a suitably fast computer, line 200 should obviously be omitted from the program.

On Screen

At line 210 the frequency is printed on the screen, and the program is then looped back to line 40 where a new reading is taken. The program loops indefinitely taking a stream of readings until it is halted from the keyboard with the usual CONTROL-BREAK combination.

On each loop of the program the output of the overflow latch is read at line 110. If an overload of the counter is detected the program is branched to line 230, and a warning is then printed on the screen before the program branches back to the beginning and tries to take a fresh reading.

The system provides very accurate results at low and middle audio frequencies, but at higher frequencies the resolution of the system is inadequate to give results that will stay perfectly in step with a high quality digital frequency meter. It would presumably be possible to obtain highly accurate results by using a machine code routine to handle the gate pulse timing. This is certainly something that will be looked into in the future.

It should also be possible to extend the operating frequency range upwards using normal prescaler techniques. For example, a divided-by-10 circuit added at the output of the gate would provide a maximum input frequency of 327·68kHz with a resolution of 10Hz.

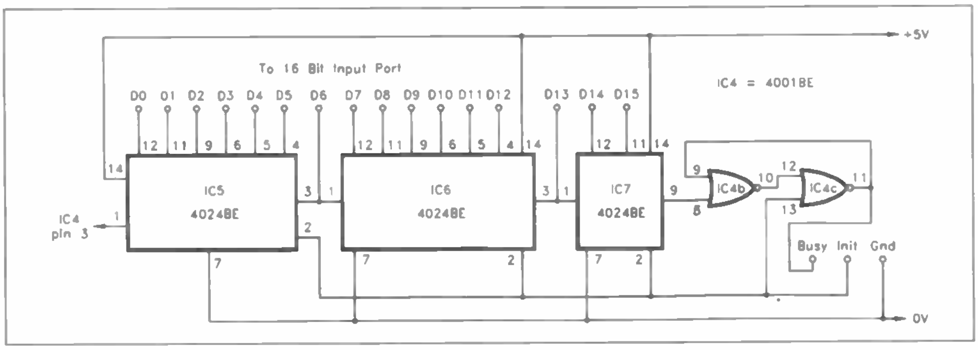


Fig.3. Counter and overflow latch stages. Five outputs of IC7 are left unused.

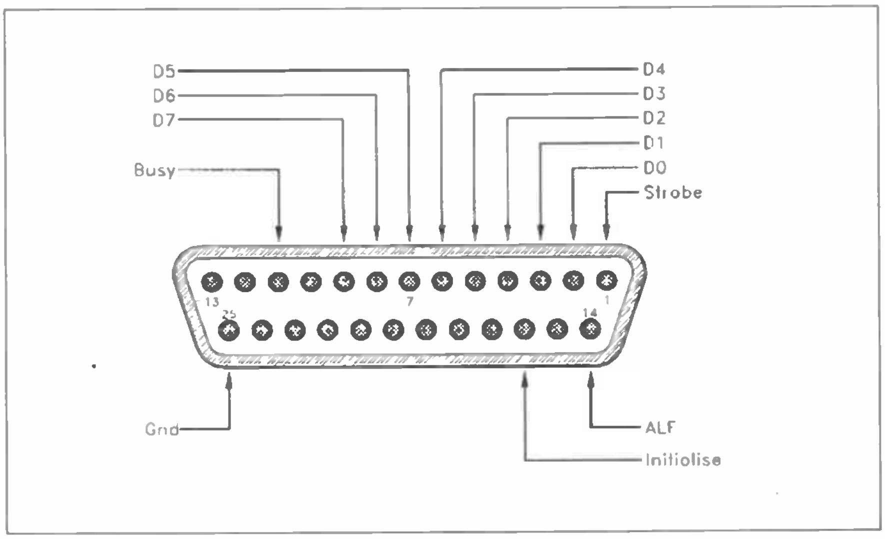
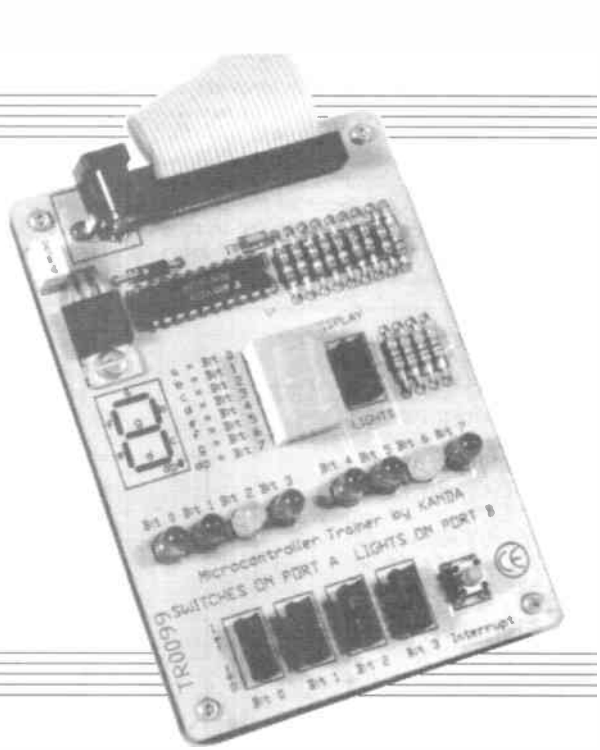


Fig.4. Connection details for the printer port. Connections are made via a 25-pin male D-type connector.

Special Review

KANDA PIC EXPLORER REVIEW

ROBERT PENFOLD



Reviewing a versatile PIC microcontroller teaching aid having program emulation and hardware support.

ANYONE involved in electronic project construction could hardly have failed to notice the impact of PIC processors in recent years. They enable complex tasks to be undertaken using what in most cases is a minimal amount of hardware. The complexities are handled by software routines rather than in hardware, which usually provides a large saving in cost.

The problem for "wannabe" PIC designers is that there are a lot of specifics to learn, even if you are familiar with microprocessor techniques and electronic circuit design. If you are familiar with electronics but do not understand the principles of microprocessors, mastering PIC project design is that much more difficult.

The Kanda PIC Explorer is an educational system which is designed to enable someone with no previous experience of microprocessors to learn PIC programming. There are three parts to the system, which are the PC software, the manuals, and some simple electronics.

The software enables programs to be typed into a simple text editor, assembled, and then run on a simulator which is not wholly implemented in software. Instead, the hardware "pretends" to be a simple PIC based system complete with switches and two types of l.e.d. display.

On the face of it, the hardware is superfluous and the simulation could be carried out using software alone. A simulation which uses both software and hardware is no less of a simulation than one that is implemented solely in software. The Explorer system does not include a PIC processor in the hardware, and it is just using software plus some simple input and output ports to simulate a PIC processor.

Nevertheless, a simulation which includes some hardware is somehow rather more believable than one which relies on simulated l.e.d.s and switches. For someone who is familiar with electronic hardware, it is perhaps easier to relate to a system which has real components at the input and output than it is to one which is wholly simulated. The hardware gives the system less of a credibility-gap.

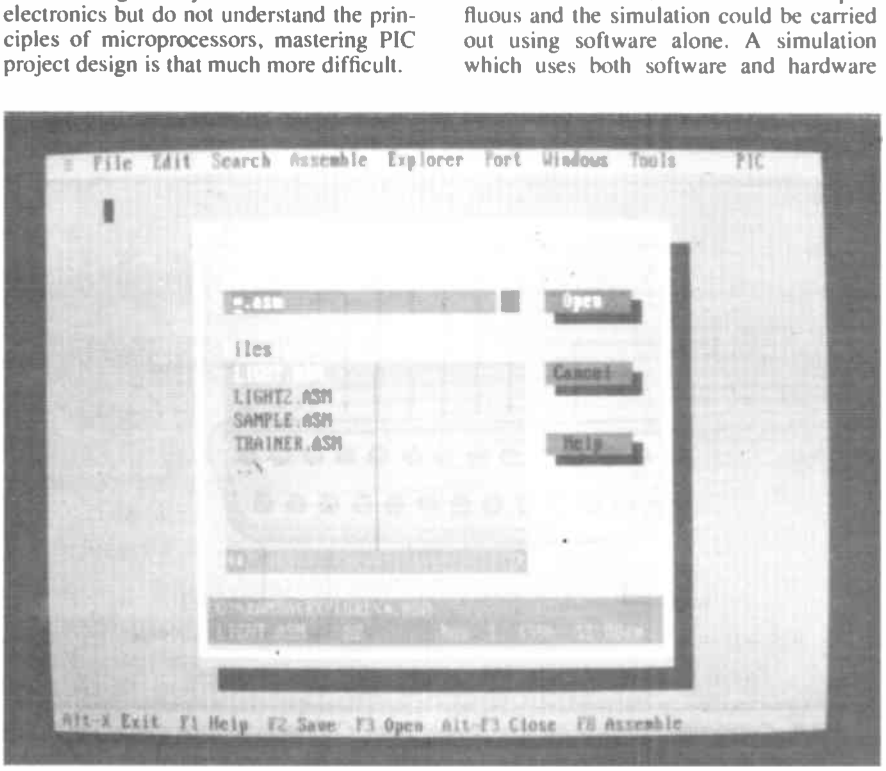
PROOF OF THE PUDDING

The hardware consists of a small board (see heading photograph) which is connected to a printer port of the PC via the cable supplied. Software configuration enables the hardware to be used on printer port one, two, or three. Power for the board is provided by a battery eliminator style mains power supply unit.

Software is supplied on a single 3·5 inch high density floppy disk, and it is easily installed on the PC where it runs under MS/DOS and not under Windows. However, I tried running the program in an MS/DOS window under Windows 95 and this did not seem to give any problems.

When you initially run the program, you are taken into the text editor. This has a simple Windows style interface with the usual pull-down menus, and there are keyboard short cuts to all the facilities. All aspects of the software utilize this pseudo Windows user-interface.

The "Tools" menu gives access to some simple utilities, such as a calculator, and an ASCII table. Although it is quite basic, the text editor is perfectly adequate for its intended purpose. Once you have completed a program listing it can be assembled by simply selecting the "Assemble" option from the pull-down menus.



Left: The file requester is one of the numerous Windows-style features.

The software uses a pseudo-Windows style interface, but it runs under MS/DOS.

If a line of the listing cannot be assembled it is highlighted and a suitable error message is provided. Once the error has been corrected, the assembler can be run again, and a fresh attempt can be made at assembling the listing.

Currently, there are several PIC processors to choose from, and they are not fully hardware or software compatible. The Kanda Explorer mimics the 16C71 and the largely similar 16C84. These are two of the more simple PIC processors, and are a good choice for training purposes.

EXPLORATION

The assembled program can be run by selecting the "Explorer" option in the pull-down menus. Of course, the fact that the program is assembled properly does not mean that it will necessarily give the desired result when it is run. It is a matter of checking the response of the hardware to see if the program is operating exactly as expected.

In addition to the l.e.d. displays, on-screen representation of the processor's registers enable the progress of programs to be followed in detail. The registers are not updated in the normal "Run" mode, and everything would presumably happen too fast for this to be of much use.

The program can be moved forwards or backwards one step at a time by pressing the spacebar and backspace key respectively. Holding down the spacebar gives free running operation at greatly reduced speed. Of course, even in the normal "Run" mode the simulation runs much slower than the real thing, and this has to be taken into account in timing loops, etc.

Everything seems to work as expected, and the only slight criticism is that the screen sometimes flashes slightly, due to large parts of the screen being updated, rather than just the relevant figures.

The circuit board is very neat and nicely made. It has a rear casing which ensures that the wires on the rear of the board do not damage the work-top. Input is via four slider switches, and output signals are monitored via two l.e.d. displays. One of these is a 7-segment type, and the other consists of two rows of individual l.e.d.s of three different colours – see heading photograph. However, only one or other of the displays can be driven at once, and a slider switch is used to select the required display.

There is a pushbutton switch that can be used to generate interrupts. The switches drive the PIC's Port A and the l.e.d.s are driven from Port B. Helpfully, an overlay on the board indicates which bit of each port connects to each switch and l.e.d.

MANUALS

Obviously the manuals are an important part of a training system such as this. The A4 size reference manual is about 60 pages long and contains plenty of technical information about PIC processors. The topics covered include a description of the complete instruction set, details of the registers, clock circuits, and a useful glossary.

It should be borne in mind that the purpose of this system is to teach you about PIC programming, and not to give the user a course in basic electronics. A reasonable knowledge of electronics in needed to obtain the maximum benefit from this system. Otherwise you end up as an expert at programming processors, but will be unable to design the circuits in which the programmed chips can be used. The technical manual covers some hardware basics, but it is not aimed at complete beginners.

TUTORIALS

The second manual is an introduction to numbering systems and logic, but it is effectively a set of tutorials which take you through the process of setting up the system and programming it.

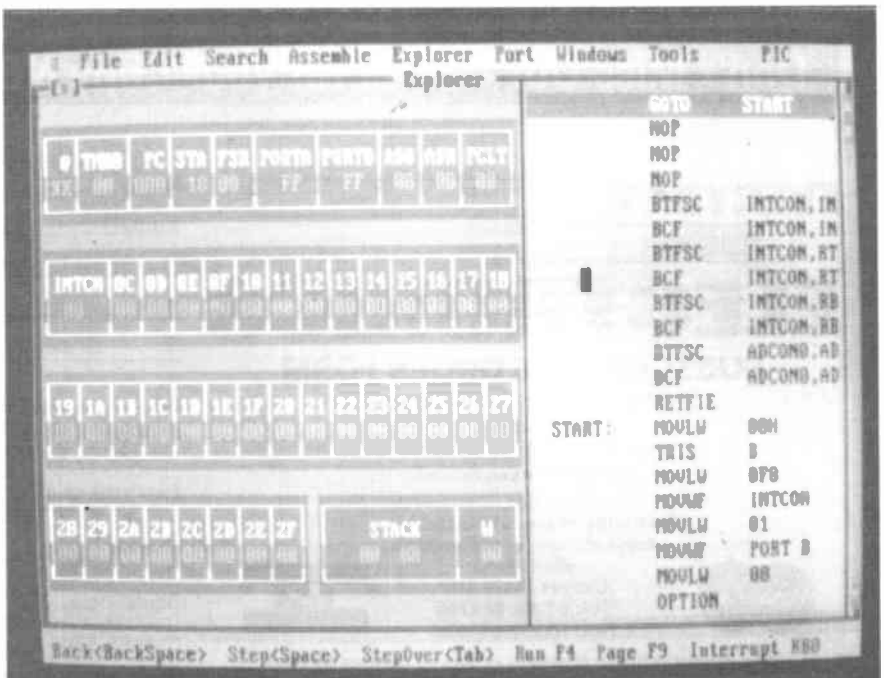
This more substantial A4 manual covers a lot of ground. It is divided into four "blocks", and the first of these covers numbering systems. This section also includes "bitwise" operations and masking.

The second section provides details of setting up and using the system, followed by some basic information about the internal arrangement of PIC processors. It then progresses to basic programming techniques such as loops and jumps.

This section also covers such things as timers, interrupts, addressing modes, and subroutines. Simple demonstration programs are provided, and you are encouraged to modify these and write your own routines. For example, if the supplied program produces a "moving" lights display, you have the task of making the lights "move" in the opposite direction.

The remaining two sections of the manual provide more information on using the switches and displays, analogue-to-digital conversion, and generally look beyond the PIC processor itself.

This main manual was not quite finished when the system was reviewed, but as



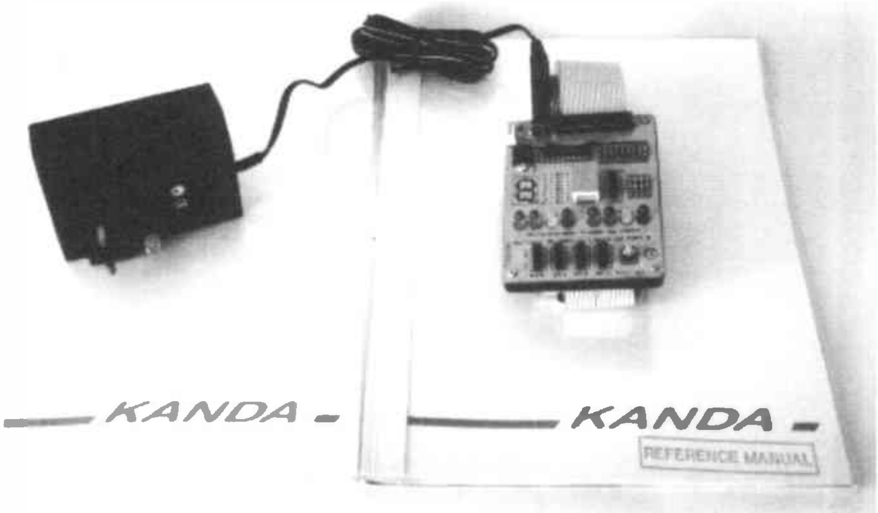
The PIC registers (left) are updated as the program is stepped through each line of the program (right).

received it seem to be well written and covers all the essentials. The plain English approach is adopted, with no talking down to the reader, or sections that do a good imitation of a scientific paper. It does not contain the common mistake of confusing the user by introducing difficult subjects before they are really needed. Subjects like interrupts, for example, are introduced as and when necessary.

Provided you have a reasonably technical turn of mind and are prepared to put in a certain amount of effort, you should be a reasonably proficient PIC programmer once you have completed the tutorials and put in some time studying the technical reference manual.

One slight problem with the manuals is that the information on setting-up and using the system is buried away in the middle of the main manual. It would be useful to have a small "Getting Started" manual, which could also give an overview of the software.

Apart from making it easier to get everything up and running, it would also be useful for reference purposes. As things stand, this information is probably all contained in the main manual, but it is scattered around and can be difficult to find.



The Kanda PIC Explorer is powered by a mains-derived d.c. power supply.

CONCLUSION

I suppose there is nothing particularly novel about this system, but it is very businesslike, and what it does it does well. Its potential as a development system is strictly limited, but I suppose it could be used as an aid to developing some simple projects.

As a learning tool it works very well, and I certainly found it useful in my quest to get into projects based on PIC processors. The cost may seem a bit high to some home users, but compared to other microprocessor training systems it represents quite good value for money.

The system includes the circuit board, software, manuals, power supply, and PC printer lead. No minimum requirements are given for the host PC, but the review system ran acceptably on an 80386 based PC.

The Kanda PIC Explorer system costs £99·00 plus VAT (but including postage and packing). It is available from Kanda Systems Ltd., Dept. *EPE*, Unit 11 Glanyravon Industrial Park, Aberystwyth, SY23 9ZZ. Tel: 01974 282570.

SHOP TALK
with David Barrington

PIC Water Descaler

If you are contemplating ordering the individual parts listed for the pot-core output matching transformer, called for in the *PIC Water Descaler* project, it could work out quite expensive as you may need to approach more than one supplier. Also, we understand, some parts may now be discontinued.

However, **Magenta Electronics** are offering the ferrite transformer as a complete kit for the sum of £4.80, plus their usual £3 post & packing charge. They are also able to supply a ready-programmed PIC 12C508 for just £6.50. Not having come across the ZM33064A 4·6V reset generator chip before, we suggest that this is ordered from the same source.

A complete kit of parts, including case and p.c.b., has been put together by Magenta for the sum of £22.95, plus £3 post & packing charge. They are also offering a plug-top mains adaptor for **£3.99. For full details contact Magenta (☎ *01283 565435*)** or E-mail: **Magenta_Electronics@compuserve.com**

The printed circuit board is available from the *EPE PCB Service*, code 170 (see page 723). For readers who wish to do their own programming, the software listing is available on a 3·5in disk from the Editorial Office, see PCB Service page 723 for details. If you are an Internet user, it can be found, *Free*, at our FTP site: **ftp://ftp.epemag.wimborne.co.uk/pub/PICS/PICdescaler**

Remote Control Finder

A couple of items will need attention when completing the line-up of components for the *Remote Control Finder* project. The main cause for concern will be the UM3763 "custom" whistle switch i.c.

This particular chip, which was originally designed for toys and eventually found its way into self-locating key fobs, has long since disappeared from the marketplace and is no longer listed by any of our advertisers.

Fortunately, the author purchased large quantities in the early stages and still has stocks which he is able to offer to readers. The UM3763 is available (*mail order only*) from Bart Trepak for the sum of £4.50 all inclusive. (Overseas readers must add £2 for post & packing).

Orders should be send to: **Bart Trepak, 20 The Avenue, London, W13 8PH.** Pay by *£ sterling* cheque or P.O.(allow 28 days for delivery).

The microphone used in the model is an Electret *insert* type and should be found at most component advertisers. The one in the model is an ultra-miniature omni-directional one from **Maplin**, code QY62S. They also stock a sub-min version, code FS43W.

The sounder WD1 is a miniature low-profile piezoelectric type, chosen for its physical size and low operating current and voltage needs. This should be readily available; the one in the model came from Maplin, code KU57M.

The printed circuit board is available from the *EPE PCB Service*, code 168.

Rechargeable Handlamp

Apart from the lantern type handlamp, the second most expensive item in the *Rechargeable Handlamp* project is the lead-acid battery.

Ranging from about 1Ah to over 30Ah, the price of these non-spill, maintenance free, batteries runs from just over £8 up to £80 plus. However, looking down the **Bull Electrical (☎*01273 203500*)** advertisement, we see that they are offering lead-acid batteries at truly knockdown prices and are certainly worth further investigation.

The printed circuit board is available from the *EPE PCB Service*, code 169. Finally, it is most important that the **Warning** notes, in bold type, set out in the article are read carefully and care is taken when building this project.

Multi-Station Quiz Monitor

No problems should be encountered by those wishing to undertake the *Multi-Station Quiz Monitor* as all components should be readily available from our component advertisers.

The large "jumbo" 10mm l.e.d.s are now fairly widely stocked, in fact, the advertiser below certainly carries supplies. Steer clear of the ultra-bright variety as they tend to produce a narrow beam and the viewing angle is restricted. Do not forget to specify a "push-to-*break*" type for the Master Reset switch S5.

Noughts & Crosses Game *(Sept. '96)*

In our round-up of component buying last month, we omitted the information on purchasing the software listing for those people who wished to program their own PIC micro for the *Noughts & Crosses Game*. This is available on a 3·5in disk from the Editorial Offices, see page 723 for details. Alternatively, the listing can be downloaded free from our Internet FTP site: **ftp://ftp.epemag.wimborne.co.uk/pub/PICS/PICnoughts**

READOUT

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

OUT BESPOKEN

Dear EPE,

It seems that one of the laments of some hobbyists is that with so much sophisticated equipment around nowadays, there is less need for home construction.

I believe the reverse is the case; I have come across such appallingly manufactured items that there is now a great need for home built items. The p.c.b.s I've come across are dreadful: try to remove components and it is likely that the tracks will lift and the p.c.b. will be destroyed. The tracks are so thin that I believe it is fraudulent to market such stuff.

Another bad thing is the use of bespoke i.c.s rather than using standard chips. No retailer seems to stock these bespoke i.c.s. If I had the time, I would scrap the p.c.b.s in some commercial equipment and replace them with boards I'd made myself.

Jack Treeby, Plymouth

You don't say whether or not you are having to service equipment that uses the i.c.s and boards you refer to. Somehow, though, I think you are more likely to be an enterprising individual who likes to repair equipment yourself, rather than pay someone else to do it. Full marks to you if this is so.

You are up against commercial realities, however. The only way in which the manufacturers of modern electronic equipment can keep their costs down and be profitable in a cut-throat market, is to use the techniques which you have encountered.

It is far cheaper, for example, for a manufacturer to have as much of the circuitry as possible encapsulated in a single i.c. than it is to use many i.c.s to do the same job. Inevitably, this means that because each equipment manufacturer's circuits will be different, then so will their "bespoke" i.c.s.

The p.c.b.s are also going to be manufactured with production costs in mind. Again, it is cheaper to have as many components packed into a small area as possible. Automated equipment is then likely to be used to assemble the board. When you are aiming at a large market, the use of people to do the assembly is work is, generally speaking, unrealistic. Machinery can do the job faster and work within more confined restrictions than can most humans.

An additional factor comes into play as well. At the very high speeds at which so much modern equipment needs to operate, track lengths between components have to be kept to a minimum, as do track widths. There is a finite time that electrical current takes to move from one point of a circuit to another, it is not instantaneous. The shorter the distance that has to be travelled, the faster the operation can be performed.

As fast as it may seem to us that electricity can travel, in terms of electronic equipment, seemingly small distances and delays become significant. Not only that, the faster equipment runs, the greater the energy expended. Electrical energy doesn't just disappear, it is converted into other forms of energy, heat for example. If track distances can be kept down, their resistances are lowered and thus there is less energy loss through heating of the tracks.

Which brings us back to i.c.s again. Exactly the same considerations apply to the connections between components of an i.c. The more you can cram into a given space, the faster the circuit can operate and with the least wasteful use of electrical energy.

Certainly all this miniaturisation makes home servicing of modern electronic equipment extremely problematic. But then, the manufacturer does not intend his equipment to be taken apart in the user's workshed. He appoints service engineers to do the job. Such engineers have been trained in the techniques required to cope with this type of equipment. They will have the special tools required, and access to the manufacturer's stock of specialised i.c.s. Quite naturally, the manufacturer will not want to have his equipment serviced by those who are not suitably equipped and trained. Any arising faulty work would bring his equipment into disrepute. Consequently, it is highly unlikely that he would permit his specialised i.c.s to become available on the open market.

If we want modern high tech equipment, the penalty to be paid by people such as yourself (and myself), who used to enjoy repairing faulty equipment in the days when it was simple, is that we can no longer do so and have to take it to a specialist if it goes wrong.

However, there is nothing to stop the really enterprising individual from become trained in modern repair techniques and investing in equipment which will allow him to cope with bespoke surface mount devices, multi-layered p.c.b.s. and astonishingly narrow tracks. Indeed a sister publication to EPE *is aimed at just such people, the* Electronic Service Manual. *But, of course, financial realities mean that investment in expensive equipment requires that it makes money for the investor, who then has to cease being an amateur and become a fully operational service engineer. Full circle!* **JB**

ORIGINALITY

We are sure that most of you know that, with very rare exceptions, we only publish articles and projects that have not been published elsewhere. For us to publish material that has been published elsewhere could breach the other publisher's copyright, unless his permission has been granted. Any material that we have published cannot be published elsewhere without our permission.

Yet again (and it's distressingly not-uncommon) we have been offered a project for inclusion in the *Ingenuity Unlimited* pages which has blatantly been extracted from another magazine. The material's sender simply photocopied the magazine page, cut it to size and sent to us. This, despite the clear statement on the *I.U.* pages that material submitted *must* be the reader's own work. Contributors are also required to sign a legally binding statement that the material they have submitted is their own work. Photocopying, cutting and stuffing in an envelope does not count as *work* in this context. **JB**

DISCRETE SHORTS

Dear EPE

I agree with P. Price (Current Shorts, May '97) – simple circuits can be challenging and instructive to the (voluntarily) unsophisticated in this field. Possibly both discrete and i.c. equivalents could be included in a magazine article.

J. Stuart, Edinburgh

Such treatment could be given through some of our "tutorial" columns, examining the pros and cons of different design philosophies and their technical implementations (Alan W. and Robert P. – any thoughts?). It is not something that could feature as part of a specific constructional project, though. Usually, these must be self-contained with as few constructional options as possible, such choices being potentially confusing to novices. **JB**

REVERSE LOGGING

Dear EPE,

Thank you for passing on a reader's comment on the availability of reverse log pots for my *Universal Input Amplifier*, Aug '97. Apparently ElectroValue has stocked them for years! It seems that "if you're not sure if a fact is true, put it in print and you'll soon find out"!

Also, in fact, Farnell Electronic Components has recently started distributing a very nice range of miniature pots which includes reverse log versions.

It is interesting to consider what I would have done if I had known of the availability of these earlier. I might have used the excellent Analog Devices SSM2017 mic amp i.c., configuring it exactly as shown in its data sheet. It costs a fair bit more though, around £3·38 compared to around 65p for the 5532 used in the project. Also, the pot the I used is more easily obtainable. So I believe that I ended up in the right place, although possibly by the long route.

Andy Millar, Callington, Cornwall.

Thanks Andy. Readers, ElectroValue's phone number is 01784 433604; Farnell's is 0113 263 6311. **JB**

STILL PER*SIOUX*ING EPE!

Dear EPE,

I have been a fairly consistent subscriber to *EPE* for over 20 years and I am pleased to say that my loyalty stems from the fact that it is undoubtedly the *best* electronics magazine around. Not only has the format kept pace with technology, but I always appreciate the careful mixture of projects in the same issue, ranging from simple to professional.

Added to this, of course, are the regular *Teach-In* series that have certainly helped me to grasp some of the fundamental principles of electronics. Also, having subscribed for a long time, it is easy to go back to old issues and revisit the earlier projects. But, I think that the strength of *EPE* is the way in which new technologies are used in a very practical way.

I look forward to each issue with eager anticipation. I like the Web site too, but you can't read that very easily in bed! (Although I anticipate that it will not be long before I can eat those words.)

Barry G. Timms Ph.D, Vermillion,
South Dakota, USA

The above is just an extract from a very long and interesting letter from Barry via the Net. He gave many examples of the circuits which he has built over the years, and also Webbed down to us a digitally captured image of the original Continuity Tester *which he built in the '70s. Great stuff, Barry, we're pleased to hear from you. Dakota is Sioux Indian territory, isn't it?*

You will all be interested to know that Teach-In 98 *starts in the November issue.* **JB**

SING MY SONG

Dear EPE,

Wow! I read with interest your reply to Eric Goodley's letter ("Railway Shorts") in your August '97 issue. Big projects is what I've been waiting for, for God knows how long.

I am seriously into music, how about a big powerful superb quality guitar amp and effects pedals (not just simple distortion), and what about a machine I've been trying to build for years: a piece of electronics that I could put between my mic and amp to measure the frequency of the notes I am singing and to correct them as necessary? Plus, a *very* serious request – I would love to tackle a portable studio (say 8-track) to record the songs I write so as to save hundreds, if not thousands, of pounds in commercial recording studios.

One final comment: I don't own a computer, I can't afford one, so please keep to electronics without software. Many of your projects I have wanted to build but don't have the necessary PC.

Paul Ferris, Bristol

If authors care to offer us amps and effects pedals, we would certainly consider them on merit, although it has to be said that the general interest in musical effects is not so powerful as it *was a decade or so ago. Other readers may care to tell us we're wrong on this! We certainly feel, though, that publishing DIY recording studio equipment would be well beyond what most readers would seem to want.*

Frequency measuring your singing is no problem, as our recent PIC-A-Tuner (May '97) proved. The correcting aspect could be problematic, however. Experienced singers put vibrato into their voice at crucial moments in the song. It seems that it would be extremely difficult to write software to determine when a frequency was incorrect due to the effect of the vibrato and when it was unintentionally off-key. That's even before any necessary correction could take place. Then, of course, the human voice is full of harmonics, so filtering/analysis techniques would have be used in order to establish the dominant tone.

However, assuming that such niceties can be assessed in software, the correction technique would not be too hard. Equipment that changes the pitch of any sound has been around for years. Basically, all that is necessary is to digitally record your voice into memory at a fixed rate, and to simultaneously play it back at another rate.

My PE Polywhatsit *of about 10 years ago did just that (your local reference library may be able to track down a copy of the PE issues in which it was published – sorry, but I can't offer you a copy or further advice on it). A problem that arises is that when increasing the pitch, you run out of data, and when lowering the pitch you have to bypass data. There are ways round both situations, but they add to the complexity of the set-up. Theoretically, the playback rate could easily be adjusted automatically once the off-tuneness has been established.*

Regarding our software-based projects, you seem to have overlooked the fact that you don't need a computer in order to build most of them. All of our PIC projects can be built using the pre-programmed chips that are available as stated within the articles and repeated in our Shop Talk *column. If you can do electronics, you can build PIC projects without being concerned by the software that is used with them. It is still true, however, that sometimes we do publish other projects for which the use of a PC-compatible computer is essential.* **JB**

MAJORING IN MUSIC

Dear EPE,

How about publishing a full-scale electronic organ project?

K.G. Hargreaves, Southport, Lancs

Perhaps you could consider publishing a multi-note vibraphone?

G.W. Hodgson, Audlem, Cheshire

These suggestions are the essence of two lengthy and interesting letters. Both ideas would indeed be welcomed by a few other people, and would be an interesting challenge to a designer.

Regrettably, though, the subjects are far too complex to find widespread appeal among EPE *readers. However, although we can't offer help or advice on these ideas, we know a man who might! Or, rather, a man who might be able to put you in touch with others who know about such things.*

That man is Don Bray, Editor pro tem of the Electronic Organ Constructors Society. We have recently heard that the EOCS is still going strong after forty years of existence. It seems possible that some of its members might be able to help. Drop a line to Don, at 34 Etherton Way, Seaford, Sussex BN25 3QB. Tell him we told you to write. **JB**

SOFT APPROACH

Dear EPE,

Congratulations on the excellent *PIC-olo Music Maker* in August '97!

Although I do not intend constructing this project, it was the clear notes on the programming aspects of the PIC16C84 which I liked. I am learning how to program these devices with difficulty and welcomed the clearly annotated code examples. Having the code available on the FTP site is also excellent.

Austin O'Hara, London, via the Net

We know that many people find benefit from reading constructional articles even though they may not wish to build them. We are especially conscious, too, of people's desires to get more heavily into programming their own PICs. We are shortly to start running a series of tutorials on getting going with PICs. In it we shall take a step-by-step approach with worked code examples. **JB**

COMPONENT SOURCES

It is not uncommon for us to be asked if we stock components for our published projects. Some people express the view that it should be just as much part of our service as making p.c.b.s available.

There are two main reasons for us not supplying components, both equally important. Part of a magazine's income comes from advertisers who pay us to publicise the items in which they specialise. If we were to supply the items which these companies advertise, we would be putting ourselves in direct competition with them.

They would not be at all happy about this, and quite likely withdraw their advertising. We would lose revenue, and have to dramatically put up the cover price to compensate.

You, the readers, would then be unhappy and perhaps cease reading *EPE*; and without readers, where would we be? No need to reply in writing!

The second reason is just as fundamental: the sheer magnitude of setting ourselves up as a major kit and component supplier would thoroughly detract us from our principle role, that of being publishers. It it is straightforward for us to send out p.c.b.s from our offices and they don't take up much space or time. But, we are simply not set up to become mail order retailers, nor do we wish to be. We prefer to leave component supply to those who specialise in it. **JB**

OLD DAYS, BARDS AND GATES

Dear EPE,

Firstly, thanks for a great mag! I've been reading *EPE* and its forerunners for around 15 years now and always look forward to reading the latest issue. Thanks for keeping things up to date and not allowing the features and projects to stagnate. Recently I've really enjoyed Steve Knight's *Great Experimenters* series as I've long been fascinated with the history of electricity/electronics.

Myself and colleagues (I work as an electronic engineer in the aviation industry) are always remembering the Good Old Days before microprocessors, PICS and Pentiums were commonplace and seem to agree that a lot of the fun has been lost since the days of lots of discrete components and p.c.b.s from consumer goods, that could be tested and repaired with knowledge and cheap test equipment.

With the huge growth of personal computing and the Internet explosion, the major electronics news seems to be mainly about privacy and hacking issues and what the latest Intel offering will do now.

Am I the only person out here who thinks that we are going too far, too fast for our existing social systems and thinks things would be a lot better if we took a step backwards and think about the benefits a little more before blindly accepting the latest "wonder"?

I am still under 30, not some moaning old fossil who has nothing better to do! I enjoy new technology and stand in awe at where we are today as opposed to even 15 years ago.

Anyway, I've written the following poem, just for a bit of fun, to evoke people's memories of what this hobby seemed to be, back in the dark ages of the 1970s and 1980s!

The Digital Superhighway to Hell

Do you remember the past, that cold wet night,
Not long ago, when we slept without fright?

Round pin plugs and bare nichrome fires,
Porcelain fuses and lead covered wires,

Warmly glowing valves with grid bias resistors,
Slowly replaced with the wonderful transistors.

Phones with bells and cams and switches,
Filament lamps and other such riches!

Strowger exchanges with their click and bang,
The proud engineer's faces as the relays sang.

Cars with points and vacuum advance,
Needle gauges, just read with a glance.

Then along came the i.c.s and digital sound,
Replacing trusted technology in a single bound.

Gone are the lamps and the nixie tube count,
In come the l.e.d.s and chips surface mount.

So where are we going and what have we done
with all the technology, under the sun?

Software and firmware and Pentiums too,
Divide and conquer with instructions too few.

Gigabits per second flow through the Internet,
Farewell secrecy for it's not a safe bet.

Surf through the night, come see my Web page,
But is it all worth it as the hackers rampage!

Untraceable bugs with consequences so dire,
Goodbye to ATC and your fly-by-wire,

The mists are thinning, 2000 problems we see,
How many others, deep in the logic tree?

Naively we wait – a false smile on our face,
Is all this progress or a disaster for our race?

Call me sentimental, even a Luddite,
But let me remember when control was in sight.

How I wish we were back there, that cold wet night,
With just one more chance to get everything right!

P.S. My computer works fine with NAND, XOR and NOR gates, but totally refuses to have anything to do with BILL Gates!

Iain Harrison, Blackburn, Lancs
iain@petshop.demon.co.uk.
http://www.petshop.demon.co.uk

You're flying high there, Iain, but do we hear hints that Julie Andrews should sing it to the tune of "My Favourite Things"? Let Tennyson sum up our outlook:

Forward, forward let us range,
Let the great world spin for ever down
The ringing grooves of change. **JB**

MICROLAB

Dear EPE,

Have you published anything further for the *Microlab* since its last appearance in July '93?

If you haven't, it's a great pity since it was such a versatile and fascinating project. It seems that there may even be quite a few other readers working on their own Microlab projects who might be interested to set up a Microlab Club, swapping ideas and projects. I would be happy to run it!

Malcolm Jackson, Chislehurst, Kent

Regrettably, due to circumstances beyond our control, we were not able to develop any add-ons for Microlab. *However, publication of this letter may inspire like-minded readers to contact you.*

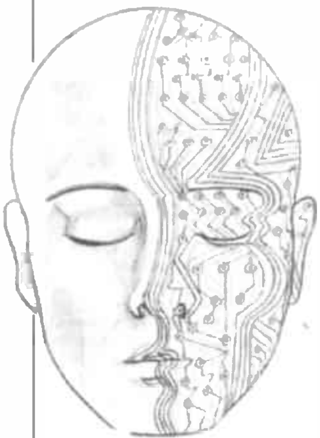
If anyone would like to contact to Malcolm, write him via us at the Editorial office and we will forward your letters. **JB**

THOUGHTS FOR THE MONTH

Our athletic net-surfer Alan W. discovered these gems on the net recently:

★ If at first you don't succeed, destroy all the evidence that you tried.
★ Experience is something you don't get until just after you need it.
★ For every action, there is an equal and opposite criticism.
★ No-one is listening until you make a mistake.
★ Success always occurs in private, and failure in full view.
★ The colder the x-ray table, the more of your body is required on it.
★ The hardness of the butter is proportional to the softness of the bread.

Much of it seems pure Murphy-esque! **JB**



INGENUITY UNLIMITED

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

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

WIN A PICO PC BASED OSCILLOSCOPE

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

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

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

Buffer/Filter for Digital Multimeters - Neater Meter Readings

WHILE making some distortion measurements I noticed that distortion figures worsened if I left a digital multimeter (DMM) switched to its frequency range, connected across the oscillator output. Listening to my meter's input terminals via a 40dB gain amplifier revealed a very "dirty" tone around 500Hz. I reckoned this was adding to the oscillator output, which would explain the apparent worsening of the distortion readings.

As it was annoying to have to keep disconnecting the meter, I incorporated a buffer amplifier and filter into the oscillator, solely to feed the meter. In Fig. 1, IC1 is an op.amp wired as a unity-gain buffer, resistors R1 and R2 being included close to IC1 to provide stability. The buffer has to be fed from the oscillator output *before* any output attenuator (note that there must be a d.c. path to 0V from pin 3 of IC1).

Since a battery-powered meter has no ground reference and "floats", a pseudo-balanced output feeds the output of the buffer via twin screened cable to the front panel sockets (SK1 and SK2) which *must* be fully insulated from any *metal panels*. Inductor coils L1, L2 and capacitors C1, C2 eliminate any h.f. from the meter whilst resistors R3 and R4 in conjunction with the low output impedance of IC1 severely attenuate the low frequency. High audio frequencies from the oscillator are also attenuated but the meter sensitivity is more than sufficient to cope with this. The filter completely resolved the problem.

B. J. Taylor, Rickmansworth, Herts.

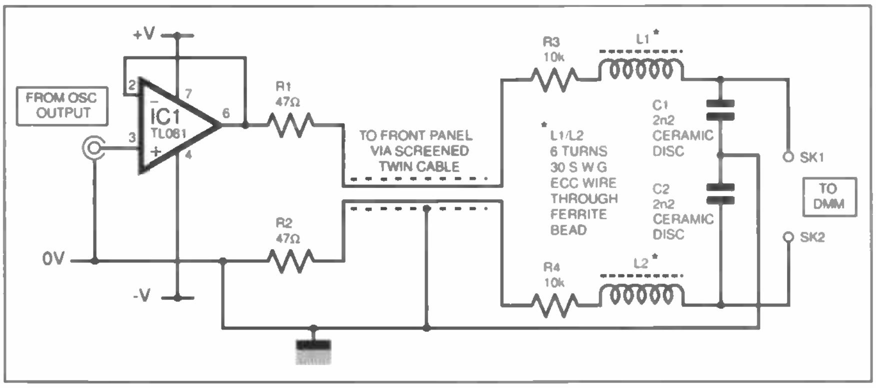


Fig. 1. Circuit diagram for the Buffer/Filter for Digital Multimeters.

Clap-O-Meter – Clap Happy!

DESIGNED as a novelty circuit, the Clap-O-Meter of Fig. 2 will prove handy for anyone organising talent contests, quizzes etc. where the audience applause needs to be measured. The input of the circuit can be potted down from a line-level signal, or from loudspeaker terminals. The sensitivity of the circuit is about 500mV r.m.s.

The circuit uses a miniature transistor output transformer T1, whose secondary remains unconnected. The circuit exhibits a high-pass frequency response due to the presence of the input section and transformer, and it responds mainly to frequencies above 3kHz.

Therefore, applause will register on the circuit whilst speech will not. The resultant signal is averaged out by capacitor C3 so that a steady signal is obtained and displayed on the moving coil meter ME1.

Walter Gray, Farnborough, Hants.

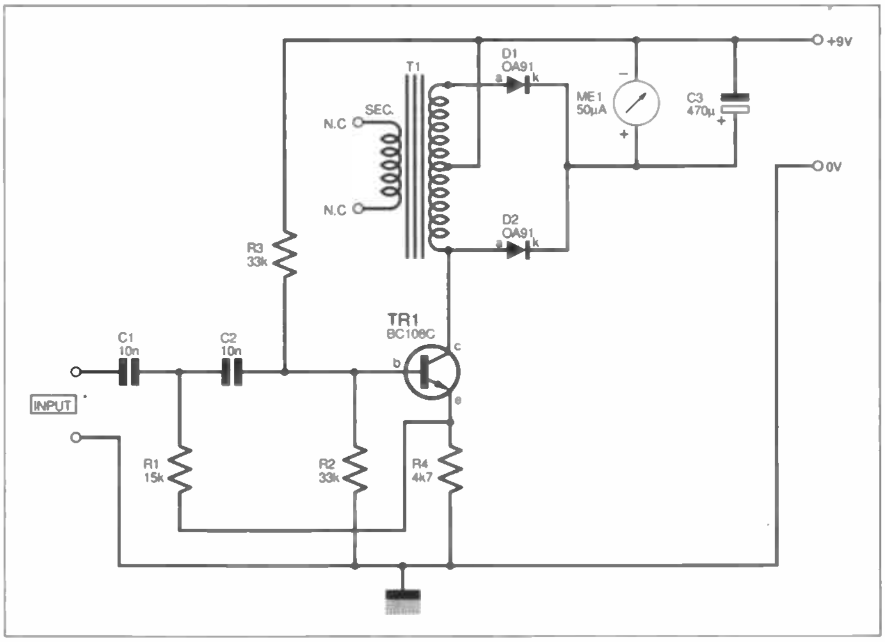


Fig.2. Circuit diagram for the applause Clap-O-Meter.

Lossless Current Sensor – Checks Conduction Angle

THE circuit suggested in Fig. 3 was originally intended to allow current to be measured for capacitor-input filters, without using "lossy" shunts or expensive Hall-effect devices. The circuit as shown is suitable for d.c. power supplies in the range of 12V to 24V d.c., at any output current. It has worked well as a cheap method of providing a high-current battery charger with an ammeter, without needing to interrupt the circuit.

When a capacitor-input filter is operating with a large value capacitor (> 1,000µF per amp at 12V), then the percentage ripple on the unregulated d.c. voltage is small. If we assume a constant d.c. voltage output then the conduction angle of the bridge rectifier will vary according to load – zero at no load, 100 per cent at short-circuit currents. In a practical environment, the conduction angle is roughly 10 to 50 per cent.

Transistors TR1 and TR2 form a pre-amp which is placed across the rectifier network to provide a "level shift" function of the diode conduction, and diode conduction turns the transistors off. Half-wave sensing was used for simplicity. Resistor R4 and capacitor C2 average the square wave conduction pulses whose duty cycle will vary in accordance with the load current. A DVM is connected to the terminals shown, to measure amperes.

The relationship between d.c. load current and DVM meter readings is non-linear and depends on the transformer d.c. resistance. As a rule of thumb, a transformer loaded such that the d.c. output voltage (with large filter capacitor) is equal to the r.m.s. open circuit a.c. output voltage will yield a square wave 100Hz output from the circuit, with a duty cycle of 50 per cent.

The 50 per cent duty cycle will roughly correspond to the full load current rating of the transformer for devices in the 100W class. Above that, 50 per cent conduction angle will be overloading the transformer whilst under 100W, conduction angles of greater that 50 per cent may be thermally permissible.

Gerard La Rooy,
Christchurch, New Zealand.

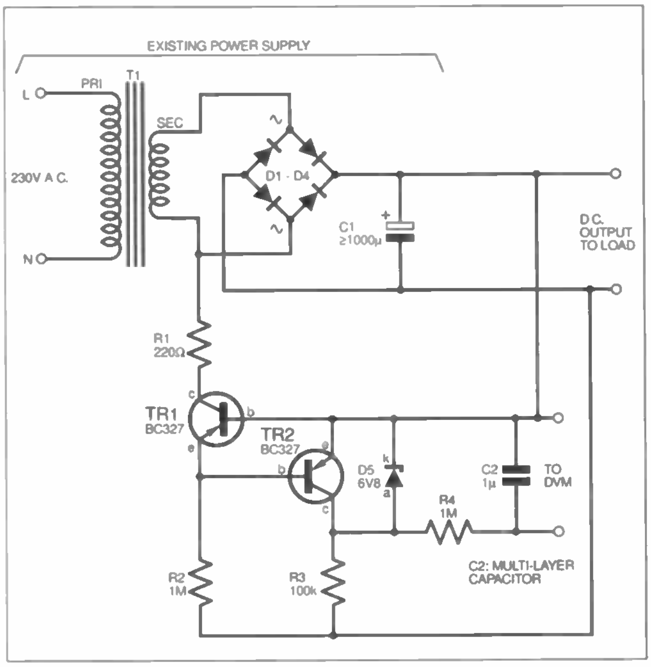


Fig.3. Lossless high-current sensor circuit diagram for 12V to 24V d.c. power supplies.

Alternate-Action Pushswitch – A Cheap Trick!

THIS novel circuit shown in Fig. 4 uses a capacitor as a "memory" element, to facilitate an "alternating" on-off action from an ordinary push-to-make switch. An added bonus is that the capacitor debounces the switch.

The circuit emulates a *pnpn* thyristor junction and provides a viable alternative to the CMOS 4013 when space is tight. Component values are shown for a 12V circuit, and the prototype powered a 30A automotive relay to operate a set of car driving lights.

When power is applied, the switch initialises in the "off" state, and capacitor C1 charges with a 100ms time constant and the voltage across the capacitor stabilises at approximately 10V. Both transistors and the l.e.d. are off, and only a leakage current flows. Closing S1 discharges the capacitor into *npn* transistor TR1 base (b) which turns it on and illuminates the l.e.d., which also pulls TR2 base low and switches the *pnp* transistor on. This completes the circuit to the relay RLA which operates and powers the load.

The regenerative action, due to the partial "thyristor" connection of the transistors, ensures that the circuit stays on when the pushswitch S1 is released. The circuit consumes some 10mA in this state, and the capacitor voltage falls to 100mV because TR1 is saturated.

Closing S1 again momentarily diverts the base drive away from TR1 and into C1, causing the circuit to turn off and stay off, even when the button is released. It can only switch on again when the switch is closed, after the capacitor voltage has settled.

Gerard La Rooy,
Christchurch,
New Zealand.

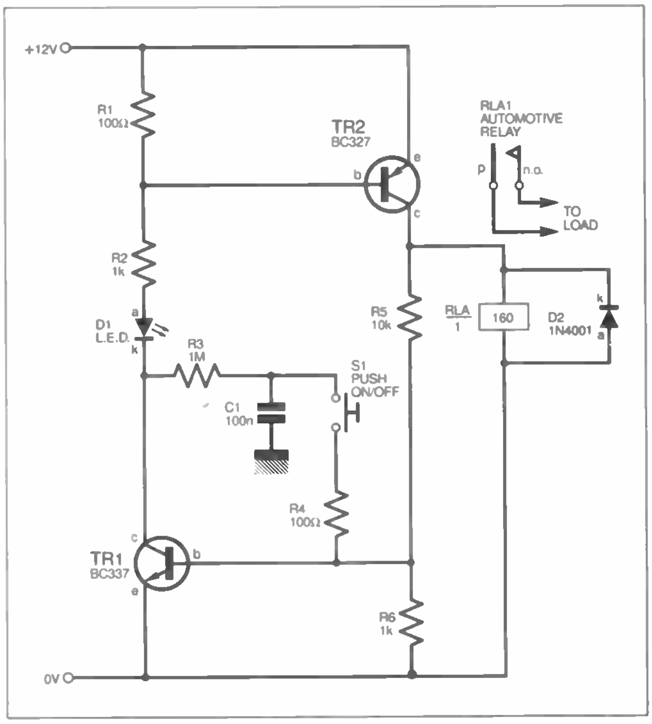


Fig.4. Alternate-action Pushswitch circuit diagram. The relay is a 30A automotive type.

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RECHARGEABLE HANDLAMP

TERRY de VAUX-BALBIRNIE

Save on batteries – make that old handlamp re-chargeable!

MANY people keep a spotlight in the boot of the car or in a cupboard at home. These lamps may give an excellent beam while the batteries are fresh. However, after a period of use, the light becomes yellow and dim.

Eventually a new set of batteries is the only cure. In most lamps, four D-size alkaline cells are used and with these costing around £6, the continuing outlay can prove prohibitive.

WORTHWHILE SAVINGS

This article describes how to convert a battery-operated handlamp to rechargeable operation. It should be noted that if it is to be kept for *emergency use only*, it would probably be better to leave it as it is. The alkaline cells will remain in good condition for a long time and will need no attention.

On the other hand, where the lamp is used more than occasionally, the conversion will be worthwhile and will soon pay for itself in terms of the savings made.

Although this circuit is suitable for a beginner to construct, it is ***essential*** to have access to an accurate voltmeter (digital multitester) to enable it to be correctly adjusted at the setting-up stage.

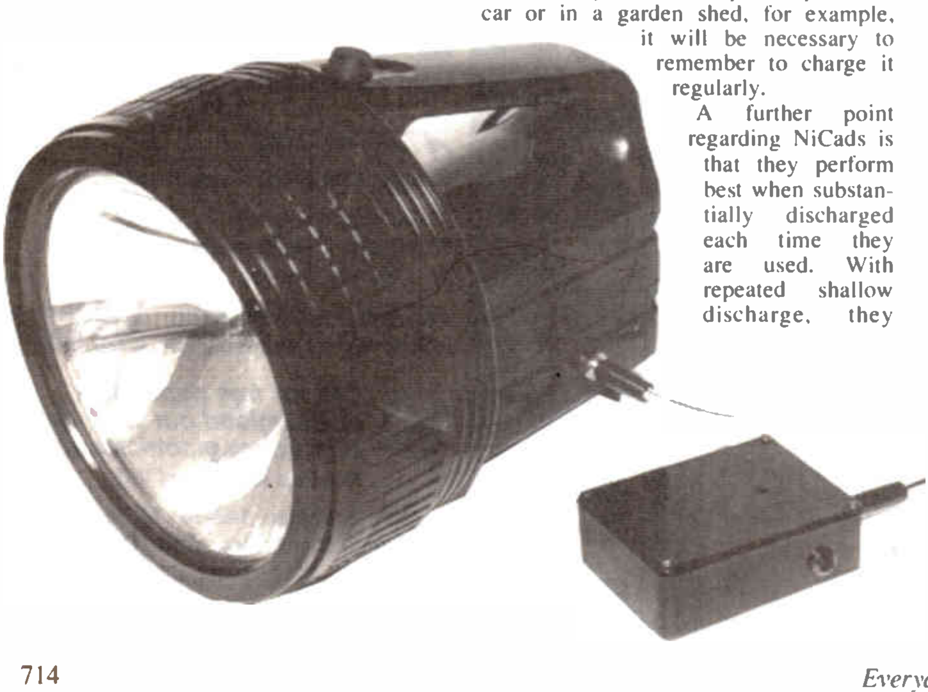
LAMP POWER

The lamp should be of the type having four "D-size cells" in a two-by-two stacked arrangement. The Yuasa NP 1·2-6 rechargeable battery which will replace them, measures 97mm × 54mm × 25mm and this should easily fit inside the battery compartment. *The lamp should be checked to make sure that it will do so before proceeding.* If buying a new lamp, the source of the unit used for the prototype is given at the end.

Commercial re-chargeable lamps are available ready-made and generally use *nickel cadmium* batteries as a power supply. Unfortunately, these soon lose their charge even when unused.

To overcome this problem, they are usually left on a continuous slow (trickle) charge when not in use. However, this cannot be done if a mains supply does not exist nearby. If the lamp is kept in the car or in a garden shed, for example, it will be necessary to remember to charge it regularly.

A further point regarding NiCads is that they perform best when substantially discharged each time they are used. With repeated shallow discharge, they tend to develop a *memory effect* so that, when needed, they will fail to take or deliver a full charge.



LEAD THE WAY

A better solution is to replace the original alkaline cells with a *lead-acid* battery. Some rugged (and expensive) industrial handlamps use this method.

Lead-acid batteries hold their charge for a longer time than the nickel cadmium variety (only three per cent loss per month approximately) and do not suffer from the memory effect. The converted lamp may therefore be left on trickle charge or given a top-up when required. If the lamp has not been used, two or three charges per year should be sufficient to keep it in good condition.

This type of battery thrives on being partially discharged then topped up and this matches the way a lamp is usually used. The only precaution which must be observed is to prevent total discharge of the battery since this can ruin it. With careful use, however, it will give several years of reliable service.

The specified 6V battery is sealed and will not leak. It can therefore be turned on its side or upside down with no ill effect.

Conversion will involve fitting the new battery and mounting a socket on the side of the lamp. A separate small charging unit is constructed and this will be plugged into the socket when the battery needs to be charged.

The charging unit has no power supply of its own. Normally, it will be connected to a commercial plug-in power adaptor. Any inexpensive non-regulated or regulated unit providing a nominal output of 12V d.c. at 300mA minimum may be used.

This avoids the need to make mains connections in the course of construction. There is a further advantage in that the charger may be powered ***direct*** from the 12V car system and this dual method of operation will be useful to some readers.

LOW RESISTANCE

It will be necessary to replace the original bulb in the lamp with one having a higher voltage rating. This is because, although the original cells provide a nominal 6V output, the bulb will be found to have a rating of only 5·4V approximately. This allows for the voltage drop which occurs across the internal resistance of the cells when the current for the bulb (about 650mA) is drawn.

The specified lead-acid battery has a very low internal resistance (60 milliohms or so). Practically the whole nominal 6V output will therefore be available to the bulb.

If the original bulb was used, it would be over-run. This would result in an extra bright light but at the expense of a very short life. In practice, it is necessary to use a 6V bulb having a similar current rating to the original.

Unlike alkaline cells, where the on-load voltage falls gradually, the full output will be available until the battery is considered to be discharged to 5·5V approximately. The bulb will therefore operate at almost full brightness during the entire discharge process.

The capacity of the Yuasa 1·2-6 lead-acid battery is 1·2Ah (amp-hours) based on a discharge time of 20 hours. Here, it is discharged in a much shorter time and this results in a reduced capacity of 0·8Ah approximately.

This is considerably less than that of the alkaline ones which it replaces. Even so, using a bulb rated at 650mA, the lamp will operate for more than one hour per charge and this will be adequate for most purposes. If the smaller Yuasa 1-6 battery is used, the capacity is about 17 per cent less.

IT'S DIFFERENT

Lead acid batteries must be charged with care. In practice, this usually means using a constant voltage source. The voltage is maintained at a value a little higher than the nominal battery voltage. The difference between this and that of the battery will then be available for charging.

Imagine the battery is poorly charged and has a terminal voltage of 5·5V. Suppose also that the charger output voltage is 6·8V. The relatively large difference of 1·3V will allow a high current to flow. It could be so high, in fact, that some form of current-limiting will be necessary to avoid damage to the battery itself or to components in the charger unit or plug-in supply.

As the battery charges, its terminal voltage rises and the difference falls. This results in a reducing current. Eventually, an end-point is reached where the fully-charged battery develops some 6·4V across its terminals and the excess voltage falls to only 0·4V. There will now be only a very small current (a few milliamps) produced and this may be allowed to flow continuously without damage. This is called "trickle", "float" or "standby" charging.

If a higher charging voltage were to be used – say 7·4V – this would have no effect at the beginning where the current is electronically limited. However, later in the cycle the current would remain at all times higher than with trickle charging. The battery would therefore charge more quickly.

This is called "cyclic" charging and is appropriate where the battery has been substantially discharged and the maximum charge rate is needed to restore it quickly. The higher end-point current necessitates removing the battery after charging to prevent possible damage. In this circuit, *trickle* or *cyclic* mode may be selected by means of a switch on the unit.

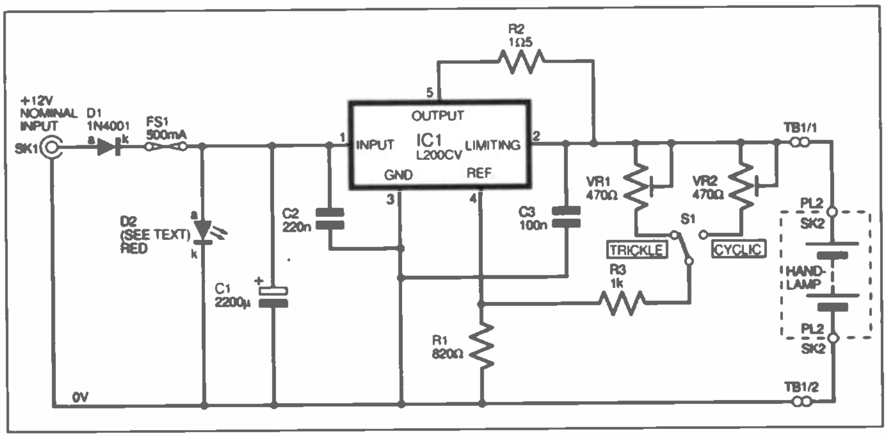


Fig. 1. Circuit diagram for the Rechargeable Handlamp.

CIRCUIT DESCRIPTION

The full circuit diagram for the Rechargeable Handlamp unit appears in Fig. 1. Details of modifications to the lamp itself follow later. Battery B1 is the nominal 6V lead-acid battery being charged.

Diode D1 provides reverse polarity protection since current will only pass from the source in the correct direction. If the polarity is incorrect, the diode will be reverse biased and no current will flow.

With the supply correctly connected, current flows through fuse FS1 and operates light-emitting diode D2. Note that this latter component is of a type having an integral series resistor. Capacitor C1 provides smoothing in case the nominal input-voltage source has not already done this adequately.

Current flows to the input, pin 1, of voltage and current regulator IC1 which then provides an output at pin 5. The output current limit is determined by the value of resistor R2, connected between this pin and the *limiting* input, pin 2.

Since the output current flows through R2, there will be a certain voltage developed across it. This is monitored by pin 2 and the current is reduced if it tends to rise above a predetermined value of 0·45V.

Using the specified value for R2, the maximum current output will be 300mA approximately (250mA for the smaller battery). This ensures that the battery will not be overcharged and also prevents overloading a plug-in adaptor which may have an output of 300mA maximum.

The voltage at the charger output (TB1) is determined by the resistance connected between pin 2 and pin 4 (*reference*) and that between pin 4 and the 0V rail. The latter consists of fixed resistor R1, so the output voltage is set by the resistance appearing between pins 2 and 4 only.

With the two-way switch S1 set to Trickle this will bring resistor R3 in series with preset potentiometer VR1. When set to Cyclic it will switch R3 in series with preset VR2. At the end of construction, presets VR1 and VR2 will be adjusted to provide the correct values for trickle and cyclic charging

COMPONENTS

See SHOP TALK Page

Resistors
R1 820Ω
R2 1Ω5 (see text)
R3 1k
All 0·25W 5% carbon film or better

Potentiometers
VR1, VR2 470Ω min. enclosed carbon preset, vert. (2 off)

Capacitors
C1 2200µ radial elect. 25V (see text)
C2 220n min. metallised polyester, 5mm pin spacing
C3 100n min. metallised polyester, 5mm pin spacing

Semiconductors
D1 1N4001 1A 50V rectifier diode
D2 5mm red l.e.d. for 12V operation, with series resistor (see text)
IC1 L200CV adjustable voltage and current regulator

Miscellaneous
FS1 20mm 500mA fuse, with p.c.b. mounting fuseholder
S1 min. s.p.d.t., p.c.b. mounting slide switch – see text
TB1 2-way p.c.b. mounting screw-terminal block (10mm spacing)
SK1 2·5mm, single-hole mounting, power socket, with plug

Printed circuit board available from *EPE PCB Service*, code 169; 12V 300mA mains plug-in adaptor; plastic box for charger size, 75mm x 56mm x 25 mm; sheet aluminium, size 45mm x 20mm for heatsink; cable tie; twin wire; small fixings; solder; etc.

LAMP
Handlamp – see text.
B1 Yuasa NP1·2-6 battery (see text)
SK2 2·5mm, single-hole mounting, power socket and plug

20mm chassis mounting fuseholder, with tag connections; twin connecting wire; foam plastic.

Approx Cost Guidance Only £11
excluding Handlamp, Batt and Mains Adaptor

respectively. Capacitors C2 and C3 are present to ensure stability of IC1.

CONSTRUCTION

Details of the printed circuit board (p.c.b.) are shown in Fig. 2. This shows the topside component layout and underside (copper track) view. This board is available from the *EPE PCB Service*, code 169.

Construction is straightforward because all the components, apart from the input socket SK1, and possibly the slide switch S1, are mounted on the p.c.b.

Begin construction by drilling the three mounting holes and soldering fuseholder FS1 and p.c.b. mounting screw-terminal block TB1 in position. In the arrangement used in the prototype, the Charge Selector switch S1 was mounted on the p.c.b. It is then operated using a small screwdriver through a hole in the lid. Most readers will change the charge mode infrequently, if ever, and this method ensures that it cannot be altered by mistake.

For those who would like easier access to the switch, it could be mounted on the side of the box with the wires soldered to the corresponding pads on the p.c.b. However, it may be necessary to use a larger box than the one specified if this method is adopted.

Solder the switch in position on the p.c.b. if this is the preferred method.

Solder all resistors (including the presets) and capacitors in position. Note that the radial electrolytic capacitor C1 is mounted *flat* on the p.c.b.

If the plug-in supply is of the *regulated* type, as in the prototype, the voltage rating of C1 may be 16V. If it is of the unregulated type, it would be safer to use one of 25V rating. First bend its end leads through a right-angle then solder them in place observing the polarity (this is marked on the body).

Add light-emitting diode D2 by first noting the polarity – the slightly shorter lead is the cathode (k) one. Cut its leads to a length of 20mm approximately before soldering it in position. If the polarity is "lost" after cutting the leads, note that there is a "flat" on the body and this, again, denotes the cathode end.

Solder the regulator IC1 in position with the metal tab facing the edge of the p.c.b. It will be necessary to spread the pins slightly so that they correspond with the layout of holes. Bend the pins as necessary so that the tab overhangs the edge of the p.c.b. slightly.

Solder 5cm lengths pieces of light-duty stranded connecting wire to the copper pads labelled in Fig. 2 as "+" and "–". Solder similar wires to the charge selector switch positions if this component is to be mounted off-board.

A small heatsink is needed for IC1 since, while delivering full power, it will need to dissipate about 1·5W. Without a heat sink, the i.c. would overheat. In the prototype, a piece of aluminium size 45mm × 20mm was found to be sufficient.

ASSEMBLY

Hold the p.c.b. and heatsink temporarily in position on the base of the box. The heatsink should be kept a few millimetres clear of the front panel and the bottom of the box to allow air to circulate.

Mark the position of the hole in IC1's metal tab on the heatsink. Mark holes also on the base of the box to correspond with those which already exist in the p.c.b. Mark a hole in the front panel for the l.e.d. D2 clip. Remove the p.c.b. and drill these holes.

Next, attach the heatsink firmly to provide good metal-to-metal contact with IC1 tab and so promote a free flow of heat. Make the hole in the side for the power-type input socket SK1 and fit this component. Drill a hole in the rear for the output lead to pass through. If the switch is to be mounted off-board, choose a suitable position, drill the holes and attach it.

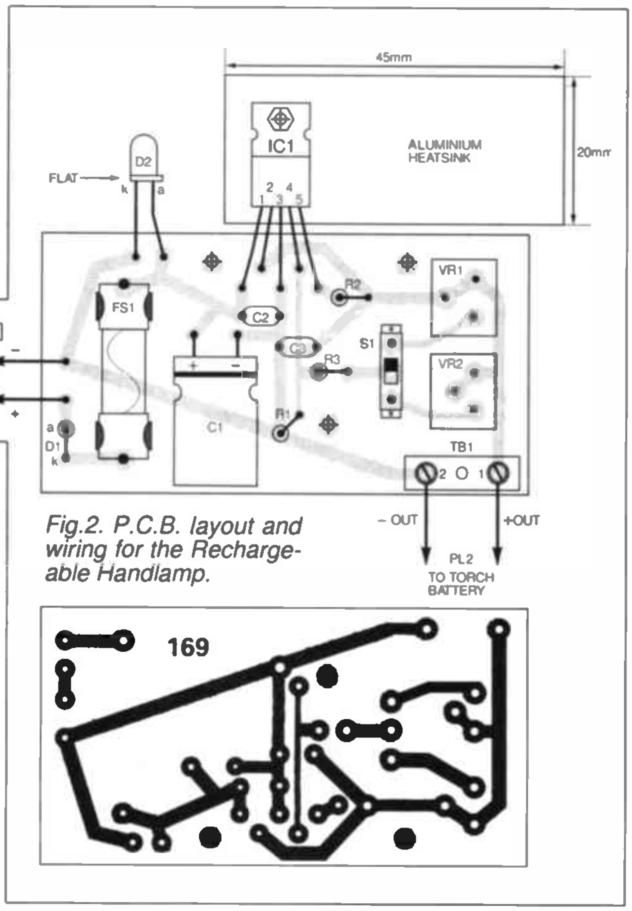


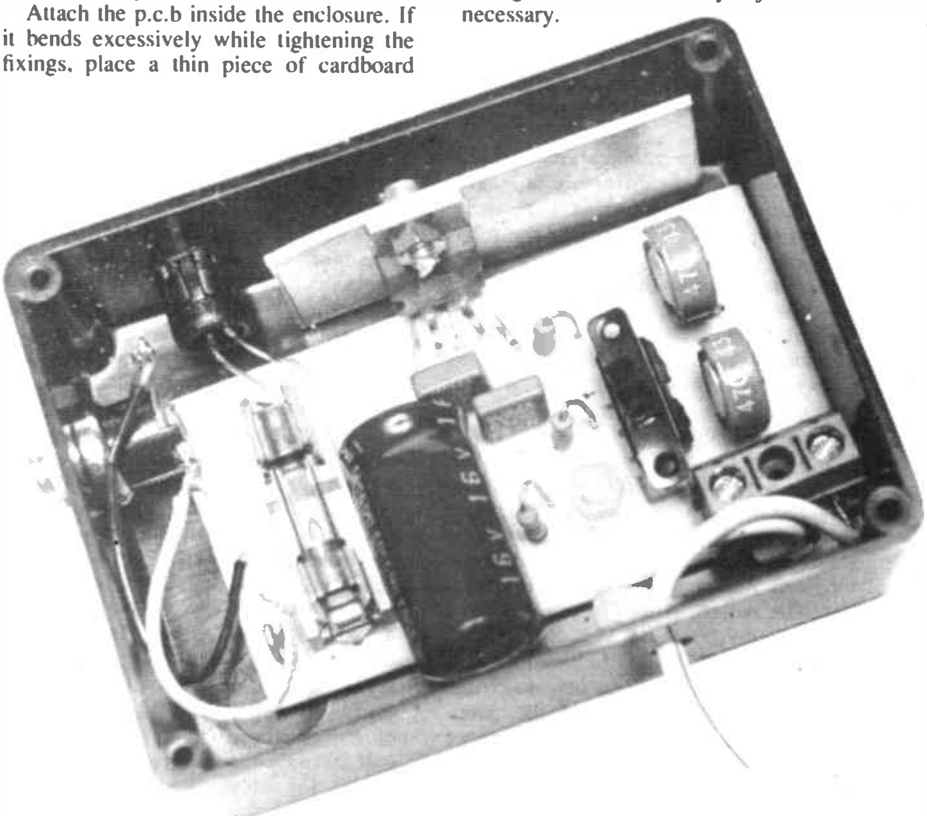
Fig.2. P.C.B. layout and wiring for the Rechargeable Handlamp.

Connect the p.c.b. wires marked "+" and "–" to the power input socket. The outer (sleeve) terminal must be the *negative* one and the inner pin, the positive.

Note that sockets of this type usually have three tags. One is used as a "break" contact when the plug is inserted. If checking which tag is which using a multitester it is therefore necessary to insert a plug first. The unused tag may be cut off if it gets in the way.

Attach the p.c.b inside the enclosure. If it bends excessively while tightening the fixings, place a thin piece of cardboard under it first to provide some padding. Engage the l.e.d. into its clip – this will involve bending the leads but make sure these are not left touching and causing a short-circuit.

If the Charge Selector switch S1 is mounted on the p.c.b. mark its position on the lid of the box and drill a small hole. Attach the lid temporarily and check that it can be operated using a small screwdriver through the hole. Make any adjustments as necessary.



Remove the lid again. Make up the output lead using a short piece of light-duty twin wire such as loudspeaker wire. Fit a power-type plug (PL2) to one end and pass the other one through the hole drilled for it. Secure a small cable tie on the inside to provide strain relief and, leaving some slack, connect it to the terminal block TB1. *Take care to observe the polarity* – the ***outer*** (sleeve) connection of the plug must be the ***negative*** one.

Insert the fuse in the fuseholder. Wire up the switch S1 if it has been mounted off-board.

TESTING

It is probably more convenient to adjust the output voltages using a plug-in adaptor rather than the car supply.

Inexpensive unregulated units develop an off-load voltage higher than the 12V specified. This should allow it to fall to the nominal value on full load. Even so, some units appear to have an excessive output voltage even on full load.

A high input voltage can be tolerated by the circuit except, possibly, by the l.e.d. This is unlikely to fail but, if it does, use a standard one with a 560 ohm resistor connected in series with it instead.

There will probably be a polarity reversal switch or plug on the power adaptor, it is quite in order to connect it with either polarity and see if the l.e.d. lights. If it does not, it should be reversed. *If the power supply unit has been borrowed from some other piece of equipment, be sure to re-adjust it to the correct voltage and polarity before using it for that purpose again.*

Set the multitester to a suitable "d.c. volts" range. To make the adjustments, ***do not*** plug the charger unit into the handlamp. Simply apply the multitester probes to the screw heads on the terminal block TB1 inside the charger unit.

Set the Charge Selector switch to the upper position (Trickle) and adjust preset VR1 to obtain between 6·8V to 6·9V which is appropriate for *trickle* charging. Repeat with the switch in the lower position (Cyclic) and adjust preset VR2 for *cyclic* operation – an output of between 7·2V to 7·5V is correct.

Check the output current limit by setting the meter to a d.c. current range greater than 500mA. Apply the probes to the screw heads on the terminal block as before. If the current exceeds 300mA, the value of resistor R2 should be increased. If it is less than, say, 250mA it could be reduced in value. A low maximum output current does no harm – it simply extends the charging time.

Do not conduct this test for more than ***30 seconds*** *at a time because the heatsink will become too hot under these circumstances.*

Once the above tests have been carried out, fit the lid of the case checking for trapped wires and short-circuits.

LAMP DETAILS

WARNING: Lead-acid batteries can deliver a very high current when short-circuited. This can cause insulation to melt, burns to the skin and possible fire. Care must be taken at all times to ensure that short-circuits cannot occur and a fuse MUST be included as described.

Begin "modifications" to the selected handlamp by clearing the battery compartment of any metal parts which could possibly cause a short-circuit. However, if there is a *secure* metal bridge at the bottom used for connecting the original cells in series, it may be useful to leave this in position. It will act as a shock absorber for the new battery.

Refering to Fig. 3, prepare the battery itself by soldering its positive terminal to one end of a 20mm fuseholder. This should be of the type having *tag* connections – not the p.c.b. variety. Make certain this joint is secure. *Do not insert the fuse itself until the end.*

Solder pieces of stranded connecting wire from the other end of the fuseholder and from the battery negative terminal to the two metal fingers or studs which would make contact with the original battery (polarity unimportant). Solder a further pair of similar wires from the fuse and battery negative terminal and pass them to the position decided on for the "charge" input socket.

Drill a hole for the socket but do not attach it yet – it will probably be easier to solder the wires to it before doing so. *Be certain to observe the correct polarity.* The inner (pin) connection of the socket must lead to the fuseholder and the outer (sleeve) one to the battery negative terminal. Attach the socket.

It is essential to provide one or two ventilation holes in the lamp for the battery to allow small amounts of gas to escape without there being a build-up of pressure. Insert the fuse and place the battery in position. Pack it round with plastic foam so that it is secure.

Check that everything is tightly held and properly insulated. Fit the 6V bulb, replace the reflector and test for correct operation.

DIM-WIT

Remember to charge the battery promptly when the bulb begins to go even slightly dim. In *trickle* mode, charging may be carried out at any time and continuously if desired. In *cyclic* mode, a useful charge will be given in only a few hours.

Due to the very small current being delivered towards the end of the cycle, it will take a long time to reach 100 per cent. In the prototype (with the charger output voltage set to 7·5V), it was found that the battery was fully-charged after 15 hours. About 75 per cent of the total charge was given in 3 to 5 hours. Overcharging by a few hours in *cyclic* mode will do no harm.

If the battery is poorly-charged, and therefore the maximum current of 300mA flows, the heatsink in the charger unit will become hot. This will make the case feel warm to the touch and is quite normal. A few ventilation holes could be drilled near the heatsink but, using the specified case, there were no problems.

The l.e.d. will light when the lamp is plugged in whether a supply exists or not. With no supply, battery current flows back to the l.e.d. and operates it. To check that there is a supply, it is therefore necessary to do this without the lamp being connected.

It is essential to switch the lamp off after use. Leaving it on will result in the battery falling into a state of deep discharge. Unless this is corrected very soon, it will be ruined.

GUTTED

Readers wishing to buy a new lamp having the correct cell arrangement to accept the Yuasa 1·2-6 battery could consider the Power Beam Spotlight from Halford's. This was the lamp used in the prototype unit. There is a compartment containing a circuit which enables the 12V car supply to power the lamp *direct* and also a long lead with a cigar lighter plug on the end.

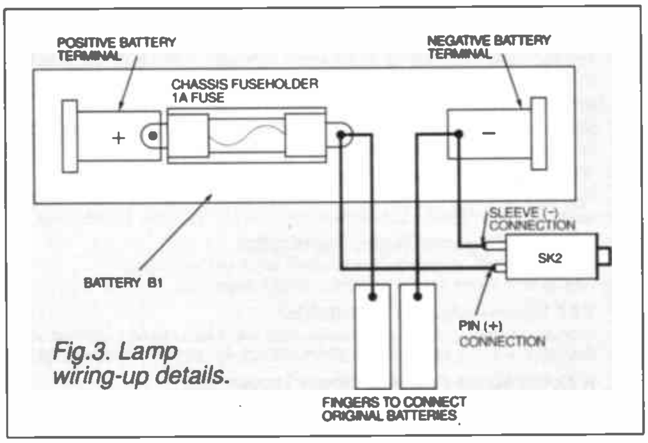
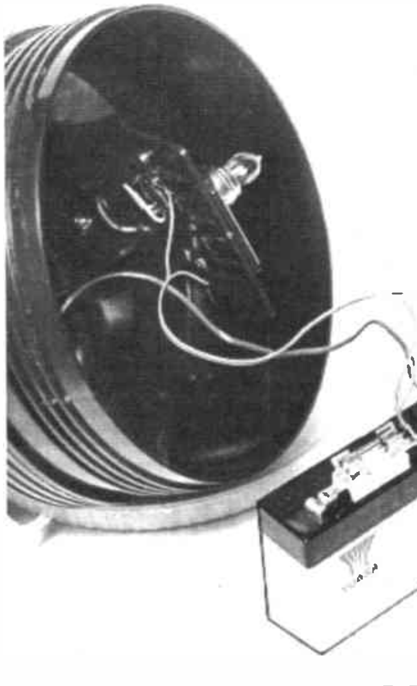


Fig.3. Lamp wiring-up details.

In the prototype, the built-in circuit was removed and scrapped. Access is gained to this by removing the self-tapping screws on each side of the bulb holder.

The lead with the cigar lighter plug was cut off and fitted with a power type plug on the other end so that it could be used (in conjunction with the Charger Unit) to charge the battery from the car supply.



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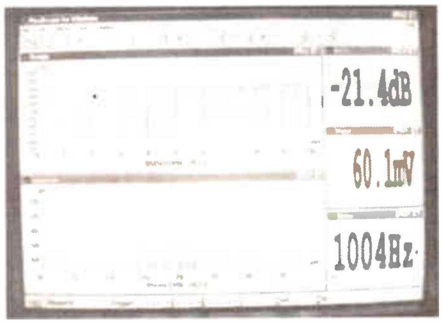

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Contains twenty of the best projects from previous issues of EE each backed with a kit of components. The projects are: Seashell Sea Synthesiser, EE Treasure Hunter, Mini Strobe, Digital Capacitance Meter, Three Channel Sound to Light, BBC 16K Sideways Ram, Simple Short Wave Radio, Insulation Tester, Stepper Motor Interface, Eprom Eraser, 200MHz Digital Frequency Meter, Infra Red Alarm, EE Equaliser Ioniser, Bat Detector, Acoustic Probe, Mains Tester and Fuse Finder, Light Rider – (Lapel Badge, Disco Lights, Chaser Light), Musical Doorbell, Function Generator, Tilt Alarm, 10W Audio Amplifier, EE Buccaneer Induction Balance Metal Detector, BBC Midi Interface, Variable Bench Power Supply, Pet Scarer, Audio Signal Generator.
128 pages (A4 size) **Order code EP1** **£2.45**

ELECTRONICS TEACH-IN 88/89 – INTRODUCING MICROPROCESSORS
Mike Tooley BA (published by *Everyday Practical Electronics*)
A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303). The book contains everything you need to know including full details on registering for assessment, etc. Starting with basic terminology, integrated circuits, logic families and numbering systems the text builds in stages, with revision and assessments built in, up to programming, languages, flow charts, etc. The course is ideal for the newcomer to the subject.
80 pages (A4 size) **Order code TI-88/89** **£2.45**

ELECTRONICS TEACH-IN No. 6
DESIGN YOUR OWN CIRCUITS
(Published by *Everyday Practical Electronics*)
Mike Tooley BA
This book is designed for the beginner and experienced reader alike, and aims to dispel some of the mystique associated with the design of electronic circuits. It shows how even the relative newcomer to electronics can, with the right approach, design and realise quite complex circuits.

Fourteen individual p.c.b. modules are described which, with various detailed modifications, should allow anyone to design and construct a very wide range of different projects. Nine "hands-on" complete DIY projects have also been included so readers can follow the thinking behind design, assembly, construction, testing and evaluation, together with suggested "mods" to meet individual needs. The practical projects have each been designed to stand on their own as complete items of equipment. P.C.B.s for all the modules and projects are available by mail order.

The subjects covered in each chapter of the book are: Introduction and Power Supplies: Small Signal Amplifiers: Power Amplifiers: Oscillators: Logic Circuits; Timers; Radio; Power Control; Optoelectronics.

The nine complete constructional projects are: Versatile Bench Power Supply; Simple Intercom; Bench Amplifier/Signal Tracer; Waveform Generator; Electronic Die; Pulse Generator; Radio Receiver; Disco Lights Controller; Optical Communications Link.
136 pages (A4 size) **Order code T16** **£3.45**

TEACH-IN No. 7 plus FREE Software
ANALOGUE AND DIGITAL ELECTRONIC COURSE
(Published by *Everyday Practical Electronics*)
Alan Winstanley and Keith Dye B.Eng(Tech)AMIEE
The highly acclaimed *Teach-In* series, which included the construction and use of the *Mini Lab* and *Micro Lab* test and development units, has been put together in book form. Additionally EPT Educational Software have developed a GCSE Electronics software program to compliment the course and a FREE DISC covering the first two parts of the course is included with the book.

An interesting and thorough tutorial series aimed specifically at the novice or complete beginner in electronics. The series is designed to support those undertaking either GCSE Electronics or GCE Advanced Levels, and starts with fundamental principles.

If you are taking electronics or technology at school or college, this book is for you. If you just want to learn the basics of electronics then this is for you. If you are teaching electronics or technology you must make sure you see it. *Teach-In No. 7* will be invaluable if you are considering a career in electronics or even if you are already training in one. The Mini Lab and software enable the construction and testing of both demonstration and development circuits. These learning aids bring electronics to life in an enjoyable and interesting way: you will both see and hear the electron in action! The Micro Lab microprocessor add-on system will appeal to higher level students and those developing microprocessor projects.
152 pages (A4 size) **Order code T17** **£3.95**

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DIRECT BOOK SERVICE

The books listed have been selected by Everyday Practical Electronics editorial staff as being of special interest to everyone involved in electronics and computing. Books are supplied by mail order direct to your door. Full ordering details are given on the last book page. For another selection of books see the next two issues of EPE.

Computers and Computing

HOW TO CHOOSE A SMALL BUSINESS COMPUTER SYSTEM
D. Weale
This book is for anyone intending to buy an IBM compatible computer system, whether it is their first system or a replacement. There are sections on hardware, application and systems programs and how to actually make your choice as well as sections on the law, ergonomics and a glossary of common terms.

The text contains many useful tips and some warnings (which could save much effort and expense).
114 pages **Order code BP323** **£4.95**

MAKING MS-DOS WORK FOR YOU (covers version 6.2)
N. Kantanis & P. R. M. Oliver
This book was written with the busy person in mind and, as such, it has an underlying structure based on "what you need to know first, appears first". Nonetheless, the book has also been designed to be circular, which means that you don't have to start at the beginning and go to the end.

The book explains: How to write customised batch files which allow you to display what you want on your screen, and in the form and order you want it, instead of being forced to use the DOS prompt on a blank screen. How to design and set up a fast interactive and professional looking menu system, so that you or anyone else can run utility applications or commercial software packages easily. How the ANSI.SYS display and keyboard commands can be used to position the cursor on any part of the screen, change the intensity of the displayed characters or change their colour. How the Edit screen editor or the Edlin line editor can be used to enter ESCape (ANSI.SYS) commands into simple ASCII files to allow control of both your screen display and your printer. How to control the operation of the two main types of printers in use today, Epson compatible dot matrix and HP compatible laser printers. How to use several routines, such as moving and finding files, protecting files from accidental erasure, a simplified backup process, a screen saver, and a disc cataloguing system.

The Debug program and how it can be used to create, see and change the contents of any file, including those of programs written in assembler code. This includes how to find your way around the names and tasks of the CPU registers and the meeting of some simple assembler mnemonics.
182 pages **Temporarily out of print**

MULTIMEDIA ON THE PC
Ian R. Sinclair
In this book, you'll find out what a CD ROM is, how it works, and why it is such a perfect add-on for a PC, allowing you to buy programmes, text, graphics and sound on a CD. It also describes the installation of a CD ROM drive and a sound card, pointing out the common problems that arise, and then shows how to use them to create a complete multimedia presentation that contains text, photos, a soundtrack with your own voice recorded as a commentary, even animation and edited video footage.
184 pages **Order code PC112** **£11.95**

A CONCISE INTRODUCTION TO MS-DOS
N. Kantaris
(Revised Edition Covers Version 6.2)
This guide is written with the non-expert, busy person in mind and, as such, it has an underlying structure based on "what you need to know first, appears first". Nevertheless, the guide is also designed to be circular, which means that you don't have to start at the beginning and go to the end. The more experienced user can start from any section.
176 pages **Order code BP232** **£3.95**

UNDERSTANDING PC SPECIFICATIONS
R. A. Penfold (Revised Edition)
If you require a microcomputer for business applications, or a high quality home computer, an IBM PC or compatible is often the obvious choice. They are competitively priced, and are backed up by an enormous range of applications programs, hardware add-ons, etc. The main difficulty for the uninitiated is deciding on the specification that will best suit his or her needs. PCs range from simple systems of limited capabilities up to complex systems that can happily run applications that would have been considered beyond the abilities of a microcomputer not so long ago. It would be very easy to choose a PC system that is inadequate to run your applications efficiently, or one which goes beyond your needs and consequently represents poor value for money.

This book explains PC specifications in detail, and the subjects covered include the following: Differences between types of PC (XT, AT, 80386, etc); Maths co-processors; Input devices (keyboards, mice, and digitisers); Memory, including both expanded (EMS) and extended RAM; RAM disks and disk caches; Floppy disk drive formats and compatibility; Hard disk drives (including interleave factors and access times); Display adaptors, including all standard PC types (CGA, Hercules, Super VGA, etc); Contains everything you need to know if you can't tell your EMS from your EGA!
128 pages **Order code BP282** **£4.95**

AN INTRODUCTION TO 6800 ASSEMBLY LANGUAGE
R. A. & J. W. Penfold
Obtain a vast increase in running speed by writing programs for 6800 based micros such as the Commodore, Amiga, Atari ST range or Apple Macintosh range etc., in assembly language. It is not as difficult as one might think and this book covers the fundamentals.
112 pages **Order code BP184** **£2.95**

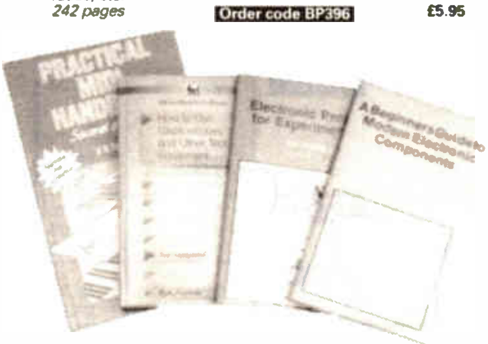
Circuits, Data and Design

PRACTICAL ELECTRONIC FILTERS
Owen Bishop
This book deals with the subject in a non-mathematical way. It reviews the main types of filter, explaining in simple terms how each type works and how it is used.
The book also presents a dozen filter-based projects with applications in and around the home or in the constructor's workshop. These include a number of audio projects such as a rythm sequencer and a multi-voiced electronic organ.
Concluding the book is a practical step-by-step guide to designing simple filters for a wide range of purposes, with circuit diagrams and worked examples.
88 pages **Order code BP299** **£4.95**

ELECTRONIC ALARM CIRCUITS MANUAL
R. M. Marston
One hundred and forty useful alarm circuits, of a variety of types, are shown in this volume. The operating principle of each one is explained in concise but comprehensive terms, and brief construction notes are given where necessary.
Aimed at the practical design engineer, technician and experimenter, as well as the electronics student and amateur.
124 pages **Order code NE11** **£13.95**

DIGITAL GATES AND FLIP-FLOPS
Ian R. Sinclair
This book, intended for enthusiasts, students and technicians, seeks to establish a firm foundation in digital electronics by treating the topics of gates and flip-flops thoroughly and from the beginning.
Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.
No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.
200 pages **Order code PC106** **£8.95**

ELECTRONIC HOBBYISTS DATA BOOK
R. A. Penfold
This book should tell you everything you are ever likely to want to know about hobby electronics, but did not know where to ask or refer. Comprehensive contents pages makes it easy to quickly locate the data you require.
The subjects covered include: Common circuits, and related data (including helpful graphs and tables of values); Colour codes for resistors, capacitors and inductors; Pinout details for a wide range of CMOS and TTL devices, plus basic data on the various logic families; Pinout details and basic data for a wide range of operational amplifiers; Data and leadout information for a wide range of transistors, FETs, power FETs, triacs, thyristors, diodes, etc; General data including MIDI message coding, radio data, ASCII/Baudot coding, decibel ratios, etc.
242 pages **Order code BP396** **£5.95**



50 SIMPLE LED CIRCUITS
R. N. Soar
Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components – the light-emitting diode (LED). Also includes circuits for the 707 common anode display.
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BOOK 2 50 more l.e.d. circuits.
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CIRCUIT SOURCE BOOK 1
A. Penfold
Written to help you create and experiment with your own electronic designs by combining and using the various standard "building block" circuits provided. Where applicable, advice on how to alter the circuit parameters is given.
The circuits covered in this book are mainly concerned with analogue signal processing and include: Audio amplifiers (op.amp and bipolar transistors); audio power amplifiers; d.c. amplifiers; highpass, lowpass, bandpass and notch filters; tone controls; voltage controlled amplifiers and filters; triggers and voltage comparators; gates and electronic switching; bargraphs; mixers; phase shifters, current mirrors, hold circuits, etc.
Over 150 circuits are provided, which it is hoped will be useful to all those involved in circuit design and application, be they professionals, students or hobbyists.
182 pages **Order code BP321** **£4.99**

A BEGINNER'S GUIDE TO TTL DIGITAL ICs
R. A. Penfold
This book first covers the basics of simple logic circuits in general, and then progresses to specific TTL logic integrated circuits. The devices covered include gates, oscillators, timers, flip/flops, dividers, and decoder circuits. Some practical circuits are used to illustrate the use of TTL devices in the "real world"
142 pages **Order code BP332** **£4.95**

CIRCUIT SOURCE BOOK 2
R. A. Penfold
This book will help you to create and experiment with your own electronic designs by combining and using the various standard "building blocks" circuits provided. Where applicable, advice on how to alter the circuit parameters is provided.
The circuits covered are mainly concerned with signal generation, power supplies, and digital electronics.
The topics covered in this book include: 555 oscillators; sinewave oscillators; function generators; CMOS oscillators; voltage controlled oscillators; radio frequency oscillators; 555 monostables; CMOS monostables; TTL monostables; precision long timers; power supply and regulator circuits; negative supply generators and voltage boosters; digital dividers; decoders, etc; counters and display drivers; D/A and A/D converters; opto-isolators, flip/flops, noise generators, tone decoders, etc.
Over 170 circuits are provided, which it is hoped will be useful to all those involved in circuit design and application, be they professionals, students or hobbyists.
192 pages **Order code BP322** **£4.99**

HOW TO USE OP.AMPS
E. A. Parr
This book has been written as a designer's guide covering many operational amplifiers, serving both as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.
160 pages **Order code BP88** **£3.99**

Project Building

ELECTRONIC PROJECTS FOR EXPERIMENTERS
R. A. Penfold
Many electronic hobbyists who have been pursuing their hobby for a number of years seem to suffer from the dreaded "seen it all before" syndrome. This book is fairly and squarely aimed at sufferers of this complaint, plus any other electronics enthusiasts who yearn to try something a bit different. No doubt many of the projects featured here have practical applications, but they are all worth a try for their interest value alone.
The subjects covered include:- Magnetic field detector, Basic Hall effect compass, Hall effect audio isolator, Voice scrambler/descrambler, Bat detector, Bat style echo location, Noise cancelling, LED stroboscope, Infra-red "torch", Electronic breeze detector, Class D power amplifier, Strain gauge amplifier, Super hearing aid.
138 pages **Order code BP371** **£4.95**

PRACTICAL FIBRE-OPTIC PROJECTS
R. A. Penfold
While fibre-optic cables may have potential advantages over ordinary electric cables, for the electronics enthusiast it is probably their novelty value that makes them worthy of exploration. Fibre-optic cables provide an innovative interesting alternative to electric cables, but in most cases they also represent a practical approach to the problem. This book provides a number of tried and tested circuits for projects that utilize fibre-optic cables.
The projects include:- Simple audio links, F.M. audio link, P.W.M. audio links, Simple d.c. links, P.W.M. d.c. link, P.W.M. motor speed control, RS232C data links, MIDI link, Loop alarms, R.P.M. meter.
All the components used in these designs are readily available, none of them require the constructor to take out a second mortgage.
132 pages **Order code BP374** **£4.95**

ELECTRONIC PROJECT BUILDING FOR BEGINNERS
R. A. Penfold
This book is for complete beginners to electronic project building. It provides a complete introduction to the practical side of this fascinating hobby, including the following topics:
Component identification, and buying the right parts; resistor colour codes, capacitor value markings, etc; advice on buying the right tools for the job; soldering; making easy work of the hard wiring; construction methods, including stripboard, custom printed circuit boards, plain matrix boards, surface mount boards and wire-wrapping; finishing off, and adding panel labels; getting "problem" projects to work, including simple methods of fault-finding.
In fact everything you need to know in order to get started in this absorbing and creative hobby.
135 pages **Order code BP392** **£4.95**

45 SIMPLE ELECTRONIC TERMINAL BLOCK PROJECTS
R. Bebbington
Contains 45 easy-to-build electronic projects that can be constructed, by an absolute beginner, on terminal blocks using only a screwdriver and other simple hand tools. No soldering is needed.
Most of the projects can be simply screwed together, by following the layout diagrams, in a matter of minutes and readily unscrewed if desired to make new circuits. A theoretical circuit diagram is also included with each project to help broaden the constructor's experience and knowledge.
The projects included in this book cover a wide range of interests under the chapter headings: Connections and Components, Sound and Music, Entertainment, Security Devices, Communication, Test and Measuring.
163 pages **Order code BP378** **£4.95**

HOW TO DESIGN AND MAKE YOUR OWN P.C.B.S
R. A. Penfold
Deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.
80 pages **Order code BP121** **£2.50**

A BEGINNER'S GUIDE TO MODERN ELECTRONIC COMPONENTS
R. A. Penfold
The purpose of this book is to provide practical information to help the reader sort out the bewildering array of components currently on offer. An advanced knowledge of the theory of electronics is not needed, and this book is not intended to be a course in electronic theory. The main aim is to explain the differences between components of the same basic type (e.g. carbon, carbon film, metal film, and wire-wound resistors) so that the right component for a given application can be selected. A wide range of components are included, with the emphasis firmly on those components that are used a great deal in projects for the home constructor.
166 pages **Temporarily out of print**

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PCB SERVICE

Printed circuit boards for certain EPE constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for airmail outside of Europe. Remittances should be sent to **The PCB Service, *Everyday Practical Electronics*, Allen House, East Borough, Wimborne, Dorset BH21 1PF. Tel: 01202 881749; Fax 01202 841692 (NOTE, we cannot reply to orders or queries by Fax); E-mail: editorial@epemag.wimborne.co.uk** . Cheques should be crossed and made payable to *Everyday Practical Electronics* **(Payment in £ sterling only).**

NOTE: While 95% of our boards are held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail.

Back numbers or photostats of articles are available if required – see the *Back Issues* page for details.

Please check price and availability in the latest issue.

Boards can only be supplied on a payment with order basis.

Special KNOCK DOWN SALE of PCBs.

We have a few p.c.b.s left from past projects these are being offered at the knock down price of £2.00 each – *no matter what size they are* **(some of these boards are worth over £15.00 each)** while stocks last. This price includes VAT and UK post – overseas orders please add 50p postage (or £1 per board for airmail postage).

Electronic Snooker Scoreboard, 832; Bike Odometer (pair of boards), 836/7; Amstrad PCW A to D Converter (double-sided), 838; Linear Power Supply (double-sided), 844; 1W Stereo Amplifier, 851; Visual Doorbell, 863; CCD TV Camera – Control Board, 865; CCD TV Camera - Combined Video, Test & Ext Plug Boards, 866a/e; EPE SounDAC PC Sound Board, 868; Microprocessor Smartswitch, 881; Print Timer, 874; Simple NiCad Charger, 884; Stereo HiFi Controller – Power Supply, 886 – Main Board, 887 – Expansion/Display Boards, (pair) 888; Dancing Fountains – Filter, 891 – PC-Compatible Interface (double-sided), 892; Seismograph – Sensor/Filter, 896 – PC-Compatible Interface (double-sided), 898 – Clock/Mixer, 897; Visual/Audio Guitar Tuner, 900; Audio Auxiplexer – Control Board, 903 – Receiver, 904; Power Controller, 905; 1000V/500V Insulation Tester, 906; Active Guitar Tone Control, 907; TV Off-er (pair), 908/909; Video Modules – 1 Simple Fader, 910 – Improved Fader, 911 – Video Enhancer, 912; Rodent Repeller, 913; Video Modules – 2 Horizontal Wiper, 916 – Vertical Wiper, 917 – 4-Channel Audio Mixer, 918; Spacewriter Wand, 921; Universal Digital Code Lock, 922; Video Modules – 3 Dynamic Noise Limiter, 919 – System Mains Power Supply, 920; Magnetic Field Detector, 923; Model Railway Track Cleaner, 924; Moving Display Metronome, 925.

£2.00 EACH inc. VAT and p&p

Any of the above for just £2 each inc. VAT and p&p.

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PROJECT TITLE		Order Code	Cost
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Foot-Operated Drill Controller		928	£5.73
Model Railway Signals		929	£5.96
12V 35W PA Amplifier		930	£12.25
Multi-Purpose Thermostat	MAR'95	931	£6.30
Multi-Project PCB		932	£3.00
Sound-Activated Switch			
Audio Amplifier			
Light Beam Communicator (2 boards required)			
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Light-Activated Switch			
Switch On/Off Timer			
Continuity Tester			
Auto Battery Charger		934	£5.36
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Simple Theremin		952	£6.68
Vandata			
Boot Control Unit		953	£10.52
Display Unit		954	£6.61
Sound Switch	OCT'95	915	£6.55
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Treble Booster			
Infra-Red Controller/Alarm (2 boards required)			
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Video Enhancer – Current Tracer – Distortion Effects Unit			
Digital Delay Line		958	£8.04
50Hz Field Meter		959	£8.32
Temperature Warning Alarm (Teach-In '96)		960	£6.15

PROJECT TITLE		Order Code	Cost
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* EPE Met Office – Sensor/Rainfall/Vane		963/965	£11.33
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Audio Meter and Amplifier		968	£5.99
* EPE Met Office –	JAN'96		
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Printer Sharer		973	£9.93
Analogue Frequency Meter	FEB'96	957	£6.70
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* PIC Water Descaler		170	£6.90

EPE SOFTWARE

Software programs for the *EPE* projects marked above with an asterisk (*) are available altogether on a *single* 3.5 inch PC-compatible disk, or as needed via our Internet site. The same disk also contains the following additional software: Simple PIC16C84 Programmer (Feb '96). The disk (order as "PIC-disk") is available from the *EPE PCB Service* at £2.75 (UK) to cover our admin costs (the software itself is *free*). Overseas £3.35 surface mail, £4.35 airmail. Alternatively, the files can be downloaded *free* from our Internet FTP site: **ftp://ftp.epemag.wimborne.co.uk.**

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NET WORK

ALAN WINSTANLEY

EPE NET WORK is our monthly column specially written for readers having access to the Internet. Our web site at **http://www.epemag.wimborne.co.uk** contains information about the current issue, a cover shot, and a photo of the featured project. New is our Recent Issues page which offers a reminder about the past three or four magazines' contents. You can also subscribe on-line, check the latest readers' letters and of course there's the *Net Work* page with links ready made for you, plus the *Net Work* A-Z Index – an alphabetical listing of all the URL's recommended over the past year, and growing every month!

Our on-line Soldering Guide and Soldering Photo Gallery is referenced daily by readers from all around the world. It has now been officially recognised by the *Edinburgh Engineering Virtual Library* (**http://www.eevl.ac.uk**) which is an on-line reference library for engineers. Praise indeed! You can read the Soldering Guide and check the colour picture gallery at our web URL at **.../solderfaq.htm.** Your monitor should be set to 800 × 600 to view the photos.

Nearly all of our PIC-powered projects have their source codes available at our FTP site **ftp://ftp.epemag.wimborne.co.uk/pub/PICS.** You then need to navigate to the project's folder, open it and download all files contained therein. More than one reader has commented that the PIC projects files appear to be "empty" – in fact, they have tried to download a folder (sub-directory) rather than opening it and fetching all the files it contains.

This month's *PIC Water Descaler* is at sub-directory **/PICdescaler.**

Junkwatch

I would have no problem at all with the rationale of sending unsolicited commercial E-mail (UCE) if there existed a legitimate mail filtering service to sift it out for the benefit of those who do not have time for/do not want their mail blocked by/cannot stand the sight of, such unwarranted intrusions into their daily business. Last month I pointed to the IEMMC, a genuine-looking mail filtering service with which I registered about four weeks ago. Since then, I have made a few Usenet postings (fatal) on topics of interest; remember that Usenet is a giant stomping ground for mailing organisations looking for active E-mail addresses.

In the past month, I have received about 120 examples of UCE. The most remarkable one landed today, actually, from a particularly incompetent-looking outfit which managed to send me their trivial tripe no less than sixteen times. Another no-brainer claims to be "Todays opertunity [sic] Tomarrows [sic] profit", signing off as "We are professionals". If it wasn't so tragic, it would be funny. Mail filtering registration has done nothing to dampen the tidal wave of "incoming".

Trade sources hope for some future relief in the form of the American Netizens Protection Act, which would treat unsolicited E-mail on the same basis as unsolicited faxes, making the sender liable to pay damages to injured parties. It would be unenforceable outside of the USA but it may discourage the practice. More interestingly, sources hope that the Unsolicited Commercial Electronic Mail Choice Act would throw some of the burden onto American ISP's who would be compelled to sift out E-mail which has been "tagged" as UCE. Perhaps this technique could catch on in the UK. Both Acts are grinding away in the machinery, so meantime I guess we can only live in hope.

Another UCE received from "PowerPromo Inc." offers, funnily enough, software which hoovers up 60,000 addresses per hour which they say includes a "newsgroup address decoder" so you "get the addresses of all those guys who put NOSPAM etc. in their addresses"! Another product "sends up to 100 E-mails per second and is supplied with two million fresh addresses". So all those who include "NOSPAM" in your address, well, best of luck.

The Salesman from Hell

Something which is guaranteed to enrage me is the disastrous quality of service and in-store advice slopped out by some High Street "hi-tech" retailers. My worst fears recently materialised in the form of the Salesman from Hell, when I recently succumbed to the lure of a digital camera, with a view to improving the turn-round time on creating web photos (for which a digicam is absolutely, er, fabulous). The lack of retail advice and understanding about some of the highly technical nature of products now on sale beggars belief.

There are exceptions, I guess, and I can give a store assistant the benefit of the doubt up to a point, but I also had to endure someone who couldn't find the product code, couldn't find the item from stock, didn't know what a .GIF was, and messed up my credit card payment. His sole contribution was "Ah, web, yeah, good, innit? My mate's got a web site. I'll fetch the (camera's) instruction book so you can look at it." (Sales-speak for, *don't ask me, you're on your own, pal.*) The sad thing was that he'd been volunteered by a colleague as their "resident expert" on digital cameras. He knew absolutely nothing whatsoever, but fortunately I had done my homework beforehand.

Yet it is extremely puzzling that a store assistant feigns ignorance about the technical merits of a product – but only until it comes to closing the sale by trying to sell an extended warranty. Naturally they make more commission that way. (Whistle and intake of breath. Cue, techno-gabble.) "LCD display – same as a laptop – very fragile – drop it, liable to crack. Can't understand it, no extended warranty – sheesh, I see you're a gambler, then?" (Not really: it's covered on my household insurance.) Would you buy a £1,500 personal computer from such an outfit? Me neither.

Latest links

This month's URLs (Uniform Resource Locators) are ready made for you on the *Net Work* page of the *EPE* web site. Simply point and click – no need to mess about!

Starting with the *Edinburgh Engineering Virtual Library* at **http://www.eevl.ac.uk,** an engineering starting point for the higher academic and research community. Also for engineers, there is a new Electromagnetic Compatibility Forum (under construction) dedicated to the subject of EMC and the issues of compliance and certification, at **http://techforum.testeq.com.** Another forum, this time for electromagnetic-related components is offered at **http://user.hk.linkage.net/~asiamag** whilst ITU Technologies in association with Amazon.Com have a new technical bookstore which focuses on titles relating to electronics, at **http://www.itutech.com/techbooks.htm.**

The subject of modem standards continues to crop up, now that 56Kbps units are starting to make an appearance. The standards are developing in the Open 56K Forum at **http://www.open56k.org.** A web site with over 700 links to electronic component manufacturers has been assembled in a mammoth project – *Dana's Index of Electronics Manufacturers* on the Web at **http://www.netcom.com/~dwsmith/index.html.**

Meantime, the *BeMa Electronics Guide* (listed in January 1997's issue) has moved to **http://www.bema-electronics.demon.nl.** Finally, take a peek at Ken Willmott's Railroad Electronics Page, for model railway enthusiasts, at **http://wits.on.ca/rail** where there is a handful of circuits for model rail fans.

Don't forget that I welcome feedback and suggestions for favourite electronics-related URLs (web and FTP). E-mail them to **alan@epemag.demon.co.uk.** My Home Page is at: **http://ourworld.compuserve.com/homepages/alan_winstanley** with a new (faster) UK mirror site now open at **http://www.tcp.co.uk/~alanwin.** The sites were recently updated.

VIDEOS ON ELECTRONICS

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

(All videos are to the UK PAL standard on VHS tapes.)

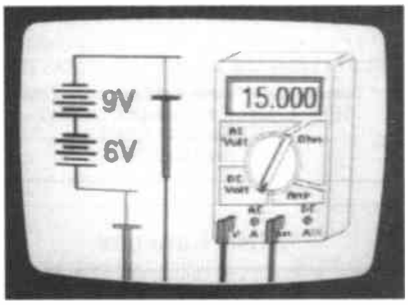
BASICS

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

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

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

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



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

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

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

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VCR MAINTENANCE

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

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

DIGITAL

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

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

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

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

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

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

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

RADIO

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

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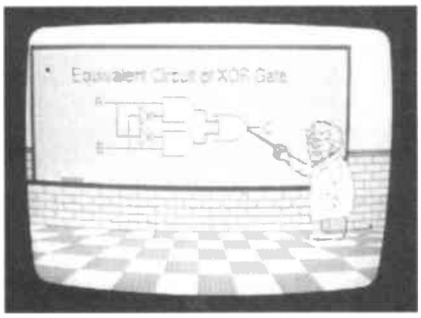

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