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JULY 1997

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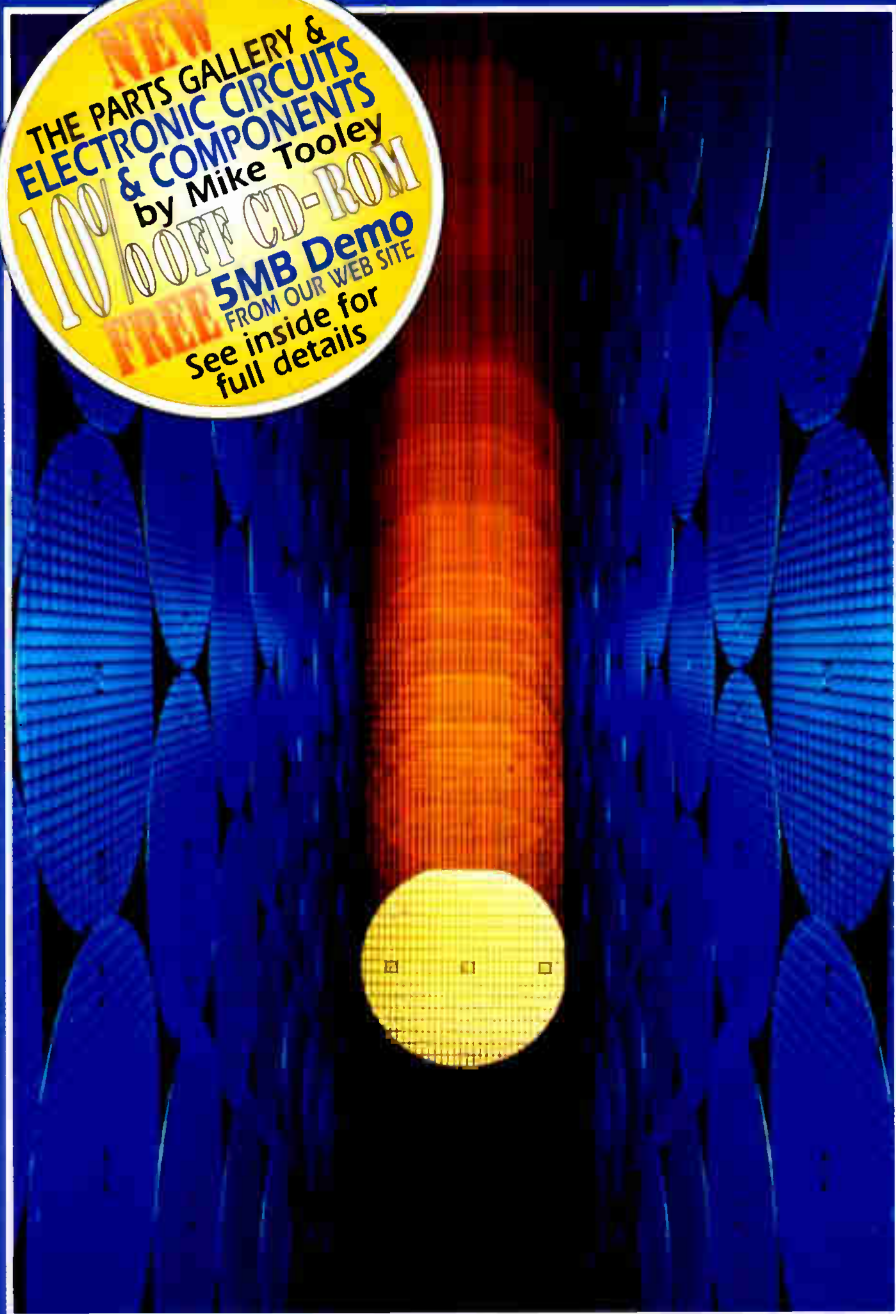

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THERE IS ONE DANGER YOU CAN'T SEE, HEAR, SMELL OR FEEL- ITS RADIATION. THERE ARE OVER 10,000 SHIPMENTS OF RADIOACTIVE MATERIAL IN THE UK EVERY YEAR BY ROAD AND RAIL! WOULD ANYBODY TELL YOU OF A RADIATION LEAK?

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

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

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

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

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

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

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

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

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

GPS SATELLITE NAVIGATION SYSTEM Made by Garmin, the GPS38 is hand held, pocket sized, 255g, position, altitude, graphic compass, map builder, nitro filled. **Bargain price** just £179 ref GPS1.

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

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

INFRA RED POWERBEAM Handheld battery powered lamp, 4 inch reflector, 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"x4.8" fits on sun visor or dash £149 ref

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

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

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

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

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

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

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

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

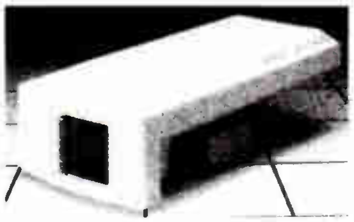
AA NICAD PACK Pack of 4 tagged AA nicads £2.99 ref BAR34

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,
16 character 2 line, 99x24mm £2.99 ref SM1623A
20 character 2 line, 83x19mm £3.99 ref SM2024A
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 189x magnification. Send or fax for further information.20kg, 885x800x1850mm 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

MICRO RADIO It's tiny, just 3/8" thick, auto tunning, complete with headphones. FM £9.99 ref EP35

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 80-106mhz, 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

12V DC MOTOR SPEED CONTROL KIT Complete with PCB etc. Up to 30A. **A heat sink may be required.** £19.00 **REF: MAG17**

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

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

GIANT HOT AIR BALLOON KIT Build a 4.5m circumfrence, 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 of the above unit at £45 ref EXM34

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

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

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

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

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

FANCY A FLUTTER? SEEN OUR NEW PUBLICATION? Covers all aspects of horse and dog betting, systems etc and gives you a betting system that should make your betting far more profitable! £6 a copy ref BET1

FIBRE OPTIC CABLE BUMPER PACK 10 metres for £4.99 ref MAG5P13 ideal for experimenters! 30 m for £12.99 ref MAG13P1

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

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

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.

RECHARGE ORDINARY BATTERIES UP TO 10 TIMES! With the Battery Wizard! Uses the latest pulse wave charge system to charge all popular brands of ordinary batteries AAA, AA, C, D, four at a time! Led system shows when batteries are charged, automatically rejects unsuitable cells, complete with mains adaptor. BS approved. Price is £21.95 ref EP31.

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

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

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

SECOND GENERATION NIGHT SIGHTS FROM £748

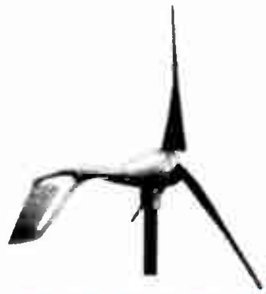
RETRON Russian night sight, 1.8x, infra red lamp, 10m-inf, standard M42 lens, 1.1kg. £349 ref RET1

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

HI POWER SURVEILLANCE TELESCOPE Continuous zoom control from 20 times to an amazing 60 times magnification. 60mm fully coated objective lens for maximum light transmission, complete with tripod featuring micro elevation control. £75 ref ZT1

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 dia blades, carbon matrix blades, 3 year warranty, 12vdc output, control electronics, brushless neodymium cubic curve alternator, only two moving parts, maintenance free, simple rooftop installation, start up speed 7mph, max output (30mph) 380w, £499 ref AIR1

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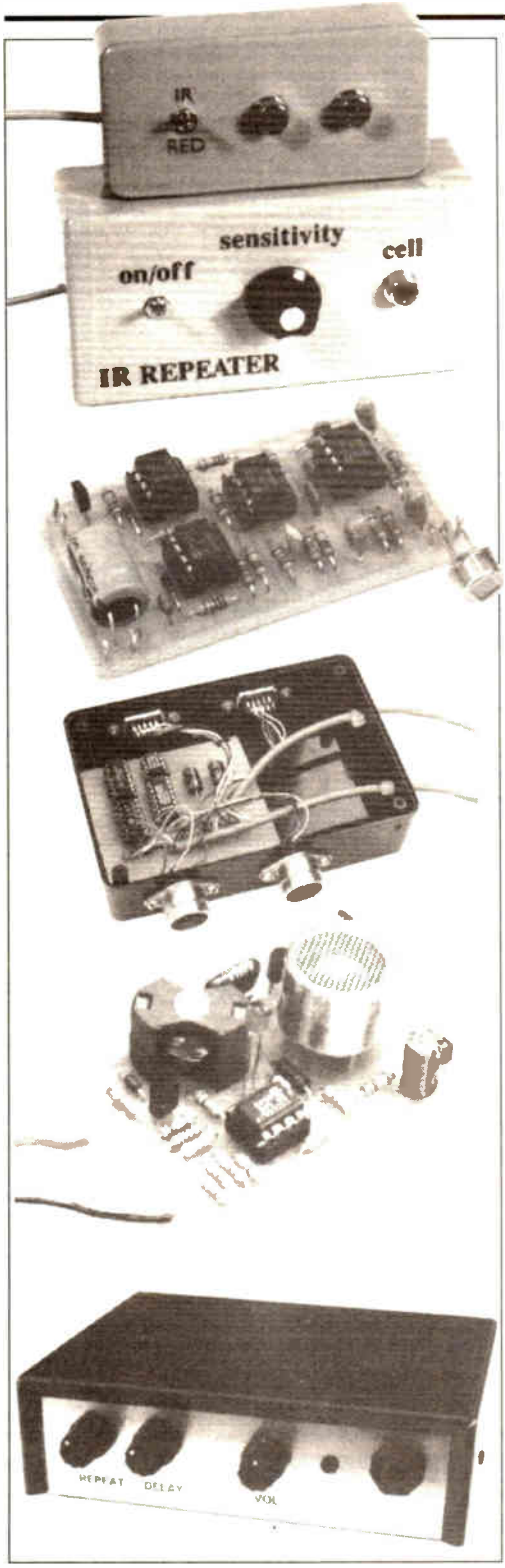

Our August '97 issue will be published on Friday, 4 July 1997. See page 487 for details.

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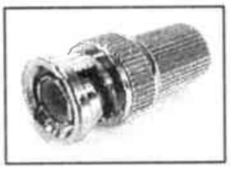


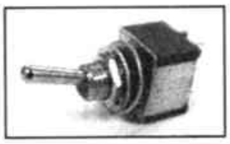
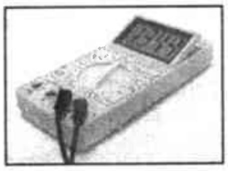

£1 BARGAIN PACKS

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

12V STEPPER MOTOR. 7.5 degree, pack of 1. Order Ref: 910.
SCREWDRIVERS. Pack of 10. Order Ref: 909.
REELS INSULATION TAPE. Pack of 5. Order Ref: 911.
10A 40V BRIDGE RECTIFIER. Pack of 1. Order Ref: 889.
LIGHTWEIGHT STEREO HEADPHONES. Moving coil so superior sound. Order Ref: 896.
25W CROSSOVERS. For 4ohm loudspeakers, pack of 2. Order Ref: 22.
REED RELAY KITS. You get 8 reed switches and 2 coil sets, Pack of 2. Order Ref: 148.
12V-0V-12V 6VA MAINS TRANSFORMER. P.C.B. mounting. Order Ref: 938.
MINI MONO AMP. 3W into 4 ohm speaker or 1W into 8 ohm. Order Ref: 495.
MINI STEREO 1W AMP. Pack of 1. Order Ref: 870.
0-1mA PANEL METER. Full vision face 70mm square. Scaled 0-100, pack of 1. Order Ref: 756.
12V SOLENOID. Has good ½" pull or could push if modified. Order Ref: 232.
6V 1A MAINS TRANSFORMERS. Upright mounting with fixing clamps, pack of 2. Order Ref: 9.
VERY FINE DRILLS. For PCB boards etc. Normal cost about 80p each, pack of 12. Order Ref: 128.
MOTORS FOR MODEL AEROPLANES. Spin to start so needs no switch, pack of 5. Order Ref: 134.
MICROPHONE INSERTS. Magnetic 400 ohm, also act as speakers, pack of 6. Order Ref: 139.
NEON INDICATORS. In panel mounting holders with lens, pack of 6. Order Ref: 180.
12V ALARMS. Makes a noise about as loud as a car horn. All brand new, pack of 4. Order Ref: 221.
OBLONG PUSH SWITCHES. For bell or chimes, these can switch mains up to 5A so could be footswitch if fitted in pattress, pack of 2. Order Ref: 263.
MIXED SILICON DIODES. Pack of 50. Order Ref: 293.
SHADED-POLE MAINS MOTOR. ¾" stack, so quite powerful, pack of 1. Order Ref: 85.
5" ALUMINIUM BLADES. Could be fitted to the above motor, pack of 2. Order Ref: 86.
LUMINOUS ROCKER SWITCHES. 10A mains, pack of 4. Order Ref: 793.
BATTERY MODEL MOTORS. Tiny, medium and large, pack of 3. Order Ref: 35.
TEST PRODS FOR MULTIMETERS with 4mm sockets. Good length, very flexible lead. Order Ref: D66.
PAXOLIN PANELS, size 8" x 6", approximately 1/16" thick, pack of 2. Order Ref: D103.
PIEZO BUZZER with electronic sounder circuit, 3V to 9V DC operated. Order Ref: D76.
ROTARY SWITCH. 6-pole 6-way, small size and ¼" spindle, pack of 2. Order Ref: D54.
FERRITE RODS. 7" with coils for long and medium waves, pack of 2. Order Ref: D52.
DITTO but without the coils, pack of 3. Order Ref: D52.
SLIDE SWITCHES. SPDT. pack of 20. Order Ref: D50.
TELESCOPIC AERIAL. Chrome plated, extendable and folds over for improved FM reception. Order Ref: 1051.
MES LAMP HOLDERS. Slide on to ¼" tag, pack of 10. Order Ref: 1054.
PAXOLIN TUBING. ¼" internal diameter. Pack of 2, 12" lengths. Order Ref: 1056.
HALL EFFECT DEVICES. Mounted on small heatsink, pack of 2. Order Ref: 1022.
PAXOLIN PANEL. 12" x 12". Order Ref: 1033.
WHITE PROJECT BOX with rocker switch in top left-handed side, size 78mm x 115mm x 35mm, unprinted. Order Ref: 1006.
NEON PILOT LIGHTS. Oblong for front panel mounting, with internal resistor for normal mains operation, pack of 4. Order Ref: 970.
WANDER PLUGS. Pack of 10. Order Ref: 986.
ANOTHER PSU. Mains operated, output 15V AC at 320mA, Order Ref: 989.
230V ROD ELEMENTS. 750W terminal-ended, 10" long, pack of 2. Order Ref: 943.
LOUDSPEAKER. 4" circular, 6ohm 3W, pack of 2. Order Ref: 951.
PROJECT CASE. 95mm x 66mm x 23mm with removable lid, held by 4 screws, pack of 2. Order Ref: 876.
SOLENOIDS. 12V to 24V, will push or pull, pack of 2. Order Ref: 877.
CROCODILE CLIPS. Superior quality, flex can be attached without soldering. 5 each red and black. Order Ref: 886.
12V-0V-12V 10W MAINS TRANSFORMER. Order Ref: 811.
18V-0V-18V 10W MAINS TRANSFORMER. Order Ref: 813.

12V RECHARGEABLE BATTERY. The Yuasa 2.3AH, whose regular price is £15, you can buy for **£3.50** and with the normal 12 month guarantee. We understand these batteries have never really been used but have simply been installed as a reserve. Order Ref: 3.5P14, or 10 for £30, VAT and carriage paid.

DO YOU NEED 240V D.C. IN A REMOTE PLACE? One easy way to get this would be using 20 of the 12V Yuasa batteries. These can easily be joined in series using our push-on tags and we will supply the 20 batteries and the 40 push-on tags for **£55**, including VAT and carriage. Order Ref: 55P2.

CHARGING THESE REMOTE BATTERIES. The ideal way, of course, would be to use solar chargers but unless you have a fortune to spend you can rule these out. The cheapest way to charge these batteries reliably is to buy an additional pack of 5 which you can carry away to a mains point. We will supply all parts to make a 75V charger which would charge the 5 up overnight. The cost of the charger kit, which includes the case and leads, is **£9**. Order Ref: 9P17.

WIND GENERATORS. Our 50V alternator, price £5, Order Ref: 5P249, would also charge them and has been suggested as a suitable means of generating electricity from the wind. At normal speeds this gives 75V and this could easily give you enough voltage and could charge the batteries in a remote place.

FIELD TELEPHONES. Outdoor events will soon be in full swing. These telephones are useful on building sites, rallies, horse shows, etc. Just join two phones together by a twin wire and you have 2-way calling and talking. You can also join one of them into the regular telephone line for outside calls if you wish to. The telephones we have are ex-British Telecom, in excellent condition, tested and in good working order, powered by batteries (not included) complete in cases with carrying sling. Price **£16** each. Order Ref: 16P8.

CHARGER FOR YUASA BATTERIES (the 12V one which we are selling for £3.50). This battery charger plugs into a 13A socket, charges at approximately ½A so it would charge the battery overnight. Complete with croc clips, ready to go, **£5**. Order Ref: 5P269.

VENNER 75A TIME SWITCH. This is a top class instrument, costs probably around £60 new. Ex-electricity board but taken out of service because they changed to solar control. These have 2 on/off per 24 hours, price **£8** each. Order Ref: 8P66.

12V MOTOR. 1/10hp with 1¼" spindle extending from each end. Motor body diameter is 3" and body length 5". Price **£8**. Order Ref: 8P65.

SOLDERING IRON. Super mains powered with long life ceramic element, heavy duty 40W for that extra special job. Complete with plated wire stand and 245mm lead, **£3**. Order Ref: 3P221.

DIGITAL THERMOMETER. Suitable for outdoors or indoors, has an extra wide temperature range −50°C to +70°C, complete with heavy duty battery which should last several years. Its sensor can be outside but with the readout inside, **£4**. Order Ref: 4P104.

MINI AM/FM TUNING CAPACITOR. Only 1" square but has a good length of ¼" diameter spindle, with 4 variable preset caps for fine tuning. Price **£1**. Order Ref: D202.

ANOTHER 7" FERRITE ROD AERIAL. This is an extra special ½" diameter with long and medium wave coils. Price **£1** each. Order Ref: D203.

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All kits are complete with PCB and other components in a blister pack. We feel that most readers will know these kits but if you want more information about them, then we have copies of the illustrated Smart catalogue available price **£1**, deductable if you order kits to the value of £20.

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FOREVER ONWARDS

One of the interesting things about electronics as a hobby is that it is continually moving forwards. Over the last couple of years we have seen microcontroller chips make large inroads into the project scene. They can be used for a wide variety of projects, and basic designs can be tailored to meet the needs of individual constructors.

Perhaps their popularity is partly due to the explosion of computer hobbyists – now they can cheaply program their own dedicated chips to perform exactly the functions they require and extend their hobby into the real world. We are beginning to see serious computer fanatics coming into electronics because of this merging of the disciplines. With programs available for under £20 and chips for under £5, it's not difficult to see why our PIC projects have taken off so rapidly.

COMPUTER LEARNING

Software for a wide range of electronics design and construction operations has been available for some time, as have educational packages. However, only now has CD-ROM software become available for the hobbyist, student and trainee. We have been so impressed by the new *Parts Gallery and Electronic Circuits and Components* that we have arranged to make it available direct to readers via our own *Direct Book Service*. Now multimedia is being used to train those with computers in electronics.

The quality of the illustrations and the text/audio commentary on this CD-ROM are of a very high standard – not surprising since the material was produced by Mike Tooley, who should be well-known to longstanding readers of *EPE*. As an introductory offer, this package is available at a discount to *EPE* readers – see page 485. Don't miss out.

The subject has always been interesting, now the learning methods are also becoming more varied and more interesting to a wider range of potential hobbyists and engineers.

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MICRO PEsT SCARER

MARK STUART

★ PIC Control ★ External Triggering ★ Two Unit Option ★

Take the humane approach to banishing unwanted "vistors" to your garden or allotment beds.

THIS project is the natural successor to our very successful earlier published design (*Everyday Electronics* May '89). It will keep pets/pests away from newly sown garden areas, and will deter them from visiting areas where they are not welcome. The frequency of operation is completely inaudible to humans, and so it can be used without annoying (or alerting!) the neighbours.

Apart from its use in gardens, there are many other possible applications – some of them of benefit to the animals concerned. One that springs to mind is as an early warning device for milk floats and other electric vehicles – which start instantly without any engine sound – and are responsible for a number of "pet" casualties each year.

ADDED EXTRAS

Additional triggering features have been incorporated into this design so that it can be driven from an external sensor – e.g. a passive infra-red detector (*see this issue*). The circuit will operate for a limited period each time it is triggered, and will then stay "silent" until the next trigger is detected. This option can be enabled or disabled as required.

Another important feature is the provision of a second output to drive another "remote" transmitter. This pulses at different times from the local one, and so gives the appearance of a separate signal coming from another direction.

As ultrasound is very directional, this will help to confuse the animal and increase the effectiveness. It will also allow wider areas to be covered.

DESIGN

A simplified functional block diagram for the Micro PEsT Scarer is shown in Fig.1. The circuit uses a 32kHz Ultrasonic Transmitter driven with short high power pulses at randomly varying intervals of between two and four seconds. Current consumption is low enough for temporary use from batteries – averaging 15mA, and would give 80 hours use from a set of six C-size rechargeable NiCads. For continuous use, it is preferable to operate the unit either from a large power source such as an old car battery, or from a simple double-insulated plug-in power supply.

A voltage regulator is included in the circuit and will accept any d.c. input from 9V to 24V and give the same performance. The supply does not need to be smoothed, as the circuit includes a suitably sized reservoir capacitor, and will work over at least 80 metres of thin twin figure-8 cable.

Another attractive possibility for power is to use a small solar panel and eight "float charged" AA size NiCad batteries. This arrangement would work for most of the "gardening" year and would be especially useful for allotments where power is not readily available, and unattended use would be an advantage.

CIRCUIT DESCRIPTION

The full circuit diagram for the Micro PEsT Scarer is shown in Fig.2. IC1 is a programmed microcontroller chip that delivers bursts of 32kHz pulses via current limiting resistor R12 to the base (b) of output transistor TR2.

The load circuit for TR2 is a resonant circuit consisting of inductor L1 in parallel with capacitor C2 tuned to 32kHz. During each ultrasonic burst TR2 is switched on and off at 32kHz.

Whilst it is turned on, current flows through TR2 into inductor coil L1 which stores up energy by magnetising the ferrite core. As soon TR2 is switched off, this stored energy causes the voltage across L1 to rise to over +50V charging capacitor C2 as it goes.

All the energy is then in C2 which discharges back into L1 driving the voltage down almost to −50V. The circuit would continue to "ring" in this way and the voltage peaks would gradually reduce, but during each cycle TR2 is turned on again, adding energy to maintain the "ringing".

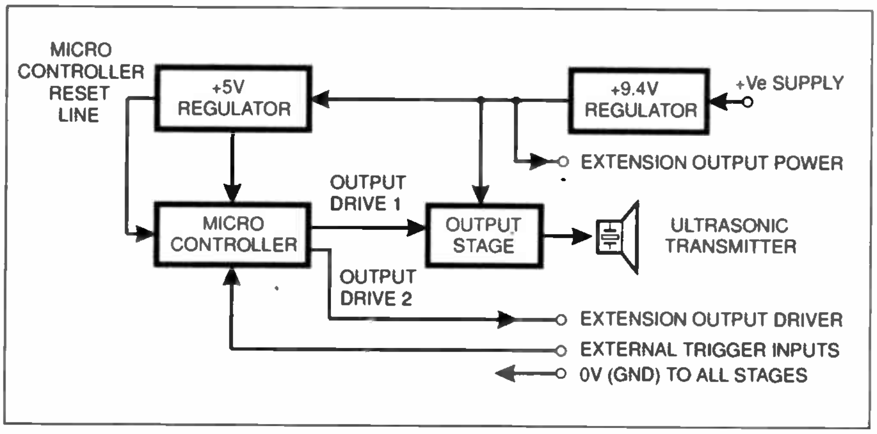


Fig.1. Simplified schematic block diagram for the Micro PEsT Scarer.

Provided the tuning is correct, and TR2 is turned on for the correct amount of time, a continuous high voltage 32kHz signal appears across coil L1, and is passed to the transmitter TX1 via Zener diode D3 and l.e.d. D4.

Diode D2 is a particularly important part of this circuit. It allows the voltage across coil L1 to swing below the negative rail. Without it, TR2 would be turned on in the reverse direction and would limit the voltage swing. To minimise energy losses, D2 ***must*** be of the type specified.

Current through the transducer TX1 is monitored by l.e.d. D4 which lights during positive half cycles to show that the circuit is operating correctly and delivering power to TX1. During negative half cycles of the output, current is routed around D4 via D3.

A low voltage Zener diode has been used for D3 so that if required, the l.e.d. can be omitted and the circuit will still operate correctly. This option can be useful if it is important not to attract attention to the device.

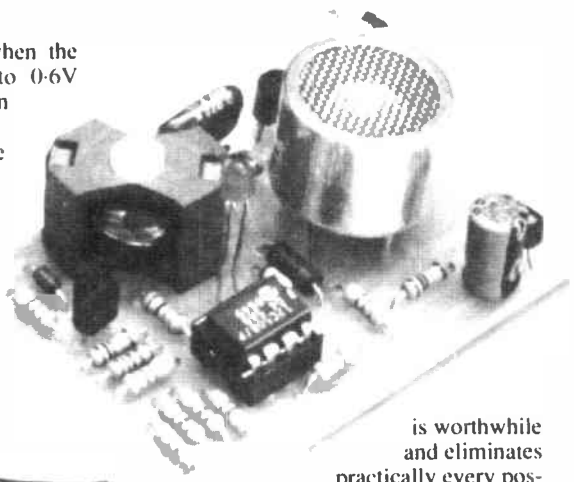
POWER REGULATION

The circuit power supply has been designed to tolerate a wide range of voltages. This is important because TX1 is driven very hard and would be damaged by overvoltage. Standard unregulated plug-in power units can produce anything up to 20V on their 9V setting, and so would be very likely to cause damage.

A voltage regulator circuit overcomes this problem by providing a constant 9·4V from any supply between 10V and 24V. Diode D6 protects against power supply reversal and passes current to 10V Zener diode D5 via limiting resistor R13.

Zener D5 works in such a way that the voltage across it is maintained at 10V over a wide range of input voltages. This regulated 10V is used as a reference voltage for the base of regulator transistor TR3.

Transistor TR3 is turned on when the voltage at its emitter (e) falls to 0·6V below its base voltage. Current then passes via D6 and TR3 to the load. If the voltage should attempt to rise above 9·4V, TR3 would be turned off, preventing any further voltage rise and so stabilising the output. Capacitor C3 provides smoothing for rough supplies, and acts as a decoupling capacitor for the 9·4V rail.



Prototype Scarer circuit board.

The 9·4V supply is used to power the output stage and to provide Extension Power if a second output stage is to be connected for "Dual Output" operation.

BROWN OUT

Power for IC1 is reduced to around 5V by means of a second voltage regulator consisting of current limiting resistor R11, Zener diode D1 and the base-emitter "diode junction" of TR1. As well as providing the low voltage supply these components also provide "Brown out" protection for IC1. Brown out is the American term for fading voltage (presumably because of the way tungsten lighting fades as the voltage is reduced).

Microcontroller i.c.s are inclined to malfunction at reduced voltage and can latch into obscure behaviour. To overcome this it is necessary to have a "Reset" pin to allow the processor to start again from the first line of the program and resume normal operation.

The device used here is normally very well behaved and will tolerate considerable supply errors without problems, however, the addition of a few components is worthwhile and eliminates practically every possibility for error. Pin 4 of IC1 is the "Reset" pin, and will return the processor to step one of the program and reset all of the internal registers when it is connected to the negative supply.

When power is first applied, resistor R3 pulls pin 4 down to the negative supply holding the processor in the reset condition. Pin 4 will remain at the negative supply voltage until transistor TR1 is turned on by base current flowing via Zener diode D1.

As the supply voltage continues to rise the voltage across D1 rises and steadies at 4·7V as D1 begins to conduct. The voltage applied to IC1 is now well within its operating range, but TR1 still remains turned off and holds the "reset" condition until the voltage at its emitter rises by another 0·6V. At this point base-emitter current flows, TR1 turns on and pulls up pin 4 to the positive supply voltage.

As soon as the "reset" pin rises, the processor starts to run, and proceeds with normal operation. In the reverse of this process, if for any reason the voltage begins to fall, TR1 turns off, the voltage on pin 4 falls, and the processor is held in

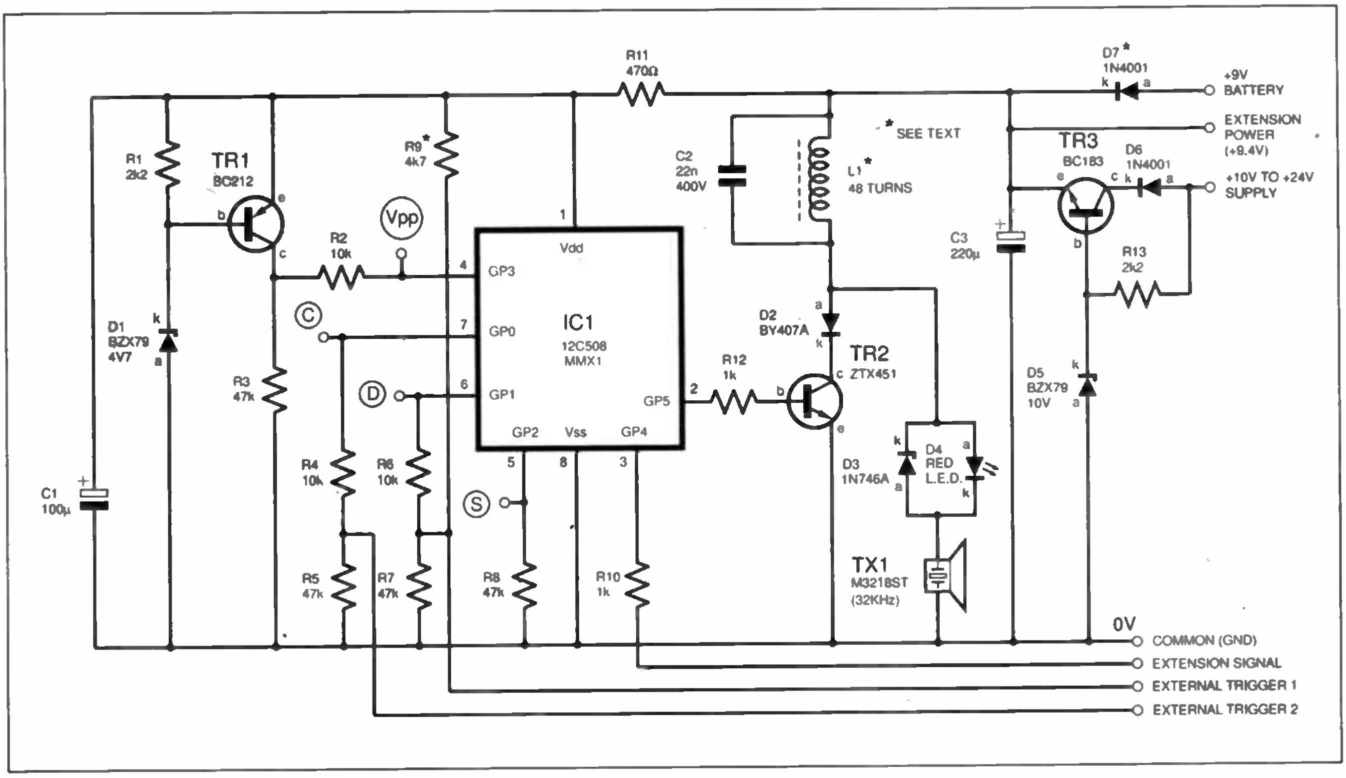
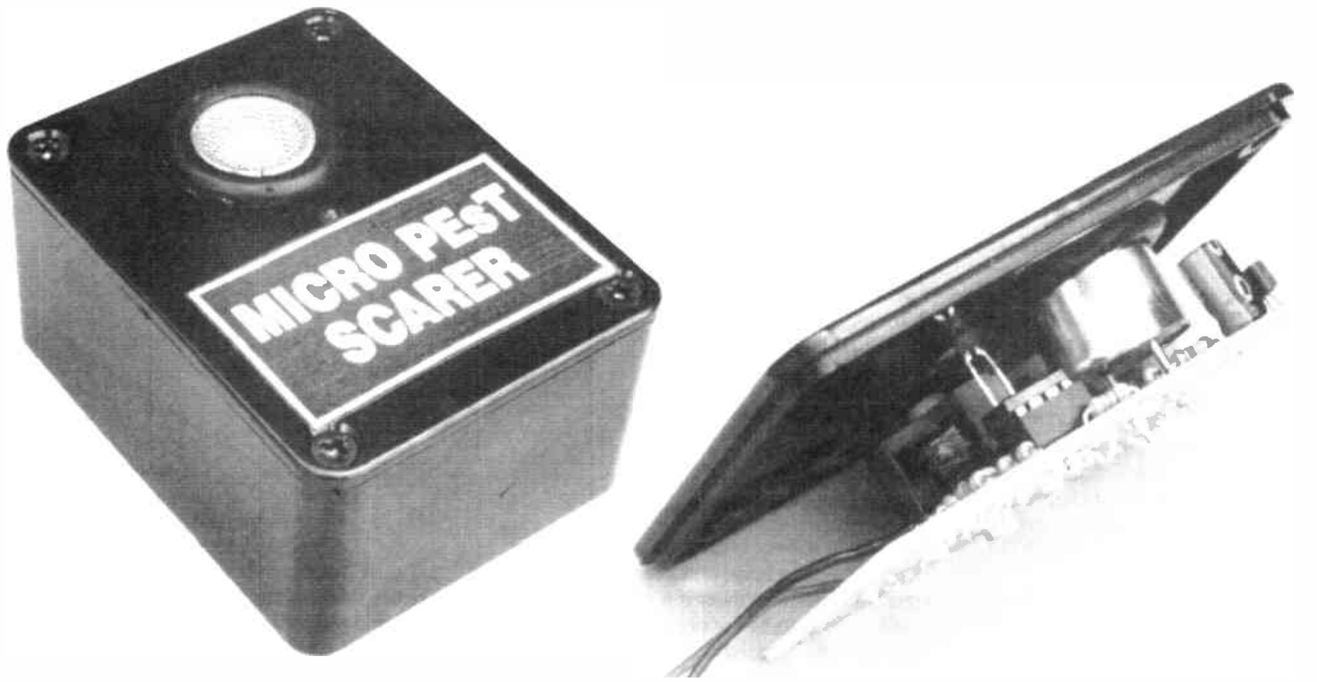


Fig.2. Complete circuit diagram for the Micro PEsT Scarer.



Mounting the prototype circuit board on the case lid using the rubber grommet and the body of the transducer to form a tight, board supporting, fit. The l.e.d. also helps to locate the p.c.b. in position.

the reset state until power returns to normal.

Regulation of the supply voltage to IC1 is provided by the series combination of D1 and the base-emitter junction of TR1. This is an unorthodox arrangement, but works very well and incorporates the "brown out" function with very few extra components.

EXTERNAL TRIGGERING

Pin 6 and pin 7 of IC1 provide the external trigger options. Resistors R4, and R6 protect IC1 from excessive current, and R5 and R7 pull down the pins to the negative supply voltage for normal operation.

Pull-up resistor R9 overrides R7 in "external trigger" mode and allows the circuit to be triggered by a negative going signal. For normal untriggered operation, the two trigger pins should be linked together so that both are pulled up by R9.

The dual output signal is always available on IC1 pin 3. This signal is used to drive a second output transistor, coil, and ultrasonic transmitter arrangement. R10 is the base limiting resistor with a similar function to R12.

To minimise the effects of cable capacitance the distance to the second output should not exceed 10 metres. For greater distances it is better to use two separate circuits – a single power supply could run two units without difficulty.

Since the two units would be operating independently, they would produce their signals at random and would therefore provide the same "confusing" signals to would-be pests.

CONSTRUCTION

The Micro PEsT Scarer is built on a small printed circuit board. Fig.3 shows the component layout and full size copper foil master. This board is available from the *EPE PCB Service*, code 162.

To make construction as simple as possible, all of the components including the l.e.d. and ultrasonic transmitter are mounted directly onto the board which becomes a complete working "module". The only wiring required is to the power supply, and to the optional output and sensing devices.

Before fitting any components, use the bare board as a template to mark the positions of the holes for mounting the ultrasonic transmitter (TX1) and l.e.d. (D4) in the case. Do this by marking through the two transducer pin holes and the two l.e.d. lead holes with a sharp point. The centres for the mounting holes are mid-way between each pair of marks.

The board can be mounted either in the lid or the base of the specified plastic box. Using the lid is more convenient as it allows better access, but it means that the four lid fixing screws are visible. Drill a 3mm hole for the l.e.d. and a hole to suit the transmitter.

CIRCUIT BOARD

Begin assembling the board by fitting all of the low profile components – resistors, and diodes. Take care to identify all of these correctly, and to insert the diodes the right way round. The line on the component layout drawing indicates the cathode (k) end of the diodes.

Make sure that the components lie flat against the board surface before soldering them. It is easier to fit and solder one or two components at a time and crop off the surplus leads on the rear of the board before fitting the next components.

Once all of the low profile parts are in place, fit a socket for IC1, and then fit

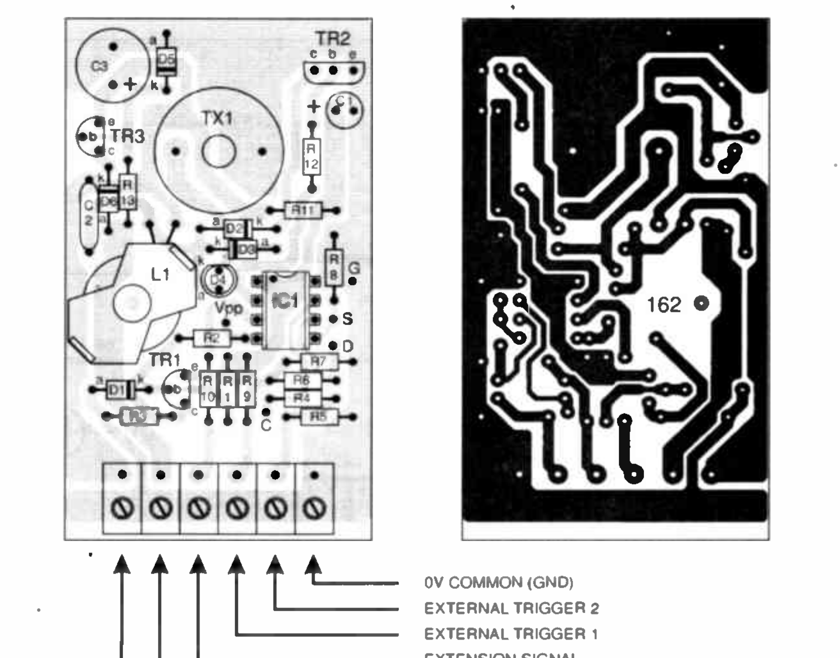


Fig.3. Printed circuit board component layout and full size copper foil master pattern. Connections to the p.c.b. are via the 6-way screw terminal block.

the capacitors. Capacitor C2 can be fitted either way round, but C1 and C3 are polarised and must be fitted with the correct polarity. The polarity is identified by a stripe – usually marked with "–" signs along the side of the capacitor nearest to the negative lead.

The transistors are all different types and cannot be interchanged. Check carefully to be sure that they are correct and fit them with their outlines matching the component layout diagram.

Do be careful to use the correct transistors – there are two pin out variations for BC212 and BC183 types, the ones used must NOT have the "L" suffix i.e. BC212L. These have the collector terminal in the middle and will not work. The correct transistors will have either a "K" suffix or *none* at all.

INDUCTOR COIL

Inductor coil L1 is supplied as a set of parts – a pair of ferrite cores, a coil former, a length of 28s.w.g. enamelled wire, a nylon M3 screw and a metal nut. Wind 48 turns of wire onto the coil former and secure the winding with a layer of adhesive tape. The winding does not need to be in neat layers, and can be wound in random fashion as there is plenty of space.

The two winding ends must be brought out on the same side of the ferrite cores so that there are 48 *complete* turns. Leave the wire ends 30mm long, scrape off 6mm of the enamel using a folded piece of fine abrasive paper, or a craft knife, and tin the two ends.

The whole assembly can now be fitted to the board using the nylon screw and fitting the metal nut on the copper track side. Cut off the unused length of the screw flush with the nut using a sharp pair of side cutters. The two wires from the coil can be connected either way round to the points marked L1 on the board.

FINAL ASSEMBLY

The board is held in position in the case by means of the ultrasonic transmitter which fits into a 18mm rubber grommet in the case panel. The l.e.d. is fitted so that it aligns with its close fitting hole in the case.

The best way to assemble this arrangement is first to fit the l.e.d. loosely into the board and then to fit the ultrasonic transmitter into the grommet in the case. Take care to fit the l.e.d. the right way round – the anode lead is the longer one, and the cathode is connected to TX1. The board can then be fitted over the transmitter pins and soldered into position.

The l.e.d. can then be pushed forward so that it fits into its hole and its leads soldered into position. If the l.e.d. is reversed it will not be damaged, but it won't light up!

The board should now be removed from the case by pressing the rim of the transmitter out of the grommet so that the circuit can be tested.

TESTING

Before fitting IC1 give the board a thorough inspection to ensure that all of the components are in the correct positions and the right way round. Check the soldering of each joint and make sure that there are no dry joints or solder bridges. Careful inspection and the use of a magnifying glass can save hours of fault finding.

The power supply secitions of the circuit should be tested before IC1 is fitted. A simple multimeter reading 0V to 10V d.c. is all that is needed, along with a power supply capable of supplying between 12V and 20V.

The supply can be either from an adaptor, or batteries, and should have some form of current limiting device to prevent damage in the event of a fault – a resistor of between 10 ohms and 100 ohms will do.

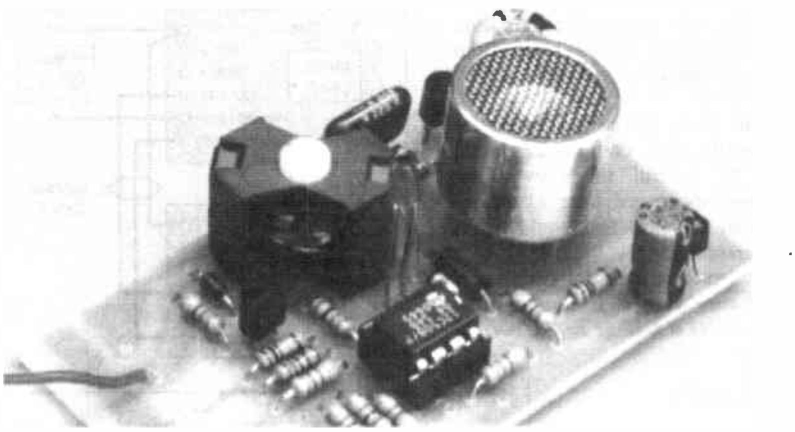
Connect the supply to the common and positive supply terminals of the board, and measure the voltage across Zener D5. This should read 10V – approximately.

If it is very low, check that D5 is the right way round. If it is higher, check that D5 is correctly soldered and that the correct component is fitted. If the voltage is correct check that there is approximately 9V across capacitor C3.

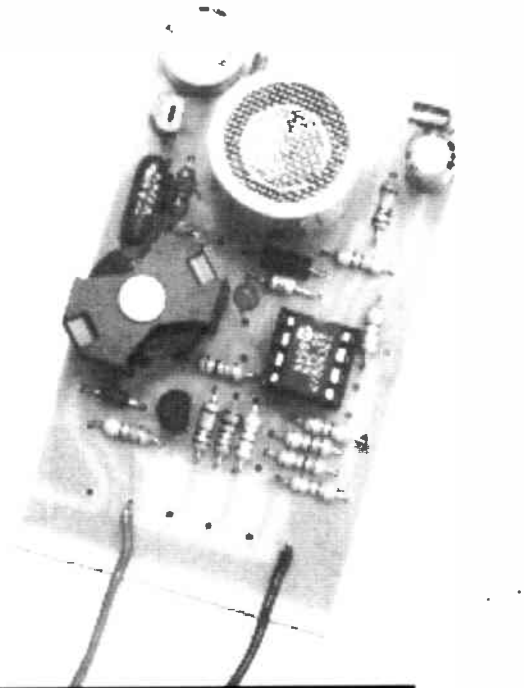
If this voltage is low, check that TR3 is fitted correctly, and then check around L1, D2, and TR2 for possible short circuits that could be responsible for excessive current drain.

Once the 9V supply is correct, check that pin 1 of the socket for IC1 is at just over 5V and that pin 4 is almost the same. If these voltages are wrong, check TR1, D1, R11, and C1.

If a variable voltage supply is available it should be possible to see the voltage on pin 4 of IC1 fall to zero as the voltage



The ferrite cores and inductor coil are held together by the board mounting nylon screw and metal nut (on the underside).



COMPONENTS

Resistors

R1, R13	2k2 (2 off)	
R2, R4, R6	10k (3 off)	
R3, R5, R7, R8	47k (4 off)	
R9	4k7	
R10, R12	1k (2 off)	
R11	470Ω	

All 0·25W 5% carbon film

See SHOP TALK Page

Capacitors

C1	100µ radial elect. 6·3V
C2	22n metallised polyester, 10mm pitch, 400V
C3	220µ radial elect. 16V

Semiconductors

D1	BZX79 4·7V 200mW Zener diode
D2	BY407A 1A fast rect.
D3	1N746A low voltage Zener diode
D4	3mm low current l.e.d. red
D5	BZX79 10V 200mW Zener diode
D6, *D7	1N4001 1A 50V rect. diode (2 off) *see text
TR1	BC212 *pnp* silicon transistor
TR2	ZTX451 *npn* high voltage switching transistor
TR3	BC183 *npn* silicon transistor
IC1	PIC12C508 MMX1 pre-programmed microcontroller

Miscellaneous

TX1	M3218ST high output 32kHz ultrasonic transducer
L1	Low loss, ferrite resonator coil (48 turns 28s.w.g. enamelled wire), plus ferrite core kit

Printed circuit board available from the *EPE PCB Service*, code 162; plastic case, size 62mm x 79mm x 39mm; 8-pin d.i.l. socket; 6-way p.c.b. mounting terminal block; 18mm rubber grommet for transducer mounting; optional plug-top "double-insulated" power supply; optional power input socket; solder etc.

Approx Cost Guidance Only £20 excluding power supply

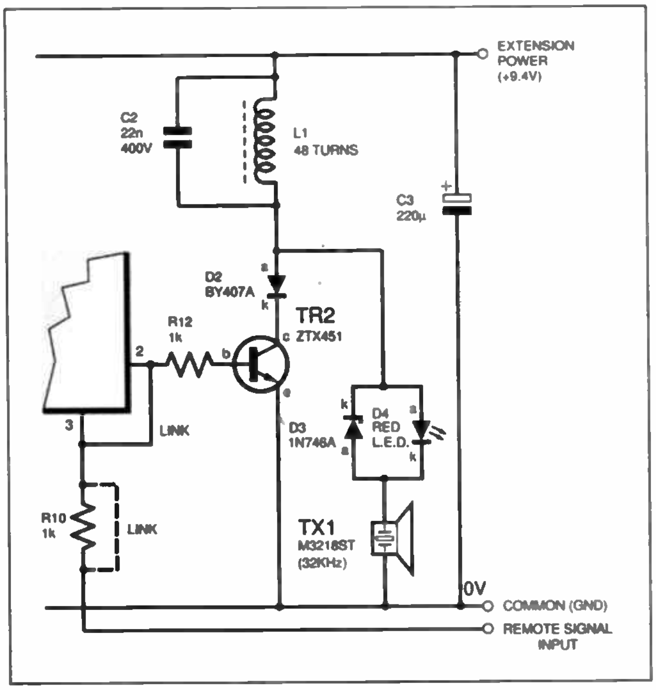


Fig.4. Extension unit modifications, just two links, one across the i.c. holder pins 2 and 3 and one across the RIO position. Plus a repeat of the components in this section of the circuit are all that is needed for the "slave" unit.

PIC 12C508 MICROCONTROLLER

This project uses a new addition to the Microchip PIC range which has been pre-programmed by Magenta so that the project can be built without any programming knowledge.

In many simple applications, the flexibility and power of a microcontroller are needed, but only a few input or output ports are required. Before this device was available it was necessary to use an 18-pin component – using more space and costing more than was necessary. (The package and shipping cost of i.c.s contributes significantly to their cost.)

With this device, Microchip have not only reduced the package size but have made full use of the available pins, and apart from the two power pins all of the other six pins can be used as I/O lines. In this configuration, an internal *R/C* clock oscillator is used instead of an external crystal. The frequency tolerance of internal oscillators is usually poor, but in this device a special "calibration" code has been programmed into each chip during manufacture to trim the oscillator to a tight specification.

Circuit Programming

Programming of the Scarer circuit is via three of the pins – one for Clock (C), one for Data (D), and a third for the Programming voltage (Vpp). The device is an OPT (one time programmable) part with 512 bytes of program memory, and 25 bytes of RAM.

For details of the programming method, refer to the Simple PIC Programmer article, published in *EPE* February, 1996, which covers a similar chip, the PIC 16C84.

It is expected that this chip will appear in many more projects – perhaps it will become the modern equivalent of the 555 timer! It is interesting to note that it costs no more than the 555 did when it was first introduced.

on pin 1 falls below 5V. It will also be posssible to check that the 5V and 9V supplies remain stable over the range of input voltages from 10V to 24V.

PULSE CHECK

Once all is well, disconnect the power, insert IC1 – the right way round with its notched end matching the component layout – and switch on. Light emitting diode D4 should light after a four second delay and should flash at two to four second intervals after that.

If D4 fails to light, check that IC1 is working by checking with a multimeter the voltages at pins 1, and 4 which should be around 5V, and by checking for the output from pin 2 which should pulse up to 1V at two to four second intervals. If the pulsing is correct, check TR2 base, which should show the pulses at a reduced level of around 0·1V. If the luxury of an oscilloscope is available it will show bursts of 32kHz on pin 2 and the base of TR2.

If the pulses are present but the l.e.d. still does not light, check the voltage at the collector of TR2 which should be 9V. If this is low, check that D2 is the right way round and that coil L1 is connected correctly and is not open circuit.

The only other components to check are TX1, D3 and l.e.d. D4. A useful way of checking D4 is to touch a one kilohm (1k) or similar value resistor across TX1. This will allow a current to pass which should light D4 if it is correctly connected and D3 is the right way round.

IN USE

With everything working, it is possible to hear a slight click each time the ultrasonic burst begins and ends. The circuit is efficient, and all of the components should stay cold in normal operation.

The circuit should not require further adjustment, and should be installed in a suitable position for use. If it is to be used outdoors the case lid should be sealed with a strip of p.v.c. tape around the joint, and the transmitter should be protected from rain by a simple plastic or wooden "shelf" or cowl.

Pieces cut from plastic drink bottles are very useful for constructing such enclosures. Be careful to allow some ventilation and not to construct a "greenhouse" around the unit that could cause excess temperature rise.

A mains adaptor is ideal for continuous use, ***but be sure that it is double-insulated and provides a voltage in the correct range.***

DUAL UNITS

The PIC microcontroller provides a second output that can be used to drive another output stage. A second board is needed and should be fitted with R12, TR2, TX1, D2, D3, D4, C2, C3 and L1.

Power is taken from the extension power connection and the common negative line, and the drive signal from the extension signal connection. A length of unscreened 3-core cable should be used for the link.

The Extension Unit must have a link fitted between pin 2, and pin 3 of the area where IC1 would fit and a link in the R10 position so that the extension signal connection is linked to R12. Fig. 4 shows this circuit alteration and Fig.5 shows the connection between the two units.

As mentioned earlier, it is also possible to power several units from a single power supply by linking them in parallel. This is shown in Fig. 6.

TAKE YOUR PIC

The chip used in this project is a recent addition to the PIC microcontroller range. It is a one time programmable (OTP) device with an internal clock oscillator, and up to six input/output pins all in an 8-pin package.

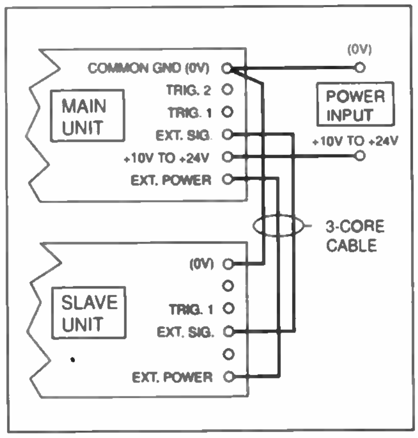


Fig.5. Interwiring between the main Scarer and a slave unit, using 3-core cable.

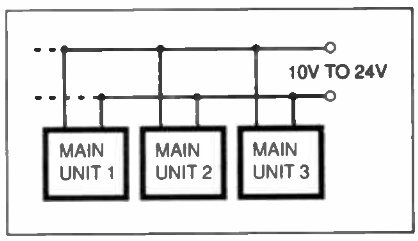
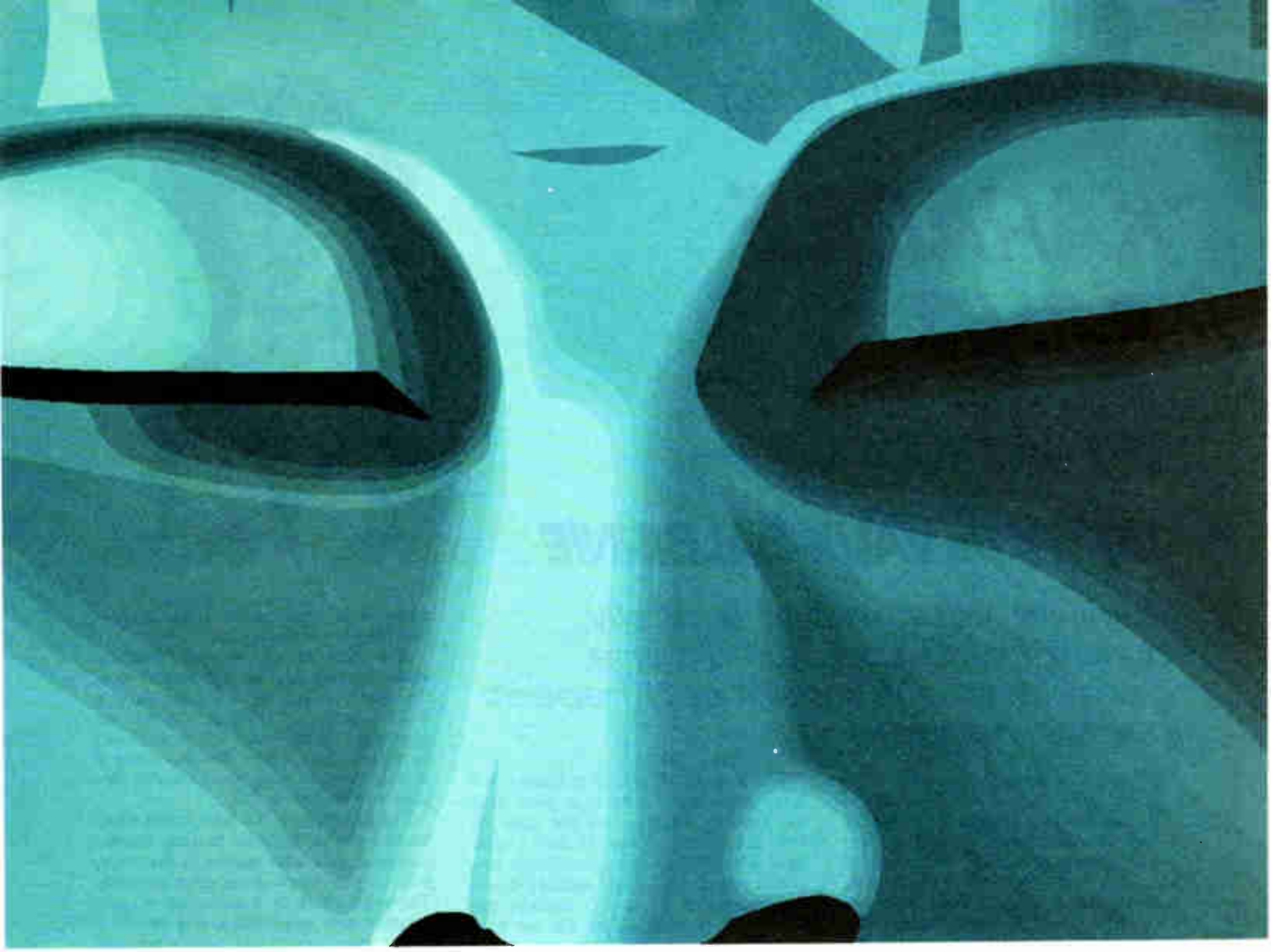
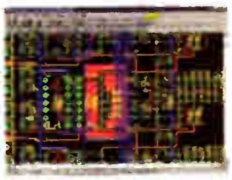


Fig.6. Running several units from a single power supply source by linking them in parallel.

The program has been written by Magenta and is already programmed into their chips – see *Shoptalk* page.

Readers who wish to program their own PICs can acquire the software either on 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* for details). The Web site file is in subdirectory PICaPEsT.





KARAOKE ECHO UNIT

TERRY de VAUX-BALBIRNIE

Assure yourself of a really tuneful way to liven up the party and a guaranteed repeat performance!

THERE is nothing like Karaoke to get the party going. For the uninitiated, this involves singing the words of a song to a professionally-made musical accompaniment or backing. For occasional use, there is no need buy a commercial Karaoke machine because most of the expensive parts will probably already exist in the home. (*Karaoke*, according to the Oxford dictionary, is Japanese for *empty orchestra*.)

BASIC REQUIREMENTS

All you need is this Karaoke Echo unit, a microphone, a domestic hi-fi amplifier and a pair of speakers. Check that the amplifier has auxiliary (Aux) inputs to enable the Karaoke Echo to be plugged in.

You must also have a recording of the music and, of course, some means of playing it. Karaoke music is available in the form of audio cassettes, compact discs and videos.

The Karaoke Echo Unit is housed in a small metal case. On the front panel there are controls which adjust the echo effect and volume. There is also a standard 6·35mm (0·25 inch) microphone jack socket and an l.e.d. (light emitting diode) indicator which serves as a reminder that the circuit is switched on. On the back there are sockets for input and output connections and an on-off switch.

The circuit consumes approximately 30mA and will normally be powered by an internal battery. An alkaline PP3 type may be expected to provide about 15 hours of service and a standard one rather less. For long periods of use, a commercial d.c. plug-in power supply unit could be used or, of course, a larger external battery.

MANY SOURCES

If an audio cassette or a CD is to be the source of the backing music, then a suitable player will be needed. This could be an inexpensive personal stereo having a headphone output socket from which to feed the Karaoke Echo Unit.

If a video cassette is used, then the video playback machine will need to have line output sockets or, as is more usual, a SCART output. A video cassette has the advantage that the words will be displayed on the television screen. The alternative is to sing from the song sheet usually supplied with the tape or CD.

The popularity of Karaoke comes about because the professional musical accompaniment, plus echo applied to the voice, makes a poor singer sound quite tolerable. The echo effect in a bathroom is, presumably, why people like to sing there!

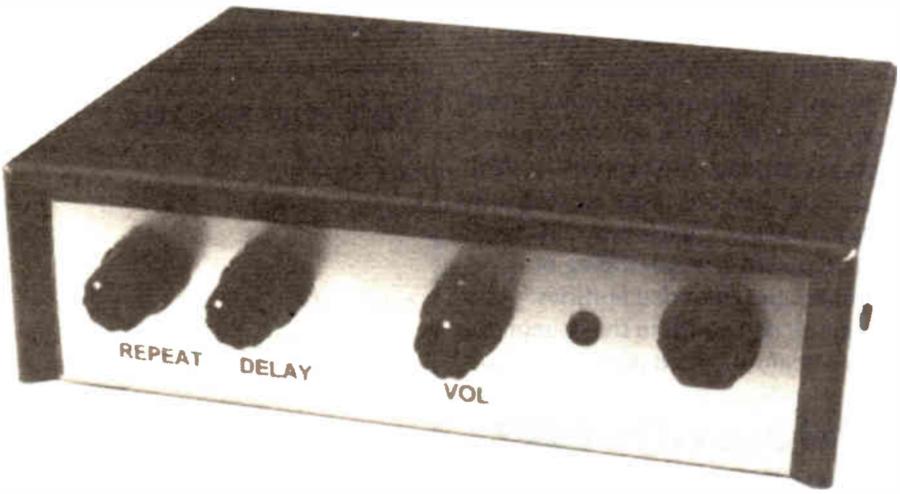
Just about anyone can make a passable attempt at Karaoke singing. This boosts their confidence, adds to the fun, and brings quieter members of the party out of their shell.

Note that if the user is going to use this system for public performances, a Performing Rights Licence is required. The address of the issuing authority in the UK is given at the end.

Although this Karaoke Echo Unit is a "budget" system, it is of a high quality. The price is kept low by providing only limited features.

For example, a commercial system will probably be fitted with at least two microphone inputs having independent controls. In this design, there is provision for only one microphone, so two or more singers will need to share it.

Also, there is no separate microphone volume control. If using the headphone output on the playback machine, the volume control on this will be used to balance the sound from the microphone with that of the backing. In other cases, the volume from the microphone will be adjusted by varying its position.



HELLO, HELLO, HELLO

The system is shown in block diagram form in Fig.1. Producing the echo involves delaying some of the microphone output and feeding it back to the input. The delay time and number of times the echo repeats as it gradually fades away are both adjustable using controls on the unit. These will

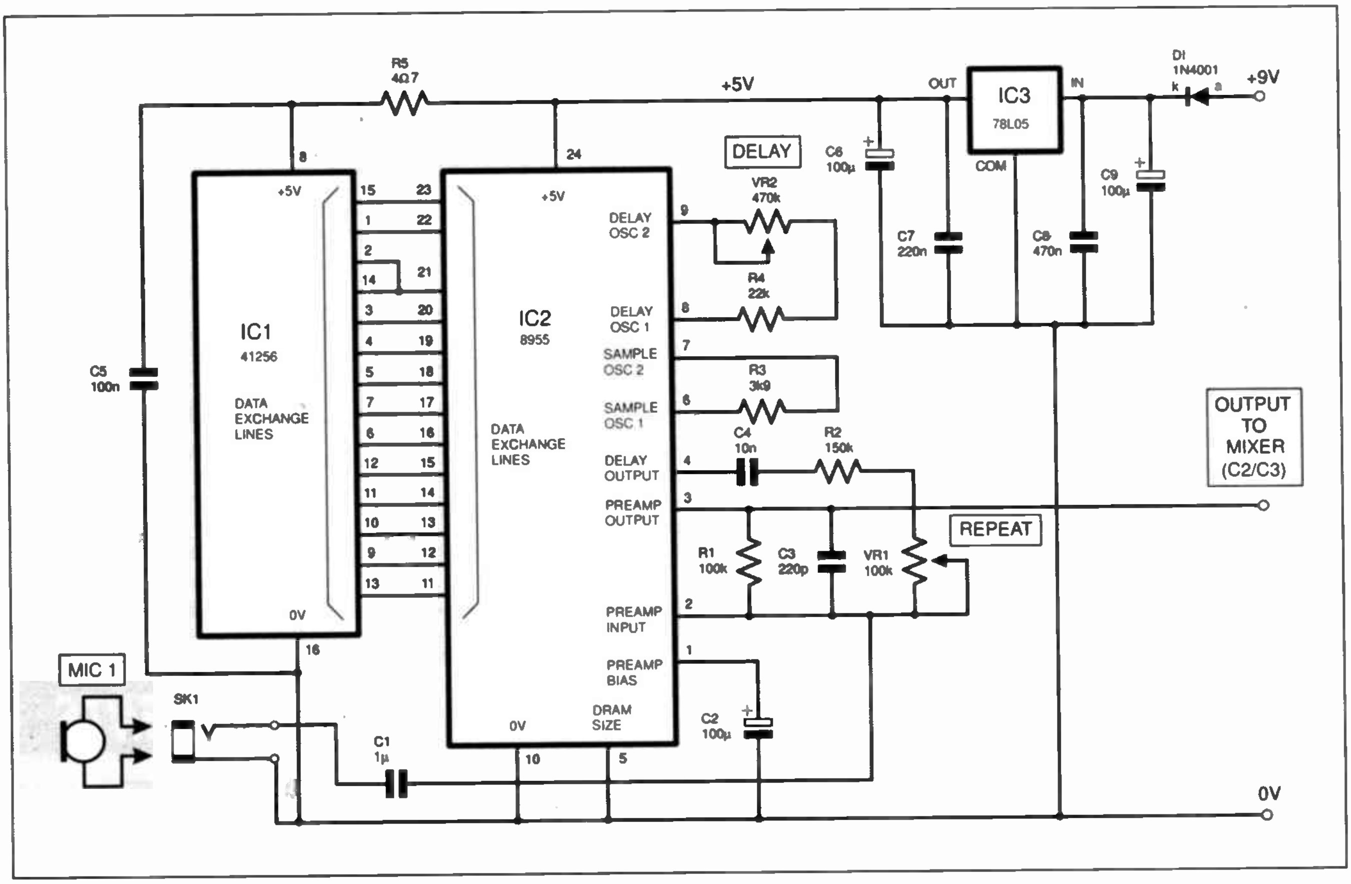


Fig.2. Circuit diagram for the Echo section of the Karaoke Echo Unit.

be set to best effect for a particular singer and song.

The output from the echo circuit is applied equally to each channel of the external power amplifier via a mixer circuit. The voice will therefore appear to come from the centre position between the speakers. This saves quite a lot of cost by not having to duplicate the echo circuit and, of course, avoids the need to purchase a second microphone.

If the levels between the left and right channels are not quite the same, the balance control on the amplifier may be used to correct them.

The echo circuit and audio mixer are described and constructed separately. The reason is that some constructors will require only a simple voice echo unit (possibly for a stage production) or they may already have a suitable mixer.

ECHO UNIT

Most of the microphone signal processing, including the echo effect, takes place in a single 24-pin integrated circuit. This is not the only way of achieving echo, of course, and this system appears to work in a very roundabout way. However, the final effect is one of high quality with little background noise.

Firstly, the microphone signal is boosted by an on-chip preamplifier. It is then digitised by a 10-bit analogue-to-digital converter. The sampling rate is set by an on-chip oscillator which operates at 25kHz. This rate (although less than that for a CD) provides a good digital representation of the microphone signal.

The digital samples are stored in a separate 256 kilobit (32Kbyte) DRAM (dynamic random access memory) i.c. This allows alternative memory chips to be used. Thus a 64 kilobit one would provide a shorter delay time.

The larger capacity unit was chosen for this design because longer delay times are appropriate to certain material and may be useful for special effects.

For example, the delay time may be increased on the last word of the song. Under the action of a further oscillator (the time delay oscillator), the digital information is drawn out of the DRAM after a period ranging from almost zero up to 0·8 seconds. The result is applied to a 10-bit digital-to-analogue converter so that a copy of the original sound signal is obtained.

Some of this is fed back to the input, where it begins a further cycle so that the echo repeats and gradually fades away. The final output is therefore a composite of direct microphone output and echo. This is passed to an external mixer where it is combined with the output from the musical backing source.

Only a small number of external components are required for decoupling, to set the oscillator frequencies and to provide adjustments to delay and repeat times.

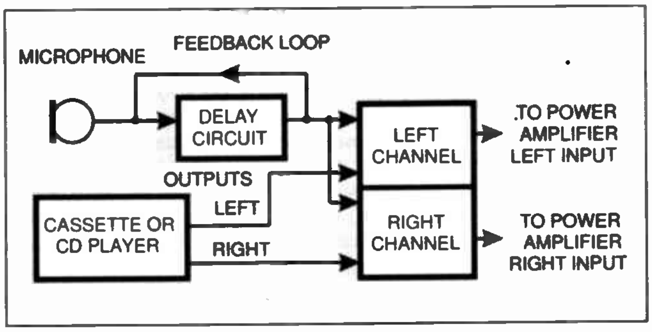


Fig.1. Block diagram for the Karaoke Echo Unit.

ECHO DETAIL

The complete circuit diagram of the Echo section is shown in Fig.2. IC2 is the digital audio processing i.c. and IC1 is the memory chip.

It is appropriate to explain the action of the unit by giving a pin-by-pin description of IC2, the digital processor:

Pin 1 is the bias input of the on-chip preamplifier. This is simply connected to the 0V line via decoupling capacitor C2.

Pin 2 is the preamplifier input and this accepts the output from the microphone, MIC1, through a.c. coupling capacitor C1.

Pin 3 is the preamplifier output. This provides a boosted signal which is passed on to the separate Mixer stage. Resistor R1 is needed for correct operation of the preamp and capacitor C3 prevents any tendency for the system to oscillate (becoming unstable and generating a high frequency signal, which sometimes happens in this type of circuit).

Pin 4 is the delayed audio output. Capacitor C4 a.c. couples this signal back to the input, pin 2, via resistor R2 and potentiometer VR1 (connected as a variable resistor). This latter component (labelled Repeat) provides control of the amount of signal fed back, and thus controls the number of times the echo is re-generated as it fades away.

Pin 5 selects the size of DRAM chip used. If the 64K variety were to be used,

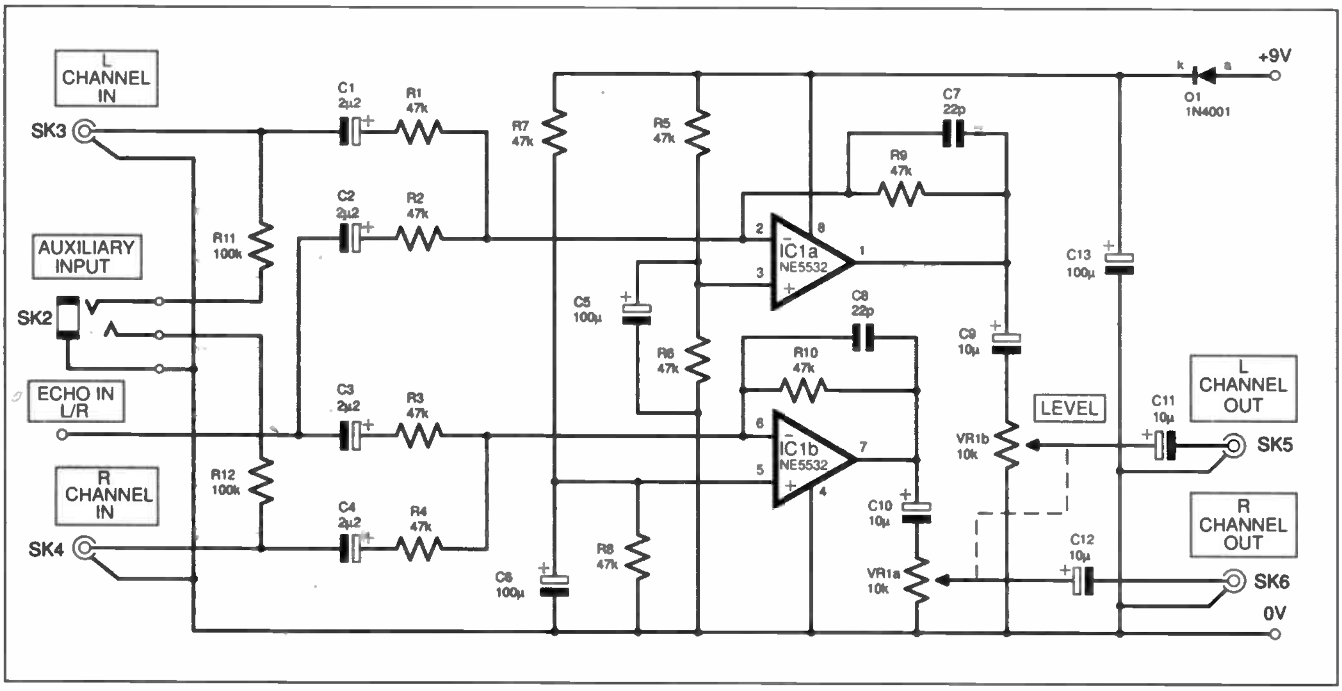


Fig.3. Circuit diagram for the Mixer stage.

COMPONENTS

ECHO UNIT

Resistors

R1	100k	See SHOP TALK Page
R2	150k	
R3	3k9	
R4	22k	
R5	4Ω7	
R6	470Ω	

All 0·25W 5% metal film.

Potentiometers

VR1	100k min. rotary carbon, p.c.b. mounting (17mm dia.) lin.
VR2	470k min. rotary carbon, p.c.b. mounting (17mm dia.) lin.

Capacitors

C1	1µ min. metallised polyester (5mm pin spacing)
C2, C6, C9	100µ radial elect. 16V (3 off)
C3	220p polystyrene
C4	10n min. disc ceramic
C5	100n min. disc ceramic
C7	220n min. metallised polyester (5mm pin spacing)
C8	470n min. metallised polyester (5mm pin spacing)

Semiconductors

D1	1N4001 50V 1A rect. diode
D2	3mm red l.e.d.
IC1	41256 256Kbit DRAM
IC2	HT8955A digital audio processor
IC3	78L05 +5V 100mA voltage regulator

Miscellaneous

SK1	6·35mm (0·25in.) mono jack socket
B1	9V alkaline battery (PP3)
S1	min. s.p.s.t. toggle switch

Printed circuit board, available from the *EPE PCB Service*, code 159; battery holder, chassis mounting; knob (2 off); l.e.d. mounting clip; 16-pin d.i.l. socket; 24-pin d.i.l. socket (0·3 inch width); plastic feet (4 off); aluminium case (155mm × 120mm × 46mm); connecting wire; solder, etc.

Approx Cost Guidance Only £26

then pin 5 would be left unconnected. For the 256K chip used here, it is taken to 0V.

SAMPLING SPEED

Pins 6 and 7: resistor R3, connected between pins 6 and 7, determines the frequency of the system oscillator, so controlling the rate at which the analogue input signal is sampled. With the resistance value specified, the rate will be 25kHz.

Pins 8 and 9: the resistance between pin 8 and pin 9 determines the frequency of the delay oscillator. Since this needs to be adjustable, potentiometer VR2 (labelled Delay), which is connected as a variable resistor, provides the variation, while fixed resistor R4 sets the minimum delay time (VR2 set to zero).

Pin 10 is the 0V connection for the chip.

Pins 11 to 23 are associated with the DRAM interface and are responsible for exchanging information between the two i.c.s. The method of processing this information is fairly complex and a detailed description would not be appropriate here. It is sufficient to say that pins 11 to 23 are connected to IC1, the DRAM chip, via its pins 1 to 15 (excluding pin 8).

Pin 24 is the 5V positive supply input.

ECHO POWER SUPPLY

IC3 is a 5V regulator which provides the correct operating voltage for the i.c.s of the Echo circuit, allowing a nominal 9V d.c. supply to be used as the power source. Diode D1 provides protection against connecting the battery with incorrect polarity.

Capacitors C6 to C9 improve the stability of the power lines. The inclusion of resistor R5 and capacitor C5 were found to be necessary to limit power line surges during the DRAM's read/write cycle (memory chips can be hungry for power by varying amounts during this cycle).

MIXER UNIT

The circuit diagram of the Mixer unit is shown in Fig.3. This is based on IC1 which is a dual low noise operational

COMPONENTS

MIXER UNIT

Resistors

R1 to R10	47k (10 off)	See SHOP TALK Page
R11, R12	100k (2 off)	

All 0·25W 5% metal film.

Potentiometer

VR1	10k min dual rotary carbon, p.c.b. mounting (17mm dia.) log.

Capacitors

C1 to C4	2µ2 radial elect. 16V (4 off)
C5, C6, C13	100µ radial elect. 16V (3 off)
C7, C8	22pF polystyrene (2 off)
C9 to C12	10µ radial elect. 16V (4 off)

Semiconductors

D1	1N4001 50V 1A rectifier diode
IC1	NE5532 dual low noise op.amp

Miscellaneous

SK2	3·5mm stereo jack socket
SK3 to SK6	phono socket, chassis mounting (4 off)

Printed circuit board, available from the *EPE PCB Service*, code 160; knob; 8-pin d.i.l.socket.

Approx Cost Guidance Only £12

amplifier; that is, it contains two separate op.amps in one encapsulation.

The two op.amp sections, labelled IC1a and IC1b, are responsible for the Left and Right channels respectively. They are used as identical inverting amplifiers. The arrangement is fairly standard and only a basic description, referring to the lefthand channel around IC1a, will be given here.

IC1a's non-inverting input, pin 3, is connected to a potential divider consisting of equal-value resistors R5 and R6. This fixes the d.c. operating level to one-half that of the supply, nominally 4·5V for a 9V supply.

The signals to be mixed are fed to the inverting input, pin 2, via a.c. coupling capacitors C1 and C2, and equal-value resistors R1 and R2. Resistor R9 feeds some of the output back to pin 2 and has the same value as the input resistors. This results in unity gain, in other words, no amplification (or attenuation) is given to the signals.

Feedback capacitor C7 very slightly restricts the upper frequency limit of the circuit, helping to reduce noise levels.

The mixer is designed to accept medium level "line" input signals, brought in from the audio source via phono sockets SK3 and SK4. Higher level signals, such as those from the headphone output socket of an audio source, can be brought in via the auxiliary input socket, SK2. Here resistors R11 and R12 are included to suitably attenuate the signals.

Processed vocal signals arriving from the Echo unit are passed, via capacitors C2 and C3, to the inverting inputs of each op.amp (that is, equally to left and right channels), where they are mixed with the music signals. Depth and realism will be provided by the stereo effect of the backing.

The audio output from each op.amp is a.c. coupled to the dual-ganged potentiometer VR1 by capacitors C9 (left channel) and C10 (right channel). The left and right outputs are then passed on to the "Aux" inputs of any ordinary power amplifier via capacitors C11 and C12 and phono sockets SK5 and SK6.

As with the Echo circuit, 9V power is brought in via a diode, D1, which gives protection against connecting the battery with incorrect polarity. Decoupling is provided by capacitor C13. Note that the exact operating voltage of this circuit is unimportant (it could be between about 5V and 18V), unlike the 5V limit imposed by the i.c.s in the Echo circuit.

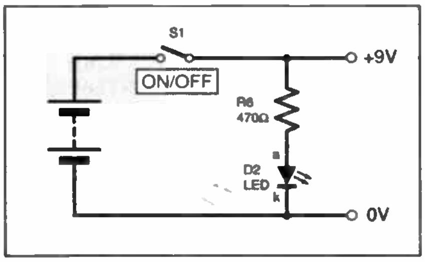


Fig.4. Details of the power supply.

POWER SUPPLY

Circuit details of the 9V power supply are shown in Fig.4. Battery B1 is switched on by S1 and is fed to both circuits.

Diode D2 is a light emitting diode which shows when the circuit is switched on. Resistor R6 limits the current drawn by D2 to about 20mA. Omitting R6 and D2 will increase the working life of the battery.

CONSTRUCTION

As in the circuit descriptions earlier, the Echo and Audio circuits are constructed on seperate printed circuit boards (p.c.b.s) and will be considered separately. This will enable readers who wish to use only one of them to act accordingly.

It is best to cut the potentiometer spindles to the correct length before proceeding. This will avoid possible damage in cutting them after they have been soldered to the circuit boards.

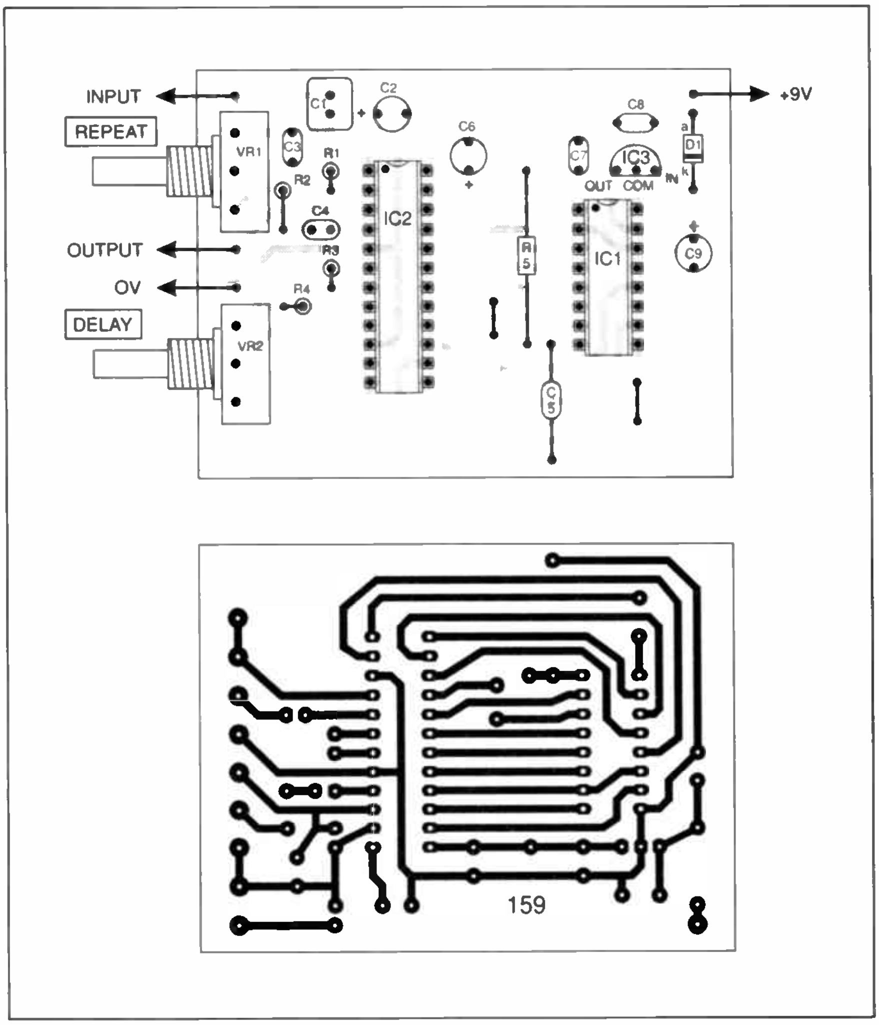
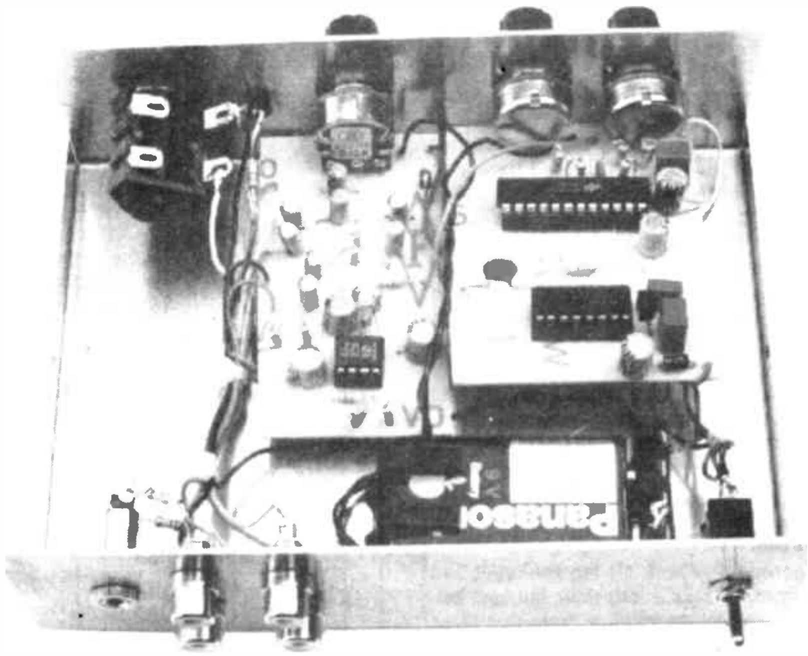


Fig.5. Printed circuit board component layout and full size copper foil track master pattern for the Echo unit.



First, fit control knobs to the spindles and decide on the length which needs to be removed. Remove the knob and, using a small vice, hold the spindle near the cutting point (do not grip the body). Support the potentiometer body with one hand and cut the spindle to size using a sharp hacksaw. Cut the other two spindles similarly and file all edges smooth.

ECHO BOARD

The printed circuit board (p.c.b.) layout for the Echo stage is illustrated in Fig.5. This board is available from the *EPE PCB Service*, code 159.

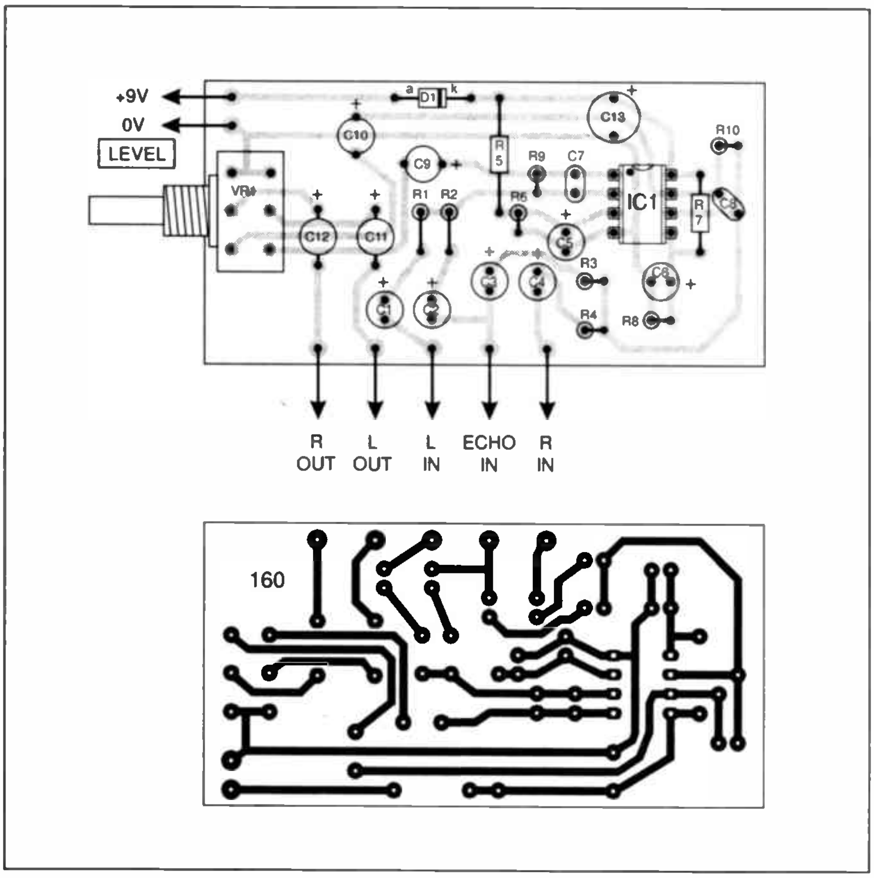


Fig.6. Printed circuit board component layout and full size copper foil track master pattern for the Mixer unit.

Begin by soldering the i.c. sockets in position. Note that the 24-pin socket is the narrow type, i.e. 0.3 inch width (7.62mm). Insert the two link wires and diode D1 (observing its correct polarity).

Follow with all resistors and capacitors. Note that three of the capacitors (C2, C6 and C9) are of the electrolytic type and must be connected with the correct polarity.

Solder regulator IC3 in position. It is important to note that with the specified device, the flat face will be adjacent to IC1. It seems that certain regulators of a similar type have their outer pins interchanged. If there is any doubt over this point, measure the voltage between IC2 socket pin 24 and the 0V line at the end of construction. This must be done with IC1 and IC2 removed because an excessive voltage would ruin them.

Solder potentiometers VR1 and VR2 to the board; use either p.c.b. mounting types, or solder them to 1mm terminal pins inserted into the board. Then solder 15cm pieces of light-duty stranded connecting wire to the points labelled Input, Output, +9V and 0V.

Thoroughly check all the soldering and then insert the i.c.s into their holders, observing correct orientation. Note that these are CMOS components and, as such, are liable to damage by static charge which might exist on your body. To prevent possible problems, touch something which is earthed (a water tap, for example) before handling the pins.

MIXER

The p.c.b. layout for the Mixer section is shown in Fig.6. This board is available from the *EPE PCB Service*, code 160.

Begin assembly of the p.c.b. by soldering the i.c. socket in position. Follow with diode D1 (observing the polarity) and all resistors and capacitors. It is essential to observe the polarity of all of the electrolytic capacitors.

Solder the potentiometer to the board. Now solder 15cm pieces of light-duty stranded connecting wire to the points labelled +9V, 0V, R Out, L Out, L In and R In (but not to Echo In). Insert the i.c. into its socket with the correct orientation. Check all your work!

CASE PREPARATION

It is necessary to use a metal case as a housing for this circuit. This provides screening and gives common earth (0V) returns for the input and output sockets.

Temporarily hold the p.c.b.s inside the case, positioning them so that there is adequate clearance between their track-sides and the base to prevent short circuits. Mark the positions of the potentiometer spindles. Remove the p.c.b.s and drill holes in the front panel to correspond. Make holes also for the l.e.d. clip and the microphone jack socket SK1.

Drill holes in the rear panel for the four phono sockets (SK3 to SK6), jack socket SK2 and the on-off switch S1. Drill holes in the base for the battery holder.

Mount the phono sockets. All but one of the solder tags supplied with them may be discarded; retain a solder tag on only one socket. Solder the output wire from the Echo unit p.c.b. to the Echo In pad on the Mixer board.

PANEL ATTACHING

Secure the p.c.b.s to the case via the potentiometer bushes and their nuts. Mount all remaining components. Check that the tip of the microphone jack plug makes proper contact with the corresponding one on the socket, SK1. This does not always happen if budget price sockets are used.

Plug in the microphone and check that the tags are not open circuit by using a multitester set to an ohms range (expect a reading of about 600 ohms). The author had to bend the tip contact of the socket inwards slightly so that it made reliable contact.

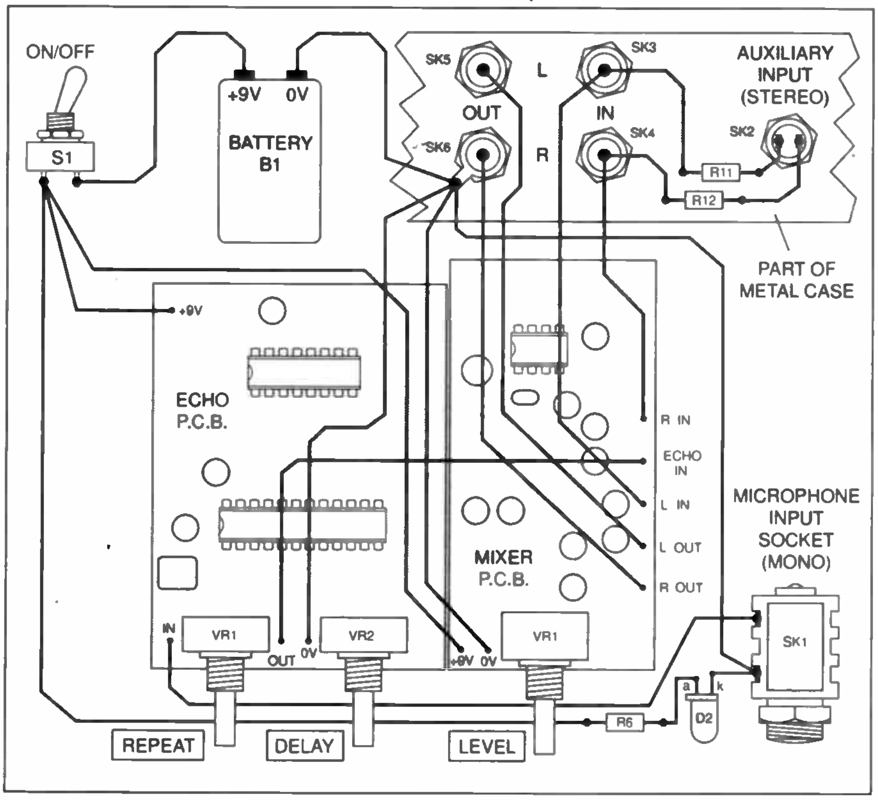


Fig.7. Details of the interwiring to all the off-board components.

Note that the mono jack socket may have four tags. Two of them are "break" contacts and can be ignored.

With the 3·5mm socket it may not be immediately obvious which tag is which; if necessary insert an open jack plug and check with a multimeter.

When satisfied about the above points, refer to Fig.7, which shows the point-to-point wiring details. Complete the wiring, shortening any wires as necessary. Use the solder tag on the chosen phono socket as a common anchorage point as shown.

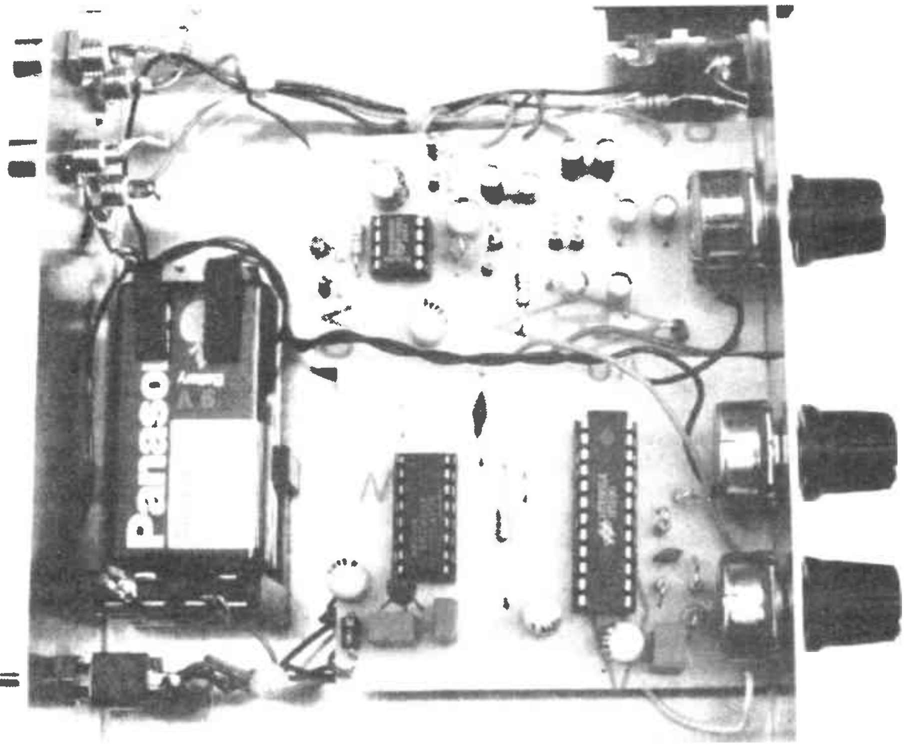
Note that the l.e.d. (D2) must be connected with the correct polarity or it will not work – the slightly shorter end lead is normally the cathode (k) as marked in the diagrams. This connects directly to the outer tag of the microphone jack socket SK1 (which is a convenient nearby earth point).

Resistor R6 is soldered in series with the l.e.d. as shown (do not connect the l.e.d. to the power supply without this resistor – that would destroy it. Solder resistors R11 and R12 between the tags of socket SK2 and those on the Left and Right channel phono input sockets (SK3 and SK4).

The nuts for the battery holder fixings should be on the underside of the case. Cut off any excess bolt shank so that it is level with the nuts, then file the edges smooth. Attach self-adhesive plastic feet to the base of the case and check that the nuts remain clear of the work surface.

Attach the potentiometer control knobs and label their functions; also label the output sockets on the back.

Make up suitably long leads with phono plugs on each end (or as appropriate for the amplifier).



TESTING

Testing is simply a matter of checking for correct operation. With switch S1 in the Off position, and with all three controls adjusted fully anti-clockwise, connect the battery, taking care over its polarity.

Using the phono-plugged leads, connect left and right outputs of the unit to the respective "Aux" inputs on the amplifier. If a video cassette player having a SCART socket on the back is to be used, obtain a lead which provides both audio output channels in the form of phono plugs.

Ready-made leads are available and these generally also have video input and output plugs. The latter, of course, are ignored. A cheaper alternative would be to make a lead yourself to provide access only to the audio signals.

If using the headphone output of a personal cassette or CD player, use twin screened cable with a 3·5mm stereo jack plug (or as appropriate to the player) on one end and a 3·5mm stereo jack plug on the other. Ready made leads of this type are also available.

Adjust the Volume control on the music playback unit to about one-quarter of total rotation. Set the amplifier to "Aux" input, adjust its Volume control to minimum and switch it on. Switch on the unit and note that the l.e.d. comes on.

Play the music and turn up the Volume on the amplifier to about one-quarter of its total rotation. Turn up the Volume control (Level) on the unit until the music reaches a listenable level without distortion, then turn up the amplifier Volume control for best effect.

If the output from a headphone socket is too high or low, change the values of the resistors (R11 and R12) connected between the phono input sockets (SK3 and SK4) and the auxiliary jack socket (SK2). Raising their values will reduce the level, and vice versa.

If the volume is too high, the sound will be distorted even when the Volume control on the unit is set very low.

When satisfied, check the microphone input without the music playing. Speak closely into the microphone. If the Volume controls are set too high, acoustic feedback will be heard (a howling noise from the speakers). Reduce the level slightly so that it stops.

Check the effects of the Repeat and Delay controls. Now try with the backing music. Make further adjustments for best effect.

ALTERNATIVE P.S.U.

For long periods of use, a plug-in d.c. power supply would be more appropriate. This should have an output of between 7·5V and 9V. Note that inexpensive unregulated units often provide a much higher output voltage than their nominal value under conditions of small load (this circuit classifies as a small load). Check with a voltmeter before using this type of power supply.

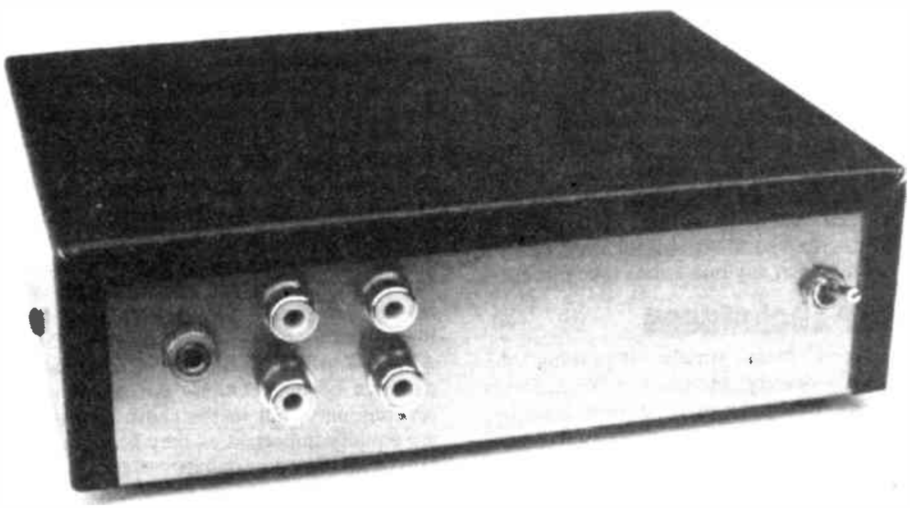
To avoid any such problem, preferably use a regulated supply having a 9V d.c. output. A power-in type socket could be fitted on the back of the unit and the connection previously taken to the battery soldered to this instead. The outer (sleeve) connection should be the negative (0V) line.

When using the system, don't forget to make a recording of the outcome using the cassette deck of the hi-fi system. Hearing their efforts played back is very entertaining for all concerned. You could also use the result as a new backing tape and add further voices.

Let's party!

PERFORMING LICENCE

Licences permitting the public performance of music are available from:
Phonographic Performances Ltd.
Ganton House
14-22 Ganton Street
London W1V 1LB
Tel: 0171 437 0311.



New Technology Update

Anyone interested in computing cannot fail to recognise the fact that disk drives are becoming cheaper and able to store more – reports Ian Poole.

THE EVER increasing requirements for even more storage space are pushing disk drive manufacturers to make cheaper and larger drives. Much of this has been fuelled by the success of "Windows" and all its associated software.

In the early days of PCs the operating systems were very crude by today's standards. Windows, in its recent forms, is now the accepted standard for PCs. It is far more user friendly, but at the cost of the use of far more memory, both within the computer as RAM and in long term storage as disk capacity. Not only is the operating system more sophisticated, but so too are all the other programs which can be run, from word processors and spreadsheets to games and teaching aids.

Too Small

To give a measure of this increase, less than ten years ago a 20Mbyte drive was considered large. Nowadays, a 20Mbyte drive would not be worth installing into a new machine because it is too small to take most of today's new software.

Currently manufacturers are seeing an increase in density of around 60 per cent per year, and there appears to be no slow down in the requirements for improvements. Not only has the capacity increased, but the physical size of the drives has also decreased. Some years ago 140mm was the accepted size. Now this has been reduced to 90mm or even 64mm.

To keep up with the requirements for increased capacity, increased speed and reduced size, drive manufacturers have needed to employ many new techniques. Although existing techniques have been refined to very high degrees, this alone has not been sufficient to provide the levels of performance which are required now.

Many new techniques have been introduced, and many existing techniques are approaching the limits of the technology. For example, improvements in read/write head sensitivity, or reduction in the height above the disk can only be taken to certain limits, beyond that new methods must be sought.

MR Heads

In the early days of disk drives, inductive heads, akin to those used on tape decks were employed. Now many manufacturers are using magneto-resistive (MR) heads. These rely on the flux around the head changing the resistance of the element in the head. This enables much smaller track widths to be used as well as higher data densities.

They also have the advantage that the output is not proportional to speed, which is the case for inductive heads. As a result, this overcomes the problem that towards the centre of the disK, where the linear speeds are slower for a given rotational speed, the output is less and densities have to be reduced.

The actual head simply consists of the resistive element whose resistance changes with the varying magnetic field. As this is not a wound element it can be made very much smaller and more cheaply than the inductive heads. However, the main advantage is that these heads can be used to read data off higher densities than inductive ones.

The drawback of MR heads is that they cannot be used for writing. This means that an inductive head is still required to perform this function, but despite this it is still possible to gain significant improvements in density. Track widths can be made much smaller because they are able to cope with much greater levels of tolerance when the read head is slightly off the centre of the write track.

The use of separate read and write heads also means that each head can be optimised for its particular function of either writing or reading data. Previously one head had to perform both operations.

High Flyers

For the future there are further developments which are being undertaken. IBM are looking into an MR head which can detect field strengths of one fifth of that required at the moment. This could significantly increase the data densities which could be attained on the disk by a factor of around five or six, and this may only be a few years away from being introduced onto the market.

Those companies which are not using MR heads still have to increase the data stored on the disks if they are to keep their market share. To achieve this many are flying their inductive heads much closer to the disk.

This can be dangerous because it increases the likelihood of a head crash. To help reduce this possibility some manufacturers have introduced a system where the head flies higher off the disk surface when it is not undergoing a read/write operation, and then reduces the height when any operations take place.

DSP Techniques

Apart from simply improving the storage density, there are other methods of improving the drive storage capacity. These include the use of Digital Signal Processing (d.s.p.) techniques to encode and decode the data in more sophisticated ways.

One of the methods being used is called Partial Response Maximum Likelihood or p.r.m.l. Using this system, advanced digital filtering techniques are used to examine the shape of the pulse.

This data is processed by the d.s.p. circuits and a maximum likelihood algorithm is used in the processing to determine whether the received signal matches the profile of an actual pulse or a spurious signal. The algorithm which is most commonly used is one named a Viterbi algorithm.

IBM has already introduced p.r.m.l. into some of its larger drives, and in the future all its drives will use the process. A number of other manufacturers also use the process.

Currently, a number of chips are available on the market which enable p.r.m.l. techniques to be used. In view of the number of manufacturers which produce them it shows a definite trend in the market towards this process. In the not too distant future it should mean that most of the drives which are bought for inclusion into PCs will use these advanced techniques.

Future

With the ever increasing pressure on storage space, the rate of disk drive development is unlikely to abate in the foreseeable future. Other developments are also taking place alongside the technical improvements.

One of these is associated with the standards which are used. The IDE standard has been most widely used for many years now, having a number of advantages over the SCSI interface which is less frequently used.

However, in its original form it had a maximum limit of 528Mbytes. Nowadays most new machines are fitted with drives of 1Gbyte and more.

Although systems could be configured as two separate drives this is clearly inconvenient. As a result the drive manufacturers had to cooperate in the definition of a new standard, EIDE (Extended IDE) which enables larger drives to be used with ease.

Other developments for further into the future are also taking place. Some are revolutionary and may not be seen for many years, but if they succeed they will be capable of storing vastly greater amounts of data. Others are much less revolutionary, but in the short term they are equally important as they keep up the rate of increase in capacity.

Innovations

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

DIRECT TV SHOPPING

A Stop-Press report from Barry Fox

It's been predicted for ages, but at last shopping can become an armchair activity.

BY EARLY next year TV viewers in the UK will be able to bank, shop and book tickets from their armchairs. Video demonstrations of products and services will beam down from a digital satellite while viewers use a remote control or keyboard to authorise payment by phone line. HMV, Sainsbury, the Midland Bank and Great Universal Stores have already said they will provide interactive services, free.

Clever technology will be used to smooth the transition from analogue to digital broadcasting, and the equipment needed to access the new services will be heavily subsidised. But it will still cost £300 to install and the owner must then pay satellite broadcaster BSkyB a regular monthly subscription to watch a new range of digital entertainment channels. BSkyB currently charges £27 a month to watch all its analogue entertainment channels. There will be more digital entertainment channels so digital subscriptions are unlikely to be cheaper.

BSkyB AND PARTNERS

BSkyB has been promising a digital satellite TV service for the last two years but has baulked at the cost of subsidising the equipment which viewers will need to buy. Now BSkyB is sharing the financial burden with British Telecom, the Midland Bank and Japanese company Matsushita Electric. Their new company British Interactive Broadcasting (BIB) will spend £265 million on subsidising the manufacture of a million set-top decoders by four contracted manufacturers, Amstrad, Grundig and Hyundai, Matsushita and Pace.

Says BSkyB's Deputy Managing Director David Chance, "Subsidy is the key cog that starts the virtuous circle. Britain is leapfrogging the rest of the world. This is the first mass scale introduction of the information society. There is no truly interactive TV service anywhere else".

Despite a subsidy of over 100 per cent on each decoder, they will still cost around £200. Professional installation of the necessary aerial and phone connection is essential and will cost another £100. The £200 receiver will also need modification, with add-on "sidecar" circuitry costing another £100, if the owner wants to use it for the new digital terrestrial TV services also promised by the BBC and commercial TV stations next year.

DIGITAL UPGRADE

BSkyB broadcasts its existing analogue services from Astra satellites at 19 degrees East. The new services will be transmitted in digital code, on higher frequencies, from new satellites which Astra will launch at 28 degrees East shortly before the end of this year.

BIB reassures the four million viewers who already have satellite dishes that they will be able to upgrade to digital interaction with a "simple adjustment" of the existing dish and then relegate their old analogue receiver to a bedroom or children's room. To make this possible BSkyB will simulcast all its analogue programmes from the digital satellite as well. But the simple adjustment is a difficult job which BSkyB admits must be done by a professional fitter.

The digital decoder will contain a 28·8 kilobits/second modem which must connect to an ordinary telephone line to send control signals back to the service provider, while a mix of data is delivered by digital satellite and the phone line. Many homes do not have a telephone socket close to the TV, so the fitter will need to install new phone wiring.

CHANGING DIRECTION

All existing dish aerials are pointed at Astra's analogue satellites at 19 degrees East and will need moving or replacing so that they point at the new digital satellites at 28 degrees East. Most existing dishes will also need some new

MONDO MAPLIN

Maplin Electronics have opened yet another store, this time a Superstore named Mondo, at Lakeside Thurrock Retail Superpark, Essex.

Mondo aims to bring "the world of technology to everyday living with a huge range of computer peripherals, hi-fi and home entertainment accessories, security devices and fun gadgets".

The new superstore reflects the growing consumer demand for hi-tech products both in the home and business. It also includes an MPS Trade Counter, and an Internet Cafe. The latter lets customers get on-line and develop their net-surfing skills.

Commenting on the choice of Thurrock as the new site, Operations Manager Bill Hobden said "this time we've purposefully gone for a site in a prime retail location". It was a major step in Maplin's strategy to find exactly the right locations in which to develop Mondo superstores in between 15 and 20 major conurbations throughout the UK.

This is now the third Mondo Maplin Superstore to open, bringing the total of Mondo and Maplin stores in the UK to 40. The other two Mondo sites are in Leeds and Nottingham.

For more information, contact: Maplin Electronics Plc, PO Box 3, Rayleigh, Essex SS6 8LR. Tel (enquiries): 01702 552911. Tel (sales): 01702 554161. Fax: 01702 553935. E-mail: **<recipient>@maplin.co.uk**. Web: **http://www.maplin.co.uk**.

electronics, called a Universal Low Noise Block converter, to pick up the high frequency digital signals. If the connecting cable from the dish is old, kinked or damp, it may not be able to carry the high frequency digital signal and will need replacing with new cabling.

If viewers want to continue using their analogue receivers, while also using a new digital receiver, they will need to add a high frequency LNB to their existing dish. This will be offset from the existing low frequency LNB by around 8cm, so that it picks up digital signals from 28 degrees East while the original LNB continues to receive analogue signals from 19 degrees East. The fitter will then have to lay a second run of cable to connect to the digital receiver.

Because the second LNB is offset, it will receive only a relative weak signal from the digital satellite. But BSkyB believes the extra power Astra is promising from its digital transmitters will make up the difference. To play safe BSkyB will use around 20 megabits/second of the 55Mb/s data stream available from each satellite transmitter, for error correction. The correction is a stream of extra bits of code which check for gaps in the programme and repair them. The 34Mb/s programme stream can carry up to 16 programmes if there is a careful mix of sports channels, which need more bits per second to cope with fast action, with studio chat shows and movies, which need fewer bits per second.

BSkyB will provide the movies on "near demand". The same film will be transmitted on half a dozen different channels, with the running times staggered by 15 minutes so that viewers never need wait more than a quarter of an hour for the opening titles.

Viewers who replace their existing analogue dishes with new ones, or new customers who fit new dishes, will also benefit from the higher transmission power and more powerful error correction. The new digital services should come through loud and clear on 40cm dishes, whereas analogue programmes have needed 60cm aerials.

PROUD BOARD MAKERS

Proto Design, the company who manufacture p.c.b.s for the *EPE PCB Service*, have proudly told us that, as part of their continued improvement to service and facilities, they have applied for and received UL certification.

This required submission of examples of their work to Underwriters Laboratories Inc. in the USA and resulted in approval to UL94 and UL796. Proto Design can now supply p.c.b.s. bearing the UL marking.

The UL Standard is essential for exporting to the USA and is the most accepted and recognised certification mark in that country. UL provides unbiased thorough product evaluations and quality assurance assessments. The British Standards Institution visits Proto Design's factory every three months to monitor production and ensure compliance.

Further improvements made by the company include increasing their Hot Air Solder Levelling capacity and introducing SMT/conventional board assembly. Proto Design offer an excellent service right across the board!

For more information, contact Proto Design, Dept EPE, Units 8/9, Ilford Trading estate, Paycocke Road, Basildon, Essex SS14 3DR. Tel: 01268 289923. Fax: 01268 289447.

ETCH-TECH

Still on the subject of p.c.b.s, hobbyist p.c.b. designers will be interested to know that Etch-Tech Boards, the manufacturers who specialise in providing services for hobbyists, have just expanded their services by introducing a range of PC based p.c.b. design packages, and "traditional" artwork preparation materials.

As a special introductory offer, Etch-Tech are offering 10 per cent off all their p.c.b. design packages until the end of July '97. What's more, if you are a member of the B.A.E.C. you can get 10 per cent off the cost of manufacturing your p.c.b.s as well.

For more details, write to Etch-Tech Boards, Dept EPE, PO Box 1566, Salisbury, Wilts SP1 3XX.

The New Solution

The options for readers who wish to design their own p.c.b.s using CAD software has never been so buoyant. Two more interesting CAD packages have hit the amateur market. They are from a company called The PC Solution which has just launched them in the UK as WinDraft and WinBoard, both originating from Ivex Design International.

Ivex was founded three years ago in the USA with the objective of providing affordable Windows based EDA tools. Their products include proven solutions for schematic design and p.c.b. layout under Windows 3.1, 3.11, NT and 95. They are currently represented in 15 countries.

WinDraft is the schematics design package, in which "everything's included for wiring, drawing, printing and finishing your design". It is also a front end tool for the p.c.b. layout package WinBoard, which, say Ivex, is an easy to use software toolset that rivals the features and functions previously only available in more expensive programs.

Minimalist (cut down) versions of the two packages are available at the all-inclusive price of £19.95. The fuller versions start at £175 each.

For more information, contact The PC Solution, Dept EPE, 2a High Road, Leyton, London E15 2BP. Tel: 0181 926 1161. Fax: 0181 926 1160.

E-mail: info@ThePCSol.Demon.co.uk. Web: http://www.ivex.com.

Radio Jobs

Management reform of Britain's radio spectrum could mean a wider choice of mobile communications and thousands more jobs. John Battle MP, Minister of State at the DTI said recently while announcing publication of the new Wireless Telegraphy Bill, which will provide new tools to manage the radio spectrum more effectively.

Speaking in London, Mr Battle said: "Our aim is to promote spectrum efficiency, competition and innovation and to sustain economic success and growth. A wide range of businesses throughout the economy use and rely on radio. Their use of radio currently contributes £13bn to GDP and supports over 400,000 jobs in radio service provision, equipment manufacture, distribution and retail activities. These figures are growing at a rate of £1bn a year and over 1,000 jobs a week.

PCS32 SCOPE

In our Jan '97 issue, Robert Penfold reviewed the Velleman "Virtual Instrument" kit for the PCS32 Storage Oscilloscope Interface. An excellent product it appeared to be.

From Holland, we have now been advised by software developers Omnia & Nedon, that they have introduced a new software package for use with the PCS32. It is Windows-based (3.1X and 95 quoted) and has been developed in association with Velleman.

Called Scope-it For Windows, it features two-channel oscilloscope and spectrum analysis functions, and both can be displayed simultaneously. Displays can be saved to disk, printed or copied to other applications. The software is fully supported for English, French, German and Dutch.

Distribution will take place via Velleman's usual agents. Maplin handle the PCS32 kit, so ask them for details of this new product (Tel: 01702 554002). Alternatively, you can find out more about this package via the Internet, at **http://www.velleman.be**

C5'S AERIAL BATTLE THICKENS

The good news is that Astra now transmits C5; the bad news is that it's not that simple! Barry Fox updates the story

CHANNEL 5, the UK's fifth terrestrial TV station, has found a way to improve reception for the millions of viewers who cannot tune in. C5 has hired a transmitter on the Astra satellite, making it the first land-based TV station in Britain to simulcast its programmes from space for free reception.

The move is expensive to C5 and reception is still not plain sailing. Astra charges around £4 million per transmitter per year and at least a quarter of all existing satellite receivers will not tune into the frequencies which Astra has allocated to C5.

The use of satellite transmitters to broadcast a terrestrial station also raises new copyright issues.

When fully operational by late 1997, C5's 42 terrestrial transmitters should cover 80 per cent of the UK population. But to avoid interference with existing transmitters in the UK and France, C5's licence from the Independent Television Commission for terrestrial transmission requires C5 to broadcast at low powers on frequencies which are outside the band for many existing TV aerials. So many terrestrial viewers cannot get clear pictures, or get no pictures at all.

C5 admits that "some people may need a new aerial". The Confederation of Aerial Installers puts the number at over three million, each costing the viewer around £150.

FREE ASTRA CHANNEL

C5 had been negotiating with Luxembourg satellite operator Astra since before the terrestrial station launched, but all 64 of Astra's transmitters were already in use. Now Continental movie channel Filmnet has moved from Astra to the Scandinavian satellite Thor, vacating channel 63 on the Astra's 1D satellite. C5 has now taken over Filmnet's transmitter.

The channel 63 transmitter is not ideal because it is on Astra's fourth satellite, 1D, which operates in a lower frequency band than Astra's first three satellites, 1A, 1B and 1C. Modern dishes and receivers are designed to receive this low band and are pre-tuned to switch between 64 channels, but older systems were designed to receive only the 48 channels transmitted by Astra 1A, 1B and 1C. Astra estimates that over 25 per cent of all satellite systems in the UK are still of the old type and thus unable to receive signals from 1D.

Owners of these old systems must either replace their existing dish and receiver or fit a device called an Expander, costing around £30, to the old receiver. This shifts the low frequency signals from 1D up in frequency by 500MHz. So satellite channel 63 behaves as if it were channel 15, and C5's programmes appear on the TV screen instead of the MTV pop music channel.

COPYRIGHT PROBLEMS

Over 23 million dishes in Europe can now pick up Astra's signals, but C5 does not have copyright clearance to broadcast its programmes outside the UK. So C5 must try to control viewing, but without charging viewers for programmes which are supposed to be free. So C5 is scrambling its signals with the VideoCrypt system, as used by Rupert Murdoch's Sky channels. But whereas most Sky channels can only be received by viewers who pay for a smart card to slot into their VideoCrypt decoder, C5 is "soft-encrypted". Unscrambling requires only a decoder, not a smart card.

C5 estimates that two million homes with satellite dishes are outside the range of its terrestrial transmitters and thus now able to receive C5 for the first time. But of these two million, 500,000 are likely to have old receivers which cannot tune in to C5 without modification.

In addition, around 100,000 homes in Eire have satellite systems with the VideoCrypt decoders needed to receive Sky. These homes can now receive C5, even though it is a British terrestrial station. As in the UK, the number of dishes is growing fast.

The ITC says that C5 is not breaching its licence by extending its broadcasting range into Eire. "If the Irish government is unhappy, it can make representations to the British government", says a spokeswoman.

Sally Osman of C5 says "All our programme deals are for the UK but all the programme providers are happy that they cover all types of distribution, whether terrestrial, cable or satellite. They are sanguine about the idea of spillover, when British TV is picked up abroad. This already happens with the BBC".

INEQUITABLE

Equity, the British actors' union, already accepts that spillover from terrestrial transmitters across the sea is inevitable, and gets a share of the money the BBC and ITV earn when they authorise Irish cable stations to relay British programmes to Irish subscribers. But Equity is not sanguine about Irish satellite viewers being able to watch the UK's C5 without anyone paying.

"We did not know this was happening; C5 has not told us", says Equity's Angela Little. "Our current agreement is for the UK only. Channel 5 will need to come back and renegotiate for Eire".

COUNTDOWN SAFETY SWITCH

A new 13A plug-in safety device, designed to supply power to a wide range of appliances, tools and equipment for only a user-set period of time, has been launched by Technotrend Ltd.

Called the Countdown Safety Switch, the low cost device will, it is claimed, improve safety and energy consumption in a variety of domestic, workshop, commercial and public sector environments.

Unlike ordinary timer switches, which are designed to switch lights or appliances on and off repeatedly to a preset pattern, with this new device the controlled appliance can be used whenever required, and will then be switched off automatically a preset time *after* the last use has ended. No chance, then, of it switching off *during* use.

It is easily set, simply by plugging it in to a normal 13A socket and then pressing two clearly marked buttons. One switches on the power, the other sets the time.

There are two versions of the switch. The first allows a range of power times to be selected, from 40 minutes down to five minutes, in five minute intervals. The second offers a choice of three fixed power times, 30, 60 and 120 minutes. In both cases, the device will switch equipment with power ratings up to 3kW.

The Countdown Safety Switch is priced at £22.99 plus VAT and is available from Technotrend Ltd., Dept EPE, Unit B5, Armstrong Mall, Southwood Summit Centre, Farnborough, Hants GU14 0NR. Tel: 01252 373242. Fax: 01252 373440.

TAKING A COUNT

Lascar Electronics have added a new up/down counter module to their range of low profile DIN-cased meters. The C790 incorporates a high contrast, 4-digit l.e.d. display for 14mm digit height. The counter's display and internal comparison register are presettable, ideal for applications such as batch counting and process control.

The C790 is mounted in a stylish 36mm × 72mm enclosure and is eminently suitable for applications that require easy installation with soldering. This has been achieved by using a snap-in enclosure, link-selectable decimal points, and the option for a screw terminal block.

For more information, contact Lascar Electronics, Dept EPE, Module House, Whiteparish, Salisbury, Wilts SP5 2SJ. Tel: 01794 884567. Fax: 01794 884616.

Techniques

ACTUALLY DOING IT!

by Robert Penfold

HAVING previously considered what tools and equipment you need to get started in electronic project construction, this time we will look at one of the more important things you need to know once you are under way. How do you tell which component is which?

Diagrams and photographs in the magazine article should sort out most of the problems. It is also well worth buying one or two of the larger component catalogues. Apart from making component buying much easier, the photographs and other illustrations help with precise identification of the components.

It is mainly the smaller components such as resistors and capacitors that seem to give beginners most problems. At least a few resistors are used in every project, and large numbers of them are used in most circuits. One of the first things you will notice about low power resistors is that they are not labelled with values.

Banding Together

Instead they are marked with coloured bands which indicate the value and a tolerance rating using a very simple method of coding. Details of this code are provided in Table 1. Fig. 1 (top left) also helps to explain the way in which the standard four band code operates.

The first task is to determine the order of the bands. You will not get a sensible result if you decode the bands "back-to-front". Bands one to three are grouped close together, and band four is out on its own, so getting their order right should be easy.

Unfortunately, some "real-world" resistors have bands that are not spaced as accurately as they might be, but it is not usually too difficult to sort out which band is which. In most cases you will get a nonsensical result if you get the bands back-to-front, so your mistake should be obvious.

The first two bands indicate the first two digits of the value. For example, suppose that the first two bands are orange and white. These bands represent 3 and 9 respectively, giving 39 as the first two digits of the value.

The third band is the multiplier, and the first two digits are multiplied by the value represented by this band. If the third band was red, the multiplier would be 100, and the value of the resistor would be 3900 ohms ($39 \times 100 = 3900$) i.e. 3k9Ω. A gold third band would represent a multiplier value of 0·1, giving a value of 3·9 ohms ($39 \times 0{\cdot}1 = 3{\cdot}9$).

Band four indicates the tolerance rating of the resistor. For most resistors this band is gold, indicating that the actual value of the component is within five per cent of its marked value. If a components list specifies that 5% resistors should be used, it is in order to use components having a lower tolerance such as 1%, although this might prove to be expensive.

Do not use components which have a *higher* tolerance rating than that specified in a components list (e.g. 10% components where a tolerance of 5% is specified).

Added Colour

Rather unhelpfully, some resistors have one of two methods of five band colour coding. Both types are included in Fig. 1.

One method is essentially the same as the four band type, but the fourth band is replaced by a group of two bands. The fourth band indicates the tolerance rating in the normal way, and the fifth band shows the temperature coefficient. Since the temperature coefficient is not normally of any practical significance to the hobbyist, the fifth band can be ignored and the other four bands then show the value in the usual way.

The other method of five band coding works in much the same way as the four band variety, but the first three bands indicate the first three digits of the value. Bands four and five provide the multiplier value and tolerance ratings in the usual fashion. The third band invariably seems to be black (0), which means that it can be ignored if the multiplier is boosted by a factor of ten.

For example, if the first two digits are red and violet (two and seven), and the fourth band is brown (x10) the value would normally be 270 ohms: Multiplying this value by ten gives the actual value of 2700 ohms (2k7Ω). Fortunately, this method of coding seems to be much less common than it was a few years ago, and with luck you will never encounter it.

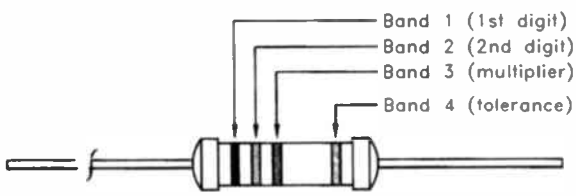


Table 1: Resistor Colour Coding

COLOUR	BAND 1	BAND 2	BAND 3	BAND 4
Black	0	0	X1	–
Brown	1	1	X10	1%
Red	2	2	X100	2%
Orange	3	3	X1000	–
Yellow	4	4	X10000	–
Green	5	5	X100000	0·5%
Blue	6	6	X1000000	0·25%
Violet	7	7	–	0·1%
Grey	8	8	–	–
White	9	9	–	–
Gold	–	–	X0·1	5%
Silver	–	–	X0·01	10%
None	–	–	–	20%

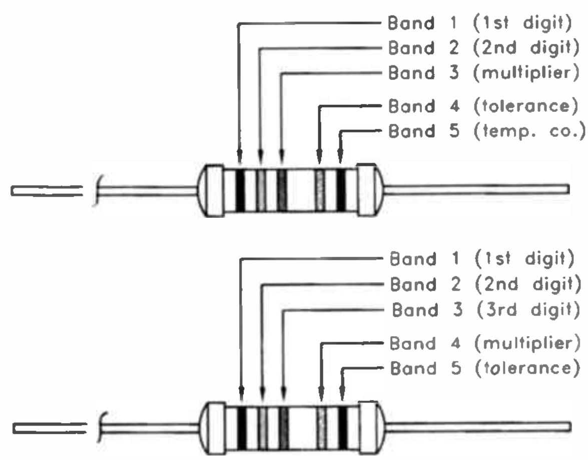


Fig. 1. Standard four band resistor colour coding (top left) and two methods of five band coding.

At one time colour codes were commonly used for capacitors, but this practice seems to have died out. Four band colour codes are sometimes used on inductors, and this gives the value in standard resistor fashion. However, the value is in microHenries rather than in ohms.

Little And Large

One slight problem with many units of measurement used in electronics is that an enormous range of values are used. It is not uncommon for the highest value resistor in a circuit to be a hundred thousand to a million times higher in value than the lowest value resistor. The resistors in my spares box have values from 0·1 ohms to 10 million ohms (10Meg).

To make high values easier to deal with, they are normally expressed in kilohms (k) or megohms (M). A kilohm is 1000 ohms (1k), and a megohm is one million ohms (1000k). Thus a resistor having a value of 3300 ohms would normally be referred to as a 3·3 kilohm resistor, and a resistor having a value of 2700000 ohms would normally have its value given as 2·7 megohm.

It is now common practice for values to be given in a slightly shortened from where the letter indicating the units of measurement also shows the position of the decimal point. A value of 5·6 kilohms would therefore be given as 5k6, and a value of 4·7 megohms would be given as 4M7. The letter "R", or Ω (omega symbol), is used as the abbreviation for ohms, and values of 0·47 ohms and 470 ohms would therefore be given as (0Ω47) 0R47 and (470Ω) 470R respectively.

This method was devised to keep values as short as possible on cluttered circuit diagrams, but it is now commonly used in components lists as well. In fact, it might be encountered anywhere that component values are given. It is even used to mark the values on some higher wattage resistors.

These are physically much larger than the resistors used in everyday project construction, which makes it possible to mark them with letters and numbers that can be read without the aid of a microscope! The value is normally followed by a letter which indicates the tolerance rating, using this method of coding:

Code Letter	*Tolerance Rating*
F	1%
G	2%
J	5%
K	10%
M	20%

Capacitors

Capacitors provide a similar problem to resistors, in that a very wide range of values are used in day-to-day electronics. The problem is slightly different though, because capacitors have what appear to be tiny values.

This is simply because the basic unit of capacitance is the Farad, and a Farad is an enormous amount of capacitance. Very large capacitors have values that are around one thousandth of a Farad, and small capacitors have values as low as millionth of a millionth of a Farad!

The values of capacitors are usually expressed in microFarads (μF), nanoFarads (nF), and picoFarads (pF). These are respectively a millionth, a thousand millionth, and a million millionth of a Farad.

Basically, all you need to remember is that 1000 picofarads equals one nanofarad, and 1000 nanofarads equals one microfarad. A capacitor having a value of 10nF could also have its value correctly given as 10000pF or 0·01μF.

To The Letter

Capacitors often have their values marked in the same way that they would appear in a circuit diagram. The value is usually followed by a letter which indicates the tolerance, and this operates in the same way as the system used for high wattage resistors. There may be a few numbers after the tolerance letter, and this indicates the maximum working voltage for the component.

For example, a capacitor taken at random from my spares box is marked "10nJ400." It has a value of 10nF, a tolerance of 5 per cent, and a maximum voltage rating of 400V. Another is marked "2n2" across the middle, with "400" marked above and below this. It clearly has a value 2·2nF and a voltage rating of 400V. In this case the tolerance is not indicated.

A few types of capacitor, but mainly ceramic types, have their values marked in a slightly cryptic manner. The value is marked using a three digit number, possibly together with a tolerance letter and a figure denoting the maximum voltage rating.

The three figure group operates in a manner that is similar to the first three bands in a resistor colour code. The first two numbers are the first two digits of the value, and the third digit is the multiplier. Simply add to the first two digits the number of zeros indicated by the third digit. This gives the value in picofarads.

For instance, if a capacitor is marked "473K", the first two digits of the value are 47, and three zeros must be added to these. This gives a value of 47000pF, or 47n in other words.

Beginners are often confused by the fact that capacitors sometimes have markings other than those which indicate the value, tolerance, and maximum operating voltage. This is also a problem with semiconductors, which sometimes have the type number buried in a mass of apparently random characters. These are such things as the manufacturer's logo in miniature, the date of manufacture in some highly cryptic form (the number of working days since the factory was opened), and batch numbers.

You simply have to learn to sort out the "wheat from the chaff." Home-in on anything that can be decoded into sensible information, and ignore anything that has no obvious relevance. Manufacturers should ensure that they do not mark components with extraneous characters that could be confused as value markings.

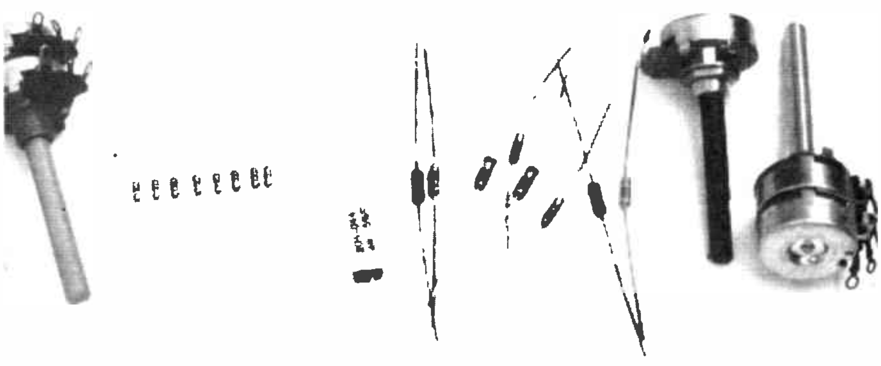
Easy As ABC

Potentiometers are available in three basic types, which are linear, logarithmic, and anti-logarithmic. Logarithmic potentiometers are mainly used for volume controls, while linear potentiometers are used for just about everything else. Anti-logarithmic potentiometers are only used in a few specialist applications.

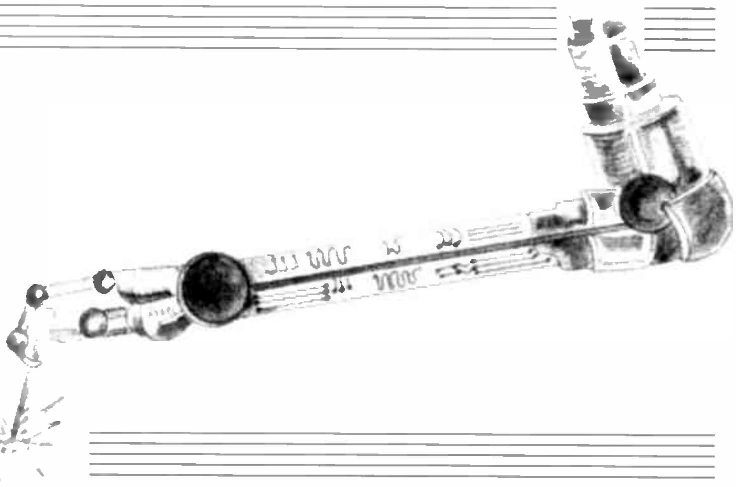
Many potentiometers are marked "log" or "lin" to show which type they are, but some only carry a code letter after the value marking. This coding is perfectly straightforward, and operates as follows:

Letter	*Potentiometer Type*
F	1%
A	Linear
B	Logarithmic
C	Antilog

If you should use the wrong type of potentiometer it will not stop the project from working, but you will obtain an odd control characteristic. This might make the project difficult to use.



Just a small sample of resistive components. Single and dual potentiometers are shown on the right.



CIRCUIT SURGERY

ALAN WINSTANLEY

This month, our In-House "Surgeon" checks out low drop-out voltage regulators, re-visits resistors and helps a reader to track down some components for the* Simple Dual Output TENS *unit. We also announce some important new additions to the* Circuit Surgery *line-up!

Bring on the Subs

OVERSEAS readers – and there are lots of you – occasionally puzzle over the problem of substituting components used in certain projects, and the more esoteric-sounding semiconductors can cause real headaches sometimes!

If you know the basic data, you can often make an educated guess for a substitute – if you're struggling to locate a part, though, you can always ask us for advice. Here's a component sourcing question, raised by ***Adele Williams*** of South Africa who writes via E-mail:

I'm interested in building the Simple Dual Output TENS *unit from the March '97 issue, but I have a problem in finding some of the components. I have searched through all the data books I've got, and I've phoned around to all the major electronics shops here in South Africa, but no luck. I would like to know if there might be equivalents available for the following components:*

ZTX108 npn *silicon transistor*
ZVN4310A n*-channel MOSFET transistor*

Furthermore, it seems that nobody keeps stock of a 470 microhenry ferrite-cored miniature choke. Is there a way to make this yourself? Thanks!

The easy bit first. The ZTX108 is just a "vanilla" equivalent, manufactured by Zetex, of the BC108 *npn* general purpose small signal transistor. The BC108 is made in a TO18 can, but there is also a BC548 in a plastic TO92 package and this is a direct alternative.

In fact, in this application, you could probably use almost any general purpose type of transistor (e.g. the ZTX300 or 2N3711 etc.) in place of the ZTX108. All you need to do is watch the pinouts, and you may have to orientate the body of a substitute transistor in order to make it fit the p.c.b.

A typical selection of common devices is shown in Fig.1a which may help you choose and fit an alternative.

A much trickier problem is posed by the ZVN4310A. This is an *n*-channel MOSFET which is also made by Zetex, and it uses the same style of "E-line" miniature plastic package as the ZTX108. I struggled to find a direct equivalent. Checking the specifications, though, the catalogue data quotes the following ratings:

V_{ds} – 100V
I_d maximum – 1 amp
$R_{ds(on)}$ – 0·5 ohms
P_d – 1·13 watts

The maximum drain-source voltage rating (V_{ds}) is probably the most significant parameter here, given the high voltage nature of the switch-mode generator circuit used in the TENS design. It is necessary to match or exceed this rating, especially as some 80V or so appears across the capacitor C3 in the circuit, depending on the tolerance of the two Zener diodes used (page 157, March '97).

The peak drain current (I_d) of about one amp provides a comfortable margin (the designer quotes a figure of 150mA flowing for some 8µs when switched on) and thus 1A or so seems a reasonable figure to specify for the drain current rating I_d. The value given in a data sheet may be a conservative one in any case, in order to guarantee long-term reliability.

The $R_{ds(on)}$ characteristic is an equivalent "resistance" between drain and source when the MOSFET is switched on. It is probably less critical to match this exactly with a substitute, but the lower the value, the more "ideal" the MOSFET will be.

Power Deal

Lastly, the power rating P_d of 1·13 watts (quite a lot for a small E-line package) must be borne in mind but, in this circuit, even though it operates at a high voltage, the MOSFET is only switched on for tiny fractions of a second and the power dissipated is minimal.

One further complication is that some types of MOSFET are optimised for use at 5V logic levels, and the ZVN4310A happens to be one of them. This takes into account the likely spread of voltages which will be encountered on the threshold levels of logical devices, and a logic-optimised MOSFET will operate reliably if driven by, say, a CMOS or TTL gate.

It's probably less of a problem here as the CMOS is powered from a 9V battery. Furthermore, the designer used two NAND gates in parallel (IC1a and IC1b): this improves the switching of the MOSFET, because the gates charge and discharge the capacitance on the MOSFET's gate terminal quicker: remember that MOSFET's are voltage-operated charge devices rather than current-driven ones like bipolar transistors.

For possible substitutes – which I haven't tried in-circuit – I came across the Toshiba 2SK941 (V_{ds} = 100V, I_d = 1·8A pulsed, $R_{ds(on)}$ = 1·8Ω, P_d = 0·9W); alternatively, the Siemens BSS296 (100V, 3·2A pulsed, 0·8Ω, 0·8W). Pinouts are shown in Fig.1b – both substitutes have the same package but differing pinouts.

My final effort is to suggest the International Rectifier IRF D110 (100V, 0·54Ω,

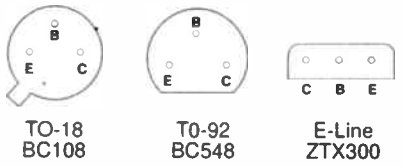


Fig.1a. Pinout details for BC108, BC548 and ZTX300 small-signal, general purpose npn *transistors.*

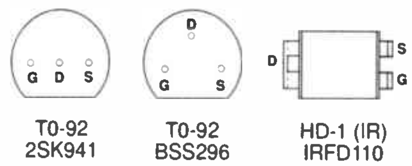


Fig.1b. Pinout details for some suggested alternatives for the ZVN4310A n*-channel MOSFET.*

1·0A max., 1·2W), but there's a snag; it's a special 4-pin d.i.l. device (called the HD-1 outline), which is also shown in Fig.1b, courtesy of my I.R. Data Book. This would need to be soldered to a small adaptor board, say, and then wired into place on the main board.

DIY Coil

If you really do want to wind your own coil, you could try using one of the RM or similar ferrite core kits. Here's a worked example. To calculate the number of turns required on a typical pot core, the formula is:

Number of turns = $\sqrt{L/A_L}$

where L is the required inductance in nanoHenrys and A_L is the "inductance factor" (also called specific inductance) of the core, which is also usually quoted in nanoHenrys. Ensure that you use the same units throughout the formula – convert everything to nanoHenrys or Henrys, but be consistent!

L = 470 microHenrys or 470,000nH
(i.e. $4{\cdot}7 \times 10^{-4}$ Henrys)

The inductance factor of a small "RM6" type pot core is said to be 160nH ($1{\cdot}6 \times 10^{-7}$ Henrys), so using the above formula you require about *54 turns* of enamelled copper wire. The next question is, what size wire? *Answer:* as large a diameter as the bobbin will allow!

Happily, the manufacturer's data sheet obligingly quotes the maximum number of turns of a given wire size which can be accommodated on a bobbin: you can get almost 50 turns of 0·4mm diameter wire onto the core, so if you use say 0·35mm dia. (29s.w.g.), the core should be able to take those 54 turns nicely.

Lastly, of course, you would have to adapt this part somehow to fit the p.c.b. of the *Simple Dual Output TENS Unit* because the board was not designed with a pot core in mind. You must also be prepared for some trial and error; you can use ferrite adjusters in the cores.

Alternatively, Philips produce a range of do-it-yourself pot core kits, retailed by Maplin (who also sell the 470μH inductor!), e.g. the LA4345 pot core has a specific inductance of 400nH and would require 34 turns of wire on a bobbin. Perhaps you can source these or similar parts in South Africa.

Incidentally, if you want a source of copper wire data, in imperial Standard Width Gauge (s.w.g.) as well as American Wire Gauge (a.w.g), then the *Coil Design and Construction Manual* by B.B. Babani is a time-honoured and handy little paperback book worth keeping on the bookshelf (it is available through the *EPE Book Service*, code BP160). ISBN 0-85934-050-3.

Low Drop-Out Regulators

You've probably seen those ordinary 3-terminal fixed and variable voltage regulators. They ensure that the voltage supply is "stabilised" (regulated) so that it will remain fairly constant no matter how much current is drawn by the load, within limits.

Without regulation, a power supply voltage will tend to fall when the current drawn rises. Many logic circuits need a stabilised voltage supply, and will malfunction on an unregulated supply.

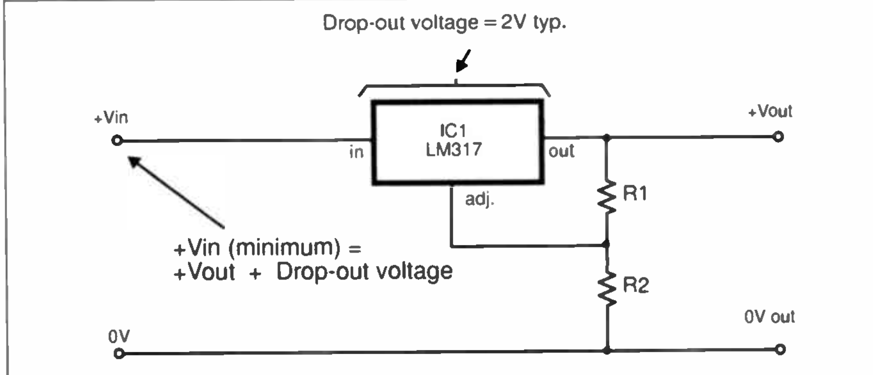


Fig.2. Circuit diagram for a three terminal regulator showing drop-out voltage.

The problem with most ordinary three-terminal regulators is that they have a "drop-out" voltage which you can't always afford to ignore. Fig.2 shows a typical set-up using an LM317 voltage regulator. This will provide a variable stabilised supply for the load, at a voltage set by the two resistors (R1/R2).

This will only hold true if the *input* voltage does not fall below a certain figure – the reason being that approximately 2V appears across the LM317 itself, between input and output. This input-output differential figure is known as the *drop-out voltage*.

You might have to dig deeply to find the drop-out voltage, but National Semiconductor's Data Sheet depicts it as a graph (Fig.3). The value depends on the junction temperature and the current drawn.

If you set an *output* level of, say, 5V, then the minimum input voltage needed by the regulator is at least 7·5V because up to 2·5V will be dropped across the LM317 itself. If the input voltage falls below this figure, the output will fall too and the device will fall out of regulation.

Power On

A simple query posed on the Internet highlights a typical problem:

I'm a keen beginner in electronics. Could anyone tell me the best way of making a steady 5V power supply for my circuit, in which I have used the 74 range of logic chips, from a 9V battery? I am told I need to use a small 9V battery but that I also need something to change the voltage from 9V to 5V. ***S.A., United Kingdom.***

An ordinary 5V regulator is probably not suitable, because you cannot afford to lose the drop-out voltage. If the battery falls by just two volts, then with 2V (say) also dropped by the regulator, you have no further "headroom" for the battery voltage to fall any further before the regulator ceases to operate.

A *low drop-out (LDO) regulator* would be an excellent choice here, because they make a feature of having a very low drop-out voltage. For example, the LM2930T-5·0 is a standard TO220 package 5V 150mA regulator, boasting a drop-out voltage of 350mV – see the graph of Fig.4. In the example, we could continue to power the logic circuit even when the battery had fallen to a mere +5·3V!

Thus LDO regulators are ideal for battery applications, and they include the usual protection features of current limiting and thermal overload: the LM2930

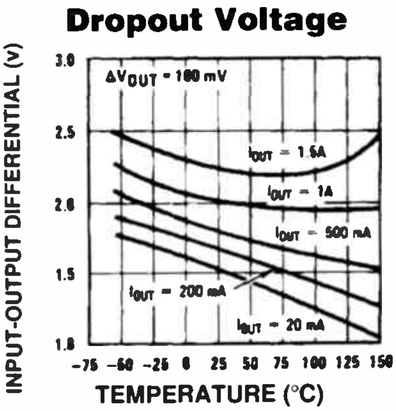


Fig.3. LM317 drop-out voltage.
(National Semiconductor)

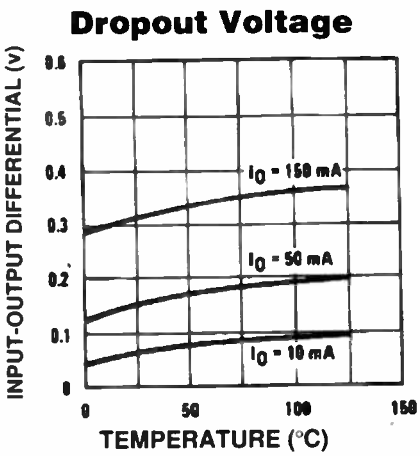


Fig.4. LM2930 low drop-out voltage.
(National Semiconductor)

also has reverse battery protection, too. Alternatives include the LM2931-Z which is a 5V 100mA LDO regulator in a small TO92 package, ideal for small low power circuits.

Next time you're considering a stabilised voltage supply, remember to check out what those "low drop-out" regulators have to offer.

Precision Resistors

Back to resistor values, a subject covered in recent issues. The standard colour codes were described in the April '97 *Circuit Surgery*. ***Jose Luis*** of Brazil tells us:

I tried to use those freeware Windows resistor programs I downloaded from your FTP site **(ftp://ftp.epemag.wimborne.co.uk/pub/software)** *but they don't resolve for values* *less than one ohm (1Ω). Would you mind letting me have any information you have for colour codes for these precision resistors?*

According to my information, the fourth band (multiplier) for values under 1Ω is:

Silver	×0·01 ohms
Gold	×0·1 ohms

The first three bands are the significant digits of the code, as usual. The fifth band (tolerance) where used, is:

Silver	±10%
Gold	±5%
Brown	±1%
Red	±2%
Green	±0·5%
Blue	±0·25%
Violet	±0·1%

All of which goes to show that if anyone tells you that all resistors are standard, don't believe them! The above codes are used by Welwyn, a major manufacturer of resistors. Hope this helps.

New Line-Up

For the past four years or so I've been privileged to have helped answer hundreds of readers' problems and queries from many dozens of countries, gaining many new friends and contacts along the way. Clearly, with the *Surgery, Ingenuity Unlimited* (now with an extra incentive from **PICO Technology Ltd.**) and *Net Work* columns – not to mention the design of our Internet site too – you can well appreciate how hectic things are getting round here! All this and a day job, too!

We've now decided to broaden the scope of *Circuit Surgery*, notably in the higher educational and advanced sectors where I now receive more mail than I can possibly hope to handle. In the next few months I will be joined by a couple of colleagues, **Ian Bell and Tony Wilkinson** of the Department of Electronic Engineering at the University of Hull.

Ian and Tony have generously offered to help handle some of the burgeoning caseload and will be helping out with digital and analogue queries and whatever else comes our way. Watch for a new E-mail address, as well.

You will also see further extensive projects commencing towards the end of the year, co-written in association with the Departmental Staff of the University. Many exciting and interesting things are in store – so be sure to watch this space! You can count on *Circuit Surgery* and *EPE* to educate, encourage and entertain you in the world of electronics. Join myself, Ian and Tony next month.

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. Please indicate clearly if your letter is not for publication. A personal answer cannot always be guaranteed but we try to help wherever possible.

READOUT

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

PIC UP THE PHONE

Dear EPE

I would be very interested to see you doing an article on "How PICs Work" or even a series on "How To Use PICs". Could you recommend some books on the subject?

Also, I recently developed a project of my own which would be ideal for incorporation into a PIC-based system. It detects the number which was last dialled on my telephone, allowing me to check on the baby-sitter's use of the phone while I've been out. It would be useful, too, to extend the design for PIC control so that taped telephone conversations can be related to the numbers called.

As yet, my PIC knowledge is not up to doing this, would you consider designing this aspect for me as an *EPE* project?

Terry Murphy, Co. Carlow, Eire

A lot of points arise here! Firstly, describing how PICs actually *work would possibly be interesting to a few people but not really very useful for most constructors. More beneficial is information on how to get them to work for you. We ran an introductory article on them, complete with a programmer, in Feb '96 and have since published several constructional projects in which additional PIC information has been included, either directly in the text or in the software itself.*

Perhaps the time is approaching when we should take another general look at PICs and their capabilities and uses. In the meantime, though, readers who have not yet become familiar with PICs should browse our Back Issues pages for PIC-related articles, and obtain our PIC software disk (see PCB Service page), studying the source code files to see what's involved in the programming.

For more detailed information about PICs, you should obtain the Microchip Data Book *and the* Embedded Control Handbook *from the manufacturers of the PICs, Arizona Microchip (also known as Microchip Technology Inc.). The former book gives full technical details of all the PICs in what has become a very large family of microcontrollers. The latter book gives masses and masses of program listings. Each book measures about 18cm × 23cm × 5cm – a treasure trove of info! They can be obtained from Arizona Microchip, Unit 6, The Courtyard, Meadowbank, Furlong Road, Bourne End, Bucks, SL8 5AJ. Tel: 01628 851077.*

Projects involving telephones are a difficult subject! There are strict regulations regarding the types of equipment that may be connected to the public phone lines and all such equipment must be "approved" for this use.

Whilst a particular design may actually meet approval as a prototype, when assembled as a DIY project by a variety of people whose electronics capabilities may be rudimentary, there would then be no guarantee that each construction would actually meet approval.

Consequently, we feel honour-bound not to publish designs intended for direct connection to telephones. Indirect connection, by means of an inductive pick-up coil for example, is another matter and designs using this technique would not necessarily be rejected by us; they would be considered purely on merit.

As a magazine, though, we do not undertake the design of projects on behalf of individual readers. Although members of EPE *staff do actually design projects which we publish, they do so as private individuals. In this respect, their designs may well have been inspired by a suggestion made by a reader, but the design is not done* for *that reader.*

Also, of course, other readers may too be inspired by something which they have read. Thus, having read this letter, someone may decide to design a PIC circuit which will do what you suggest and offer it to us for possible publication.

Although you will see familiar names frequently cropping up as authors of EPE *articles, any reader is welcome to submit articles for our consideration. We will examine them from several points of view: their originality, usefulness, interesting nature, technical merit, availability of components, cost, ease of assembly and setting up, reasonable use of English grammar, adequacy of description, clarity of drawings, etc.*

If they meet our approval, we publish them some months later, having edited them to meet our "in-house" format and grammar requirements, then making payment to the authors at £55 per published page, pro-rata, for which sum we also purchase full copyright of the material. An additional payment of £55 is made in respect of software involved but which is not published on the pages (i.e. that which is made available to readers on disk). Prior to publication, we require the completed project for examination and photography.

If readers have an idea they think we might be interested in, ask us by phone, letter, fax or E-mail. Please don't send entire projects (i.e. the physical item) to us "on-spec", though typescripts and drawings may be sent in "without permission", at the sender's own risk.

We have guide line sheets (and Net downloads) for prospective authors, contact us if you would like a copy. JB

REAL COMPONENTS

Dear EPE

I am currently doing a degree in Electronic Engineering and am seeking information on "real" components, that is, real and actual characteristics as opposed to their ideal characteristics. As we know, electronic components are not perfect and do not always do what they are supposed to do!

I am finding it difficult to locate primary material on this subject. Can you point me in a suitable direction?

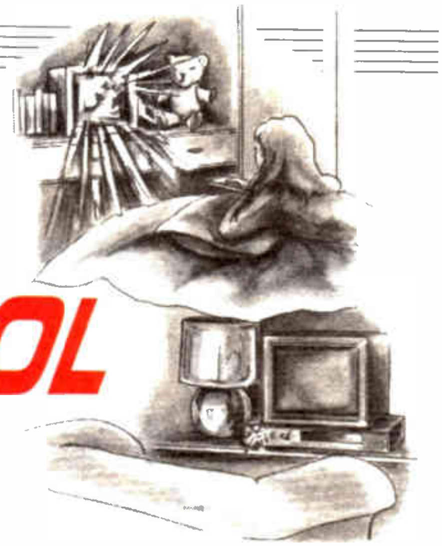
Tony Balzano, Cambridge

Curious, at your presumed locality (Cambridge University?) one might have expected that relevant electronic research material would abound. My instinctive response to people searching for in-depth electronic material is normally two-fold: to recommend Foyle's bookshop in London as being an excellent source of fascinating books on electronics (and other subjects); to recommend asking a local lending library for the address of the nearest reference library that specialises in books on electronics (all reference libraries probably have some books on the subject, but specific ref-libs specialise in particular subjects).

Another good source of specialist technical material is Butterworth Heinemann, Linacre House, Jordan Hill, Oxford OX2 8DP. Tel: 01865 310366. Give them call.

However, it strikes me that you really might be better off going straight to the horses' mouth(s) – the manufacturers. They will, of course, have done extensive work in the design of their components, whatever their nature. Their data sheets (many of which I assume you have) will only be a summary of the results of that work. If you are doing this research for your thesis, I would expect that most manufacturers would be sympathetic to your request for more exclusive information. It's worth a try. Ref-libs can be good sources of manufacturer's addresses (there quite a few quoted in our sister publication, the Electronics Service Manual, *as well).* JB

More Letters on page 484



INFRA-RED REMOTE CONTROL REPEATER

ROBERT PENFOLD

Indulge in the hi-tech art of laziness – control your video or satellite tuner from the bedroom when it's in the lounge!

On the face of it, this project may seem about as useful as ready-sealed envelopes and non-soluble soap. It effectively turns a "wireless" infra-red remote control system for a satellite receiver, video recorder, etc. into a wired remote control system.

You simply aim the infra-red remote control at the "repeater" receiver unit, and it sends a signal along a cable to the transmitter. The latter then transmits an infra-red signal that controls the video recorder or satellite receiver.

This may seem to be a waste of effort, but it is very useful if you have a television set in (say) a bedroom wired to the video recorder or satellite receiver in the lounge. From the bedroom you can watch a video or a preselected satellite channel, but you have no control over the signal source. To change channels, switch off the recorder, fast-forward, or whatever, you have to go downstairs to the lounge.

ALL WIRED-UP

A wired remote control system is a crude way of doing things, but, unlike an infra-red system, it is not restricted to short range line-of-sight control. A cable can be taken through walls, ceilings and floors, and it can carry the control signals for many metres if necessary. In this case there should be no major problem in installing the cable, as it will run alongside the existing cable which carries the signal to the television set.

The simple infra-red repeater system featured here has been tested with a maximum cable length of 20 metres. This should be adequate for most purposes, but the system would probably work perfectly well with substantially longer cables if necessary.

A simple direct coupled circuit is used, and this gives a very limited operating range at the receiving end of the Repeater. In fact, the remote control must be within about 0·5 metres of the Repeater. A greater operating range would obviously be preferable, but the system is still workable with this limited range.

At the transmitter end of the system, a range of up to a few metres is obtained. Although the unit will be left running for hours at a time, the circuit has a very low standby current consumption which makes battery operation a practical proposition.

With some forms of pulse coding it is essential that there is no significant distortion of the signal's timing, and even slight changes to the mark-space ratio can prevent the signal from being decoded properly. Fortunately, the coding used in infra-red remote control systems seems to be fairly tolerant, and some "smearing" of the reconstituted signal will not prevent the system from working.

On the other hand, the output from the repeater must be reasonably accurate if the system is to function reliably.

A phototransistor receives the pulses of infra-red from the handheld remote control, and converts them into minute current pulses. A simple d.c. amplifier stage boosts the current pulses, and provides an output signal that is a reasonable replica of the original pulse signal.

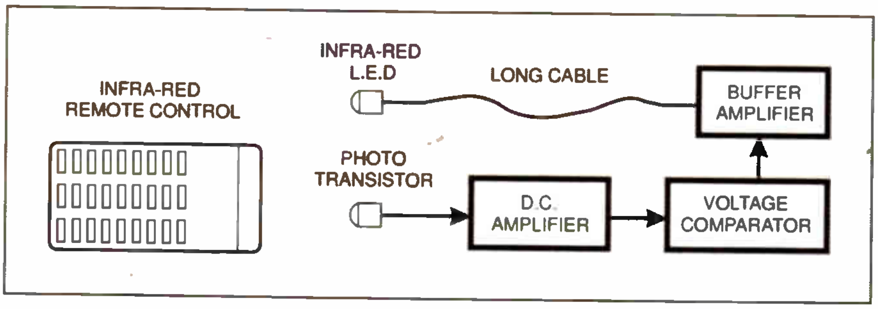


Fig.1. System block diagram for the Infra-Red Remote Control Repeater. The infra-red l.e.d. (transmitter) is sited with the main household receiver and the "repeater" phototransistor with the second TV.

The system has been tested with Ferguson and Toshiba equipment, but it should work with any infra-red remote control that utilizes one of the standard chip sets.

SYSTEM OPERATION

The block diagram of Fig.1 helps to explain the way in which the unit functions. The normal remote control emits pulses of infra-red light, and a system of pulse coding is used to tell the receiver which function is required (increase volume, change to channel three, less/more colour etc.).

The original intention was to use this signal to drive the infra-red l.e.d. (light emitting diode) at the far end of the system, but this did not work. The l.e.d. current is slightly too low to give worthwhile range, and the rise and fall times of the signal are too long.

The signal is speeded up by feeding it to a voltage comparator, where it is compared to a reference voltage. If the signal is below the reference level, the output of the comparator goes high, and if it is above the reference potential it goes low.

This "squares" the output signal, as shown in Fig.2, where the upper waveform

(a) is the input to the comparator, and the lower one (b) is the output signal. The voltage comparator drives the infra-red l.e.d. via a buffer stage that enables a suitably high drive current to be provided.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Infra-Red Remote Control Repeater system is shown in Fig.3. The phototransistor is designated as TR1, and under dark conditions it has the minute leakage currents associated with normal silicon transistors.

Light falling on TR1 causes its leakage current to rise, and the higher the light level, the higher the leakage current. The pulses of infra-red "light" from the remote control handset therefore produce small pulses of current through TR1.

Following TR1, the current pulses drive the base of common emitter amplifier TR2 via current limiting resistor R1. It is unlikely that TR1 would ever conduct strongly enough to cause an excessive current flow, and R1 is really included to protect TR2 if the leadout wires of TR1 should be accidentally short circuited.

The completed IR Repeater. The small box on top contains the IR l.e.d. transmitter.

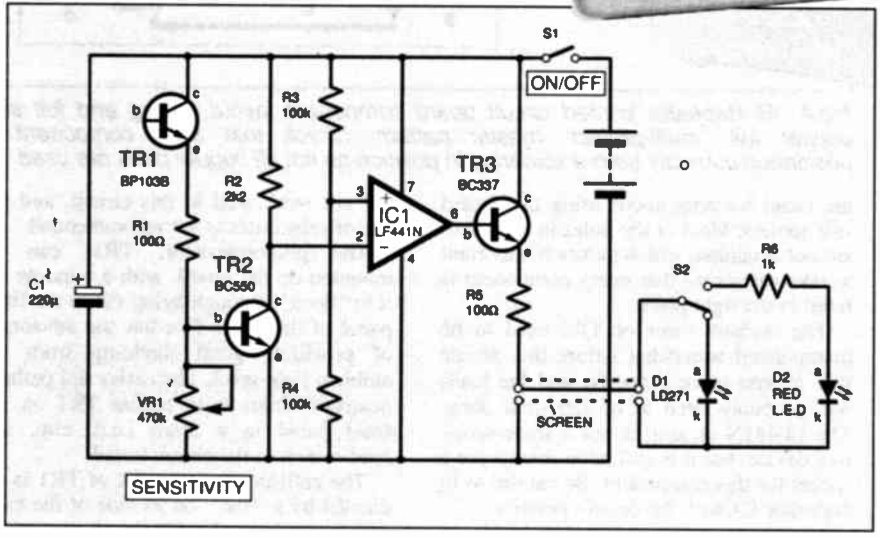


Fig.3. Complete circuit diagram for the Infra-Red Remote Control Repeater.

Its value must be close to the minimum that will do the job so that it interferes with the normal running of the circuit as little as possible.

SENSITIVITY

Potentiometer VR1 acts as a sensitivity control, and the unit will only function properly if this control is given a suitable setting. With VR1 at maximum resistance it only takes a few microamps through TR1 in order to switch on TR2, giving high sensitivity.

In practice, such high sensitivity is unlikely to give usable results. One reason for this is that the background light level would almost certainly be high enough to produce a leakage of a few microamps through TR1, and hold TR2 in the "on" state. Also, TR1 would be operating at such a low current that it would be too slow to respond properly to the pulses of infra-red.

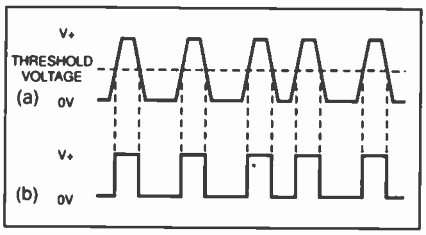


Fig.2. The "slow" waveform at the top (a) is "squared" to produce the lower waveform (b).

At the other extreme, with VR1 near to minimum resistance, a current of several milliamps would be needed through TR1 in order to switch on TR2. A current of this order might not be reached even with the remote control receiver used at point-blank range.

At a range of in-between settings, the sensitivity will be such that TR2 is not biased into conduction by the ambient light level, and TR1 operates at a high enough current to give a fast switching speed.

Component IC1 is an operational amplifier, but it is used here as a voltage comparator. Resistors R3 and R4 provide a reference potential of half the supply voltage to the non-inverting input of IC1, and the output from the collector of TR2 is coupled to the inverting input.

An op.amp amplifies the voltage difference across its inputs, and has a very high voltage gain (typically 100,000 or more). Therefore, the non-inverting (+) input only needs to be at a fractionally higher voltage than the inverting (−) input in order to send the output fully positive, or a fractionally lower voltage in order to send the output fully negative. This gives the required "squaring" of the relatively slow pulse signal from TR2.

IN-PHASE

Transistor TR3 is used as an emitter follower buffer stage at the output of IC1, and this drives the infra-red l.e.d. (D1) via current limiting resistor R5. The l.e.d. is pulsed with a current of about 50 milliamps, which is high enough to give a reasonable operating range, but is not so high as to risk "zapping" D1.

The signal is inverted through common emitter amplifier TR2, but IC1 is used to provide a further inversion so that the input and output signals are in-phase. This is an important point, since an inverted version of the signal would probably not be decoded properly.

It would also result in infra-red l.e.d. D1 being switched on under standby conditions, which would give the circuit a high current consumption. Instead, under standby conditions D1 is switched off, as are TR1 and TR2.

A low power op.amp is used for IC1 and the values of resistors R3 and R4 have been made quite high so that a very low current passes through this potential divider. Consequently the circuit has a standby current consumption of only about 200µA. Even a cheap PP3 size battery will provide a few thousand hours of use.

TRANSMITTER

The transmitter could simply consist of infra-red l.e.d. D1, but it is useful to have the option of switching the output of the unit to an ordinary red l.e.d. (D2). Switch S2 provides the changeover switching, and R6 limits the current to a safe level for an ordinary l.e.d.

The problem with an infra-red l.e.d. is that it provides no light output in the visible part of the spectrum, which makes life difficult when initially testing the system. By switching to D2 instead, it is possible to see if the sensitivity is so low that no output signal is being produced, or so high so that the l.e.d. is permanently switched on. This makes it much easier to find a suitable setting for VR1.

CONSTRUCTION

This project is constructed on the *EPE Multi-Project* printed circuit board (p.c.b.)which was first published in March '95. For this Infra-red Remote Control Repeater design, the board is used with the component layout and wiring shown in Fig.4, along with the full-size master copper track layout. This board is available from the *EPE PCB Service* code 932.

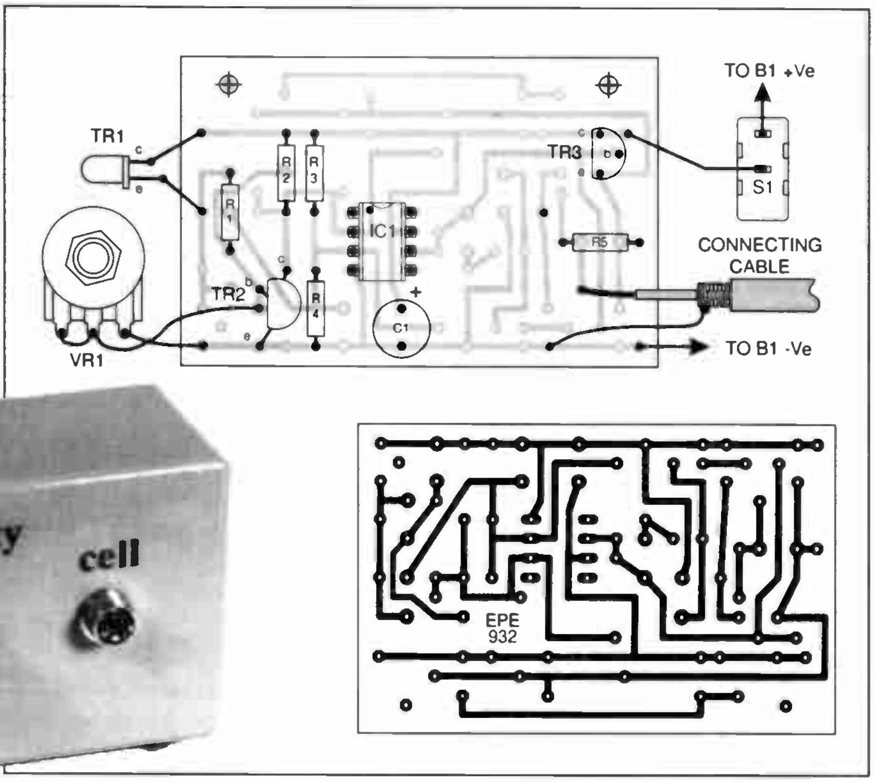


Fig.4. IR Repeater printed circuit board component layout, wiring and full size copper foil "multi-project" master pattern. Check that each component is positioned correctly before soldering in position as not all copper pads are used.

Although the IR circuit is very simple, the usual warning about using this board still applies. Most of the holes in the board are not occupied, which makes it important to take extra care that every component is fitted in the right place.

The leadout wires of TR2 need to be manipulated somewhat before this device will fit into place properly, and the leads will probably need to be left quite long. The LF441N op.amp is not a static-sensitive device, but it is still advisable to use a socket for this component. Be careful to fit capacitor C1 with the correct polarity.

PHOTOTRANSISTOR

The BP103B device used for TR1 looks more like a 5mm l.e.d. than a transistor. Other phototransistors, such as the TIL81, did not work well in this circuit, and the use of substitutes is not recommended.

The phototransistor, TR1, can be mounted on the board, with a window for it to "look" through being cut in the front panel of the case. This has the advantage of providing good shielding from the ambient light level. The easier and perhaps neater solution is to mount TR1 on the front panel in a 5mm l.e.d. clip, and hard-wire it to the circuit board.

The collector (c) terminal of TR1 is indicated by a "flat" on its side of the case, and the collector lead is the shorter of the two. The base terminal is not connected in this circuit, and there is no base leadout wire on the BP103B, anyway.

Virtually any small to medium size plas-

COMPONENTS

Resistors

See SHOP TALK Page

- R1, R5 100Ω (2 off)
- R2 2k2
- R3, R4 100k (2 off)
- K6 1k

All 0·25W 5% carbon film.

Potentiometer

- VR1 470k carbon rotary, lin.

Capacitor

- C1 220µ radial elect, 16V

Semiconductors

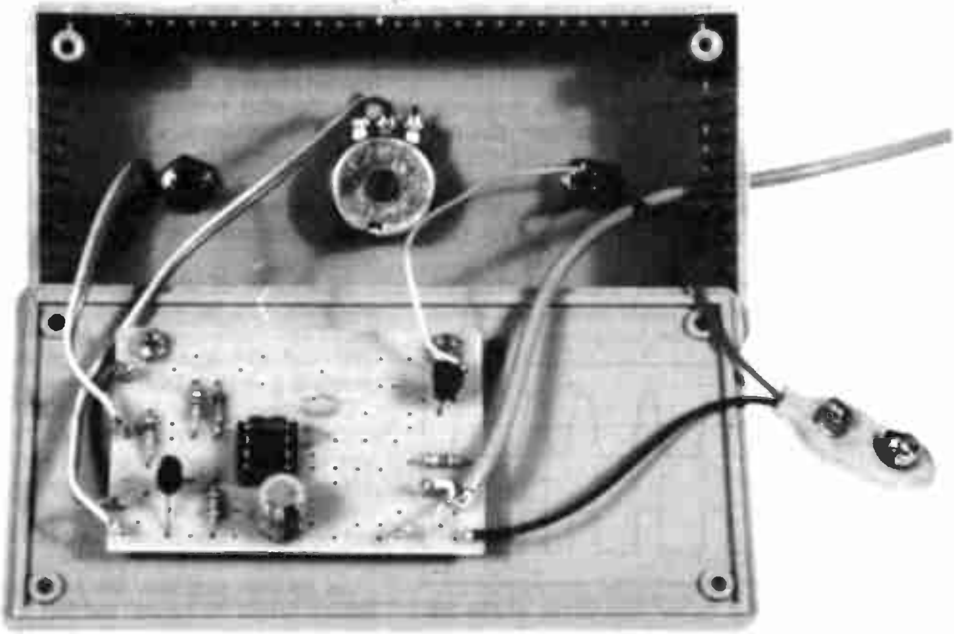
- D1 LD271 infra-red l.e.d. (or similar), 5mm
- D2 red l.e.d., 5mm
- TR1 BP103B silicon *npn* phototransistor
- TR2 BC550 silicon *npn* transistor
- TR3 BC337 silicon *npn* transistor
- IC1 LF441N op.amp

Miscellaneous

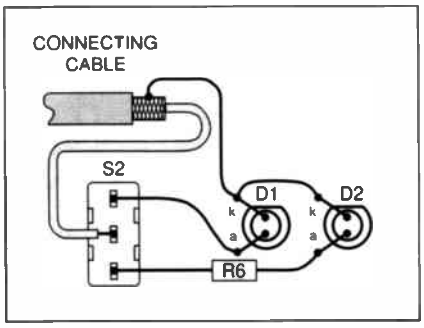
- S1 s.p.s.t. min. toggle switch
- S2 s.p.d.t. min. toggle switch
- B1 9V battery (PP3 size)

Printed circuit board, available from the *EPE PCB Service*, code 932; plastic case (2 off) see text; knob; 8-pin d.i.l. socket; connecting cable; 5mm l.e.d. holder (2 off); battery connector; screened audio cable; multistrand wire; solder, etc.

Approx Cost Guidance Only £15
excluding screened cable



The completed Repeater board is mounted on the lid of the Receiver.



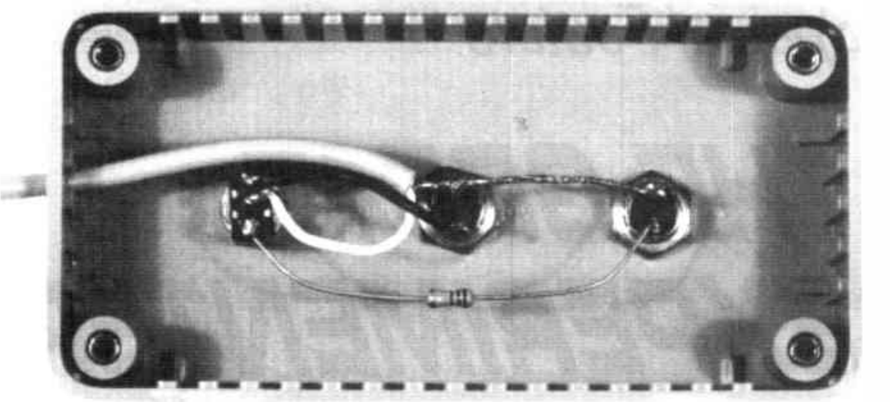


Fig.5. Remote transmitter wiring and (right) infra-red l.e.d. transmitter box.

tic box will accommodate the main circuit. The circuit board is mounted on the lid of the case, which then becomes the removable rear panel. It is bolted in place using 6BA or metric M3 screws.

Controls VR1, S1 and (where appropriate) TR1 are mounted on the front panel of the larger Repeater case. The cable from the transmitter can be connected to the p.c.b. via a plug and socket if desired, and 3·5mm jack connectors are a good choice.

On the prototype, the cable is simply threaded through a 3·5mm diameter hole drilled in one side of the case and then soldered direct to the p.c.b. It is not essential to use a screened cable, but a thin screened audio type is probably the most practical choice.

The smallest of plastic boxes should comfortably house the four components of the transmitter unit. The wiring for this is shown in Fig.5, and is very straightforward indeed. Resistor R6 is simply wired between the appropriate tag of switch S2 and anode (a) of diode D2.

TESTING AND USE

Start the simple testing procedure with normal l.e.d. D2 switched into circuit by S2. With the unit switched on and TR1 aimed towards a light source, it should be possible to switch D2 on and off by adjusting VR1. Due to the very high gain of the circuit, there should be a well defined switch-over point, with no intermediate brightness available. If the unit does not operate correctly, switch off at once and recheck the wiring.

In normal use, phototransistor TR1 must be aimed away from any light sources that could block proper operation of the circuit. Start with VR1 almost fully backed off in a counter-clockwise direction, and then direct the output of the handheld remote control transmitter at TR1.

Bear in mind that both the remote control and TR1 are fairly directional, and must be aimed at each other reasonably accurately. It is unlikely that the signal from the remote control will cause D2 to flash, but D2 should soon respond if VR1 is gradually advanced.

The unit should work with VR1 at around this setting if S2 is used to switch the IR diode D1 into circuit. D1 must be aimed in the general direction of the video recorder or satellite receiver, and initially it is best to use it at a range of only a metre or two.

Adjusting VR1 further in a clockwise direction should give improved sensitivity, but advancing it too far will result in the unit ceasing to work. It is just a matter of using a little experimentation to find the optimum setting for VR1.

SHOP TALK
with David Barrington

Micro PEsT Scarer

As the PIC12C508 microcontroller, used in the *Micro PEsT Scarer*, is a "One Time Programmable (OTP)" chip, **Magenta Electronics** are making it available to readers *ready programmed* for the sum of only £6 inclusive. If you wish to do your own programming, the software listing is available on a 3·5in. disk from the Editorial Office – see PCB page 507. If you are an Internet user, it is available *Free* from our FTP site: **ftp://ftp.epemag.wimborne.co.uk/pub/PICS/PICapest**

A complete kit of parts, including p.c.b. and a suitable plastic case, has been put together by Magenta for £19.99, plus £3 post & packing. They are also offering a plug-top "double-insulated" power supply for £4.99 if you want mains operation. For full details contact **Magenta ☎ 01283 565435** or E-mail: **Magenta_Electronics@compuserve.com**

The PEsT Scarer printed circuit board is available from the *EPE PCB Service*, code 162.

Karaoke Echo Unit

Signal processing, including the echo effect, in the *Karaoke Echo Unit* project is carried out by the 24-pin digital audio processor i.c. type HT8955A. Obviously, this "special" i.c. is not likely to be stocked by your favourite local component stockist and may take some finding.

However, it is currently listed in the "New" **Maplin** catalogue as a Voice Echo, code AE14Q. They also stock the 41256 256Kb DRAM, code QY74R.

Moving on to the Mixer stage. The dual low-noise op.amp type NE5532 should be generally available from most of our components advertisers. This device offers better noise figures than standard 741/TL081 op.amps and it is suggested that this i.c. be used here. If difficulties arise in obtaining it, Maplin have it listed as code YY68Y.

Remember to specify a dual "logarithmic" type when ordering the Level control potentiometer for the Mixer circuit.

The choice and size of case is left to the individual, but it *must* be a ***metal*** type and be able to take one or two p.c.b.s. The two printed circuit boards are available from the *EPE PCB Service*, codes 159 (Echo) and 160 (Mixer).

Infra-Red Remote Repeater

Only the phototransistor (BP103B) and infra-red l.e.d. could possibly cause sourcing problems for constructors wishing to undertake the *Infra-Red Remote Repeater*.

The BP103B device looks more like a 5mm l.e.d. than a normal transistor. Other phototransistors, such as the TIL81, did not work well in this circuit and substitutes are not recommended. The BP103B was obtained through **Maplin**, code CY87U.

The high intensity LD271 infra-red emitter is "matched" to the phototransistor and also came from the above source, code CY85G. Some alternative 5mm infra-red l.e.d.s might be offered by suppliers and may work in this circuit; but they have *not* been "bench tested" with the model.

This project is built on the EPE Multiple Project PCB, this board is available from the *EPE PCB Service*, code 932 for the sum of just £3 inclusive! More projects using this p.c.b. will be appearing in the next few months.

Micropower PIR Detector

The miniature pyroelectric PIR sensor called for in the *Micropower PIR Detector* comes in a package similar to a TO5 transistor, with a "window" in its top. The Murata E600ST0 appears to be only listed by Maplin, code UR69A.

Another item that seems to be only available from one source is the ZVN4424A *n*-channel MOSFET. This device appears in the RS listing and is available through **Electromail (☎ 01356 204555)**, quote code 157-4619.

The μPIR printed circuit board is available from the *EPE PCB Service*, code 152.

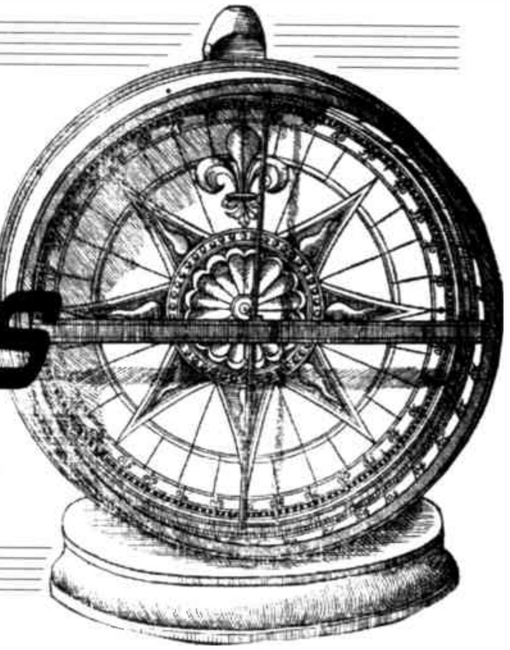
Computer Dual User Interface

We do not expect any component buying problems to arise when ordering parts for the *Computer Dual User Interface* project. The exception is going to be the triple video amplifier chip type MAX467.

For nearest stockists, or "one-off" price on credit card orders, readers can contact **Maxim (UK)** on **☎ 01734 303388.** The other semiconductors should be readily available.

Most advertisers stock a fairly large selection of connectors and cables, and it will also depend on the particular system set-up. The printed circuit board is available from the *EPE PCB Service*, code 161.

Special Feature



THE GREAT EXPERIMENTERS

A short history - Part Three

STEVE KNIGHT

Despite difficulties, including opposition from some of his contemporaries, Ohm eventually established his Law.

In the previous instalments of this series we have seen how the work of Galvani, Volta and Schweigger developed the qualitative principles of the electric cell and the galvanometer, and how Andre Ampere carried the study of electro-magnetism into the quantitative arena of the new science.

Now the time has come to look at the researches of Georg Simon Ohm, a German physicist who struggled for a long while against poverty and isolation to discover the famous law which bears his name and so develop the quantitative study of current electricity.

My own personal encounter with Ohm's Law was many years ago when, at the local Technical College, we were being introduced to the mysteries of the electric circuit. We had to perform a simple experiment in the course of this work using a voltmeter, an ammeter and an adjustable rheostat (plus, of course, a battery) in a set-up where we recorded a range of voltages against the corresponding currents.

Georg Simon Ohm (1789-1854).

When a graph of voltage versus current was plotted, the points all lay closely on a straight line, from which we deduced that current was directly proportional to voltage. At the conclusion of my written work I stated: "As the graph is a straight line, we may assume that Ohm's Law is correct". I still have the book.

The physics master was outraged at this message. "Assumed, lad!", he remarked. "Nothing is assumed about Ohm's Law". And with that he crossed out the last part of my conclusion and wrote in its place: "we have proved that Ohm's Law is correct".

Well, we had actually done nothing of the sort. We cannot *prove* Ohm's Law from the use of voltmeters and ammeters which are instruments calibrated in terms of Ohm's Law being valid, so begging the question.

It might have been better if the physics master had written: "we have verified Ohm's Law"; but I accepted his decision and wondered afterwards how Mr Ohm had managed to sort the problem out in the first place, having no voltmeters or ammeters and even lacking the words "volts" and "amps".

Let us see how he did it.

EARLY DAYS

Ohm was born in 1789 at Erlangden in Bavaria, and was the eldest of two sons of a locksmith, who happened to be a man of good commonsense and appreciation of the value of learning. Father was a poor man but he managed to send both of his sons first to an elementary school and later to a secondary school or Gymnasium as it was then known in Germany, though it dealt with other things than parallel bars and weight lifting.

Here the lads were able to learn the basics of both science and mathematics, and both of them displayed considerable ability in these subjects, Georg particularly so in science; and although their father had wished for them that they would carry on his trade, he felt himself unable to insist upon their doing so.

With some financial assistance, he managed to send his sons for a while to Erlangden University which was in their home town. On leaving the University prematurely because of the lack of funds, Simon went to Switzerland and did work as a private tutor, so that by the time he was twenty-two years old he had saved enough money to go back to Erlangden and complete his university degree.

It was an unfortunate time in Europe then because of the difficulties brought about by the Napoleonic wars, and Simon was forced to return to his father's shop. The mechanical skills that he learned there throughout this period no doubt helped him in later years when, being unendingly short of money, he was able to construct much of the experimental apparatus that he used for his research at the Cologne college, where he eventually found a position as a teacher of mathematics and physics.

It was during his ten year stay at this college that he carried out the experiments which by 1826 established his name among the great men of electrical science.

ELECTRICAL CONDUCTION

In 1822, the French mathematician, Jean Baptiste Fourier, published a work called "The Analytical Theory of Heat" in which he formulated and solved the then difficult equations concerning the flow of heat energy through solid bodies. He also introduced the mathematical world to the now familiar Fourier series which have proved of immense usefulness to physicists ever since.

One of the primary features of Fourier's publication dealt with the conductivity of heat along various materials. In its simplest sense, this examined the relative ability of rods of different substances to transmit the passage of heat energy along their lengths when one end was subjected to a higher temperature than the other; that is to say, different metal rods, having the same temperature difference between their ends, transferred quite different quantities of heat energy.

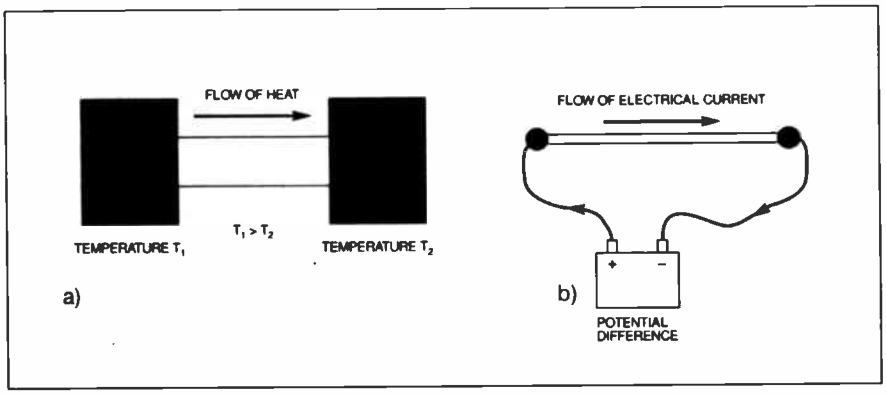


Fig.1. The flow of heat between two temperature levels (a) is analogous to the flow of eletrical current been two points at different voltage levels (b).

Fourier's conclusion was that the total quantity of heat which flows in a given time is directly proportional to the temperature gradient between the relevant ends or faces, see Fig.1a.

The contents of Fourier's work attracted the attention of Ohm. He considered the mathematics of heat flow along a metallic rod and compared it with the flow of electric current along a metallic conductor or wire. He related the idea of heat flow or "flux of heat" as Fourier called it, with the idea of current strength in electricity.

Fourier's conclusion that the "flux" was proportional to the differences of temperature, suggested to Ohm the related idea that electrical current strength could be proportional to the voltage (or potential) difference between the terminals of a battery, see Fig.1b.

Fourier had provided a list of the relative heat conductivities for a number of metal rods, and Ohm picked as a starting point in his investigations the effect of electrical conductivity using wires of different materials.

He took a number of wires, each of the same gauge (or thickness) but of different metals and, starting off with copper, he determined the lengths of each of the wires so as to get the same deflection on his galvanometer; which, of course, indicated the same current strengths. So he was in this experiment finding the effect of *length* on the conductivity of different metals.

Taking the relative length of the copper conductor as 1000 units (this could be quite arbitrary, of course), the lengths of the other materials which gave the same current strengths were as follows:

Copper	1000	Iron	174
Gold	574	Platinum	170
Zinc	333	Tin	168
Brass	280	Lead	97

So, for example, copper was three times as good as zinc or roughly six times as good as tin. You may ask: where is silver? which we know now is marginally better than copper. Well, Ohm *did* include silver wires in his experiment and initially gave its relative value as 356, so making it fit between gold and zinc.

This error, which he later corrected, could have arisen and most probably did arise due to a poorly gauged specimen of silver wire, since the technology for accurately drawing wire may have been, in those days, rather suspect. I don't know, but with an identical length of silver to the other wires he used, the problem must have come about from an incorrect assessment of what the cross-section or thickness of the silver specimen was.

Ohm now turned his attention to what effect the cross-sectional area of his wires had on their conductivities. He soon discovered the fact that for all his specimens the conductivity was unchanged if the cross-sectional area was kept proportional to the length; this would follow, of course, from the fact that if, for example, we double the cross-sectional area of a wire, then we are effectually using two of the original wires in parallel and to restore the conductivity it is then necessary to double the length.

It was probably this result that drew Ohm's attention back to the silver wire in the first experiment, where a smaller cross-section than he anticipated led to a lower value for the conductivity.

Whatever the truth was, the conductivity of a given specimen of wire depended upon three factors (actually four, but Ohm did not look into this fourth factor) and we can summarize his conclusions as follows:

1. the length of the wire
2. its cross-sectional area
3. the material from which it is made

The temperature of the wire also influences its conductivity but the effect is small enough over the range of room temperatures that Ohm no doubt worked in, that the omission of this factor was not significant. (Although, in 1817 he had published an essay on geometry which, he mentioned, had been "written in a room without a fire".)

RESISTANCE

Now, looking at conductivity from another angle, as it were, if a wire has a *high* conductivity, that is, it conducts electricity very well, then its opposition to the flow of current is very *low;* and conversely. This approach introduced Ohm to the concept of *resistance* in a conductor and this resistance, from his experiments, was seen to be proportional to the length of the wire and *inversely* proportional to the cross-sectional area.

For instance, making the cross-sectional area smaller results in a lower conductivity but a higher resistance; thin wires show more resistance per unit length than do thick wires. Hence:

resistance = 1/conductance = $k \times (l/a)$

where:
l is the wire length
a the cross-sectional area, and
k is some constant of proportionality which depends upon the wire material.

Today we call k the "resistivity" or the "specific resistance" of a specimen.

TROUBLE WITH BATTERIES

As his researches continued, Ohm became aware of the inadequacy of the batteries he was using. His days were not those of energetic sources or of those which last up to six times as long as the competition; rather "Never Steady" than "Ever Ready".

We must keep in mind, of course, that he was not agonizing over voltage variations; it was simply that *whatever* it was that drove the current (whatever that was) around the circuit was not very stable.

Ohm had by now begun his researches into the establishment of his famous law and the last thing he wanted was an unreliable component within his circuits.

We have already noted how Fourier's work on the flow of heat had suggested to Ohm the influence of the voltage between the two terminals of a battery as a factor in deriving the relationship he suspected. He quickly recognised that the circuit resistance was the other factor.

In his experiments the resistance was seen to be made up of two parts: first of all there was the resistance of the wires joining up the battery terminals, and he called this the *external* resistance. There was also the resistance of the battery itself which he called the *internal* resistance. This internal resistance lay at the root of all his troubles.

So long as he was forced to use batteries, he was at the mercy of something which could not be directly determined, as could that of a plain wire conductor. That is to say, his formula could not be used to find internal resistance, and at this stage he did not have Ohm's Law to assist him! His problem can be well appreciated.

However, he had sent a record of his observations to a couple of scientific journals, one of which was edited by Johann Schweigger, and in the course of his accounts he pointed out the difficulties he was experiencing with batteries. To this he received a suggestion that he might do better if he dispensed with batteries altogether and replaced them with a thermoelectric supply.

Now there are a number of ways of generating an electric current besides the use of batteries, and at about this time one of these had been discovered by Thomas Seebeck. Seebeck was an Estonian-born German physicist then living in Berlin. He came from a wealthy family (which was rarely the lot of those other experimenters who seemed to be endlessly strapped for cash) and studied medicine, though he spent much of his life on researching physics.

In 1822 he demonstrated that if a circuit is made up of a loop of two dissimilar metals with two junctions, then when the junctions are maintained at different temperatures, a current flows around the loop. Seebeck's invention is shown in Fig.2 where his original metals were copper and bismuth; the points where these metals meet are known today as *thermocouples*, typically used now to measure temperature.

Ohm, on getting this information,

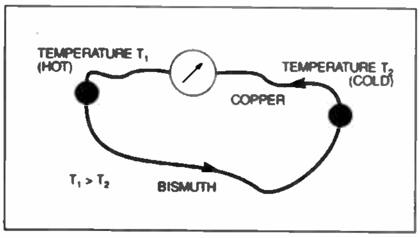


Fig.2. The thermo-electric principle.

decided to use the Seebeck effect in place of his troublesome batteries. He set to work using an apparatus such as is shown in Fig.3, maintaining one of the junctions at 100°C by immersion in a steam-jacket and the other at 0°C by immersing it into an ice-jacket.

The copper part of the circuit loop was arranged to provide a sort of on-off switch; by introducing or removing the connecting wire from the cups of mercury, which acted as the terminals of the "switch". Ohm could make or break this circuit as required, without affecting the total wire length in the system.

To measure the current strength, Ohm used a galvanometer, but not the tangent instrument which we have already discussed. He used instead a torsion galvanometer which was similar in form to that employed by Coulomb, but adapted to his own particular purpose.

This galvanometer functioned by having a magnetic needle suspended by the fibre or ribbon thread and adjustable from a graduated restoring head. When the needle was placed under one of the wires making up the circuit and a current flowed, the angle through which the needle deflected was measured to provide an indication of the current strength.

As in Coulomb's experiment, the deflection was not measured directly but the needle was restored to its initial or zero position by rotating the calibrated brass head, so unwinding the twist in the suspension. It is therefore the angle θ through which the head is rotated which is observed and recorded.

Ohm was now ready to confirm what he had mentally deduced about the relationship between voltage, current and resistance in an electric circuit.

OHM'S LAW

Ohm used in succession eight samples of copper wire, each of the same cross-sectional area but of different lengths, and obtained a table of values connecting the wire lengths against the restoring angle of the galvanometer head. When he plotted these related figures (the graph is shown in Fig.4), Ohm concluded that he had an inverse relationship and to use his own words, "the numbers can be represented satisfactorily by the equation:

$X = a/(x + b)$

where X demonstrates the magnetic intensity of the conductor whose length is x, and a and b are constants depending upon the exciting force and the resistance of the remaining parts of the circuit".

Without getting into any complicated mathematics, let us see how this equation leads us to Ohm's Law. Since "the intensity of the magnetic effect" on the needle depends upon the current strength (the Oersted effect), we can now replace X with our modern day symbol for the current, I.

Ohm now says that a is a constant "depending upon the exciting force": this exciting force is what we know today as the *electromotive force* acting in the circuit, symbol E.

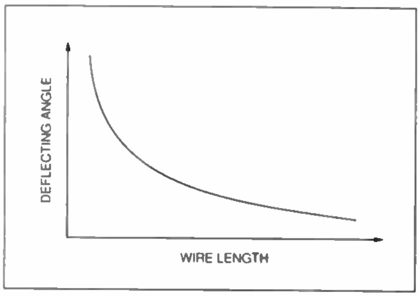


Fig.4. The graph of restoring angle (current strength) against wire length (resistance) from which Ohm deduced his law.

What did his denominator, $x + b$ signify? Well, x was the length of the copper conductor and Ohm had already shown that the resistance of a conductor is proportional to its length; and b is a constant "depending on the resistance of the remaining parts of the circuit".

So $x + b$ represents the *total* resistance of the circuit: the copper part x and the resistance of the bismuth part, the two mercury cups and the switch wire, which is b. As these items remained constant all the time, Ohm was able to calculate a definite value for b; hence $x + b$ is a measure of the external circuit wires, symbol R, and the in-series resistance of the thermo-electric battery itself, symbol r.

Thus, in today's symbols we have

$I = E/(R + r)$ or,

Current = electromotive force/total resistance

This, of course, is our favourite ingredient, Ohm's Law.

Ohm consolidated the results of his research by changing the conditions of the

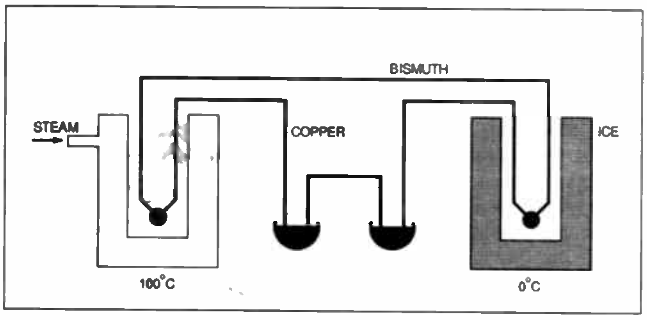
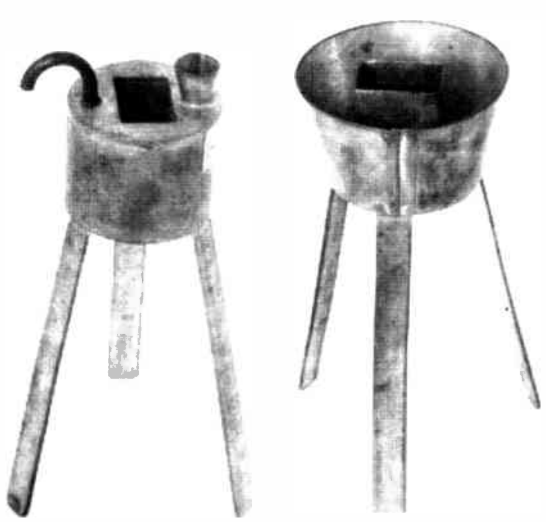
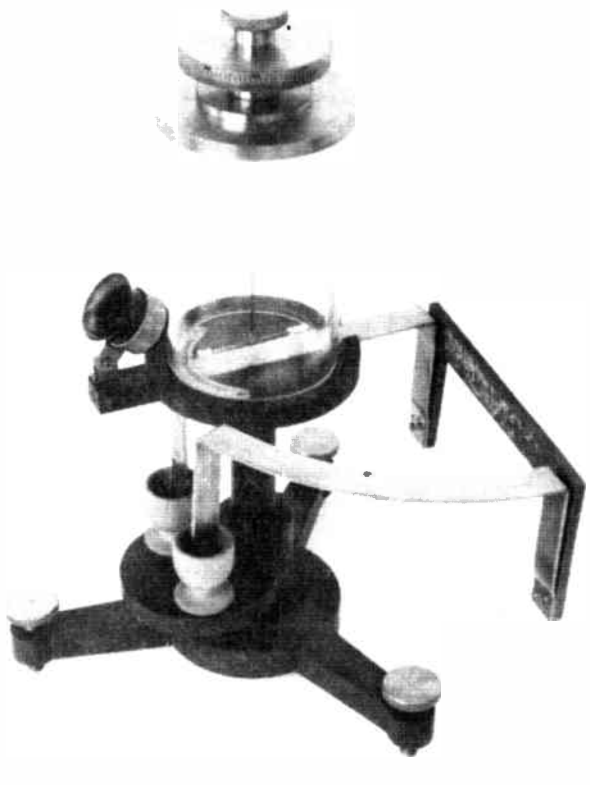


Fig.3. Ohm's apparatus using thermo-electricity as his source of voltage.





Above: Ohm's torsion galvonometer.
Left: Part of Ohm's thermo-electric apparatus.

component parts of his equipment; using brass, for example, in place of copper, and thermo-junction temperatures which were different from 0°C and 100°C used in his original experiment. These variations, of course, changed both the current strength and the electromotive force as well as both the external and internal resistances, but his formula remained unaffected.

POORLY RECEIVED

When in 1827 Ohm published his results in a book entitled "*The Galvanic Circuit Worked Mathematically*", which set out the theoretical basis and the practical results of his law from first principles, a number of critical voices turned up, just as they had over Ampere's work; and in some scientific circles (if they deserve that title) the book seemed to be ignored altogether.

To be entirely unbiased, some of this may have resulted from the fact that Ohm's occasional articles about his experimental work which appeared in German scientific journals, principally then edited by Schweigger as we have noted, did not attract any serious attention. As a consequence, when Ohm's book appeared, it was treated by a number of critics as a fanciful theoretical argument about the workings of the electric circuit unsupported by experiment.

To quote one of these critical voices, Ohm's theory was "a web of fancies" which need not be considered or appraised by even the most superficial examination. And he carries on, "Those who regard the world with an eye of respect should turn away from this book as a manifestly incurable delusion, whose only purpose is to detract thought away from nature's honour and prestige".

Well, whatever nature may have thought about this, it is not difficult to visualize Ohm's reaction to such criticism. Any seeker after truth, as Ohm had been for his ten years at Cologne, was bound to be offended, even deeply disappointed, by this reception of his work. His ambition had been to become a university professor, and the work he had accomplished over those ten years, based as it was on the undisputed logic of experimental fact, should have enabled him to achieve his ambition.

But the barrage of criticism went on unabated. A particularly nasty feature came from the Minister of Education himself; a certain school official, who was an opponent of the experimental approach to science and who had come into contact with Ohm, possibly through some administrative matter, became particularly hostile to Ohm's work and his attack reached the ears of the Minister.

Henry's electromagnet of 1828.

This man, whose thoughts seemed far removed from his position, expressed his opinion that "a physicist who perceived such heresies was an unworthy teacher of science".

Following upon this, Ohm resigned his appointment at Cologne and for the next six years took up casual coaching in Berlin, plus a few lessons a week at a school where the yearly salary was totally inadequate. But Ohm's work was sound, it existed in black and white, and it covered a subject that was being increasingly investigated by the scientific world.

It was no credit to his home country that the first recognition of his labours came from abroad, particularly from the enquiries of Joseph Henry, the American physicist whose name is given to the unit of inductance (the Henry). He discovered the principle of electro-magnetic induction independently of Michael Faraday, and together with the physicists Lenz in Russia and Wheatstone in England, looked to the rumoured theories of Ohm among his colleagues.

These included Alexander Bache, great grandson of Benjamin Franklin who was professor of science at Pennsylvania University, but he had little information to give. But international communication was difficult and it was not until Henry visited England in 1837 that he obtained the information he was looking for.

In the meanwhile, Ohm had obtained an appointment at the Nuremburg Polytechnic and it was here that he spent most of his time working on subjects outside the province of electrical research. Whether this was some kind of internal revolt against the subject that had brought him so much misery and disappointment, we don't know. But from the interest that Henry and several other physicists showed in his electrical writings his achievements were brought out of obscurity and criticism, and from that time onwards Ohm's fortunes changed.

In 1841 the Royal Society of London awarded him the coveted Copley medal in recognition of his services to science by the discovery of his now celebrated law. Finally, in 1849 he received the mark of recognition that he had most prized; that of professor at Munich University, where he worked quietly and unassumingly until his death in 1854.

Yet for all that, it was not until nearly thirty years later that the true recognition of his achievement came at the 1881 meeting of the International Congress of Electricians in Paris which, as we have already seen, paid its respects to Andre Ampere by naming the practical unit of electric current after him. It also paid a similar honour to the memory of Georg Simon Ohm, after whom was named the practical unit of resistance: the Ohm.

PART FOUR

Michael Faraday, arguably the greatest experimental physicist of them all, and an Englishman at that, is the subject of next month's feature.

ACKNOWLEDGEMENT

The illustrations used in this article have been kindly supplied by the Science Museum, London

READOUT

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

PIN BOARD WIZARD

Dear EPE

Each new year I have hoped to see a change in the policy of *EPE*, but this year you have gone even further down the murky lane of printed circuit boards. For the DIY person and small scale producer, whom I assume are your main readers, the only advantages of p.c.b.s over so-called pin boards are that they look prettier and it is easier to replace a faulty i.c. The relative advantages of pin boards are that they are cheaper, easier, quicker to produce, have a lower fault liability, are more compact and offer a better layout.

With the pin boards that we have been using continuously here in my part of South Africa for over 30 years, we use 1/8in chipboard with 1/2in brass nails, which have become very cheap because the shoe trade now use glue in place of brads. These are driven through guide holes into the chipboard to provide mounting posts for the component leads. I.C. sockets can be used but we prefer to solder wires to the i.c. tags and glue the i.c.s to the chipboard.

Perhaps you could persuade Alan Winstanley to describe such pin boards with the same, or greater, enthusiasm he recently displayed for p.c.b.s (Jan '97 issue).

Kind regards, all in fun,

Freddie Clifford, Wetton, South Africa.

We admire ingenuity and thoroughly uphold the belief that in an emergency anything that has the possibility of being substituted for the proper tool could and should be used. Never mind calling a spade a spade, if a bit of tin roof sheeting can dig a hole, use it if the spade's gone walkabout. Your ingenuity, though, seems to excel in taking electronics back to the Brass Age!

Although you sign off "all in fun" I'll assume for the sake of general courtesy that you are not "boardering" on the fringe (of technophobia, that is – but I must admit to having checked your letter's date for signs of April 1st), and that you are actually reporting the technological approach which best suits your local environment in South Africa. Having travelled widely, I am aware that the ultimate in technology is not always appropriate to developing cultures.

Nonetheless, we are obliged to disappoint you and not request Alan to do a chipboard appraisal treatise. We have to take a compromise approach regarding constructional projects, reflecting the "recent" in component sophistication whilst taking into account the capabilities and facilities of the majority of our readers. This means, for example, that we will happily use the latest in microcontrollers, but we would probably not use its surface mount version which would be difficult for many readers to handle conveniently.

Experience has also taught us that, as useful as stripboard *construction techniques can be (and, by implication, other non-p.c.b. techniques), the achieved constructional accuracy of readers is less satisfactory than for those who assemble projects based on p.c.b.s. With a p.c.b., the tracking is already correctly routed on the board. With stripboard, much of the tracking is only accomplished by the correct insertion of wire links across the board. Also with stripboard, it is not uncommon for track cuts to be omitted or made in the wrong tracks. With ready-made p.c.b.s., all that basically is required is to ensure that the components are soldered into their allocated positions.*

With both p.c.b.s and stripboards, the occurrence of bad soldered joints is equally possible, so from that point of view there is little to choose between them, though admittedly closely-run tracks on a p.c.b. can be more prone to solder shorts.

Your belief that nailed boards make for better layouts than p.c.b.s leaves us puzzled (although maybe Indian fakirs *might agree with you!).*

We agree that p.c.b.s are inevitably more expensive than stripboard, but for most of our readers the proven fact that constructional success is more assured through using them, far outweighs the cost consideration in all but the most minor cases. Despite chipboard's name, we certainly wouldn't recommend it for chip assembly. It's better used for workshop pin-ups than pinouts. JB

WHO'S GOT FIVE?

Dear EPE

I have always accepted that TV aerials fall into three groups, "A", "B" and "CD". My own installation generally receives the Fenton transmitter which transmits group "A" signals. Now along comes Channel 5 transmitting on approximately channel 35. In theory, the response of group "A" aerials falls off at about that frequency. How do I explain to customers that their poor reception of C5 may be due to "fall-off" at this frequency? How do I replace their aerial, and with what – a group "CD" aerial with its accompanying "wideband" disadvantages?

E. Steele, Hanley

Barry Fox commented on this expected problem in Innovations *of May '97, pointing out that existing aerials are not suitable for UHF channels 35 and 37 as used by Channel 5. There is another report from him on C5 and its new satellite link in this current issue.*

Here in Wimborne we are not served (terrestrially) by C5 yet, but I have first hand experience of trying to receive C5 in Orpington, Kent, a few miles from C5's transmitter at Beulah Hill, which is not far from the big Crystal Palace aerial that serves the other London TV channels. Even though it is possible to actually see the Crystal Palace aerial from the outskirts of Orpington, I have been unable to receive a clear C5 picture. It's not just "snow", it's almost total obliteration.

Asking a major audio retail chain store in the district for recommendations on what to do, sales staff advised me that they did not know and that their roof-top aerial, which is about 40 feet high and a mile closer to Beulah Hill, could not receive a good picture.

Although I have not done so yet, I recommend that if you have C5 reception problems, you contact C5 at 22 Long Acre, London WC2E 9LY. Main tel: 0990 770021. That number has an answerphone service which gives you details of which other numbers to call for specific queries. The number for reception queries is 0541 555551.

What experience have other readers had with C5 reception? JB

UPDATING SPEED

Dear EPE

Further to Ian Poole's interesting *New Technology Update* column in *EPE* May '97 regarding processing speeds, the company I work for, Digital Equipment Corporation (sometimes known as DEC), has been shipping "Alpha" processors with speeds of 150MHz and greater for four to five years; in fact our current top of the range system clocks in at 600MHz and you can imagine that faster systems are in the pipeline.

For further information, see DEC's page at **http://www.digital.com/info/semiconductor** and follow links to "Alpha".

Gerald Connolly, via the Internet

As Ian said, "Pentium chips running at over 100MHz are commonplace". Indeed, some might even say that they are now "pedestrian". By coincidence, I recently chanced upon an article about microprocessors published some 15 years ago in which the statement was made: "whilst microprocessor speeds of as high as 1MHz may seem incredible ..."! Could we, in 15 years (or even less), be putting an exclamation mark as a editorial comment after a similar statement made now about speeds of 1GHz or even 100GHz?

Does anyone have any idea what the highest likely/possible "commonplace" maximum speed will turn out to be? Is there, as with the (assumed) light speed barrier, a supposed processing speed barrier which can never be broken? If so, why? And, in answering, remember that "experts" have often made statements about things being "impossible", assertions which have subsequently turned out to be fallacious. JB

COLOURED SHORTS

Dear EPE

I read, with real interest, the letter from P.P. Doncaster in the May '97 issue (*Current Shorts*).

As with most things, there must be a deal of compromise – and in this case, based solidly on the level of understanding of electronics. The "smaller" circuits of yesteryear can really be equated to "*n* joints per sq. cm". I suspect that P.P. would be very content to introduce a "level of joints per sq. cm" and swat-up like mad – as I do – on what is going on between them.

To me, the crucial point is good, clear, circuit descriptions: that's the aspect which prods me into a project, or kills it stone dead at fence No.1. In this respect, my ideal would be sections of the circuit diagrams identified by various colours for the voltages, and the lines to be straight for d.c. and undulating for a.c. And, *please, please*, quoting the various voltages that to be expected at relevant points.

My interest in electronics is relatively new – I am struggling with the RAE (B Licence) – but have found a real hobby for my retiring years.

Ken L. Sapsed, Langstone, Hants

Colour can indeed enhance a circuit's clarity, but at a price. Its use in this way would add to our production costs, resulting in an increase in the cover price. Our research indicates that readers would prefer to pay for content rather than cosmetics. Although we make limited use of "spot" colour which does not add to the cover price, this is due to a spin-off from advertisers' requirements.

EPE *is sectionally printed as eight pages per side of a printing block (which is subsequently folded, cut and combined with other blocks). If one of those pages is for an advertiser who requires colour (and pays for it), we can also use the same colour for editorial purposes on the other seven pages (depending on the page positioning within the mag) without incurring significant extra costs. You will have seen many examples of this in recent issues – examine the relative positioning of the colour pages in this issue. But the cost of preparing artwork (schematics, etc.) would increase significantly if we used various coloured lines rather than just tinting selected areas as we do now.*

We agree that the inclusion of voltages at strategic points could be beneficial. Somehow, though, it's not something we've ever really done. Perhaps we are remiss in this. (With tongue in cheek, we could reply that we don't in order to encourage readers to learn how to make their own calculations from the component values shown and that it is an educationally desirable exclusion!) JB

More letters on page 474

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MARCH '96

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FEATURES ● Teach-In '96 Part 7 ● Ingenuity Unlimited ● Thermionic Valves Part 2 – The C.R.T.

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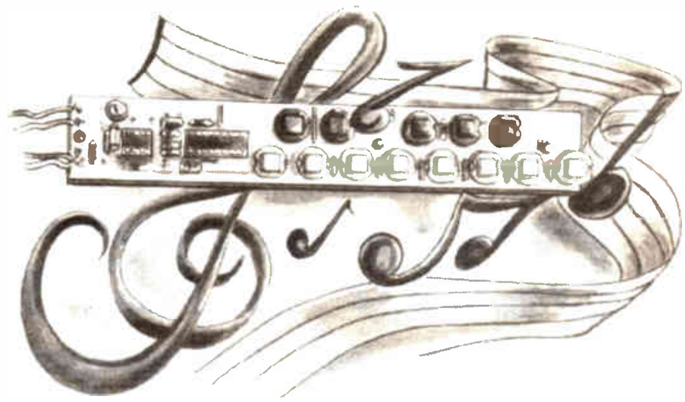

PIC-OLO!

Some of you will remember the days before Rolf Harris became involved with Animal Hospital and recall the Stylophone which he made famous. That extraordinary (for its time) little musical instrument used a stylus which, when touched on metallic keyboard-like pads, caused single notes to be played.

Over the years, there have been many imitations and, unashamedly, PIC-OLO is the latest. But, it has taken the idea a triplet of logical steps forward: it uses a microcontroller (the PIC16C84), 13 keypads arranged in piano keyboard style, C to C1 including five sharps, and it can chord – up to four notes at a time can be played. It's in a slimline case (electrical conduit!) and can be used with headphones, a small speaker or plugged into the hi-fi. Not a stylus in sight!

COLOSSUS RECREATED
Wartime technology outperforms Pentium PC!

Every other weekend a group of volunteers welcomes visitors to a cluster of decaying huts in the grounds of a stately home near Bletchley. Despite what the British security services would wish, and thanks to the accidental publication of top secret documents in the US, the Bletchley volunteers can for the first time recreate the technology used during World War II to crack the codes used by the German military.

Barry Fox relates the fascinating tale of how UK engineers built the world's first electronic computer and cracked the codes to win the war. The surprise discovery, which raises questions on the best future for computing, is that the wartime technology can still outperform the latest Pentium PC.

UNIVERSAL INPUT AMPLIFIER

It is unfortunate that the sound quality of many items of low cost PA and recording sound equipment are let down by the performance of their input amplifiers. This is because the demands placed on a PA or recording input amplifier are really quite heavy. Ideally it should be able to cope with input signals ranging from the quietest microphone to the output of a CD player, whilst having low distortion and low noise at all times.

The circuit described here is designed to replace the input stage of a mixer or pre-amp and will provide a gain adjustable over a very wide range with low noise. It is also a straightforward task to assemble several of these circuits to form a simple mixer.

VARIABLE BENCH POWER SUPPLY

Simple, safe, inexpensive and easy to build, this project will appeal to a wide range of readers. A regulated mains power supply unit is undoubtedly one of the most useful pieces of equipment for the electronics experimenter. Ideally, the supply should have a wide output voltage range, and be capable of providing high currents, but a high specification is invariably accompanied by a high price.

Fortunately, for most purposes a supply unit having a modest specification will suffice. This p.s.u. has an output voltage of 1·2V to 12V at up to 500mA. Despite the simplicity of the circuit it provides excellent regulation.

EVERYDAY PRACTICAL ELECTRONICS

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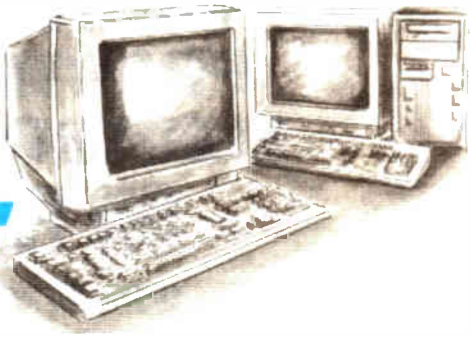
AUGUST ISSUE ON SALE FRIDAY, JULY 4

COMPUTER DUAL USER INTERFACE



MARTIN CAMPBELL

How to easily and cheaply key into your computer from two different locations.

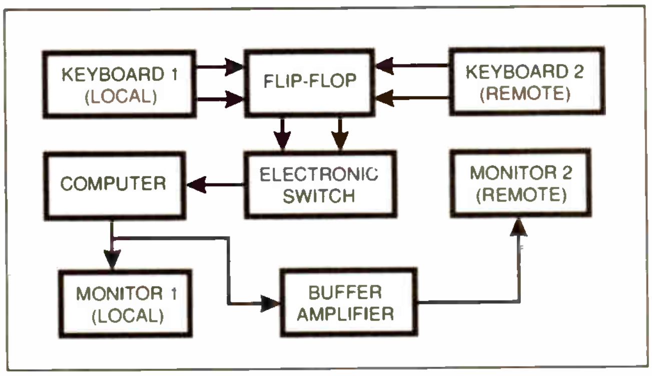


Fig.1. System block diagram for the Computer Dual User Interface.

DESCRIBED here is an interface that allows one computer to be used by two users at different locations, up to approximately ten metres apart, although *not* at the same time. The unit's cost is far below any currently available commercial equivalent. It is self-contained and takes its supply from the host computer.

SYSTEM OPERATION

The block diagram of Fig.1 helps to explain how the unit functions. The two keyboards, one local and one remote, are connected to the computer via an electronic switch. A flip-flop toggles the switch into a state where one or other of the keyboards is connected to the computer.

The VGA monitor output from the computer is fed directly to the local monitor and to the remote monitor via a buffer amplifier.

Touching any key on either keyboard toggles that keyboard into operation. The information will always be displayed on both monitors.

CIRCUIT OPERATION

The circuit diagram for the complete Computer Dual User Interface appears in Fig.2.

Both keyboards are connected to IC1, a type 4066 quad bidirectional analogue switch, which is wired as a dual double-pole single-throw (d.p.s.t.). switch.

Operation of these switches is by IC2, a type 4093 quad dual-input Schmitt trigger NAND gate, of which only gates IC2a and IC2b are used, wired in the standard flip-flop configuration.

Assume that, initially, IC2a output pin 3 is high, "enabling" IC1 control pins 5 and 6 and so turning on switches S2 and S3 within IC1. Switches S1 and S4

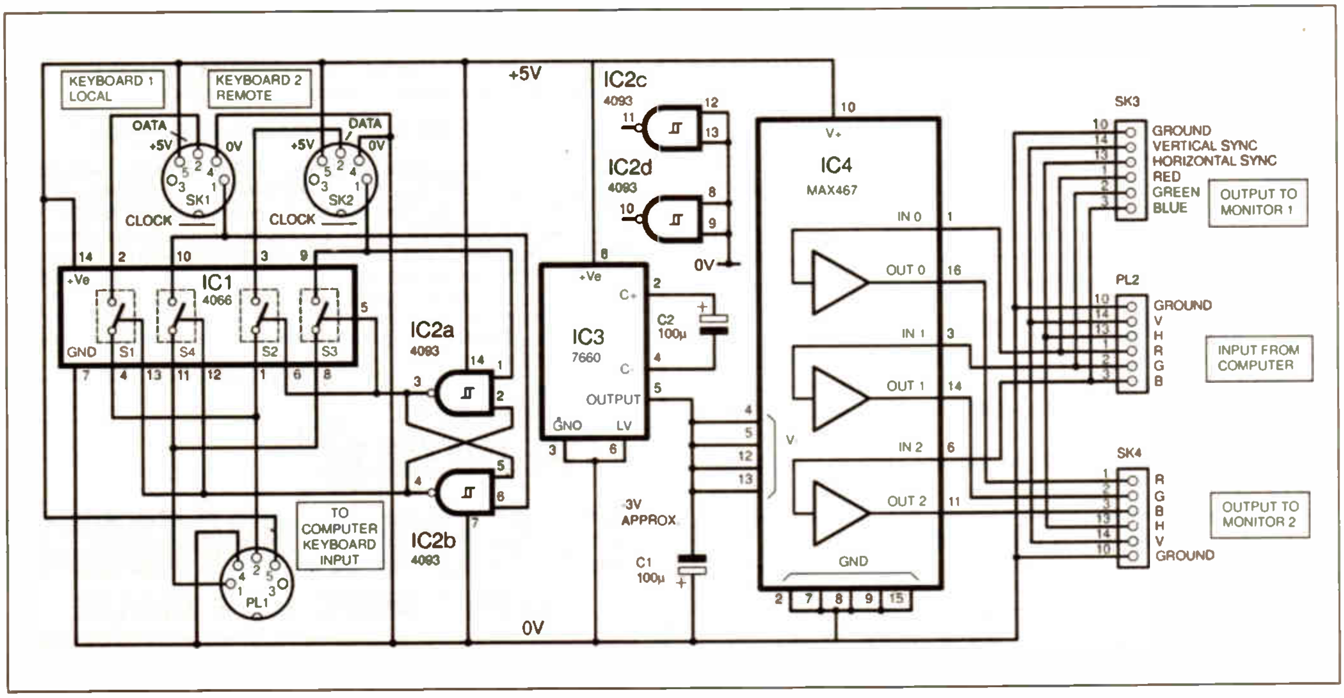
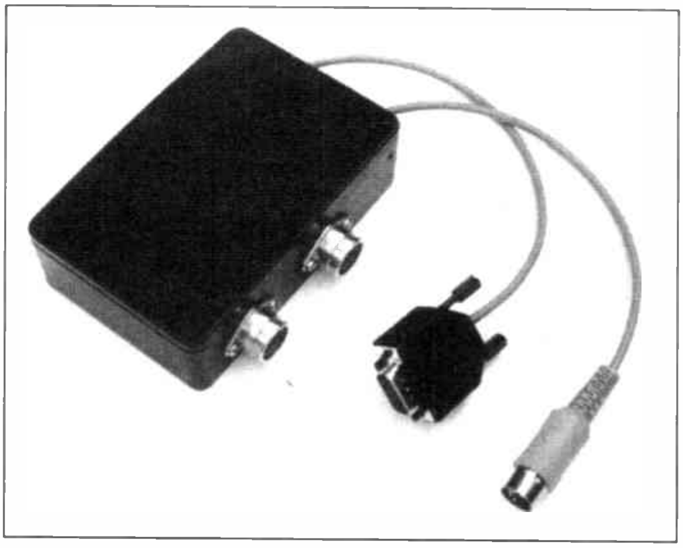
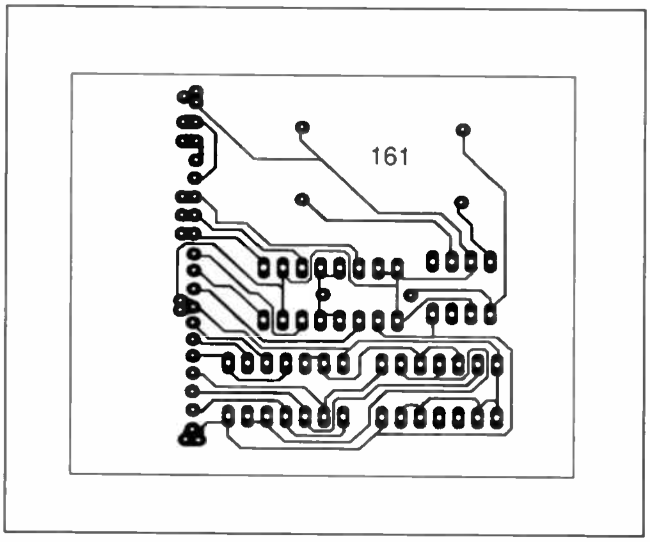


Fig.2. Complete circuit diagram for the Computer Dual User Interface.



Completed Interface showing the DIN and D-type line plugs.



Printed circuit board full size copper foil master.

are held turned off by the inverted logic level of IC2 output pin 4. This allows the clock and data signals from the remote keyboard (KB2) to pass to the computer.

If, now, a key press is made on the local keyboard (KB1), the clock signal from this keyboard will be sensed at IC2b input pin 6. This will force the flip-flop action, resulting in IC2a output pin 3 and IC2b output pin 4 going low and high respectively. Switches S1 and S4 within IC1 now turn on, whilst switches S2 and S3 turn off. The data and clock signals from the local keyboard (KB1) are now acknowledged by the computer.

VIDEO MULTIPLEXER

Irrespective of which keyboard is in use, the video output signal from the computer is routed to both VDU (visual display unit) monitors. So that it can cleanly drive the remote monitor as well, although the signal needs to be buffered. This is done by IC4, a MAX467 triple video amplifier.

The amplifier has a fixed gain of one and, by buffering the signal between the two monitors, helps to prevent interference patterns. It was found that the vertical and horizontal synchronizing signals did not need to be buffered.

POWER SUPPLY

The power supply for the Interface is provided by the +5V line of the computer's keyboard connector. IC4 requires a split supply of plus and minus 3V minimum. A 7660 voltage inverter, IC3, is used to generate the negative supply needed.

In conditions of no load on IC3's output, the inverter will generate an almost equal but opposite polarity voltage to that of its power supply. However, the output voltage is affected by the current drawn and, in this instance, approximately −3V is delivered, which is as required by IC4.

CONSTRUCTION

Details of the printed circuit board layout and the off-board wiring are shown in Fig.3. This board is available from the *EPE PCB Service*, code 161.

First solder in the single link wire on the board, followed by the four i.c. sockets, and then the electrolytic capacitors, C1 and C2, observing their correct polarity.

Connections between the board and the case-mounted sockets should be kept as short as possible. Thin, light-duty stranded wire was used in the prototype; ribbon cable could be used.

Shielded (screened) wire is not necessary for the keyboard and local monitor, though it *must* be used for the

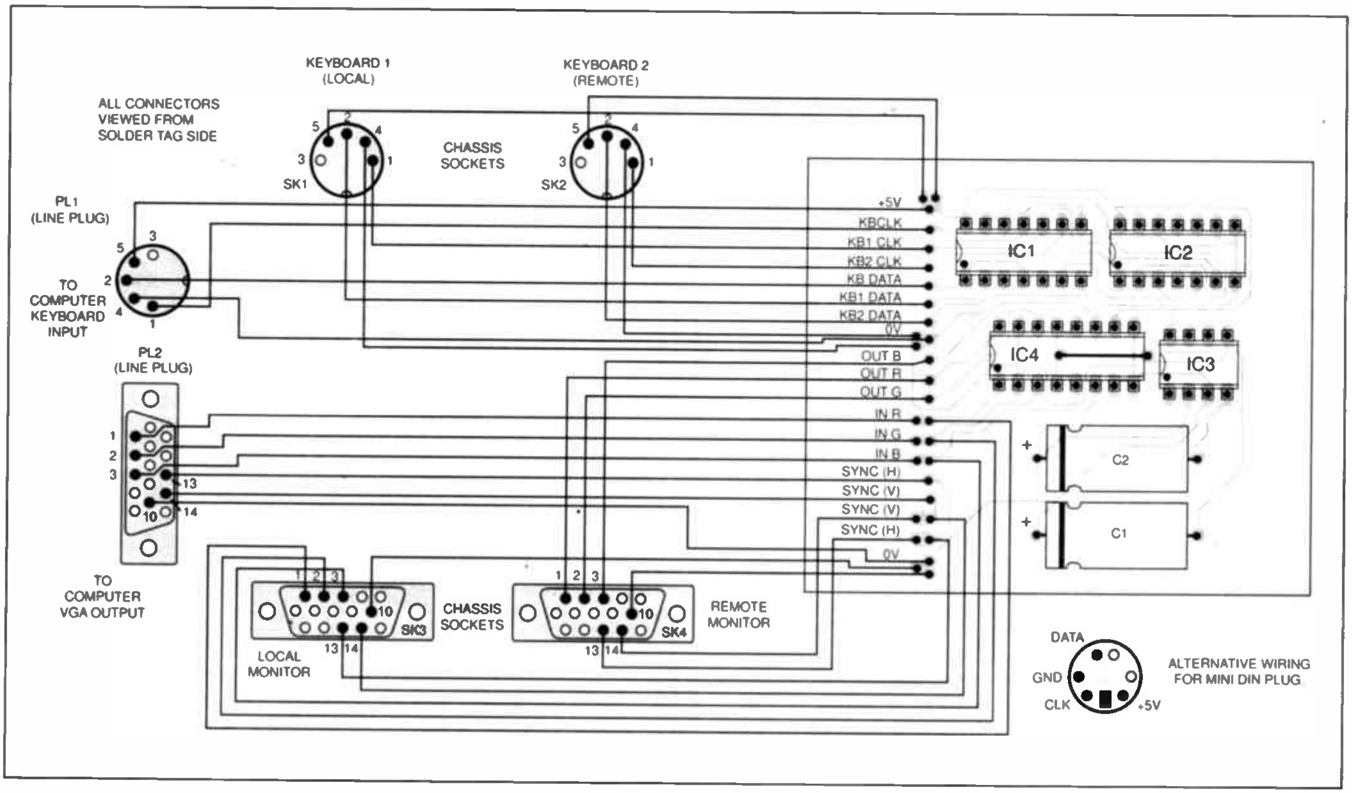


Fig.3. P.C.B. layout and interwiring to the off-board DIN and D-type sockets and line plugs.

COMPONENTS

Capacitors
C1, C2 100μ axial elect. 16V (2 off)

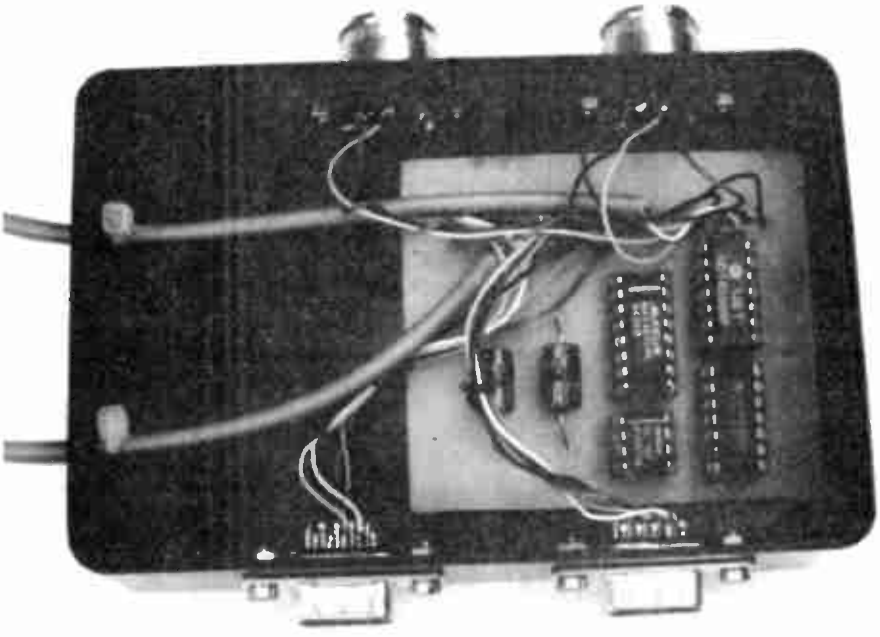
See **SHOP TALK** Page

Semiconductors
IC1 4066 quad analogue switch
IC2 4093 quad Schmitt NAND gate
IC3 7660 voltage inverter
IC4 MAX467 triple video amplifier

Miscellaneous
SK1, SK2 5-way 180° DIN socket (2 off)
SK3, SK4 15-way high-density VDU connector, female (2 off)
PL1 5-way 180° DIN line plug
PL2 15-way high-density VDU connector, male

Printed circuit board, available from the *EPE PCB Service*, code 161; 8-pin d.i.l. socket; 14-pin d.i.l. socket (2 off); 16-pin d.i.l. socket; 6-way individually-screened cable with high-density male and female 15-way connectors for remote VDU; plastic case, 120mm × 80mm × 35mm; connecting wire; solder, etc.

Approx Cost Guidance Only £21 excluding cables



Layout of components inside the completed Interface case. To keep wiring neat, use cable ties or wire off-cuts to group each socket wiring together.

remote monitor if it is some distance away, otherwise the image sharpness may deteriorate. The remote monitor wires should be *individually* screened, with their screens connected together at the monitor end.

Some computers now use miniature DIN connectors for keyboard connection and the pinout order for this type is also shown in Fig.3.

Take the usual anti-static precautions before handling the i.c.s, by touching a grounded (earthed) item, for example. If the computer does not respond as usual when first connecting this Interface, *immediately switch off* and recheck your assembly.

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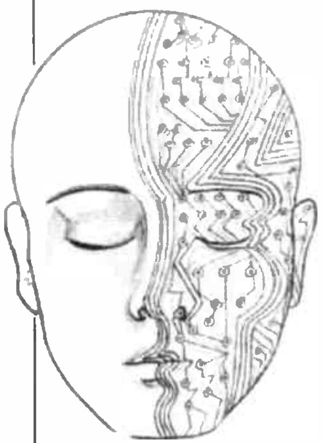
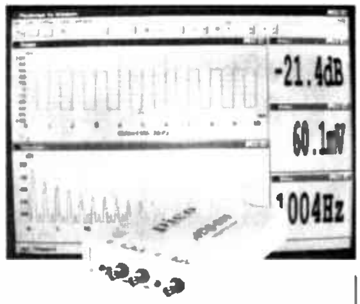


INGENUITY UNLIMITED

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.

Multi-sided Dice – Playing the Game

Depicted in Fig.1 is a circuit diagram for a Multi-sided Dice – one which will display counts from 1 to 4, 6, 8, 10, 12 or 20 depending on the position of selector switch S2. This is very useful not just for traditional games, but also role-playing games and similar, when multi-sided dice are essential equipment!

The circuit is formed of a clock (IC1) driving a divide-by-two counter (IC2) followed by a decade counter (IC3). When pushswitch S1 is closed, the counter advances at a rate of several kilohertz and displays one number when S1 is released. Because of the high clock rate, the choice of numbers appears to be random.

The decade counter IC3 outputs each drive two l.e.d.s. However, the cathodes (k) of the l.e.d.s (D1 to D20) are toggled by the flip-flop IC2, so that only one l.e.d. can be illuminated at a time. The number of "sides" is determined by resetting the decade counter IC3 as soon as it counts outside of the allowable range, e.g. for a six-sided dice the counter resets as soon as it reaches seven.

The Multi-sided Dice is powered from battery B1, a 9V PP3 type. Capacitor C2 provides decoupling for the supply. Remember to use anti-static precautions when handling the CMOS devices.

Andrew Gale,
Weston-Super-Mare, Avon.

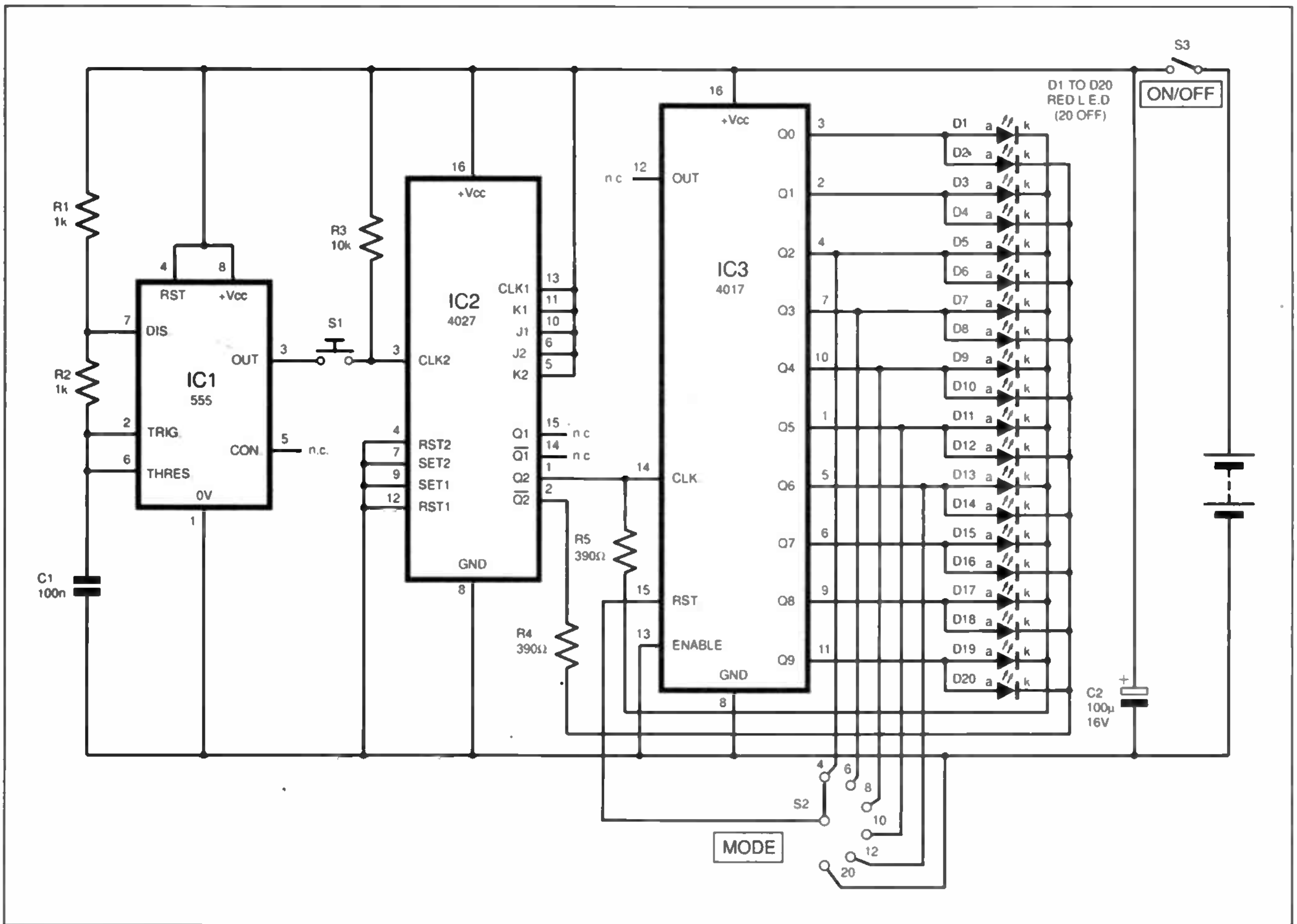


Fig. 1. Circuit diagram for a battery powered Multi-sided Dice.

Intruder Alarm – Detects Light Fingers!

A FEATURE of the Intruder Alarm circuit of Fig.2 is that it utilises the 50Hz signal emitted by an ordinary electric light bulb as a signal source. The source of light was an exterior ornamental lamp powered from the mains, mounted adjacent to the window. Filaments are driven at the mains frequency which cannot be discerned readily by the human eye.

A light-dependent resistor (l.d.r.) R1 is mounted *inside* the room to one side of the window where it detects the light signal and converts it to a sine wave. The result is then amplified by transistors TR1 and TR2, with potentiometer VR1 allowing the sensitivity to be adjusted. The amplified output is rectified by diodes D1 and D2 as part of a voltage doubling circuit.

Under normal conditions, the d.c. voltage saturates transistor TR3 on, which shunts TR4 base (b) towards 0V and prevents it from conducting. Any movement between the lamp and the l.d.r. causes a reduction in the signal, cutting off TR3 and so now TR4 conducts.

This sends a negative-going trigger signal to IC2, a 555 monostable, which triggers immediately and powers IC3 (entry delay timer), another monostable which drives a relay RLA on when it times out (pin 3 goes low). With resistor RC at a value of 180 kilohms, the entry delay is about 30 seconds. Contacts RLA1 are used to drive an external bell or siren.

The value of resistor RB on IC2 sets the alarm ring period; a value of 2M2 (2·2 megohms) produces a period of about 3½ to 4 minutes. The timer IC1 acts as power-on delay which will disconnect IC2 and IC3 from the 0V rail for about 30 seconds with a value of 2M2 for resistor RA.

Mike Brown,
Poole, Dorset.

Spatial Stereo Effect – Spaced Out Sound

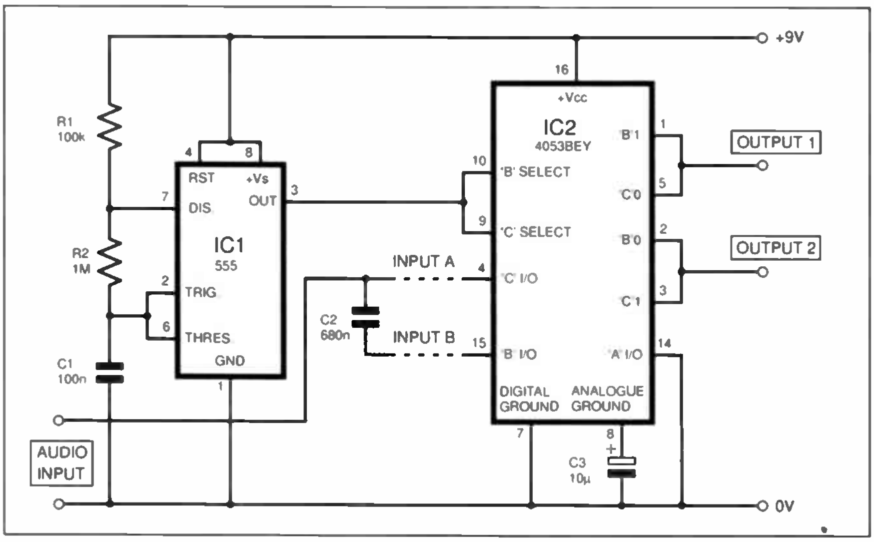


Fig.3. Spatial Stereo Effect circuit diagram.

THE simple Spatial Stereo Effects circuit diagram shown in Fig.3 was designed to put some "space" into a mono sound source when heard over a pair of stereo speakers. This is achieved by filtering out some of the lower frequencies and alternating this with the original signal into the left and right audio channels.

Using a 555 timer in astable mode, running at about 14Hz, IC1 output (pin 3) toggles the "B Select" and "C Select" lines of IC2, a 3-pole 2-way bi-directional switch of which switches B and C are used. At one stage, the signal input A at pin 4 (C in/out) appears at Output 1, and the signal input B at pin 15 (B in/out) appears at Output 2. Seven hundredths of a second later the situation is reversed, with input A being connected to Output 2, and input B connected through to Output 1.

Capacitor C2 filters some of the lower frequencies from input A and sends it to input B. Capacitor C3 was incorporated to help prevent IC2 from picking up 50Hz mains hum which otherwise leads to it switching prematurely.

The two outputs can be connected to the stereo inputs of an amplifier, or directly to stereo headphones. The circuit worked well with the audio input being connected to a mono earphone of a radio, whilst listening to the resultant signal with stereo headphones.

Mohab S. Refaat,
Cairo,
Egypt.

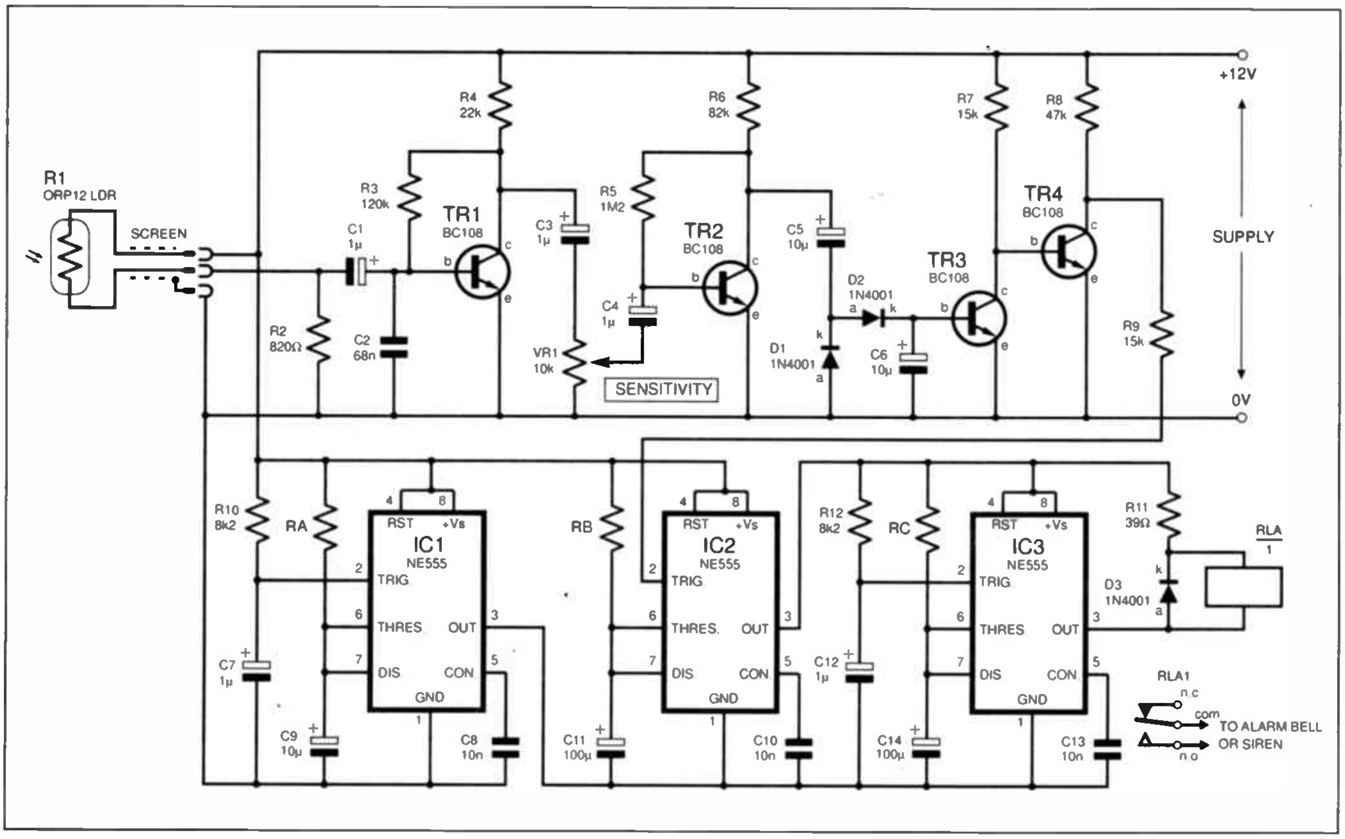


Fig.2. Circuit diagram for a "light bulb" Intruder Alarm. For values of RA, RB and RC see text.

F.E.T. Tester – Go-No-Go Glow

The junction F.E.T. Tester circuit diagram shown in Fig.4 will allow a rapid "go-no-go" check of small-signal *n*-channel field-effect transistors (f.e.t.s) of the MPF102, 2N3819 etc. variety. A small modification enables the circuit to be used to check the less common *p*-channel types.

The circuit chosen was a "Pierce" crystal oscillator which has very few components. L1 is a small 1mH r.f. inductor. A readily-available 4·433MHz crystal is used in the feedback network, and when the oscillator is running its output is fed, via capacitor C2, to the base (b) of transistor TR1, which drives the l.e.d. (D1) on. No base bias was found necessary.

Three flying leads terminated in crocodile clips are taken from the circuit and hooked to the relevant pins of the f.e.t. The l.e.d. D1 will glow when a functional f.e.t. is connected. To check a *p*-channel device, TR1 should be replaced with a *pnp* BC212 transistor, and the battery and l.e.d. polarities reversed.

The circuit was constructed on stripboard, and you could also assemble a simple crystal checker by mounting a crystal socket on the housing in place of X1.

D. Allen, Cheltenham, Glocs.

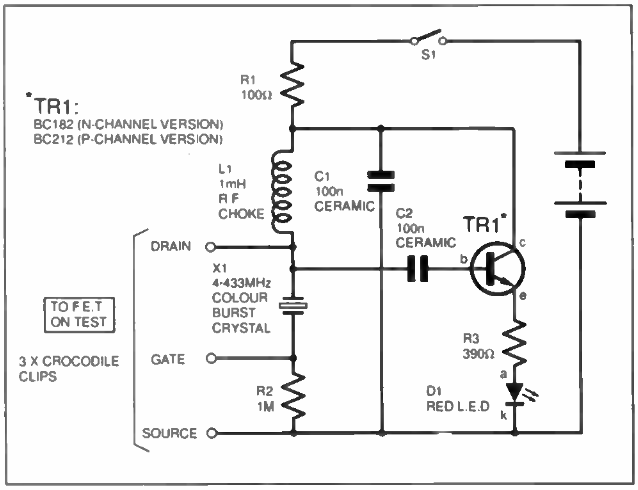


Fig.4. F.E.T. Tester circuit diagram.

Versatile Linear Regulator – Power Charge

The Voltage Regulator illustrated in Fig.5 has been used in the field in various forms for battery charging. It uses discrete components with a power MOSFET, TR3, to provide a variable supply which has several desirable features. It has a low drop-out voltage (typically 150mV @ 6A) plus good line and load regulation – approximately 80mV. The regulator will shut down under short-circuit overload conditions.

With the values of components shown, it is ideal for charging 12V gell cells up to 13·8V d.c., using a 16V d.c. unregulated input derived from a conventional capacitor-input filtered supply. The output voltage is trimmed using potentiometer VR1.

The main shunt element TR3 is an *n*-channel BUK456/60 rated at 41A continuous, and this should be mounted on a suitable heatsink depending on the load.

Gerard La Rooy, Christchurch, New Zealand.

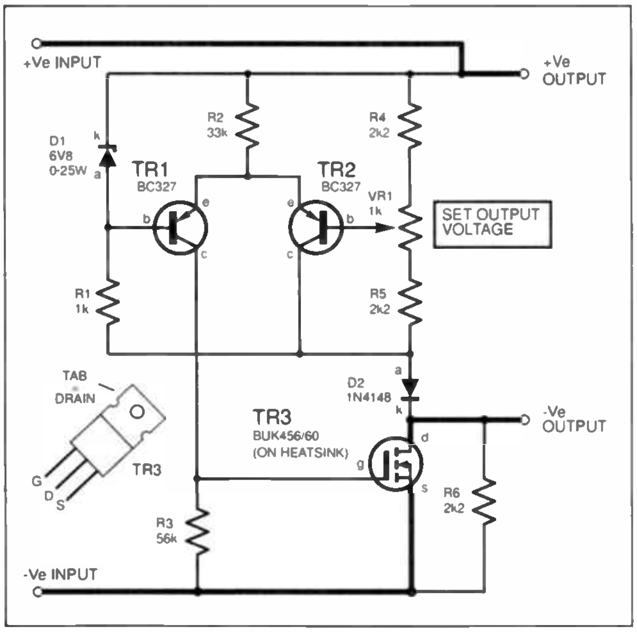


Fig.5 (left). Circuit diagram for a Versatile Linear Regulator.

Novel Fibre-Optic Tester – Sound-to-Light

Professional engineers involved with fibre optics may find the novel circuit of Fig.6 interesting. It gives a quick indication of the state of both multi-mode and single/mono mode fibre links and consists of a Transmitter containing a professional-grade high-power infra-red (IR) SMA-type emitter l.e.d. (D1) modulated by IC2 – nothing more sophisticated than a chip removed from a musical greeting card! After much experimentation, this proved to be the best and most simplistic solution.

The musical i.c. is a "chip-on-board" type to which some flying leads were soldered and hooked-up to some stripboard. A 9V battery was added and a 78L05 voltage regulator, IC1, is also mounted on the stripboard to provide a 5V rail. Diode D3 limits the reverse voltage across the infra-red emitter D1 and it also gives an indication that the source is actually working.

Receiver

The Receiver is based on D2, an IR SMA-type detector, biased by resistor R1. This is fed to a non-inverting op.amp. IC3a having a gain of 30. Its output is buffered by IC3b which drives a piezo sounder X1 directly (the piezo also having been recovered from the greetings card).

Both units were built into small plastic boxes with on-off switches and powered by PP3 batteries. The system can be tested by pointing the emitter l.e.d. D1 at the receiving l.e.d. D2 and the tune played by IC2 should be heard over the piezo sounder.

The Novel Fibre-Optic Tester can be used not only to test installed fibre optic links but also fibre-optic patch cords, the level of the received signal giving an indication of the losses in the link. With experience, it soon becomes apparent what kind of signal strength to expect under various circumstances.

John Barker, Morley, Leeds.

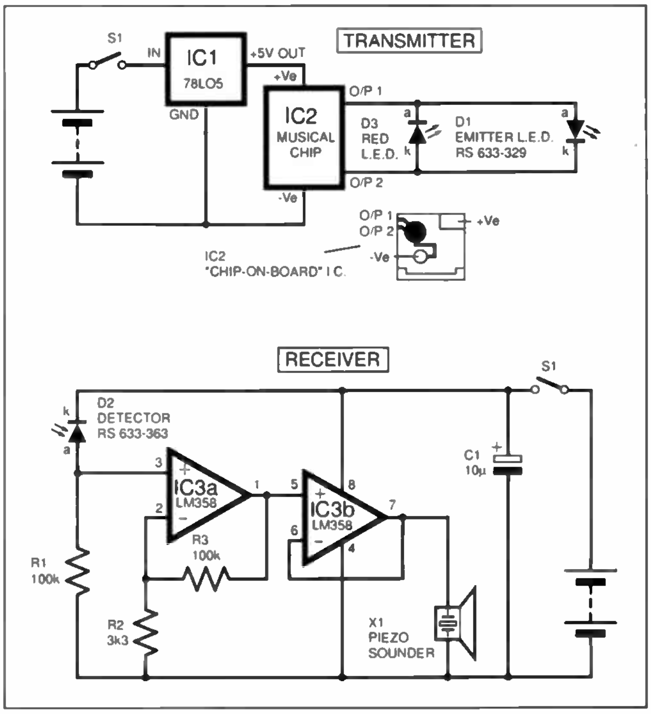


Fig.6. Transmitter and Receiver circuit diagrams for the "musical" Fibre-Optic Tester. The emitter and detector l.e.d.s are expensive and should he handled with care.

(Electromail (Tel: 01536 204555) codes 633-329 and 633-363.)

ELECTRONICS WORKBENCH V5·0

ROBERT PENFOLD

On-screen circuit design and testing made easy.

NO DOUBT many readers will have tried the demonstration disk of the Electronics Workbench program that was supplied free with *Everyday Practical Electronics* a few years ago (Oct. 94). The introduction of this program produced a bit of a stir due to its use of virtual instruments, which were new to most of us at that time. The idea was to have a circuit simulator that was as easy to use as possible, with test instruments, and not just circuits, being simulated. Testing a circuit with the simulator was, as far as possible, just like testing a real circuit using real test instruments.

Touch of SPICE

Electronics Workbench has now reached version 5.0, but the basic concept remains the same. You draw up a circuit diagram for the circuit you wish to test, and then use virtual function generators, oscilloscopes, etc. to test various aspects of its performance. Although the word "SPICE" does not appear in the name of this program, in common with most other advanced analogue circuit simulators it utilizes the Berkeley Institute SPICE (Simulation Program with Integrated Circuit Emphasis) algorithms for analogue circuit simulations. It utilizes the latest 32-bit version (3F5), and this rendering of Electronics Workbench is claimed to be some five to ten times faster than previous versions.

Electronics Workbench is available in two forms incidentally, which are the standard program, and the up-market EDA version reviewed here. The two programs are essentially the same, but the more expensive EDA version offers more simulation types (see Table 1), and is supplied with 8000 or so rather than 4000 component models.

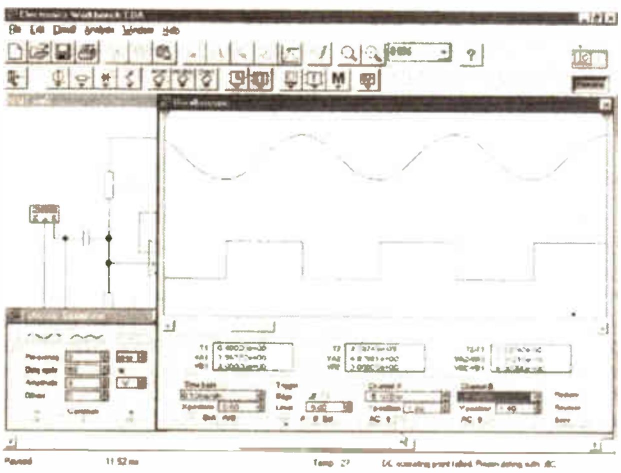
The SPICE algorithms are augmented by "native" 32-bit routines which permit the simulation of digital circuits. The analogue and digital simulators are fully integrated to provide a mixed mode simulator. In other words, digital and analogue circuits can be simulated, but so can circuits that contain a mixture of the two, such as pulse width modulators and frequency-to-voltage converters.

Circuits can be simulated using idealised components, but the supplied library also includes a vast range of "real world" components. This means that most circuits can be easily simulated using models of the actual components you will use in the real thing. It will not normally be necessary to choose a near equivalent or to seek out suitable library component models elsewhere.

Installation

The minimum hardware required to run this software under Windows 3.1 or 95 is a 486 PC with 8 megabytes of RAM (16 megabytes recommended), and 20 megabytes of hard disk space. The program will run under Windows NT, but then requires a minimum of 12 megabytes of RAM. As the program uses 32-bit routines it requires the Win32s extensions to run under Windows 3.1, but these are automatically loaded with the main software unless the installation program is instructed to the contrary. The software is supplied on six high density disks, and installation under Windows 95 proved to be very straightforward.

The screen layout follows the Windows convention, with title and menu bars at the top of the screen. Beneath these are two rows of control buttons, and the upper row gives quick access to general functions (open, save, etc.) and editing functions which enable the circuit symbols to be flipped, rotated, etc. The lower row of control buttons is used to actually place circuit symbols and virtual instruments on the drawing area. Apart from the usual



The virtual function generator at the bottom left hand section of the screen is producing a squarewave signal. This is fed to a filter circuit which produces a (more or less) sinewave output signal. Both signals are displayed on the screen of the "expanded" virtual oscilloscope.

Table 1
Comparison of Version 5.0 with the EDA version

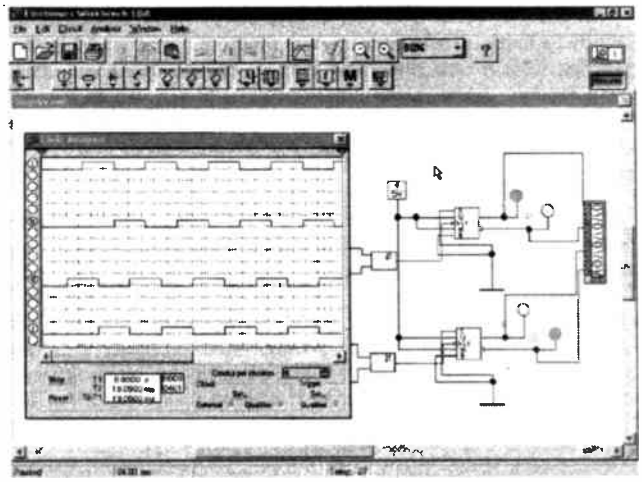
ANALYSES	VERSION 5.0	EDA
DC Operating Point	Yes	Yes
AC Frequency	Yes	Yes
Transient	Yes	Yes
Fourier	Yes	Yes
Noise	Yes	Yes
Distortion	Yes	Yes
Parameter Sweep	No	Yes
Temperature Sweep	No	Yes
Pole Zero	No	Yes
Transfer Function	No	Yes
DC Sensitivity	No	Yes
AC Sensitivity	No	Yes
Worst Case	No	Yes
Monte Carlo	No	Yes

scrollbars and a status line at the bottom of the screen, the remaining screen area is used for the circuit diagram.

In order to place a component on the screen you first operate the appropriate button for that type of component, such as the analogue integrated circuit button if you wish to use an operational amplifier. You then select the most suitable of the available options. In most cases this will not give you exactly the desired component model straight away, but having dragged a component onto the drawing area it is easily "fine tuned". Simply double-clicking on a component brings up a dialogue box which enables the value to be changed, the required operational amplifier to be selected, or whatever. A wide range of components are available, including such things as voltmeters, ammeters, bulbs, buzzers, and seven segment displays.

"running the simulation is just a matter of operating the virtual on/off switch"

Placing interconnections is very simple, and it is just a matter of clicking on the leadout of a component and then dragging a "wire" to the next component. The program automatically routes the wires, but they can be tidied up manually with a bit of "clicking" and dragging. The library of basic circuit symbols includes the all-important dot which enables multiple connection points to be produced. Editing circuits is very simple, as the mouse can be used to drag wires and symbols around the screen, and there are a range of easily accessed editing tools. The finished circuit diagrams are not the neatest you will encounter, but the program is not really intended for the production of pretty diagrams. Its purpose is to provide an easy means of entering circuits into the simulator, and this it does very well. However, if required, circuits can be printed out on any Windows compatible printer.



Here the logic analyser is used to monitor the four outputs of a stepper motor driver circuit. The analyser can handle up to 16 input signals, and data is recorded so that it can be examined in detail later.

Virtual Instruments

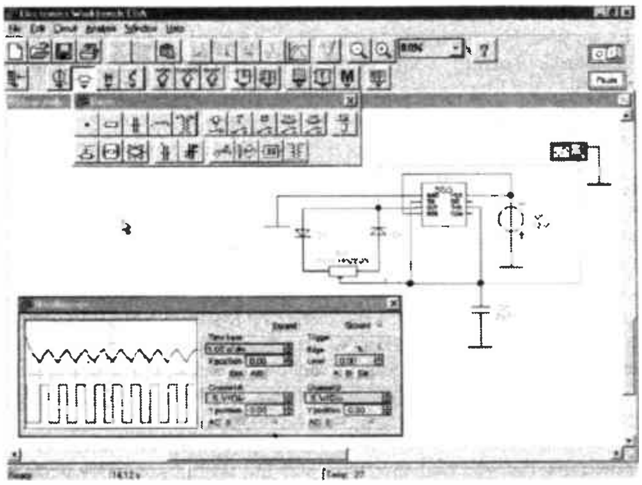
Once the circuit has been produced, the virtual instruments must be connected to it. This is very easy, since these instruments are represented by special circuit symbols, and are added in the same way as normal components. The available instruments include a multimeter, a function generator, an oscilloscope, a bode plotter (for frequency response and phase measurements), a word generator, and a logic analyser. Once the circuit has been completed and the virtual instruments have been added, running the simulation is just a matter of operating the virtual on/off switch at the top left-hand corner of the screen. No compilation stage is required in order to convert the circuit schematic into data for the circuit simulator.

Changes can be made to component values and virtual instrument control settings "on the fly", which makes it quick and easy to perfect circuits that do not work properly at the first attempt. The virtual instruments are rather small, but the oscilloscope can be expanded to fill a large portion of the screen. Also, the "Analysis" option on the main menu bar gives access to conventional analysis routines which produce almost screen filling graphs. These have the slightly idiosyncratic frequency scaling that is virtually a standard feature of circuit analysers, complete with occasional lapses into scientific notation that use more digits than simply giving the frequency in Hertz. Fortunately, a grid having more sensible scaling can be added at the touch of a button. There seems to be no table of results available for some of the analyses, but the Bode plotter has a moveable cursor and a digital readout which provides phase and magnitude values for each test frequency.

The "Analyse" menu option also provides access to the types of analysis that are not available via the virtual instruments. These include Fourier, noise, and distortion analysis. For this review Electronics Workbench was run on a PC fitted with a 166MHz 6X86 processor, and everything seemed to happen impressively quickly. Of course, things inevitably slow down significantly when testing complex circuits, such as multi-stage elliptic filters, but the general speed of operation compares well with the other circuit analysers that I have tried.

Ease of Use

Virtual multimeters, oscilloscopes, function generators, and so on are not just a gimmick, and they genuinely make the program more user friendly. Some software which takes the virtual instrument approach to circuit simulation is only intended for use by novices, but Electronics Workbench is definitely not in this category. It is a heavy-weight circuit simulator which uses on-screen test equipment to make the program quicker and easier to use, as well as providing facilities that would not otherwise be possible. You need to have a good understanding of conventional circuit design and testing techniques in order to make full use of the program. In fact some aspects of the program require an advanced knowledge of circuit testing, but you can simply ignore the more advanced facilities if you do not require them.

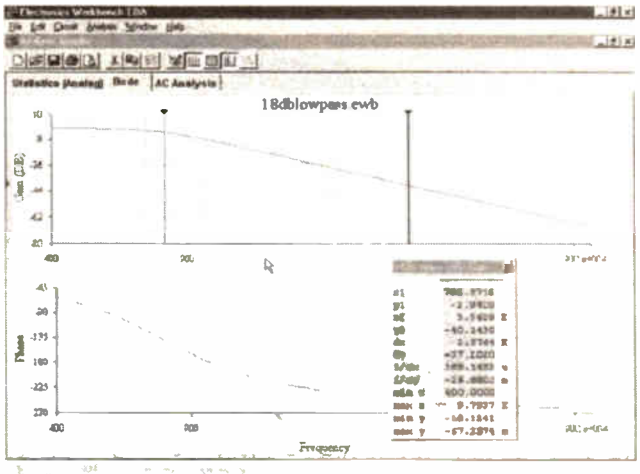


The component library includes the all-important 555 timer. Here the virtual oscilloscope shows the waveforms across the timing capacitor and at the output pin. This screen also shows one of the component selection boxes.

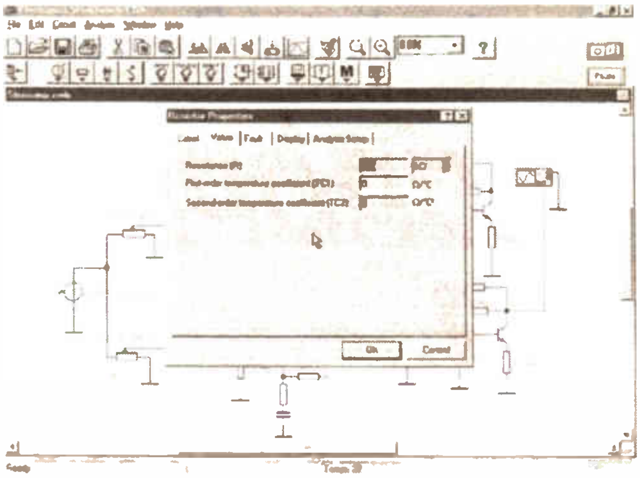
"the virtual approach works well, and makes circuit testing more fun as well as quicker and easier"

The program is generally easy to use, and this is demonstrated by the fact that it is possible to draw up and test simple circuits without recourse to the manuals. By "playing" with the on-screen controls you soon get the hang of things. Four A5 size manuals are supplied. The "User's Guide" provides an introduction to using the program that includes some simple step-by-step examples. This manual is all right as far as it goes, but it is a bit vague on some topics such as the bode plotter and some types of analysis. It is sometimes necessary to adopt the "suck it and see" approach whether you want to or not.

The "User Guide" is backed up by a much larger "Technical Reference" manual which gives details of the components, indicators, virtual instruments and other technical information. The other two manuals are a comprehensive list of the component models supplied, and a manual covering the import and export of SPICE netlists.



This is the output from the Bode plotter shown as full screen graphs. Individual test results can be read via the moveable cursors and the readout window. This facility is available for both the phase and the gain graphs.



Double "clicking" on a component brings up a window that enables the value, etc. to be easily modified.

Conclusion

We have not yet reached the stage where it is possible to solder virtual components onto a piece of virtual stripboard to produce a virtual radio, and then adjust the on-screen tuning control until *Radio One* pours from the computer's loudspeakers. On the other hand, programs like Electronics Workbench are certainly heading in that direction. When a test circuit failed to work there was no laborious checking through a netlist. Instead I found myself using the virtual test instruments to seek out the bad connection in much the same way that I would have tried to locate the fault on a real circuit board!

As implemented on Electronics Workbench the virtual approach functions well, and makes circuit testing more fun as well as quicker and easier. Although virtual instruments tend to be associated with low-end simulators for educational use, they can work well in advanced simulators, as Electronics Workbench clearly demonstrates. Checks on audio circuits produced results that were in keeping with the "real thing", and the SPICE simulator engine should ensure reliable results provided accurate component models are used.

The version of the program originally supplied for review had a fault in the virtual logic analyser, but this has been rectified in the current version, which showed no problems during the test period. Circuit simulation has proved its worth when developing numerous types of circuit, and Electronics Workbench is certainly one of the best. It can handle analogue circuits from v.l.f. to u.h.f., plus digital circuits and mixed mode circuits. It can also handle quite large circuits. The huge library of component models supplied with the program, including a good range of logic devices, is a definite plus point.

Price

As is often the case, the lower cost version of the program would seem to offer better value for money. The more expensive EDA version is aimed fairly and squarely at industrial users who design circuits for large scale production. Presumably they will not balk at a price of £795 plus VAT, which actually compares quite well with other high-end simulators.

At £199 plus VAT the standard version is not exactly cheap, but it offers extremely good value for money. It is probably a bit too expensive to attract many hobbyist buyers, but I doubt if any that are tempted would make use of the 30 day money-back guarantee. The standard version would seem to be well suited to educational use, where it can operate in a basic fashion for teaching electronics to beginners, or at a higher level for advanced students. (*Note: There is an Education version available and a Student edition is due for release later in the year – Ed.*) It should also suit professional users who do not need the advanced features such as Monte Carlo and temperature sweep testing.

Electronics Workbench Version 5·0 is available from Robinson Marshall (Europe) Plc, Dept EPE, Nadella Building, Progress Close, Leofric Business Park, Coventry CV3 2TF. Tel 01203 233216, Fax 01203 233210, E-mail: **Sales@rme.co.uk** Add £7.99 for UK postage.

MICROPOWER PIR DETECTOR

ANDY FLIND

Part 1

A three module integrated intruder deterrent. The PIR is a self-setting, stand-alone, battery powered module for boats, caravans, garages or garden sheds.

THE Micropower PIR Detector (µPIR) is the first of three projects designed to form an integrated intruder alarm system. This can be used to protect any property but is intended especially for premises where battery power is an essential requirement.

The µPIR Detector project may be used on its own, but the block diagram in Fig.1 shows it as part of a complete system, the rest of which will be described in the forthcoming issues.

The Controller Unit, to be described next month, considerably increases versatility by providing adjustable sensitivity and timed alarm periods. It incorporates a power output stage for the direct operation of Sirens, Beacons and similar deterrent devices.

The final part of this short, three part, series will describe the provision of a neat, weatherproof "secret" disarming switch featuring a "delay on reset" to allow the user to leave the protected area.

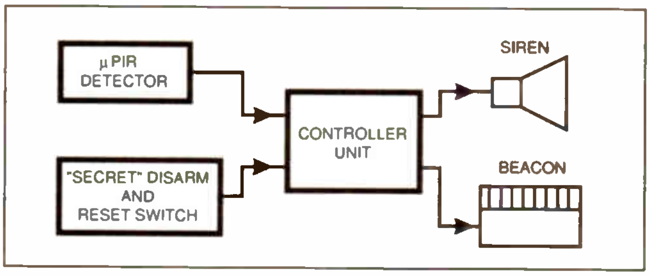


Fig. 1. Block schematic of the integrated system.

PIR DETECTOR

A passive infra-red (PIR) detector is probably the most popular and widely used type of sensor found in modern intruder alarm systems. Its many advantages include simple installation, as a single sensor can cover a wide area.

With careful siting it may detect people "loitering with intent" before any attempt is made to force entry and warn them off by activating a siren or security lighting, thereby preventing damage to the property. It is also self-resetting, a feature not always inherent in door or window operated switches or glass-breakage detectors.

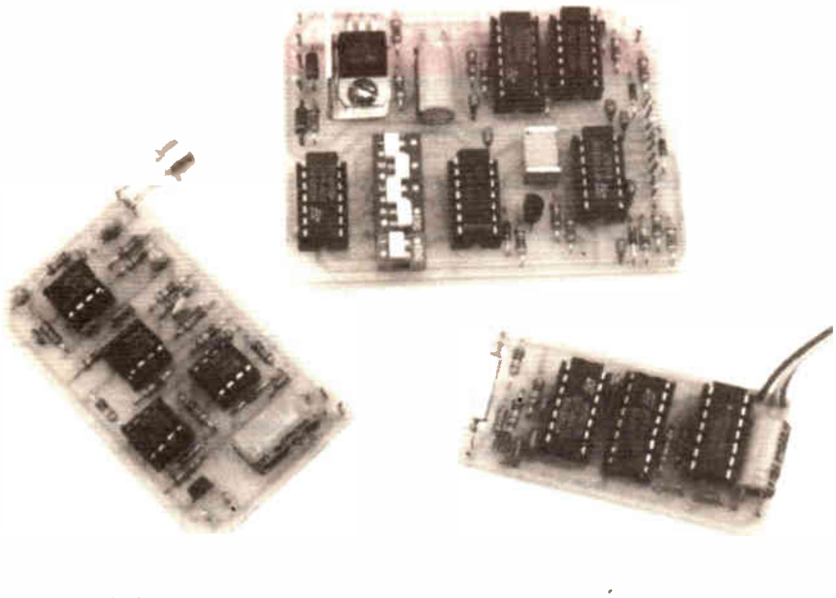
For example, an intruder might force a window but make off when this triggers a siren. However, if the owner of the property does not wish to alienate the neighbours or suffer prosecution for noise nuisance, the alarm should stop automatically after a preset time.

Meanwhile, the felon could be hiding nearby, and on realising that the alarm has stopped with the window still open, might return to continue the job! In contrast a PIR will reset to the "ready" state when the intruder leaves the area and retrigger the alarm on further intrusions.

CUSTOM-BUILT

Although complete PIR sensors can be purchased at reasonable cost there are still instances where it is worth constructing one from scratch. Most commercially made sensors are readily identifiable. This is not always wise, as knowledgeable thieves are apparently in the habit of creeping up beneath these and disabling them!

A custom-built detector can be concealed to prevent this. Of course, its often sensible to have detectors visible within the property as the sight of these through windows can deter potential thieves. A combination of visible sensors (dummies?) and concealed ones should prove really effective.



The "custom-built" three module line-up that can be linked together to form an integrated alarm system: (left to right) µPIR Detector, Control Board and Disarm/Reset Board.

The main advantage of the present design is that it uses "micropower" circuit techniques. Most PIR sensors draw too much current for use in continuously operating battery-powered systems. The prototype of this project operates with a quiescent current of around 30µA from 6V, which makes operation for over two years possible from a pack of four alkaline AA cells.

These days it is not just houses that are targeted by the burglars. The average garden shed often contains a lawnmower and expensive garden tools, all easy to dispose of at car boot sales. Add to this the ease with which a shed in a dark, secluded corner of the garden may be broken into compared with a secure, well-lit house where the occupants may be at home, and the security hazard becomes obvious.

Other potential targets where mains power may not be available are garages, caravans and boats. Readers will no doubt be able to think of many more examples. For these, a PIR sensor capable of long-term operation from a battery will have a serious advantage.

CIRCUIT DESIGN

The aim with this design is to produce a circuit that will operate reliably but use a quiescent current of only 50µA or less. The first challenge was the provision of adequate supply voltage regulation.

The PIR sensor used is supplied in a package similar to a TO5 transistor with a "window" for the infra-red radiation to enter (see Fig.2). Inside it has a piezo-electric element which produces a tiny voltage when the radiation strikes it. This behaves like a small capacitor so a resistor is placed across it to discharge any standing voltage, so the output responds to changes of the radiation intensity.

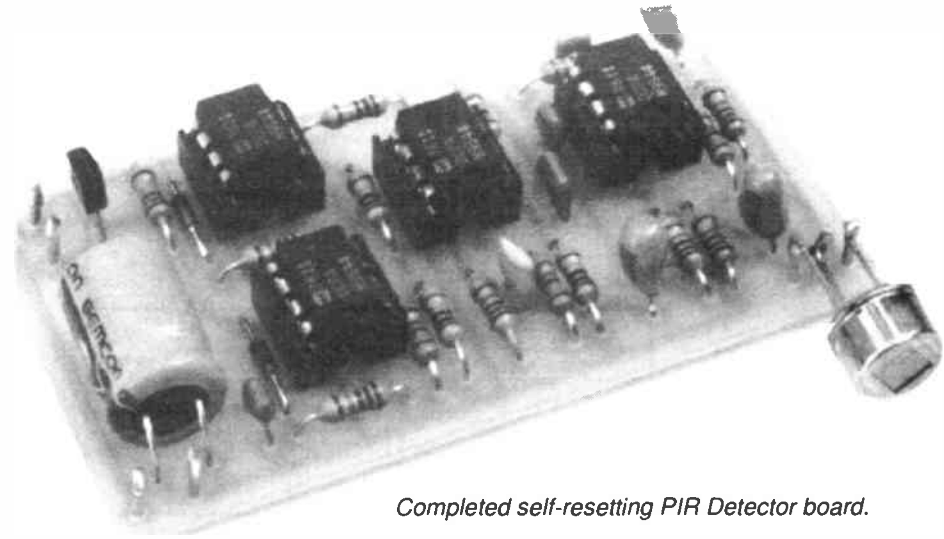
The capacitance of the element is tiny, so the value of the parallel resistor is many tens of megohms hence the output is buffered by an internal f.e.t. An external source resistor must be provided for this, so that the output voltage can be developed across it.

Typically, this has a value of one hundred kilohms (100k) so the current taken by the sensor is a few microamps at most. However, the voltage changes in response to infra-red radiation are tiny, typically half-a-millivolt, and the output voltage also varies quite a bit with any change of supply voltage so a reliable detector circuit needs a very stable supply.

Voltage regulators draw current when operating. One of the best is the LP2950, a high-performance 5V CMOS device that draws just 125µA of quiescent current. However, this is still nearly three times the target consumption for the whole circuit.

A breakthrough arose when it was realised that voltage regulation is not actually necessary! The supply voltage doesn't have to be precise, just stable. A battery supplying a tiny and virtually constant current will have short-term voltage stability that is perfectly adequate for this project.

The necessary amplification and level sensing functions are handled by ICL7611 op.amps. which can be connected to draw only 10µA each. In fact, the two used as voltage comparators in this project draw even less, probably because their outputs are always driven to one of the supply rails and therefore never operate in "class A-B".



Completed self-resetting PIR Detector board.

This leaves only the problem of providing an output connection that uses no supply current. This is done by using a small MOSFET device as a switch. This uses virtually no drive current at all when turned "on" by a positive gate voltage, but can sink sufficient current from an external circuit to operate it reliably. The MOSFET used can withstand a drain (d) to source (s) voltage of 240 volts when "off", allowing interfacing to just about anything.

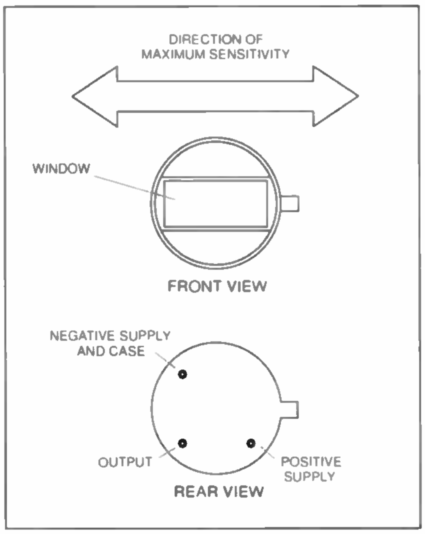
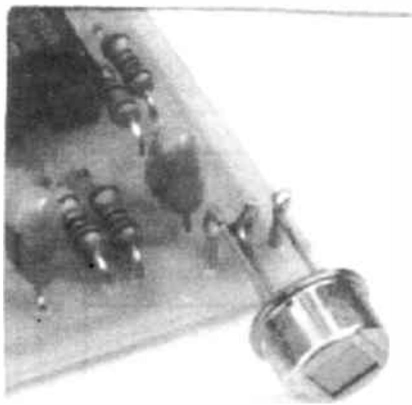


Fig.2. PIR sensor operation and pinout details.



Close-up of the PIR detector "viewing window".

CIRCUIT DESCRIPTION

The complete circuit diagram for the Micropower PIR Detector is shown in Fig. 3. IC1 is the sensor, supplied through the resistor R1 with additional local decoupling from capacitor C1. This and the two capacitors C3 and C5 are tantalum bead

COMPONENTS

µPIR DETECTOR

Resistors

R1, R2	100k (2 off)
R3, R4, R6	180k (3 off)
R5, R9, R14, R15	10M (4 off)
R7, R8, R10, R11, R12	1M (5 off)
R13	680k
R16	2M2

All 0·6W 1% metal film

See SHOP TALK Page

Capacitor

C1	10µ bead, tantalum 16V
C2	22n resin-dipped ceramic
C3, C5	3µ3 bead, tantalum (2 off)
C4	4n7 resin-dipped ceramic
C6	100n resin-dipped ceramic
C7	1000µ radial elect. 10V
C8	470n resin-dipped ceramic
C9	2n2 resin-dipped ceramic

Semiconductors

D1, D2	1N4148 signal diode (2 off)
TR1	ZVN 4424A *n*-channel MOSFET
IC1	PIR detector, Murata E600STO
IC2, IC3, IC4, IC5	7611 CMOS op.amp (4 off)

Miscellaneous

B1	6V battery pack (4 x AA cells), with holder

Printed circuit board available from *EPE PCB Service*, code 152; case, size and type to choice (see text); 8-pin d.i.l. socket (4 off); multistrand connecting wire; solder pins (4 off); solder etc.

Note: Components for test circuit and interface circuits not included.

Approx Cost Guidance Only £21 excluding case & Batts.

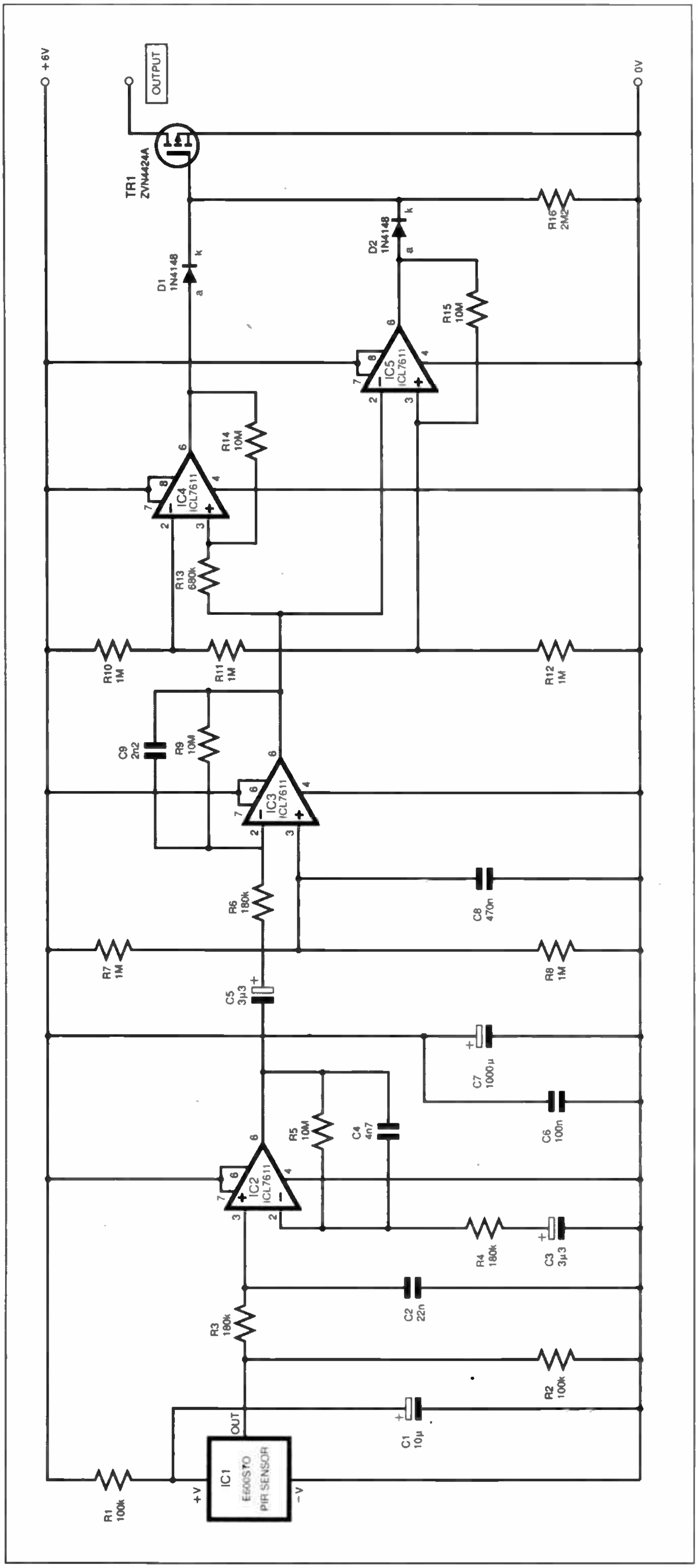


Fig. 3. Complete circuit diagram for the "stand-alone" Micropower PIR Detector.

types, chosen for their exceptionally low leakage. The sensor's output voltage appears across resistor R2 which is the source resistor for the internal f.e.t. in IC1.

Two amplification stages are provided by the two op.amps IC2 and IC3, the first is a non-inverting stage and the second is inverting. Together they provide a total maximum voltage gain of 2800 at a frequency of just over 1Hz, reducing rapidly both above and below this. The quiescent output of IC3, from pin 6, is half the supply voltage.

A "window" comparator, formed by IC4 and IC5, detects voltage changes below about one third of the supply and above two-thirds. Both op.amps have positive feedback, supplied through resistors R14 and R15, to provide a clean switching action, and both outputs go positive to indicate active input.

The gate of MOSFET TR1 is normally held low by resistor R16 so that it is "off", but a positive voltage input from either of the diodes D1 or D2 will turn it "on" to activate an external circuit (see Fig.5). Whilst "on" a couple of microamps of extra supply current flows through R16 but this is too small to have any effect on circuit operation. The unusually large value of the main decoupling capacitor C7 helps to maintain supply voltage stability at low frequencies.

Each of the four ICL7611 op.amps is arranged to draw just 10μA by connecting pin 8 to the positive supply, which is conveniently present at pin 7. This gives them a rather low slew rate, but this is not a problem with this application.

The supply voltage for the circuit may be anywhere between 4V and 10V, though it is intended for operation from the 6V given by four AA cells. A 9V PP3 can be used.

If the constructor wishes to operate it with a mains power supply it may be supplied from a 5V regulator. If this is the case the LP2950 regulator is recommended as it offers better rejection of input voltage variations than the 78L05 type.

CONSTRUCTION

All components for the Micropower PIR Detector are mounted on a small single-sided printed circuit board (p.c.b.) and the component layout, together with a full size copper foil master, is shown in Fig.4. This includes the simple test circuit but not the output drive components, see later. This p.c.b. is available from the *EPE PCB Service*, code 152.

The board is fairly compact since in most cases it will have to share a case with the battery pack. However, construction should prove straightforward.

Because of the high impedances present in much of the circuit it is advisable to take extra care to avoid any contamination of the p.c.b. A good "scrub-up" before commencing construction is a worthwhile precaution, and if there is any doubt about the cleanliness of the board it should be wiped over with suitable solvent.

The usual procedure of fitting resistors, diodes and small capacitors, followed by d.i.l. sockets for the four op.amps and the larger capacitors makes for an easy task. The mounting of MOSFET TR1 can also be carried out at this stage. Precautions against damage by static are advisable during construction to avoid the possibility of damage to TR1 and the op.amps, which are CMOS types.

BOARD TESTING

Testing can commence with the temporary connection of PIR sensor IC1 and the insertion of IC2 before connecting a 6V power supply. Unless a very stable bench supply is available this should be a pack of four AA cells. It will probably be necessary to cover the window of IC1 with a bit of black adhesive tape whilst testing to obtain stable voltage readings.

The output of IC2 will take around twenty seconds to settle due to the long time constants used in this circuit. During this period it will swing from rail to rail, but should eventually settle to about half a volt, the exact value depending on the individual PIR sensor in use.

Before inserting IC3, electrolytic capacitor C7 should be discharged by placing a 100 ohm resistor across the supply connections, as it will take a very long time to discharge otherwise. With power reapplied, the output of IC3 should settle to about half the supply voltage, again after around twenty to thirty seconds.

If the window of IC1 is now uncovered and a hand moved across it, the output should swing violently. It will probably be necessary to restrict the field of view of IC1 for this test by placing a tube of some kind over it.

Finally, IC4 and IC5 can be inserted and the complete circuit tested. For this a means of indicating the output from TR1, with its own power source, will be necessary. The off-board components to the bottom right corner of the p.c.b. in Fig.4 shows how this can be done with an l.e.d., though a meter set to a "resistance" range could also be used. An analogue meter may be preferred to a digital one for this, but it should be remembered that the lead polarity of many analogue meters is reversed when measuring resistance so this should be checked first.

FINAL ASSEMBLY

The detector can be housed in virtually any case of the constructor's choice. It is very sensitive so if interference problems are experienced a metal case may effect a cure. If it is to be used in a harsh or damp environment, such as a garden shed or boat, the assembly will have to be moisture proof, though an alternative approach would be to pot the p.c.b. in a resin potting compound.

The PIR sensor "window" is rectangular and maximum sensitivity is to objects moving across the area in front of it in the directions indicated in Fig.2. Various lenses can be obtained for use with these sensors to increase sensitivity, though this design is really intended for use without these as a sensitive short range device to pick up, for instance, intruders loitering in front of a doorway or window.

In such applications it will usually be necessary to restrict the field of view with a tube, or a small hole in the case. Such a hole will need covering to prevent moisture and insects entering.

Materials transparent to visible light are often almost totally opaque to the long wavelength infra-red detected by this type of sensor. Thin polythene sheet seems to work well though, and "cling-film" has also proved very successful.

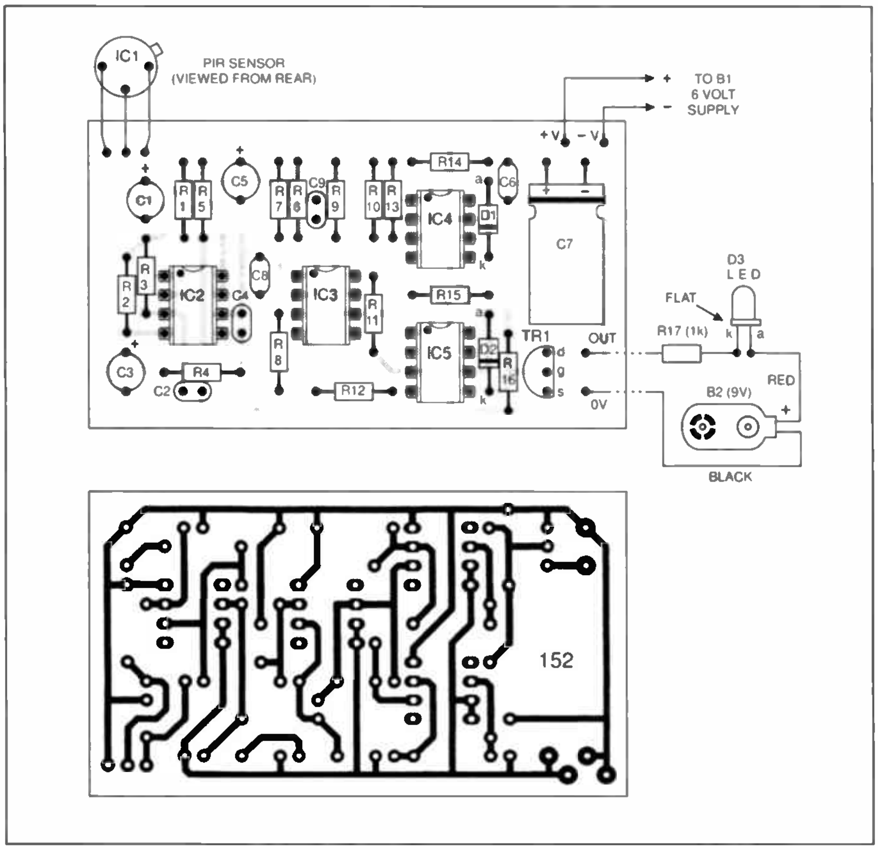


Fig.4. Component layout and full size p.c.b. copper foil master.

INTERFACE CIRCUITS

Some simple output interfaces are shown in Fig.5. The first shows how a relay can be operated by the output. Note the diode across the coil which must always be used to prevent back-e.m.f. from damaging MOSFET TR1 when it breaks the circuit. The second circuit shows a transistor used with the PIR Detector for controlling a power MOSFET which can switch a current of several amperes.

However, to be of really practical use the detector should form part of a system. A "pulse-counting" circuit can be used for adjusting the sensitivity to prevent false alarms and a timer should be included to set the duration of the alarm once triggered.

Using CMOS components it is possible to construct a control circuit which provides these functions but uses virtually no current at all during standby, and next month this will be described in detail.

NEXT MONTH: Control System.

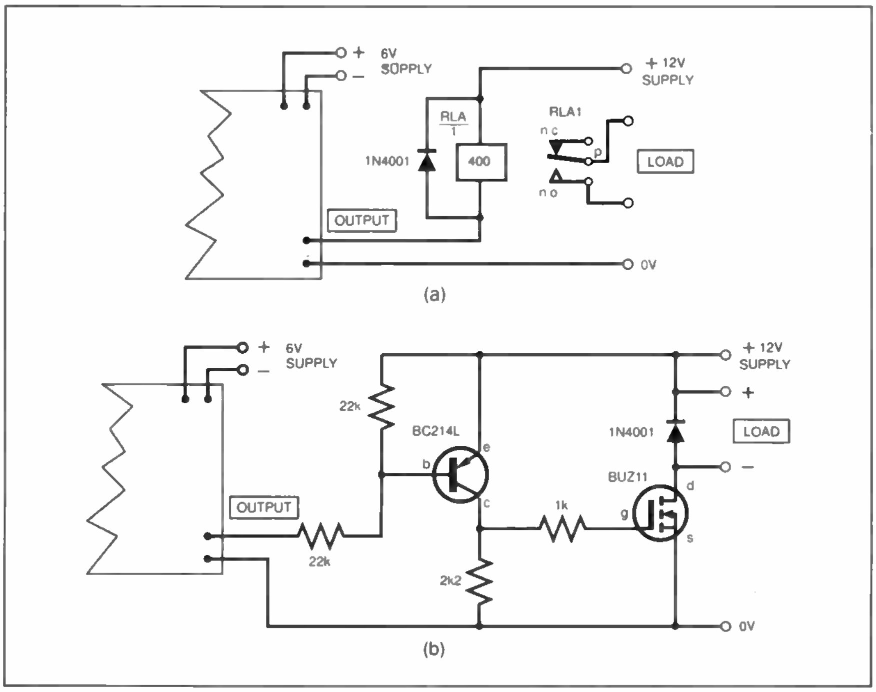


Fig. 5(a) Using the PIR Detector to "trigger" a relay and (b) controlling a power MOSFET alarm (load) driver.

VIDEOS ON ELECTRONICS

A range of videos selected by EPE and designed to provide instruction on electronics theory. Each video gives a sound introduction and grounding in a specialised area of the subject. The tapes make learning both easier and more enjoyable than pure textbook or magazine study. They have proved particularly useful in schools, colleges, training departments and electronics clubs as well as to general hobbyists and those following distance learning courses etc.

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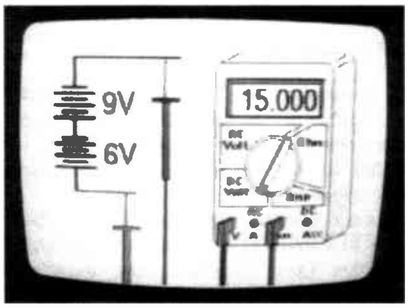

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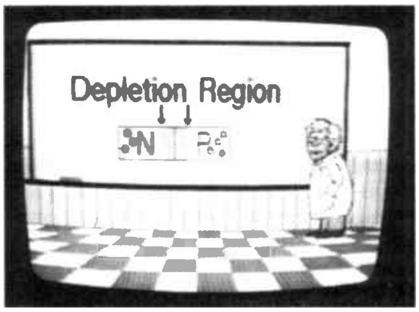

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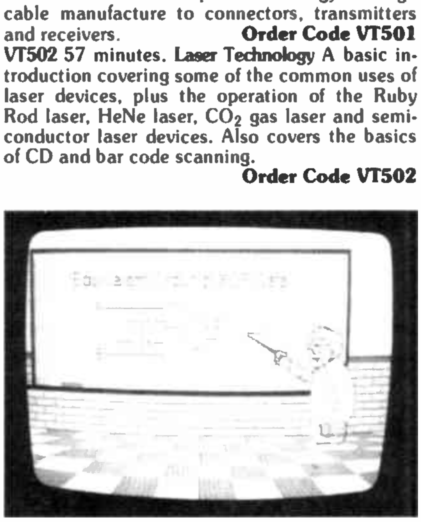

Each video uses a mixture of animated current flow in circuits plus text, plus cartoon instruction etc., and a very full commentary to get the points across. The tapes are imported by us and originate from VCR Educational Products Co, an American supplier. (All videos are to the UK PAL standard on VHS tapes)

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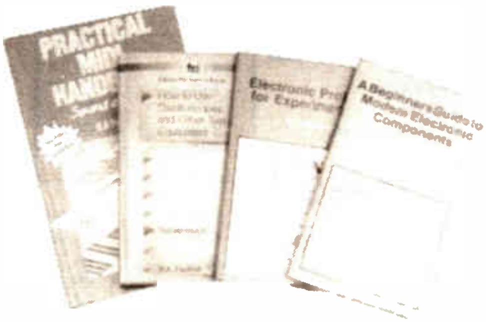

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EPE SOFTWARE

Software programs for the *EPE* projects marked above with an asterisk (*) are available altogether on a *single* 3.5 inch PC-compatible disk, or as needed via our Internet site. The same disk also contains the following additional software: Simple PIC16C84 Programmer (Feb '96). The disk (order as "PIC-disk") is available from the *EPE PCB Service* at £2.75 (UK) to cover our admin costs (the software itself is *free*). Overseas £3.35 surface mail, £4.35 airmail. Alternatively, the files can be downloaded *free* from our Internet FTP site: **ftp://ftp.epemag.wimborne.co.uk.**

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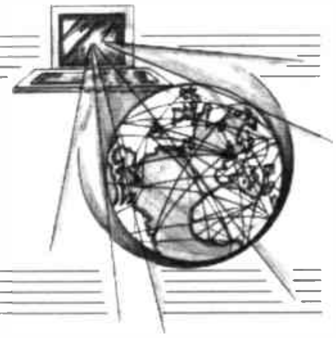

ALAN WINSTANLEY

Hi, y'all

EPE Net Work is our monthly column specially written for electronics enthusiasts with Internet access. We offer a special "welcome" to new readers in the USA, who from this issue have their own version of the magazine now available in Silicon City and other stores in the States! We hope you like what you see – E-mail us and say hello!

The *EPE* Web Site, **http://www.epemag.wimborne.co.uk**, is fast and functional, and offers you the latest information on current and previous issues, subscription rates, back issue availability, a 1996 A-Z project index, the *EPE On-line Soldering Guide*, readers' letters and more. Remember, too, our FTP site, where you can download the files needed for most of our PIC projects and more besides. This month's new addition, is at **ftp://ftp.epemag.wimborne.co.uk/pub/PICS/PICapest**

How Secure Is Secure?

One of the burning issues on the web is that of "secure trading". In the context of the Internet, this implies the wisdom, safety and prudence of buying merchandise on-line. All you have to do is fill out a form on the screen, tap in your credit card number, and sit back and wait for the stuff to be delivered.

In the case of a "secure" web site, your details are encrypted in such a way as to make it unreadable by any party except the intended recipient. Otherwise, your name, address and credit card details are sent over the network as an ordinary E-mail: this data will pass through many machines and routes, alongside tens of millions of other E-mails. The worry for many Internet users is that this data could fall into the hands of criminals en route.

But how secure are we already? In a celebrated case in the UK, a schoolboy found the discarded carbon copies of credit card payment vouchers in the dustbin of a local restaurant. He used them to run up a hefty series of purchases which were charged to the credit accounts of the unsuspecting diners.

His scam was soon uncovered, but it highlights how ordinary credit transactions – like paying a restaurant bill – carry a degree of risk which we seem to accept as routine. Also, once you've bought something, whether in person, by phone, fax, letter or Internet, your credit card details can remain in the supplier's records for ever, or at least until they're dumped in a dustbin.

Probably No Riskier

Personally speaking, I think there is probably no more risk in transacting over the Internet than there is in everyday shopping. As part of the agreement with your credit card provider, you are protected against fraud and theft, though a provider could argue that in transmitting your details by Internet, you have failed to take adequate precautions to guard your card, and may try to hold you at least partly liable. This would be unprecedented.

I think that non-delivery or damage in transit pose a greater potential problem with on-line transacting than the risk of your card number being intercepted: it boils down to how well the goods are packed and transported and you can always dispute any related payment with the credit provider.

However, it makes good sense to try and authenticate the credentials of the supplier if you stumble across a web site where you're tempted to buy on-line. You need to use your judgement: does the supplier have a reputable name? Is it widely advertised? Overall, does the supplier's web site hang together well, and look genuine and professional? Is there an E-mail address for contacting the supplier? If you're unsure, don't buy, or maybe return in a week or two and see if it's still there! The chances are, it will be.

For example, I had no problems at all when some merchandise (my highly coveted Pop Rocket T-shirts!) arrived from California when I ordered via their web site. The URL was advertised in their software which I'd bought a month or two earlier, and it seemed a safe bet, even though the Pop Rocket's site is "insecure".

I also order books from the USA by Internet (**http://www.amazon.com**). Perversely, it is the genuine on-line trader who probably faces greater risks from Internet ordering, because he exposes himself to the entire planet's on-line community. For example, we have already had instances where overseas readers attempted to buy reprints etc. from our web site, using forged credit card numbers.

When ordering, you can recognise when you are connected to, say, a Netscape Secure Server because a blue bar appears across the edge of the browser window, and the "broken key" symbol at the bottom left will become a solid key. The URL will also appear as https:// to indicate that a Netscape Secure Sockets Layer (SSL) has been implemented and your data is safe. MS Internet Explorer shows a padlock symbol in the status bar, rather than a key.

In all the on-line excitement it's easy to get carried away, so consider configuring the "nagware" in your browser to ensure that it pops up with warning messages at appropriate times whenever security issues are involved. In Netscape 3, click Options/ Security Preferences/General and Show An Alert Before, and click all the boxes to act as a reminder. Also remember in the same dialogue box to enable SSL2 and SSL3 Secure Sockets Layers. In Microsoft Internet Explorer 3, click View/ Options/Advanced and Warnings and check everything you see.

However, many genuine on-line forms are technically insecure, meaning that the information is transmitted just as an ordinary E-mail. Some hardened users will never order using such a system, and so we intend to implement Netscape Secure Sockets Layer technology on the *EPE* web server quite soon. Meantime, the SET (Secure Electronic Transactions) standard systems adopted by Visa and Mastercard are still undergoing trials in the UK, and won't be ready much before the end of 1997.

Hot Links

Keep me posted with your suggestions for electronics-related sites! Here are more electronics sites for you to try: these URL's are ready-made for you on the *Net Work* page of our web site.

Firstly, definitely worth bookmarking is Alex's Electronic Test Bench, packed with links to many electrical and electronic sites at **http://www.iserv.net/~alexx**. It includes a superb electronics glossary index. Charles Triccas in Malta offers **http://www.arec.org/** as the web site for the Amateur Radio, Electronics & Computers Association of Malta with a Call Book for all Malta hams. Planning a trip overseas?

There's a splendid resource of electrical and telephone information for world travellers at **http://www.concentric.net/~Kropla** with data on phone systems and worldwide supplies. Beware of the music though!

A new resource at **http://www.computerfairs.co.uk** lists forthcoming UK computer fairs, radio rallies and shows. Novices discovering the 555 might try **http://www.totalweb.co.uk/lizard1/** (that's lizard-one) for suitable projects, with interactive forms for obtaining component values. There are several excellent on-line projects for beginners, too.

Also there is Find-A-Sat, helping with set-up details for any TV satellite over Europe. Finally, **http://www.geocities.com/BourbonStreet/4589/index.html** lists a variety of pointers to FAQs, Q&A, circuits and resources and is worth browsing. (GeoCities have a unique way of organising their "homesteaders", go back to their Home Page to see how.)

See you next month for more *Net Work*. My E-mail address is **alan@epemag.demon.co.uk**. My Home Page is **http://ourworld.compuserve.com/homepages/alan_winstanley**.

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Miscellaneous

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VALVE ENTHUSIASTS: Capacitors and other parts in stock. For free advice/lists please ring, Geoff Davies (Radio), Tel: 01788 574774.

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COPIES OF TELEVISION MAGAZINE from Oct. 1983 to present, including indexed guide to TV and VCR faults. Offers to: 01952 460618.

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IDEAL FOR:

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- Gigging Bands
- Home & professional studios
- Audio/Hi-Fi

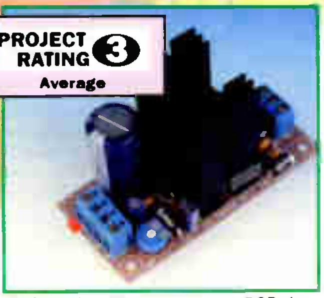
PROJECT RATING 3 Average

Kit includes all components, PCB, box, box label, sockets, wire, etc., and full instructions. Requires Alkaline PP3 battery (not included in kit).

AUDIO LEAD CHECKER KIT LU26D £19.99
Construction details: Audio Lead Checker Leaflet XZ20W 80p
Issue 114 / June 1997 Electronics & Beyond XD14Q £2.25

1.5A VARIABLE VOLTAGE POSITIVE AND NEGATIVE REGULATED PSU KITS

PROJECT RATING 3 Average



FEATURES:

- Output reverse polarity and back-voltage protection
- Output voltage range: 1.25V to 37V (depending on input)
- LED power-on indication
- Variable output voltage
- Low noise
- Compact dimensions
- Easy to build
- Can be used with single, split and twin secondary transformers
- EMC / CE compliant

Kit includes all components, PCB, heatsink and full instructions. Mains transformer, other mains-side components and enclosure are dependant on users intended application and therefore not included in the kit.

VARIABLE POSITIVE PSU KIT LU86T £10.99
VARIABLE NEGATIVE PSU KIT LU87U £10.99
Construction details: Positive and Negative Variable PSU Leaflet XZ40T 50p
Issue 113 / May 1997 Electronics & Beyond XD13P £2.25

SIREN SOUND GENERATOR KITS

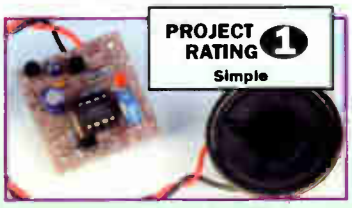
FEATURES:

- Easy to build – ideal beginners' project
- Three versions available
- Auto power-off for long battery life
- Low quiescent current (typically 1μA @ 3V)
- Wide supply voltage range: 2.4V to 24V
- Speaker or buzzer output drive
- Touch, switch contact or digital input to trigger siren
- Pulsed LED output
- Compact PCB
- EMC / CE Compliant

IDEAL FOR:

- Audible warning devices
- Sirens and alarms
- Children's toys

PROJECT RATING 1 Simple



Kit includes all components, PCB, LED, piezo sounder and full instructions. Enclosure, loudspeaker, switch/touch pads, battery, etc., are dependant on user's intended application and therefore not included in the kit.

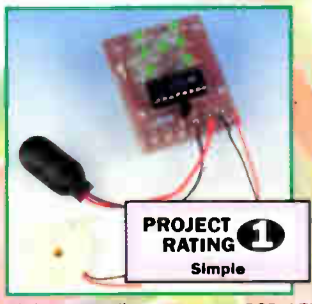
CAR ALARM SIREN KIT LU85G £7.99 USA POLICE SIREN KIT LU88V £7.99
WAILING POLICE SIREN KIT LU89W £7.99
Construction details: Siren Sound Generator Leaflet XZ42V 50p
Issue 112 / April 1997 Electronics & Beyond XD12N £2.25

These kits are:

- Supplied with high-quality fibre-glass PCBs – pre-tinned, with printed legend and solder resist
- Supplied with comprehensive instructions and a constructors' guide
- Covered by the Maplin Get-You-Working Service and 12-month warranty

Kits do not include tools or test equipment. Kits may require additional components or products, depending on application, please refer to construction details or contact the Maplin Technical Support Helpline (Tel: 01702 556001) if in doubt.

ELECTRONIC DICE KIT



PROJECT RATING 1 Simple

FEATURES:

- Easy to build – ideal beginners' project
- Auto power-off for long battery life
- Low quiescent current (typically 1μA)
- 3V supply voltage (2 x 1.5V cells ideal)
- Touch, switch contact or digital input to 'roll' dice
- 'Rolling dice' sound effect
- Dice can be interlinked for games requiring more than one dice
- EMC / CE Compliant

Kit includes all components, PCB, LEDs, piezo sounder and full instructions. Enclosure, fixing hardware, switch/touch pads, battery, etc., are dependant on user's intended application and therefore not included in the kit.

ELECTRONIC DICE KIT LU78K £7.99
Construction details: Electronic Dice Leaflet XZ43W 50p
Issue 112 / April 1997 Electronics & Beyond XD12N £2.25

VIDEO DISTRIBUTION AMPLIFIER KIT

FEATURES:

- Composite video input/output
- Four outputs as standard
- Units can be cascaded for multiple outputs
- Easy to build and use
- Compact dimensions
- Video gain (0dB to 8dB) control
- HF boost (0dB to 8dB) controls
- Wide bandwidth: 20Hz to 50MHz
- 75Ω or high impedance input
- 75Ω outputs
- Single +12V DC @ 50mA Supply
- EMC / CE Compliant

PROJECT RATING 1 Simple

IDEAL FOR:

- Video signal distribution
- Video dubbing/duplication
- CCTV/Security

Kit includes all components, PCB, potentiometers and full instructions. Enclosure, knobs, coaxial cable, connectors, etc., are dependant on user's intended application and therefore not included in the kit.

VIDEO DISTRIBUTION AMPLIFIER KIT LU79L £14.99
Construction details: Video Distribution Amplifier Leaflet XZ38R 50p
Issue 111 / March 1997 Electronics & Beyond XD11M £2.25

CONTINUITY TESTER KIT

FEATURES:

- Easy to build – ideal beginners' project
- Audible continuity indication
- Can discriminate between semiconductor junctions and 'true short-circuits'
- Compact, lightweight and portable
- Battery powered
- No setting up required
- EMC / CE Compliant

PROJECT RATING 1 Simple

IDEAL FOR:

- Tracing faults on PCBs
- Checking components
- Tracing wiring

Kit Includes all components, PCB, box, box label, sockets, wire, speaker, test leads, etc., and full instructions. Requires Alkaline PP3 battery (not included in kit).

CONTINUITY TESTER KIT JA13P £19.99
Construction details: Continuity Tester Leaflet XZ39N 50p
Issue 111 / March 1997 Electronics & Beyond XD11M £2.25

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