THE No.1 MAGAZINE FOR ELECTRONICS TECHNOLOGY & COMPUTER PROJECTS

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SEPTEMBER 2000

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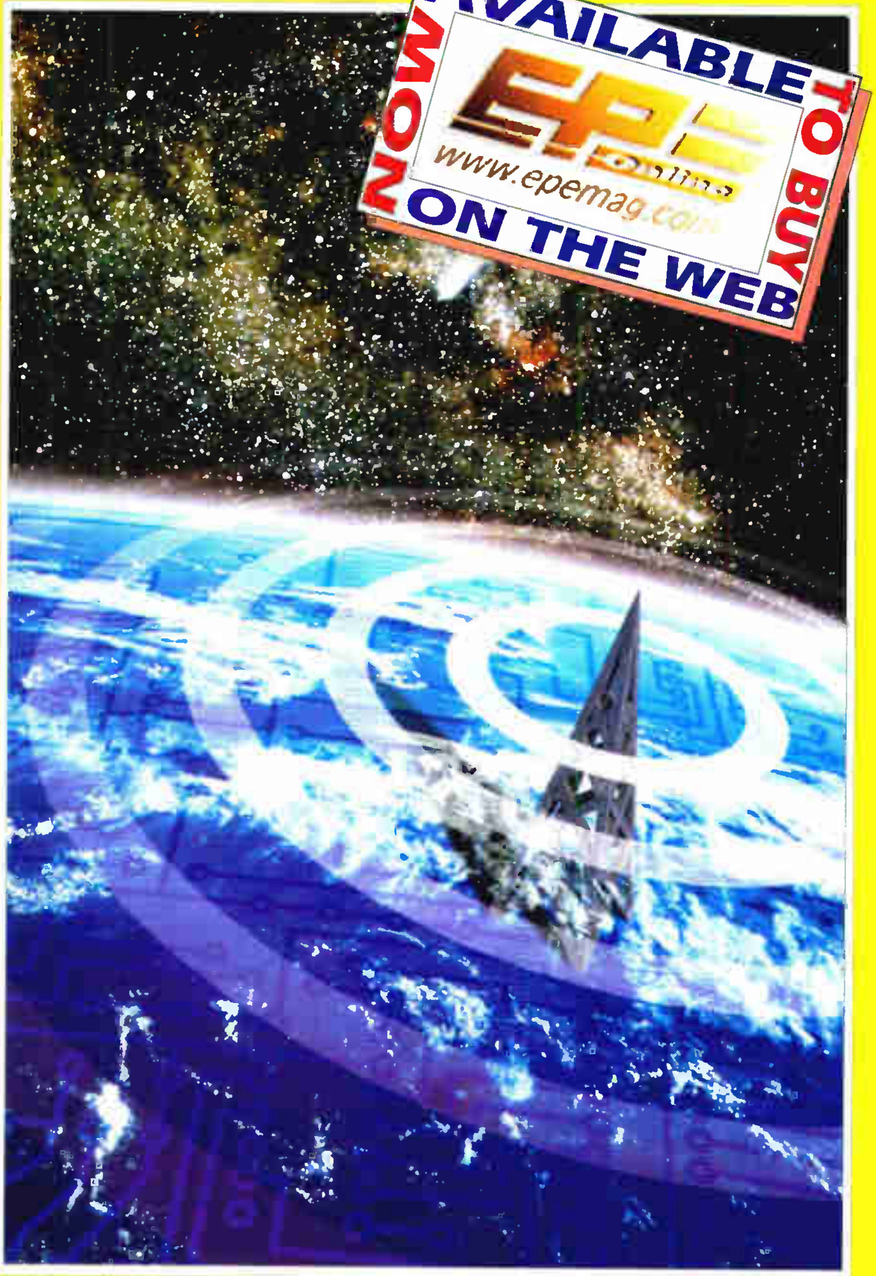

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World Radio History

12v 18Ah SEALED LEAD ACID BATTERIES, new and boxed, unused pack of 4 £39.95 ref CYC7 or £15 each ref CYC6

AUTOMATIC CHARGER For the above batteries charges 2 at once, charge level indicator circuitry, 6 hour charge £10 ref CYC8

A new range of 12v to 240v INVERTERS

IV400S (400 watt) £89

IV800S (800watt)£159

IV1200S (1200 watt) £219

ECG MACHINES?/6v 10AH BATTS/24V 8A TX Ex government ECG machines! Measures 390X320X120mm, on the front are controls for scan speed scan delay, scan mode, loads of connections on the rear including video out etc On the front panel are two DIN sockets for connecting the body sensors to Sensors not included Inside 2 x 6v 10AH lead acid batts (not in good condition), pcb's and a 8A? 24v torroidial transformer (mains in) sold as seen, may have one or two broken knobs etc due to poor storage £15 99 ref VP2

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

PC SUPPORT HANDBOOK The ultimate technical guide to building and maintaining PC's. Over 460 A4 pages packed with technical data and diagrams just £10 ref PCBK. If you want 4 copies for £33 ref PCBK2. Also available is a CD packed with diagnostic programmes to use with the book £5 ref PCBK1

D SIZE NICADS Tagged, 1200mA, 1.2v pack of 4 for £6 ref CYC9 or as a pack of 24 for £22 ref CYC10

D SIZE SEALED LEAD ACID BATTERIES

2v 2 5ah rechargeable sealed lead acid battery made by Cyclon 60x45mm (standard D size) supplied as a pack of 12 or 20 giving you options for battery configerations eg 12v at 5ah, 24v at 2 5ah, 6v at 10ah These batteries are particularly useful in that you can arrange them in your project to optimise space etc (eg boat ballast etc) Pack of 12 £10 ref CYC4, pack of 20 £16 ref CYC5

HYDROPONICS DO YOU GROW YOUR OWN? We have a full colour hydroponics catalogue available containing nutrients, pumps, fittings, enviromental control light fittings, plants, test equipment etc Ring for your free copy.

PC COMBINED UPS AND PSU The unit has a total power of 292 watts, standard mother board connectors and 12 peripheral power leads for drives etc Inside is 3 12v 7 2aH sealed lead acid batteries Backup time is 8 mins at full load or 30 mins at half load Made in the UK by Magnum, 110 or 240vac input, +5v at 35A, -5vat 5A, +12v at 9A, -12v at 5A outputs 170x260x220mm, new and boxed £29 95 Ref PCUPS2

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

AERIAL PHOTOGRAPHY KIT This rocket comes with a built in camera! it flies up to 500 feet (150 m) turns over, and takes an aerial photograph of the ground below The rocket then returns wih its film via its paracute Takes 110 film Supplied complete with everything including a launch pad and 3 motors (no film) £29 98 ref astro

PROJECT BOXES Another bargain for you are these smart ABS project boxes, smart two piece screw together case measuring approx 6"x5"x2" complete with panel mounted LED Inside you will find loads of free bits, tape heads, motors, chips resistors, transistors etc Pack of 20 £19 95 ref MD2

TELEPHONES Just in this week is a huge delivery of telephones, all brand new and boxed Two piece construction - Illuminated keypad, tone or pulse (switchable), recall, redial and pause, high/low and off ringer switch and quality construction Off white colour and is supplied with a standard international lead (same as US or modems) if you wish to have a BT lead supplied to convert the phones these are £1 55 each ref BTLX **Phones £4.99 each ref PH210 off £30 ref SS2**

3HP MAINS MOTORS Single phase 240v, brand new, 2 pole, 340x180mm, 2850 rpm, builtin automatice reset overload protector, keyed shaft (40x16mm)Made by Leeson £99 each ref LEE1

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

CHIEFTAN TANK DOUBLE LASERS 9 WATT+3 WATT+LASER OPTICS Could be adapted for laser listener, long range comms etc Double beam units designed to fit in the barrel of a tank, each unit has 2 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 freq The units also contain a receiver to detect reflected signals from targets £99 Ref LOT4

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

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

SOLAR NICAD CHARGERS 4 x AA size £9.99 ref 6P476, 2 x C size £9 99 ref 6P477

BRAND NEW MILITARY ISSUE DOSE METERS Current NATO issue Standard emergency services unit Used by most of the worlds Military personel New and boxed Normal retail price £400. BULLS bargain price just £99The PDRM 82 M is a portable, lightweight, water resistant gamma radiation survey meter to measure radiological dose rate in the range 0 1to 300 centigrays per hour in air The Geiger Muller (G M) tube detecting unit is energy and polar response corrected The radiation level is displayed on a Liquid Crystal Display The microcomputer corrects for the non-linearity of the G M tube response The instrument is powered by three international C size batteries giving typically 400 hours operation in normal conditions. The dose rate meter PDRM 82M designed and selected for the United Kingdom Government, has been fully evaluated to satisfy a wide range of environmental conditions and is nuclear hard The construction enables the instrument to be easily decontaminated The instrument is designed for radiation surveys for post incident monitoring Used in a mobile role, either carried by troops or in military vehicles for rapid deployment enabling radiation hot spots to be quickly located Range 0 - 300 cGy/h in 0 1 cGylh increments Over range to 1500 cGy/h - indicates flashing 300 Accuracy f20% of true dose rate +0 1 cGylh, 0 - 100 cGy/h f30% of true dose rate, 100 - 300 cGy/h Energy Response 0 3 MeV to 3 MeV - within f20% (Ra 226) 80 KeV to 300 KeV - within i40% (Ra 226) Detector Energy compensated Halogen quenched Geiger Muller Tube Controls Combined battery access and ON/ OFF switch Batteries 3 International standard C cells Weight 560 grms Operating Temperature Range -30deg C to +60 degC Indications High contrast 4 digit LCD Battery low indication Dose rate Rising/Falling £99 ref PDRM

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

PHILIPS VP406 LASER DISC PLAYERS, SCART OUTPUT, JUST PUT YOUR VIDEO DISK IN AND PRESS PLAY, STANDARD AUDIO AND VIDEO OUTPUTS,. £14.96 REF VP406

SMOKE ALARMS Mains powered made by the famous Gent company, easy fit next to light fittings power point Pack of 5 £15 ref SS23 pack of 12 £24 ref SS24

4AH D SIZE NICADS pack of 4 £10 ref 4AHPK

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

10 WATT SOLAR PANEL Amorphous silicon panel fitted in a anodized aluminium frame Panel measures 3' by 1' with screw terminals for easy connection **3' x 1' solar panel £55 ref MAG45**

12V SOLAR POWERED WATER PUMP Perfect for many 12v DC uses from solar fountains to hydroponics! Small and compact yet powerful works direct from our 10 watt solar panel in bright sun Max hd I7 ft Max flow = 8 Lpm 1 5A Ref AC8 £18 99

SOLAR ENERGY BANK KIT 50x 6"x12" 6v solar panels(amorphous)+50 diodes £99 ref EF112

PINHOLE CAMERA MODULE WITH AUDIO! Superb board camera with on board sound! extra small just 28mm square (including microphone) ideal for covert surveillance Can be hidden inside anything even a matchbox! Complete with 15 metre cable, psu and tv/vcr connnectors £49 95 ref CC6J

SOLAR MOTORS Tiny motors which run quite happily on voltages from3-12vdc Works on our 6v amorphous 6" panels and you can run them from the sun! 32mm dia 20mm thick £1 50 each

WALKIE TALKIES 1 MILE RANGE £37/PAIR REF MAG30

LIQUID CRYSTAL DISPLAY Bargain prices, 40 character 1 line 154x16mm £6.00 ref SMC4011A

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

AUTO SUNCHARGER 155x300mm solar panel with diode and 3 metre lead and cigar plug 12v 2w **£12.99** REF AUG10P3

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

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

MINATURE TOGGLE SWITCHES These top quality Japanese panel mount toggle switches measure 35x13x12mm, are 2 pole changeover and will switch 1A at 250vac, or 3 A at 125vac Complete with mounting washers and nuts Supplied as a box of 100 switches for £29 95 ref SWT35 or a bag of 15 for £4 99 ref SWT34

VOICE CHANGERS Hold one of these units over your phone mouth piece an you can adjust your voice using the controls on the unit! Battery operated £15 ref CC3

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30 WATTS OF SOLAR POWER for just £69, 4 panels each one 3'x1' and producing 8w, 13v. PACK OF FOUR £69 ref SOLX

200 WATT INVERTERS plugs straight into your car cigarette lighter socket and is fitted with a 13A socket so you can run your mains operated devices from your car battery £49 95 ref SS66

THE TRUTH MACHINE Tells if someone is lying by micro tremors in their voice, battery operated, works in general conversation and on the 'phone and TV as well! £42 49 ref TD3

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

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

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

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

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

12V OPERATED SMOKE BOMBS Type 3 is a 12v trigger and 3 smoke cannisters each cannister will fill a room in a very short space of time! £14 99 ref SB3 Type 2 is 20 smaller cannisters (suitable for mock equipment fires etc) and 1 trigger module for £29 ref SB2 Type 1 is a 12v trigger and 20 large cannisters £49 ref SB1

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

NEW LASER POINTERS 4 5mw 75 metre range hand held unit runs on two AA batteries (supplied) 670nm £29 ref DEC49J

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

NEW HIGH POWER MINI BUG With a range of up to 800 metres and 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

IR LAMP KIT Suitable for cctv cameras, 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&rear waveguides, 1 1"x2 7"x4 6" fits on visor or dash £149

LOPTX Made by Samsung for colour TV £3 each ref SS52

LAPTOP LCD SCREENS 240x175mm, £12 ref SS51

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

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

INFRA RED REMOTE CONTROLS made for TV's but may have other uses pack of 100 £39 ref IREM

RCB UNITS Inline IEC lead with fitted RC breaker. Installed in seconds. Pack of 3 £9.98 ref LOT5A

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

AUTO SUNCHARGER 155x300mm solar panel with diode and 3 metre lead and cigar plug 12v 2w **£12.99** REF AUG10P3 **STEPPER MOTORS** Brand new stepper motors, 4mm fixing holes with 47 14mm fixing centres, 20mm shaft 6 35mm diameter, 5v/phase, 0 7A/phase, 1 8 deg step (200 step) Body 56x36mm £14 99 ea ref STEP6, pack of 4 for £49 95 PIC based variable speedcontroller kit £15 ref STEP7

World Radio History

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

VOL. 29. No. 9 SEPTEMBER 2000
Cover illustration by Jonathan Robertson

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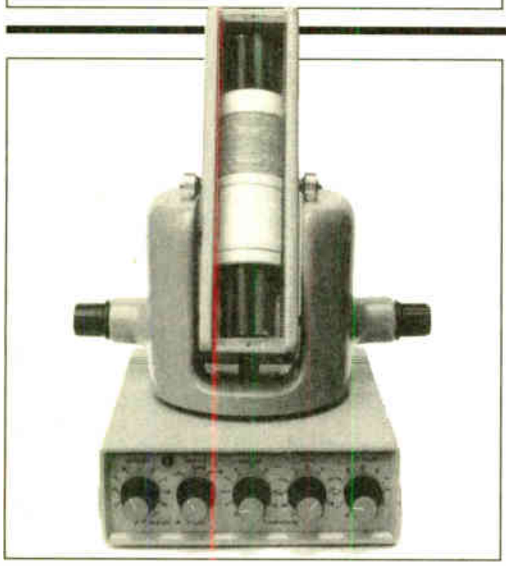

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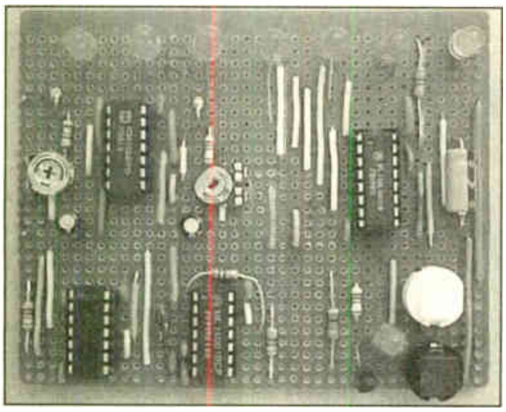

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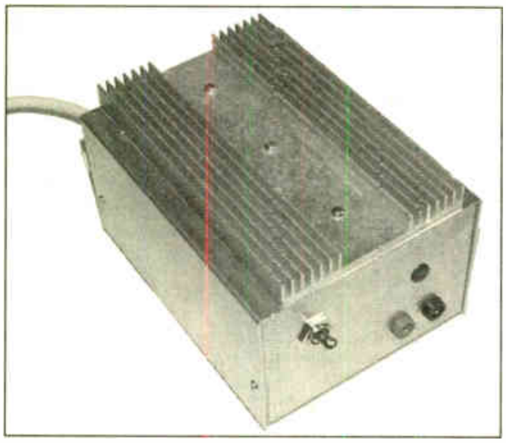

Regulars and Services

NOTE NEW PUBLISHING DATE
See Editorial page 651 for full details.

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Our October 2000 issue will be published on Thursday, 7 September 2000. See page 643 for details

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For overseas PAL versions state 5.5 or 6 mHz sound specification.
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NEW State of the art PAL (UK spec) UHF TV tuner module with **composite** 1V pp video & **NICAM** hi fi stereo sound outputs. **Micro electronics** all on one small PCB only 73 x 160 x 52 mm enable full tuning control via a **simple 3 wire link** to an IBM pc type computer. Supplied complete with **simple working** program and documentation. Requires +12V & + 5V DC to operate.
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5¼" **Teac** FD-55F-03-U 720K 40/80 (for BBC's etc) RFE	£29.95(B)
5¼" **BRAND NEW Mitsubishi MF501B 360K**	£22.95(B)
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8" **Shugart 810** 8" SS HH *Brand New*	£195.00(E)
8" **Shugart 851** 8" double sided refurbished & tested	£260.00(E)
8" **Mitsubishi M2894-63** double sided *NEW*	£295.00(E)
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5¼" **SEAGATE ST-238R** 30 mb RLL I/F Refurb	£69.95
5¼" **CDC 94205-51** 40mb HH MFM I/F RFE tested	£69.95
5¼" **HP 97548** 850 Mb SCSI RFE tested	£99.00
5¼" **HP C3010** 2 Gbyte SCSI ***differential*** RFE tested	£195.00
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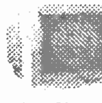

Mitsubishi FA3415ETKL 14" SVGA **Multisync** colour monitor with fine 0.28 dot pitch tube and resolution of 1024 x 768. A variety of inputs allows connection to a host of computers including **IBM PC's** in CGA, EGA, VGA & SVGA modes, **BBC, COMMODORE** (including Amiga 1200), **ARCHIMEDES** and **APPLE**. Many features: Etched faceplate, text switching and **LOW RADIATION MPR** specification. Fully guaranteed, in EXCELLENT little used condition.
Tilt & Swivel Base £4.75
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Ex demo 17" 0.28 SVGA Mitsubishi Diamond Pro monitors, Full multisync etc.
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Just In - Microvitec 20" VGA (800 x 600 res.) colour monitors.
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PHILIPS HCS35 (same style as CM8833) attractively styled 14" colour monitor with both **RGB and standard composite** 15.625 **Khz video inputs via SCART socket and separate phono jacks. Integral audio power amp and speaker for all audio visual uses.** Will connect direct to **Amiga and Atari BBC** computers. Ideal for all **video monitoring / security applications with direct connection to most colour cameras**. High quality with many features such as front concealed flap controls, VCR correction button etc. Good used condition - fully tested - guaranteed
Dimensions: W14" x H12¾" x 15½" D. **Only £99.00** (E)

PHILIPS HCS31 Ultra compact 9" colour video monitor with **standard composite 15.625 Khz video** input via SCART socket. Ideal for all monitoring / security applications. High quality, ex-equipment fully tested & guaranteed (possible minor screen burns). In attractive square black plastic case measuring W10" x H10" x 13½" D. 240 V AC mains powered. **Only £79.00** (D)

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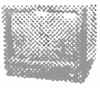

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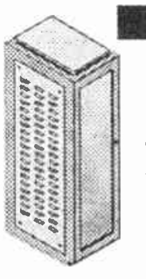

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Less than Half Price!

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

OPT Rack 1 Complete with removable side panels.	£345.00 (G)
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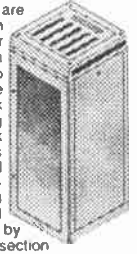
32U - High Quality - All steel RakCab



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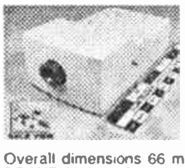

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World Radio History

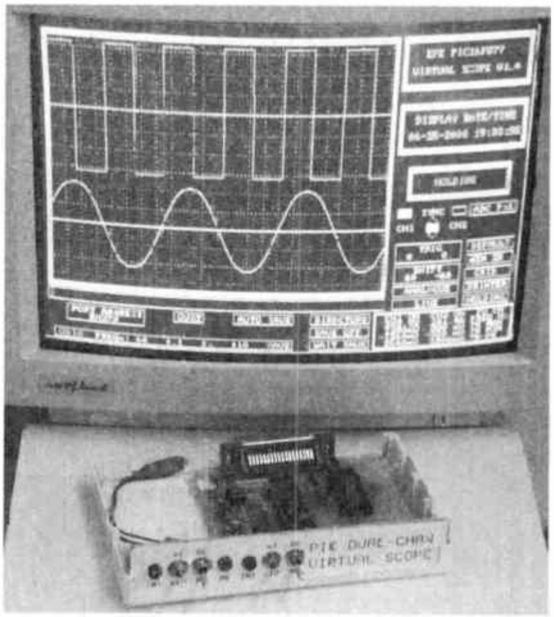
NEXT MONTH

PIC VIRTUAL SCOPE

A dual-channel virtual oscilloscope for monitoring audio frequency waveforms via a PIC microcontrolled interface and your computer. Performance sits mid-range between the simple scope interface of the current Teach-In 2000 *series, and the versatile* EPE Virtual Scope *of 1998. Provides waveform display of two signals simultaneously at rates much higher than the* TI *design offers, although lower than* V-Scope. *With care, even less-experienced hobbyists should stand an excellent chance of constructing it successfully.*

It requires a PC-compatible computer capable of running QBasic or QuickBASIC and for it to "read" mouse controls via those programming dialects. The controlling program allows you to check on both points before purchasing any components. The author has run the prototype under Windows 3.1, 95 and 98.

Many of the functions offered by this design are closely similar to those provided by V-Scope, *including output of waveform data to disk and printer. Frequency counting and waveform amplitude measurement are also included.*



Top Tenner

FRIDGE/FREEZER ALARM

Many people have a sizeable amount of capital tied up in their deep-freeze. A long power cut or a failure of the freezer itself can lead to significant financial loss, not to mention the prospect of losing the delicious smoked trout from last summer's fishing holiday. The disaster is not discovered until later, when it's too late to do anything about it. Similar remarks apply to the contents of a refrigerator, though it may be more a matter of disappointment than loss when somebody (who was it?) leaves the door ajar and the chilled lemonade warms up on a summer's day.

This circuit sits in the freezer and simply waits for the temperature to rise above a preset limit. Then it turns on a loud buzzer, one that is loud enough to be heard with the freezer door shut.

WIND-UP TORCH

A common problem with small torches is the short life-span both of the batteries and the bulb. The batteries of a small "penlite" torch will commonly last only two to three hours, and many bulb filaments burn no more than a few weeks before fusing.

With new l.e.d. technology, it is now possible to build a torch that quite adequately lights the way five to ten metres in front of one. In fact, since power consumption is so small, it is possible to power the light for a considerable length of time from a few turns of a small generator and a capacitor "reservoir" – the sole source of power for this torch (no batteries). In addition to this, the white l.e.d. used in this circuit has a life expectancy of years, not weeks as in the case of a standard filament bulb.

While the light output of the Wind-up Torch *is modest in comparison with some modern torches, it matches several candlepower at medium power, and is thus quite serviceable. It will provide ample light around a camp table, for walking on a footpath, or for reading. The light output of the torch is continuously variable, and its expected service from each full wind (about a 30-second wind) is as follows: as a book-light – 1½ hours; as a medium-power beam – 40 minutes; as a beam for walking – 15 minutes.*

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● **DISCO STROBE LIGHT** Probably the most exciting of all light effects Very bright strobe tube. Adjustable strobe frequency 1-60Hz. Mains powered. PCB: 60x68mm Box provided **6037KT £29.90**

● **ANIMAL SOUNDS** Cat, dog, chicken & cow. Ideal for kids farmyard toys & schools **SG10M £5.50**

● **3 1/2 DIGIT LED PANEL METER** Use for basic voltage/current displays or customise to measure temperature, light, weight, movement, sound levels, etc. with appropriate sensors (not supplied) Various input circuit designs provided **3061KT £12.95**

● **IR REMOTE TOGGLE SWITCH** Use any TV/VCR remote control unit to switch onboard 12V/1A relay on/off **3058KT £9.95**

SPEED CONTROLLER for any common DC motor up to 100V/5A. Pulse width modulation gives maximum torque at all speeds 5-15VDC Box provided **3067KT £14.95**

● **3 x 8 CHANNEL IR RELAY BOARD** Control eight 12V 1A relays by Infra Red (IR) remote control over a 20m range in sunlight 6 relays turn on only the other 2 toggle on/off 3 operation ranges determined by jumpers Transmitter case & all components provided Receiver PCB 76x89mm **3072KT £44.95**

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ORDERING INFO: Kit 3096KT – **£14.95**; Assembled AS3096 – **£24.95**; Assembled with ZIF socket **£39.95**.

OPTIONAL EXTRAS: DOS software registration **£14.95**; Windows software registration **£21.95**; 40-pin wide ZIF socket **£15.95**; Power supply **£5.95**; lead **£4.95**.

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Used to automatically operate a tape recorder (not supplied) via its REMOTE socket when sounds are detected All conversations recorded Adjustable sensitivity & turn-off delay 115x19mm **3013KT £7.95 AS3013 £19.95**

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

● **4 WATT FM TRANSMITTER** Comprises three RF stages and an audio preamplifier stage Piezoelectric microphone supplied or you can use a separate preamplifier circuit Antenna can be an open dipole or Ground Plane. Ideal project for those who wish to get started in the fascinating world of FM broadcasting and want a good basic circuit to experiment with 12-18VDC PCB 44x146mm **1028KT. £23.95**

● **15 WATT FM TRANSMITTER (PRE-ASSEMBLED & TESTED)** Four transistor based stages with Philips BLY 88 in final stage 15 Watts RF power on the air 88-108MHz Accepts open dipole Ground Plane, 5/8, J, or YAGI configuration antennas 12-18VDC PCB 70x220mm SWS meter needed for alignment **1021KT £69.95**

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● **LED FLASHER 1** 5 ultra bright red LED's flash in 7 selectable patterns **3037MKT £4.95**

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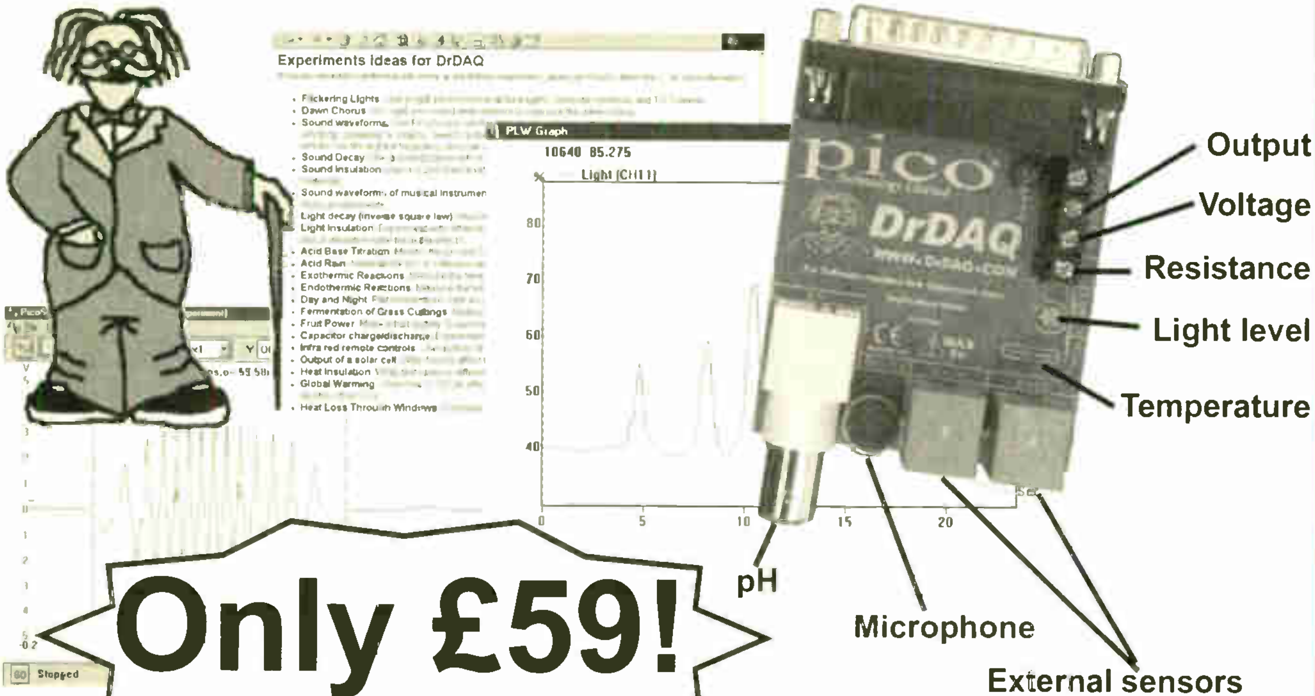
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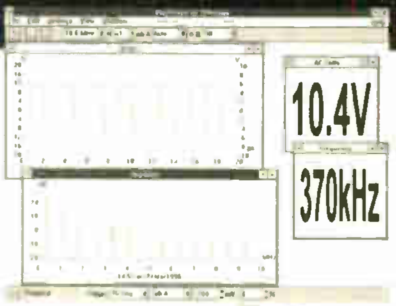

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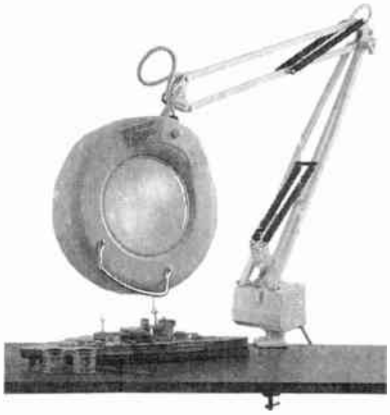

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The latest MAGENTA DESIGN – highly stable & sensitive – with I.C. control of all timing functions and advanced pulse separation techniques.

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

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

KIT 847 ....£63.95

PORTABLE ULTRASONIC PEsT SCARER

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

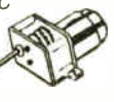
KIT 842....................£22.56

ICEBREAKER

PIC REAL TIME IN-CIRCUIT EMULATOR – SEE PAGE 669

DC Motor/Gearboxes

Our Popular and Versatile DC motor/Gearbox sets.
Ideal for Models, Robots, Buggies etc. 1·5V to 4·5V
Multi ratio gearbox gives wide range of speeds.



LARGE TYPE – MGL £6.95
SMALL – MGS – £4.77

Stepping Motors

MD38...Mini 48 step...£8.65
MD35...Std 48 step...£9.99
MD200...200 step...£12.99
MD24...Large 200 step...£22.95

PIC PIPE DESCALER

- SIMPLE TO BUILD
- SWEPT FREQUENCY
- HIGH POWER OUTPUT
- AUDIO & VISUAL MONITORING

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

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

MICRO PEsT SCARER

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

- **RANDOM PULSES**
- **HIGH POWER**
- **DUAL OPTION**

Plug-in power supply £4.99

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

WINDICATOR

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

KIT 856...................................£28.00

★ TENS UNIT ★

DUAL OUTPUT TENS UNIT

As featured in March '97 issue.

Set of 4 spare electrodes £6.50

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

KIT 866. . Full kit including four electrodes £32.90

1000V & 500V INSULATION TESTER

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

KIT 848. . . . . £32.95

EPE TEACH-IN 2000

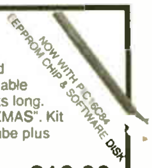
Full set of top quality *NEW* components for this educational series. All parts as specified by *EPE*. Kit includes breadboard, wire, croc clips, pins and all components for experiments, as listed in introduction to Part 1.
**Batteries and tools not included.*

TEACH-IN 2000 -

KIT 879 £44.95

MULTIMETER £14.45

SPACEWRITER



NOW WITH PIC16F84 (EPROM CHIP & SOFTWARE DISK)

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

KIT 849 ....£16.99

12V EPROM ERASER

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

KIT 790 ....£29.90

SUPER BAT DETECTOR

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

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

KIT 861 ....£24.99

ALSO AVAILABLE Built & Tested. . . £39.99

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

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

Kit No. 845 ....£64.95

EPE PROJECT PICS

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

ULTRASONIC PEsT SCARER

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

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

KIT 812...............................£15.00

SIMPLE PIC PROGRAMMER

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

Power Supply £3.99

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

EXTRA CHIPS:
PIC 16F84 £4.84

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

PIC 16C84 DISPLAY DRIVER

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

Kit 860 £19.99

Power Supply £3.99

FULL PROGRAM SOURCE CODE SUPPLIED – DEVELOP YOUR OWN APPLICATION!

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

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

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

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

Kit 855 £39.95 LOTS OF OTHER APPLICATIONS

PIC TOOLKIT V1

• PROGRAMS PIC16C84 and 16F84 • ACCEPTS TASM AND MPASM CODE
Full kit includes PIC16F84 chip, top quality p.c.b. printed with component layout, turned-pin PIC socket, all components and software*
*Needs QBASIC or QUICKBASIC

KIT 871 . . . £13.99 Built and tested **£21.99**

PhizzyB

ALL PARTS FOR SERIES INCLUDING PCBs, PROGRAMMED CHIP, CD-ROM AND DISPLAYS

MAIN BOARD – FULL KIT	**£131.95**	BUILT.............	**£149.95**
I/O PORT KIT....................	**£16.99**	BUILT.............	**£24.99**
L.C.D...............................	**£12.49**	POWER SUPPLY	**£3.99**
8-BIT SWITCH/LATCH.....	**£7.95**	INT. MODULE.	**£10.45**

68000 DEVELOPMENT AND TRAINING KIT

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

KIT 621
£99.95

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

Mini-Lab & Micro Lab Electronics Teach-In 7

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

EPE PIC Tutorial

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

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

PIC TUTOR BOARD KIT

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

KIT 870 .... £27.95, Built & Tested £42.95
Optional: **Power Supply – £3.99, ZIF Socket – £9.99**
LCD Display .... £7.99 LED Display £6.99
Reprints Mar/Apr/May 98 – **£3.00** set 3

PIC TOOLKIT V2

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

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

SUPER PIC PROGRAMMER

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

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

Kit 862 £29.99

Power Supply £3.99

DISASSEMBLER SOFTWARE £11.75

PIC STEPPING MOTOR DRIVER

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

Kit 863 £18.99

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

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

8-CHANNEL DATA LOGGER

NEW!

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

KIT 877 £49.95 inc. 8 × 256K EEPROMS

MAGENTA

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

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ELECTRONIC COMPONENTS

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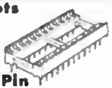
All Major Credit cards Accepted SWITCH SOLO

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

DIL Sockets



Stamped Pin

6 Pin DIL 0.3"	£0.06
8 Pin DIL 0.3"	£0.06
14 Pin DIL 0.3"	£0.11
16 Pin DIL 0.3"	£0.11
18 Pin DIL 0.3"	£0.12
20 Pin DIL 0.3"	£0.12
24 Pin DIL 0.6"	£0.12
28 Pin DIL 0.6"	£0.13
40 Pin DIL 0.6"	£0.19

Turned Pin

8 Pin DIL 0.3"	£0.11
14 Pin DIL 0.3"	£0.20
16 Pin DIL 0.3"	£0.23
18 Pin DIL 0.3"	£0.25
20 Pin DIL 0.3"	£0.28
24 Pin DIL 0.6"	£0.35
28 Pin DIL 0.6"	£0.39
40 Pin DIL 0.6"	£0.64

ZIF Sockets

Universal ZIF DIL Sockets

24 Way 0.3-0.6"	£5.78
28 Way 0.3-0.6"	£6.60
32 Way 0.3-0.6"	£7.50
40 Way 0.3-0.6"	£8.93

Transistor Sockets

T018-4 Base Socket	£0.24
T05 Base Socket	£0.24

IDC Cable Sockets

10 Way Socket	£0.25
14 Way Socket	£0.35
16 Way Socket	£0.37
20 Way Socket	£0.37
26 Way Socket	£0.38
34 Way Socket	£0.39
40 Way Socket	£0.55
50 Way Socket	£0.80

IDC Cable Plugs ***NEW***

10 Way Plug	£0.52
14 Way Plug	£0.58
16 Way Plug	£0.62
20 Way Plug	£0.66
26 Way Plug	£0.70
34 Way Plug	£0.80
40 Way Plug	£0.92
50 Way Plug	£1.12

PCB Box Headers

10 Way Straight	£0.23
14 Way Straight	£0.33
16 Way Straight	£0.36
20 Way Straight	£0.41
26 Way Straight	£0.55
34 Way Straight	£0.68
40 Way Straight	£0.75
50 Way Straight	£1.03
10 Way 90	£0.32
14 Way 90	£0.44
16 Way 90	£0.42
20 Way 90	£0.63
26 Way 90	£0.82
34 Way 90	£0.81
40 Way 90	£1.17
50 Way 90	£1.14

PCB Latch Headers

10 Way Straight	£0.41
14 Way Straight	£0.45
16 Way Straight	£0.51
20 Way Straight	£0.55
26 Way Straight	£0.73
34 Way Straight	£0.88
40 Way Straight	£0.92
50 Way Straight	£1.27
10 Way 90	£0.46
14 Way 90	£0.48
16 Way 90	£0.54
20 Way 90	£0.59
26 Way 90	£0.81
34 Way 90	£1.03
40 Way 90	£1.23
50 Way 90	£1.41

DIL Headers

14 Way DIL	£0.51
16 Way DIL	£0.53
24 Way DIL	£0.90
40 Way DIL	£1.37

Transistion Headers

10 Way Transistion	£0.42
14 Way Transistion	£0 42
16 Way Transistion	£0.48
20 Way Transistion	£0.48
26 Way Transistion	£0.52
34 Way Transistion	£0.56
40 Way Transistion	£0.63
50 Way Transistion	£0.84

Large Range of Connectors available - contact our sales department for full details

D Type Connectors

Solder Bucket

9 Way Male Plug	£0.24
9 Way Female Socket	£0.24
15 Way Male Plug	£0.36
15 Way Female Socket	£0.39
15 Way H.D. Plug	£0.48
15 Way H.D. Socket	£0.64
23 Way Male Plug	£0.44
23 Way Female Socket	£0.50
25 Way Male Plug	£0.36
25 Way Female Skt	£0.37

IDC Ribbon Mounting

9 Way Male Plug	£1.08
9 Way Female Socket	£0.93
15 Way Male Plug	£1.32
15 Way Female Socket	£1.32
25 Way Male Plug	£1.18
25 Way Female Socket	£1.13

Right Angled PCB

9 Way Male Plug	£0.33
9 Way Female Socket	£0.33
15 Way Male Plug	£0.39
15 Way Female Socket	£0.39
15 Way H.D Socket	£0.58
25 Way Male Plug	£0.52
25 Way Female Socket	£0.51

Plastic D Covers

9 Way Cover - Grey	£0.29
9 Way Cover - Black	£0.30
15 Way Cover - Grey	£0.32
23 Way Cover - Grey	£0.38
23 Way Cover - Black	£0.38
25 Way Cover - Grey	£0.34
25 Way Cover - Black	£0.37
9 to 9 Cover / Case	£0.80
25 to 25 Cover / Case	£0.84
9 to 25 Cover / Case	£0.80

Audio Connectors

2.5mm Jack Plug	£0.25
2.5mm Line Socket	£0.16
2.5mm Chassis Socket	£0.20
3.5mm Mono Plug	£0.24
3.5mm Mono Line Skt	£0.30
3.5mm Mono Chassis	£0.14
3.5mm Stereo Plug	£0.36
3.5mm Stereo Line Skt	£0.37
3.5mm Stereo Chassis	£0.22
¼" Mono Plug	£0.34
¼" Mono Line Socket	£0.35
¼" Mono Chassis Skt	£0.37
¼" Stereo Plug	£0.40
¼" Stereo Line Socket	£0.38
¼" Stereo Chassis Skt	£0.38
NEUTRIK Speakon Plug	£2.81

Phono Series

Red Line Plug	£0.20
Black Line Plug	£0.20
Yellow Line Plug	£0.20
White Line Plug	£0.20
Red Line Socket	£0.20
Black Line Socket	£0 20
Yellow Line Socket	£0.20
White Line Socket	£0.20
Red Chassis Socket	£0.20
Black Chassis Socket	£0.20
Gold Plated Plug Red	£0.66
Gold Plated Plug Black	£0.66

XLR Series - metal

3 Pin Line Plug	£1.46
3 Pin Line Socket	£1.71
3 Pin Chassis Plug	£1.50
3 Pin Chassis Socket	£1.49
Neutrik Line Plug	£1.68
Neutrik Line Socket	£1.99
Neutrik Chassis Plug	£2.13
Neutrik Chassis Socket	£2.32

See Next / Last Months Ad. for ELECTRONIC COMPONENTS

RF Connectors

BNC Plug 50Ω Solder	£0.99
BNC Plug 50Ω Crimp	£0.68
BNC Plug 75Ω Solder	£0.95
BNC Plug 75Ω Crimp	£0.68
BNC Chassis Socket	£0.81
F Plug - Twist	£0.24
F Plug - Crimp	£0.26
TNC Plug 50Ω Solder	£1.24
TNC Plug 50Ω Crimp	£0.85
TNC Plug 75Ω Solder	£1.40
TNC Plug 75Ω Crimp	£1.16
UHF Plug 5mm Cable	£0.63
UHF Plug 11mm Cable	£0.75
UHF Chassis Skt- Sqr	£0.50
UHF Chassis Skt- Rnd	£0.73

Extensive range of RF connectors in stock, inc.FME, SMA, Mini UHF & N Type.

Terminals

Colours Red, Black, Green, Blue, White or Yellow

2mm Solder Plugs	£0.18
2mm Chassis Sockets	£0.26
4mm Plugs - Solder	£0.33
4mm Plugs - Screw	£0.38
4mm Stackable Plugs	£0.40
4mm Shrouded Plugs	£0.74
4mm Chassis Sockets	£0.24
4mm Binding Posts	£0.46
33mm Crocodile Clips	£0.10

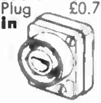
Power Connectors DC Low Voltage

DC Plug 0.7ID 2.35OD	£0.47
DC Plug 1.3ID 3.4OD	£0.32
DC Plug 1.7ID 4.0OD	£0.47
DC Plug 1.7ID 4.75OD	£0.47
DC Plug 2.1ID 5.0OD	£0.25
DC Plug 2.5ID 5.0OD	£0.24
DC Plug 3.1ID 6.3OD	£0.46
DC Line Socket 2.1mm	£0.57
DC Line Socket 2.5mm	£0.68
DC Chassis Skt 2.1mm	£0.40
DC Chassis Skt 2.5mm	£0.41

IEC Mains 6A 250Vac

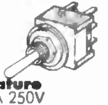
3 Pin IEC Line Socket	£1.08
3 Pin IEC Line Plug	£1.78
3 Pin Chassis Socket	£0.55
3 Pin Chassis Plug	£0.72

8 Way Bulgin



8 Pin Line Plug P551	£4.08
8 Pin Chassis Skt P552	£1.39

Toggle Swifches



Sub-Miniature

3A 125V 1A 250V

5mm Ø Mounting Hole

SPST 5 x 10mm	£0.58
SPDT 5 x 10mm	£0.60
SPDT C/Off 5 x 10mm	£0.81
DPDT 9.2 x 10mm	£0.66

Miniature

6A 125V 3A 250V

6.2mm Ø Mounting Hole

SPST 8 x 13mm	£0.65
SPDT 8 x 13mm	£0.54
SPDT c/off 8 x 13mm	£0.60
SPDT c/o Biased 2 way	£0.97
SPDT c/o Biased 1 way	£1.04
DPDT 12 x 13mm	£0.72
DPDT c/off 12 x 13mm	£0.80
DPDT c/o Biased 2 way	£1.28
DPDT c/o Biosed 1 way	£1.28

Standard

10A 250V Push on terminals

12mm Ø Mounting Hole

SPST 18 x 30mm	£1.28
SPDT 18 x 30mm	£1.31
SPDT c/off 18 x 30mm	£1.43
DPDT 21 x 30mm	£1.65
DPDT c/off 21 x 30mm	£1.68

Slide Switches

Miniature

300mA 125V

7 x 15mm Mounting Hole

DPDT 7 x 23mm	£0.18

Standard

1A 125V

5.5 x 12mm Mounting Hole

DPDT 12 x 35mm	£0.25
DPDT c/o 12 x 35mm	£0.27

Rotary Switches

150mA 250V

Make before Break 22mm Ø

9.8mm Ø Mounting Hole

1 Pole 12 Way	£0.84
2 Pole 6 Way	£0.84
3 Pole 4 Way	£0.84
4 Pole 3 Way	£0.84

Push Switches

Miniature Round

250mA 125V 28 x 10mm

7mm Ø Mounting Hole

Non Latching Push to Make

Black PTM	£0.23
Red PTM	£0.23
Yellow PTM	£0.23
Green PTM	£0.23
Blue PTM	£0.23
White PTM	£0.23

Non Latching Push to Break

Black PTB	£0.24

Standard Square

1A 250V

39 x 15MM

12mm Ø Mounting Hole

Non Latching Push to Make

Black PTM	£0.60
Red PTM	£0.60
Blue PTM	£0.60
White PTM	£0.60

Latching -push On push Off

Black	£0.65
Red	£0.65
Blue	£0.65
White	£0.65

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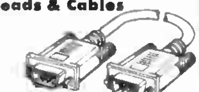

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World Radio History

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

VOL. 29 No. 9 SEPTEMBER 2000

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HARD WORK

You cannot please all of the people all of the time!

I keep a close eye on all the p.c.b. orders that come into the office, so I can quickly see which projects are the most popular. Over a period of time – and I've been doing this job for over 22 years now – I have built up a feeling for what will be popular, but sometimes you wonder if you are going down the wrong road. This morning I received a letter from a reader asking if we could include some simple projects, "a lot of the projects are of an advanced nature", he said, "perhaps just a few beginners pages and projects."

But, I thought, we have been publishing *Teach-In 2000* for the last eleven months and our *Starter Projects* since the June '99 issue, altogether about 10 or more pages in each issue dedicated to beginners. Now we have the *Top Tenner* series of projects, each of which can be built for around £10. All in all, I believe we cater for the beginner as well as more experienced constructors, but do tell me if I've got it wrong.

The interesting thing is that it is rarely these simple projects that are the most popular; top of the popularity list last year – by a country mile – was *PIC Toolkit Mk2* from the May '99 issue.

NEW DATES

Please note that from next month our publishing date is changing. The October issue will be published on *Thursday*, September 7 and subsequent issues will be published on *the second Thursday* in the month. This is for production reasons to fit in with other work in our typesetting and production departments. I should also inform you that the cover price will increase to £2.75 next month – the first rise since May 1997. If you take out a subscription, the actual price you pay is under £2.30 per issue (UK) and that includes delivery to your door – the equivalent of two free issues each year! See below for subscription prices.

Mike Kenward

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World Radio History

Top Tenners

STEEPLECHASE GAME

OWEN BISHOP

Project 2

This short collection of projects, some useful, some instructive and some amusing, can be made for around the ten pounds mark. The estimated cost does not include an enclosure, for many of them work just as well as an open board.

All of the projects are built on stripboard, and have been designed to fit on to boards of standard dimensions. All of the projects are battery-powered, so are safe to build. In a few cases in which, by its nature, the project is to be run for long periods, power may be provided by an inexpensive mains adaptor. Again, the cost of such a unit is not included because most spares boxes contain a few of these, possibly pensioned off from obsolete electronic gadgets.

AT FIRST glance, this is a very simple game. There is a row of seven l.e.d.s across the top edge of the circuit board, all of them red except for the one on the right, which is green. A timer drives a counter that turns on the l.e.d.s one at a time, starting from the left, in order.

The travelling display represents a horse approaching a jump, which is the green l.e.d. If the player presses the white button (switch S1) at the exact moment when the green l.e.d. is lit, this counts as perfect timing and a "clear jump" is scored. There is an eighth l.e.d. close to the white button to indicate when this happens. However, there is no time to gloat over a successful jump because the horse is already pounding toward the next fence.

The travelling display repeats regularly, with only short pauses between.

Now comes the catch! Although this is a digital game, which one might expect to run as regularly as clockwork (a digital clock, we suppose), there is an element of uncertainty that taxes the skill of the player. Like most horses, the steeplechaser may accelerate or hang back as it approaches and takes the jump. The player must take this into account if the horse is not to jump too soon or too late, and fall at the fence.

This game can be played by one person just for fun, but also makes a game for two or more opponents. You can make your own rules about this but, as a suggestion, a player may attempt ten jumps in succession, and count the number of clear jumps scored. The turn then passes to the next contestant until all have played.

The winner is the player with the highest score out of ten. A tie results in a jump off. Players take jumps alternately and drop out if they do not achieve a clear jump.

HOW IT WORKS

Referring to the Steeplechase Game circuit diagram in Fig.1, IC2 is a decade counter that has 1-of-10 outputs. This differs from an ordinary binary divider/counter because only one output is high at a time. The counter is incremented as the input from the timer IC1 rises from logic low (0V) to logic high (+6V). The output that is currently high goes low and the next output in order goes high.

There are seven l.e.d.s driven by the counter so they each go high in turn, producing the travelling display referred to earlier. There is a gap of three counts between "runs" because there are no l.e.d.s for stages 7, 8 and 9.

The aim of the player is to press the pushbutton switch (S1) while the seventh l.e.d. is lit, but more about that later.

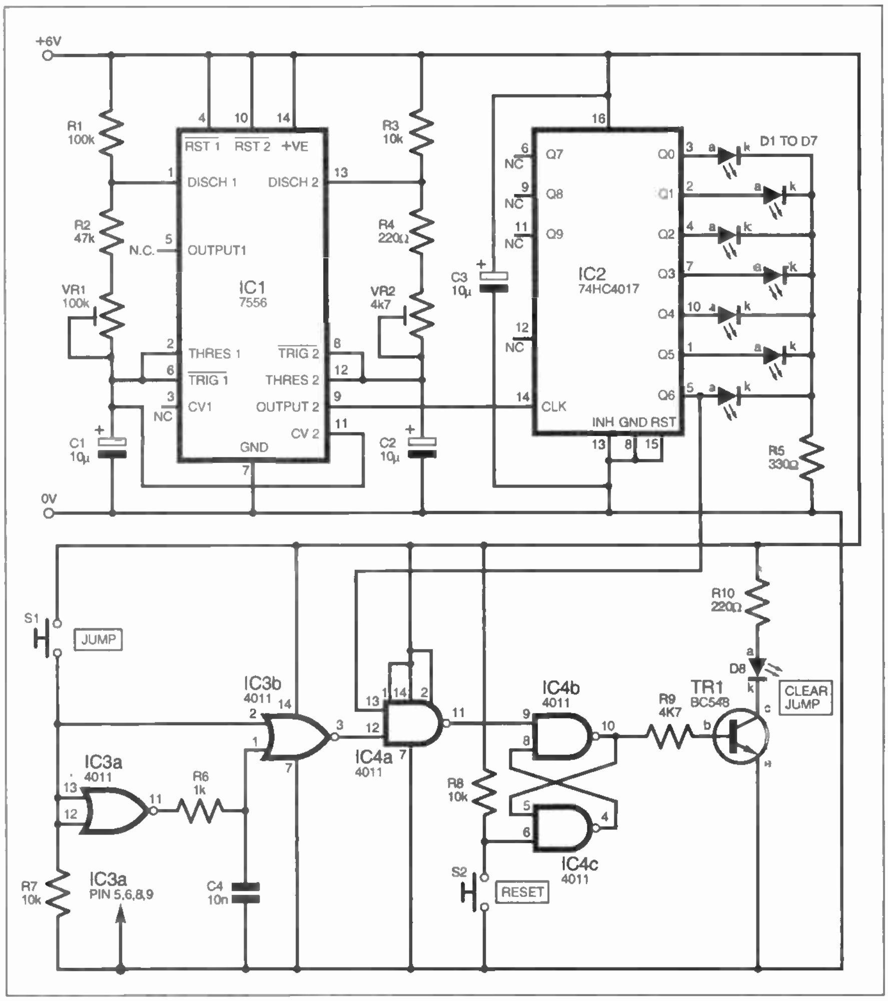
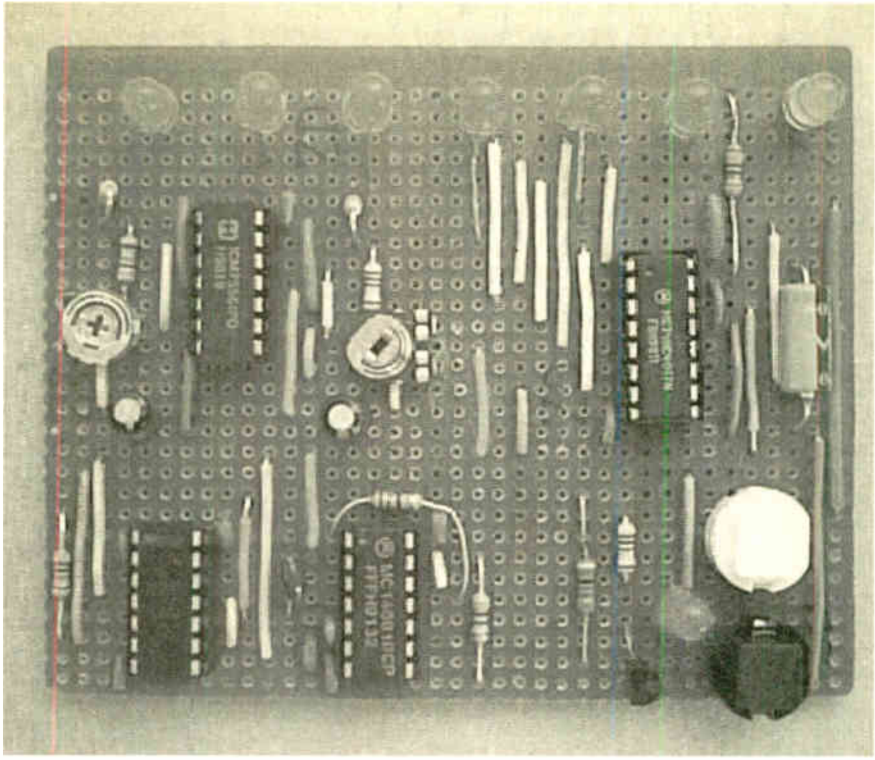


Fig.1. Complete circuit diagram for the Steeplechase Game.



Steeplechase prototype circuit board.

The counter could be driven by a single 7555 timer integrated circuit (i.c.) but this circuit uses the 7556 dual timer instead, shown as IC1. The counter is driven by the timer on the right of IC1, call it Timer 2.

From the values allotted to the components (R3, R4, VR2 and C2), we can calculate that the clock runs at a frequency of between 7Hz and 14Hz, depending on the setting of preset VR2. This allows the players to adjust the skill level of the game.

These frequencies are modified by the action of the other timer in IC1 (Timer 1). The values of R1, R2, VR1 and C1 show that the frequency of this clock can range between 0·74Hz and 0·37Hz.

CONTROLLING TIME

To understand how one timer can influence another we need to look more closely at the connections. In Fig.1 there is a connection between the positive plate of capacitor C1 and pin 11 of IC1. Pin 11 is the control voltage (CV) input of Timer 2.

In the more familiar single 7555 timer, the control voltage input is at pin 5, and we normally ignore it. Either we connect a low-value capacitor between it and the 0V line, or we simply leave it unconnected. In this circuit, it is doing something useful just for a change.

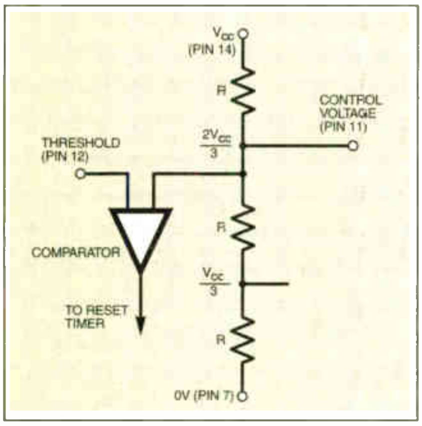


Fig.2. Part of the internal circuit of the timer.

Part of the internal circuit of the 7556 timer is shown in Fig.2. This is the part that is concerned with detecting when the voltage across the timing capacitor has reached two-thirds of the supply voltage (Vcc, or +VE). The resistor chain has three equal value resistors and, since they are all manufactured on the same chip, these are very closely matched. This explains why the timer i.c. has such good accuracy.

A comparator detects when the threshold voltage (the voltage across the capacitor) has risen to be exactly equal to two-thirds of the supply. At this point, the comparator changes state and resets the timer. Its output goes low.

The circuit in Fig.2 shows why it is unnecessary to connect anything to the timer control voltage input when using the timer in the normal way. In the absence of any connection, that point on the resistor chain sits at two-thirds of Vcc.

However, if an external voltage is connected to the resistor chain through the control voltage input, it is possible to pull the voltage at that point higher or lower than two-thirds of supply. The comparator will then reset the timer when the capacitor charge reaches a voltage other than two-thirds of the supply voltage. It resets earlier or later than usual.

If the timer is running as an astable, as in this circuit, the effect is to alter its frequency.

In this circuit, the source of the control voltage is the voltage across the capacitor of Timer 1. This is a sawtooth waveform, frequency around 0·6Hz, ramping up from one-third of the 6V supply (2V) to two-thirds of the supply (4V) as the capacitor charges, and falling sharply back to one-third of the supply in each cycle as the capacitor is discharged.

This is a good example of frequency modulation. The counter is being driven by a square-wave oscillator at around 10Hz, which is frequency modulated by a 0·6Hz sawtooth. The depth of modulation is fairly high, producing a noticeable effect on the frequency applied to the counter. In terms of the horse, its rate of approach to the fence is tantalizingly erratic. It is not actually unpredictable, but a player needs to get the feel of the timing to be successful in jumping the fence.

JUMP CIRCUIT

The "clear jump" l.e.d. (D8) is switched by transistor TR1, which is fed from the output of a set-reset flip-flop. This is built from two NAND gates, IC4b and IC4c, and is triggered by a low input pulse at pin 9, supplied by NAND gate IC4a. It is reset by a low pulse to the other input, pin 6, produced by pressing Reset switch S2.

The flip-flop can be set only if both inputs of IC4a are high at exactly the same time, one supplied by counter IC2 from output Q6, the other generated by the player through IC3b. With the clock running at (say) 10Hz, each output of IC2 is high for 0·05s. The player has to produce a trigger pulse to occur within that period when only output Q6 is high.

COMPONENTS

See SHOP TALK page

Resistors

R1	100k
R2	47k
R3, R7, R8	10k (3 off)
R4, R10	220Ω (2 off)
R5	330Ω
R6	1k
R9	4k7

All 0·25W 5% carbon film or better.

Potentiometers

VR1	100k min. preset, horiz.
VR2	4k7 min. preset, horiz.

Capacitors

C1, C2	10µ radial elect. 10V (2 off)
C3	10µ axial elect. 10V
C4	10n polyester

Semiconductors

D1 to D6, D8	5mm l.e.d., red (7 off)
D7	5mm l.e.d., green
IC1	7556 CMOS dual timer
IC2	74HC4017 CMOS decade counter
IC3	4001 CMOS quad 2-input NOR gate
IC4	4011 CMOS quad 2-input NAND gate
TR1	BC548 *npn* transistor

Miscellaneous

S1, S2	min. push-to-make switch (2 off, black, white)

Stripboard, 29 strips x 39 holes; 6V battery and connector clip; 1mm terminal pins (2 off); 14-pin d.i.l. socket (3 off), 16-pin d.i.l. socket; connecting wire; solder, etc.

Approx. Cost Guidance Only **£10**

World Radio History

The trigger pulse is generated by the two NOR gates IC3a and IC3b, connected to produce a high output pulse on a falling edge occurring at input pin 2. In other words, the pulse is generated when the player *releases* pushbutton switch S1. Note that it is not possible for the player to cheat by pressing and holding the switch while the horse canters up to the fence.

The pulse is generated when the switch is first released. It lasts a little less than one time constant, or 10µs, as determined by the time constant set by R6 and C4. If the switch is released an instant too soon, the pulse is finished before the Q6 output from IC2 goes high. Thus, it is essential to release the switch within the 0·05s that the output is high.

The circuit should be powered by a 6V battery (do not use any other supply voltage).

CONSTRUCTION

The Steeplechase Game is constructed on a piece of stripboard, 39 holes wide by 29 holes (strips) down. The layout details are shown in Fig.3. Dual-in-line (d.i.l.) sockets should be used for all i.c.s. Note that some resistors are mounted vertically.

There are a lot of wire links on the board, preferably use sleeving on them to prevent accidental short circuits between them. Note that two links have one end beneath VR1 and VR2. Ensure that the i.c.s., l.e.d.s and electrolytic capacitors are inserted the correct way round. Also ensure that all the required track cuts are made in the correct positions.

Begin construction with IC3 and IC4. Note that only two of the four gates of IC3 are used, and only three of the four gates of IC4. In the layout shown, the inputs to unused gates are connected to 0V or +6V. When assembling this part of the circuit, solder in the lead connecting IC4 to IC2. This is the wire link from N21 to S21 in Fig.3. Solder the end at S21 but leave the other end free.

To test this section of the circuit, connect the free end of the link to 0V. Pressing S1 should have no effect, l.e.d. D8 remaining unlit. Then connect the wire link to +6V. Now, pressing S1 should cause D8 to light, and then pressing S2 turns it off.

If this part does not work correctly, check all the connecting wires and also check that the copper strips have been cut at the correct points.

Next install the socket for IC2, l.e.d.s D1 to D7 and resistor R5, but do not put IC2 in its socket yet. Check the wiring by connecting the terminal pin at F1 to +6V. Take a flying lead connected to 0V and touch it against the individual pin sockets in the socket for IC2. The l.e.d.s should come on one at a time as the appropriate pin is grounded (see Fig.1 to check which l.e.d. should light.)

Finally, assemble the timing circuits based on IC1. Again, check very carefully that you have cut the copper strips at the correct points. Insert IC1 and IC2.

When the circuit is complete, test the effects of altering the setting of VR1 and VR2. The overall speed of the horse is controlled by VR2. The amount by which its speed varies is controlled by VR1.

May the best horse win! ☐

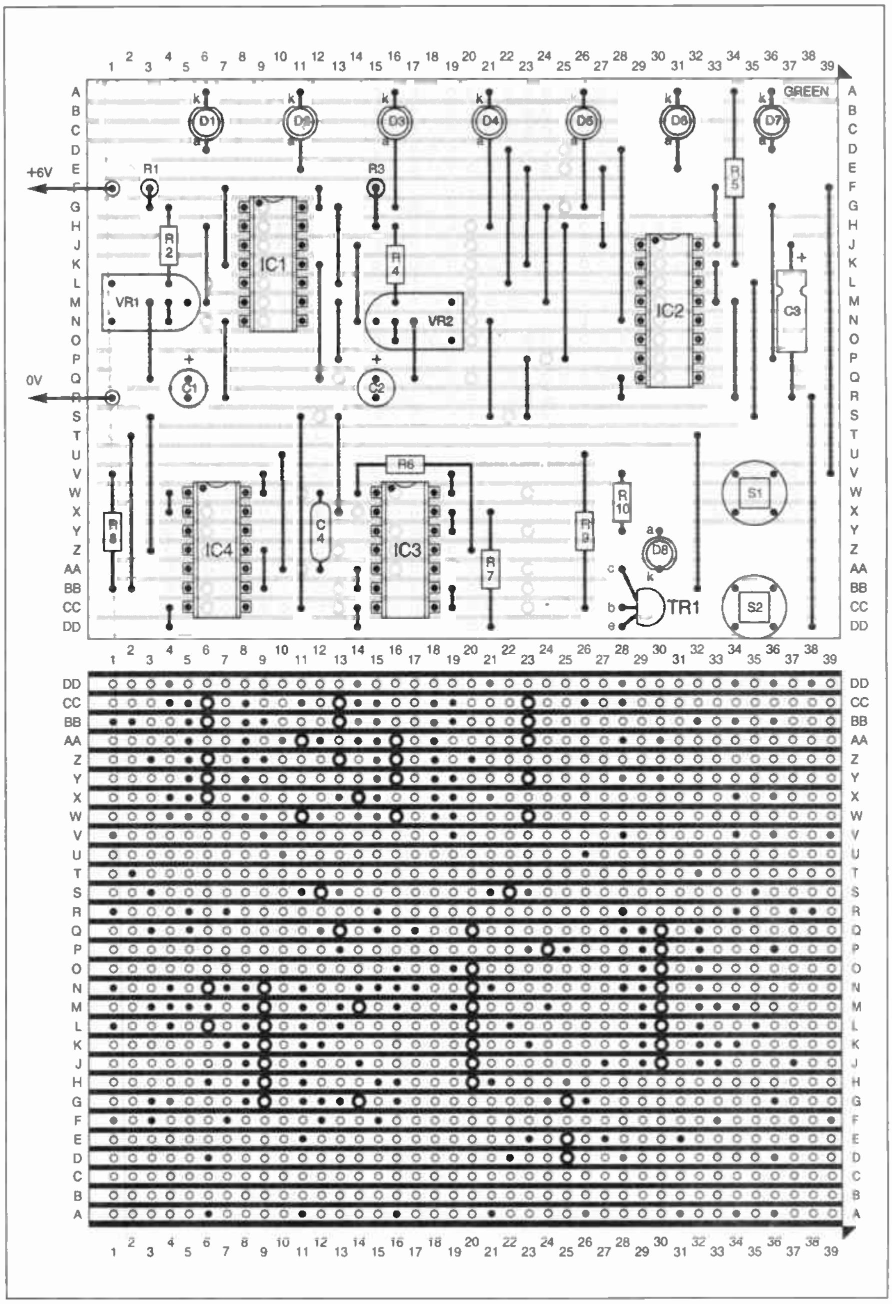


Fig.3. Steeplechase Game stripboard component layout and details of breaks required in the underside copper tracks. Note the wire links under the two presets (VR1, VR2).

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

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

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

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World Radio History

News . . .

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

CAN E-MAILS CARRY VIRUSES?

Following on from recent headline-hitting virus attacks, Barry Fox asks an all-important question.

Now that most people and companies (except some PR folk!) are waking up to the risks of sending binary files as E-mail attachments, the question most commonly asked is – can a virus hide inside an E-mail sent as plain ASCII text, or in the rich text format that wordprocessors like Word provide as a save option.

Graham Cluley of anti-virus company Sophos has tried to clear the air for us. At the same time he makes positive suggestions and warnings.

Text and RTF Safe

Plain ASCII text is 100 per cent safe; but if someone sends an HTML Web page written in plain text, and the PC uses an Internet Browser to view it, this could let Active X (the Microsoft system which allows programs to run inside Web pages) release a hidden virus.

This can happen if the file is deliberately re-named. The original version of Microsoft Outlook allowed this to happen automatically, it saw HTML and took over to display it as a Web page. Viruses Bubble Boy and Cakworm work this way. A free software patch for Outlook can be downloaded from the Microsoft site to prevent this. But the PC owner must be literate and be able to handle download upgrades.

In its present form Outlook does not automatically open attachments. "That's why any system of active E-mail would be horrendous", says Cluley.

RTF in native form is safe too, because it is plain text with a little fancy formatting. It does not support macros. But there is now a sneaky new virus, called Cap, which waits until you try and save a Word document as RTF, silently intrudes to save it as a virus-infected Word file, and sticks the letters RTF at the end so that it looks safe to open. Because Windows treats a Word file as a Word file, whatever the letters on the end, the virus springs to life when the file opens.

Advice to Microsoft

Cluley says Microsoft should change Windows so that it checks the file extension against the embedded file identifier, and only open a file if the extension and identifier match. Currently Windows ignores file extensions and relies on the embedded identifier. "If they don't match" says Cluley "this should tell Windows there is something wrong".

Cluley says Windows should also stop hiding file extensions which helps virus writers get away with double extensions, like **File.jpg.exe**.

Windows should also give the option to disable all Macros, in a way that does not let viruses turn the option back on.

Outlook should by default send only ASCII – currently it may reply in HTML if it receives HTML.

Cluley suggests that as a temporary safeguard users can remove the Windows Scripting Host from Windows and disable Active X. This will stop VBS batch files running and will probably make no difference whatsoever to normal operation of the computer. But the user has to know how to burrow around inside the Windows Settings Panel to Add/Remove programs, and alter the Security Settings inside Internet Explorer.

The Internet should be getting easier and safer to use, not more risky and complicated.

The simple solution, says Cluley, is for Microsoft to sell Windows in a default state that is safe from viruses, and then let users to change risky settings if they know how and dare.

WAP Phone Viruses

Interestingly, Cluley believes that risk of WAP cellphone viruses has been greatly over-exaggerated. The Spanish virus Timofonica connected to a Web site, which then E-mailed short SMS messages to random phone numbers. So it only caused irritation. A side effect of the PC LoveBug virus was to make a PC send some of its code to any SMS address in the Outlook address book. But it could not spread itself that way because current cellphones do not have the processing power or memory capacity to harbour viruses. There have been no viruses yet for Windows Pocket CE and Palm devices, which do not support Macros.

"Virus writers want to infect the world", says Cluley. "They will not waste time infecting devices that cannot spread infection". But this may change as higher speed mobile devices work hand in hand with PCs.

Terrestrial digital broadcaster On Digital will soon provide Internet connection via an add-one module and phone line. Will this leave digital receivers open to infection that, for instance, re-flashes their operating system chips?

"It all depends on the kind of digital signature they use" says Cluley. "The box must ignore any update that arrives without the correct digital signature; it could be PGP or Verisign, with private and public key. But the general rule is simple – the more bits the better."

TOOLS SITE

SHESTO Ltd, specialist suppliers of tools and equipment for technicians and craftsmen, have opened their web-site. They describe it as "an ideal way to locate hard-to-find and innovative tools".

Over 900 products can be viewed and selected via this "easy to use and navigate" web site. It also features the latest news on exhibitions and events of interest to model makers, electronics, hobby and DIY enthusiasts.

Each month special offers will be available at very advantageous prices, as well as features on interesting new products that have come on the market. The site uses the latest web security systems so you can order on-line with complete confidence.

The site is at **www.shesto.com**. Other contacts with Shesto Ltd can be made with them at Unit 2, Sapcote Trading Centre, 374 High Road, Willesden, London NW10 2DH. Tel: 020 8451 6188. Fax: 020 8451 5450. E-mail: sales@shesto.co.uk.

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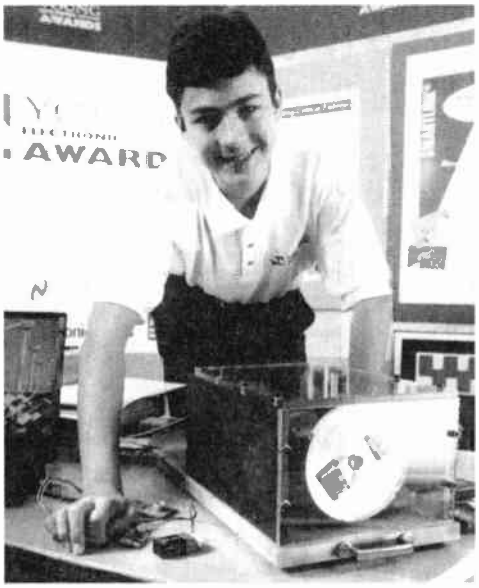
YEDA 2000



THE 2000 Young Electronic Designer Awards ceremony took place in London on 6 July. HRH The Duke of York presented the awards at the Millennium Dome during a celebration dinner attended by 200 guests including parents, teachers, local dignitaries and members of the business community.

The Awards, now in their 15th year, recognise the creativity and initiative of young people using modern technology. They are open to students between the ages of 12 to 25 in secondary schools, colleges and universities. The competition challenges young designers to invent and produce a novel electronic device that meets an everyday need.

The overall objective is for contestants to have fun putting their ideas into practice and in so doing to discover the exciting opportunities which a career in the electronics, communications and IT industries can offer.

Awards were made in three categories, The Duke of York's Award for the most imaginative concept, a prize for the most commercially viable project and the IEE Award to the best new entrant to YEDA. There were also three special prizes, one each for the Senior, Intermediate and Junior categories.

The Duke of York's Award went to Martin Rosinski (pictured above) of Ponteland Community High School, Ponteland, Newcastle upon Tyne. Martin, 15 years old, invented *Smartlink*, the world's smallest data logger developed for stress measurement in difficult industrial applications where existing systems cannot be used. His efforts were rewarded with a magnificent crystal trophy, which he can keep for a year, a special certificate signed by the Duke, £1000 and an IBM Thinkpad, courtesy of IBM.

Information on the other award winners, and details of the annual Awards scheme, can be obtained from The YEDA Trust, 60 Lower Street, Pulborough, W. Sussex RH20 2BW. Tel: 01798 875559. Fax: 01798 873550. E-mail: yeda@cix.co.uk.

PICO CATALOGUE

PICO Technology's latest catalogue has been received. Renowned for the excellence and variety of their PC-based Test and Measurement equipment, Pico's catalogue is well worth obtaining if you are looking to upgrade your workshop facilities.

The PC-based equipment ranges include oscilloscopes, spectrum analysers and meters, data acquisition, temperature and humidity, environment monitoring, and signal conditioning. A range of related accessories is offered as well.

Pico, of course, will also be well known to you for their kind sponsorship of our *Ingenuity Unlimited* pages. To find out how you too could be a winner of a Pico PC-based scope, see this month's *IU* pages.

This latest catalogue includes three new product ranges, a high resolution version of the ADC-11, an EnviroMon logger with rechargeable battery pack and a vast memory, and the DrDAQ data logger with built in sensors for light, sound and temperature.

For more product information contact Pico Technology Ltd., Dept EPE, The Mill House, Cambridge Street, St Neots PE19 1QB. Tel: 01480 396395. Fax: 01480 396296. E-mail: post@picotech.com. Web: www.picotech.com.

Mobiles and Masts

THE National Radiological Protection Board (NRPB) has published a report on exposure to radio waves near to mobile phone base stations (a matter which is frequently in the news and the subject of public controversy).

The NRPB made measurements at mast sites in the vicinity of where people lived, worked or had frequent access. In all cases the total exposures were a small fraction of national and international guidelines. Typical average exposures were 0·002 per cent of the guidelines. The measurements were frequently comparable to those from TV, FM radio and other transmitters. See web sites www.nrpb.org.uk and www.iegmp.org.uk.

Oldham RAE Course

OLDHAM Amateur Radio Club tell us that they will be starting a new RAE course, beginning on 17 September 2000, The course runs until May 2001, ready for the examination. Enrolment commences on 12 September at 8pm at the Moorside Conservative Club, Ripponden Road, Moorside, Oldham.

The Club is a registered City & Guilds Examination Centre, able to host the RAE and Novice exams, and welcomes external candidates.

For more details contact the Oldham Amateur Radio Club, 196 Middleton Road, Hopwood, Heywood OL10 2LH. Alternatively, telephone/fax the Club Secretary, Mike Crossley (M1CVL), on 01706 367454. Mention *EPE* when responding.

Organ Society

NEWISH readers of *EPE* who do not yet know that the Electronic Organ Constructors Society exists and would like to become involved in such a society, are invited to contact Peter Cox, the EOCS Membership Secretary, 10 Victoria Street, Reading, Berks RG1 4NQ for more details. Tel: 0118 957 3865.

The Society has been in existence for several decades, holding periodic meetings in the London, South Essex and South Coast regions, although anyone from any part of the world can join. The *Electronic Organ Magazine* is the quarterly journal of the EOCS and includes articles from members (and others). The latest issue has recently been received at *EPE* HQ, and as usual covers a diverse range of subjects including constructional features, letters, details of Society meetings and other pertinent matters.

It is interesting to note that an EOCS web site is being constructed (but not yet accessible) and one of its features will be a discussion forum of the type provided by ourselves. News about the EOCS site progress can be accessed through EOCS member Martin Bates' site, **www.batesuk.freeserve.co.uk**. Martin says to "then click on the supermarket trolley, then the Wersi logo".

Summery Greenweld!

"SUMMER'S here at last", proclaims Greenweld's Summer 2000 catalogue. Well, maybe as the *named* seasons go, but weather-wise – what do you think? Anyway, irrespective of meteorology (but Greenweld say that at least *they* are "full of sunshine"), here's a *summery* of what's in their cat:

Tools galore, multimeters (one under a tenner), new hot melt guns and Antex soldering irons, photographic films and equipment, electronic components including digital i.c.s, audio/visual gear, motors, project and computer books, and more (including "surplus")!

To get your copy of this 32-page bumper value cat, contact Greenweld Ltd (Dept EPE), PO Box 144, Hoddesdon EN11 0ZG. Tel: 01277 811042. Fax: 01277 812419. E-mail: service@greenweld.co.uk.

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READOUT

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

WIN A DIGITAL MULTIMETER

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

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

★ LETTER OF THE MONTH ★

BETTER BIN-DEC CONVERSION

Dear EPE,

I see you have been using your old binary to decimal routine again, this time in *PIC-Gen* (July '00). I *hate* it, please accept mine. It is neat and fast and 24-bit but easily modified to 16 or 32-bit. Execution time is constant and so can be used where timing is critical. I hope that some readers will make use of it, I do like to see good programming techniques.

I got the idea from the way some processors execute a decimal adjust instruction in hardware, so did a bit of simple arithmetic and some lateral thinking. The version I sent you is my generic one, no real need for the subroutines unless they are called from elsewhere. In the 16-bit version I expanded the two inner loops, the resulting code is hardly any bigger, executes faster, uses only one loop counter and does not use the FSR. Great for the smaller PICs.

Peter Hemsley, via the Net

To go back in time for a moment, in my PIC-Agoras *bike computer (April '97, and which I still use), numerous calls to multiplication and division routines were required. The PIC16x84, as used in that design, does not have division or multiplication commands (nor does the PIC16F87x family) and I wrote special routines for these functions.*

Being short of program space, the binary-to-decimal conversion was performed by the same division routine. Since then, a modified "library" version has been used in all my PIC programs needing it for bin-dec conversion to suit l.c.d. readout.

I tried Peter's bin-dec routine and was impressed, it works beautifully. Thank you Peter. This is the listing:

```
BINDEC:   CALL CLRDIG
          MOVLW 24
          MOVWF COUNTER1
          GOTO SHIFT1
ADJBCD:   MOVLW DIGIT1
          MOVWF FSR
          MOVLW 7
          MOVWF COUNTER2
          MOVLW 3
ADJLOOP:  ADDWF INDF,F
          BTFSS INDF,3
          SUBWF INDF,F
          INCF FSR,F
          DECFSZ COUNTER2,F
          GOTO ADJLOOP
SHIFT1:   CALL SLCNT
SLDEC:    MOVLW DIGIT1
          MOVWF FSR
          MOVLW 8
          MOVWF COUNTER2
SLDLOOP:
          RLF INDF,F
          BTFSC INDF,4
          BSF STATUS,C
          BCF INDF,4
          INCF FSR,F
          DECFSZ COUNTER2,F
          GOTO SLDLOOP
          DECFSZ COUNTER1,F
          GOTO ADJBCD
          RETURN
SLCNT:    RLF COUNT0,F
          RLF COUNT1,F
          RLF COUNT2,F
          RETURN
CLRDIG:   CLRF DIGIT1
          CLRF DIGIT2
          CLRF DIGIT3
          CLRF DIGIT4
          CLRF DIGIT5
          CLRF DIGIT6
          CLRF DIGIT7
          CLRF DIGIT8
          RETURN
```

Peter's routine will have its first EPE *outing with my forthcoming* PIC Monitored Power Supply *(Nov or Dec '00), in which Peter's "remmed" comments will also be listed.*

Note that on entry, variables COUNT0-2 already hold the number to be decimalised and the answer goes into variables DIGIT1-8. When outputting the conversion data to an l.c.d., the decimal values held in the eight DIGIT variables must be IORed with decimal 48 to convert them to ASCII. In my Power Supply *software an additional routine blanks leading zeros as appropriate.*

SPAM!

Dear EPE,

I hesitate to suggest that Alan Winstanley could ever stand correction, but possibly not for long enough. I have always understood that SPAM (see *Network* July '00) is a contraction of SPiced hAM. I was told this in the forties, and have heard it repeated over the years.

In the early seventies I was given some tins of Chinese made pork luncheon meat by a friend who had done some work for a Chinese supermarket. The taste took me straight back to the original Spam, and it did the same for him.

Michael Elphick, via the Net

Alan dropped below warp speed for half a mo and replied:

As things turn out, you are indeed correct. I eventually found a manufacturer's reference to the product, which originally started life as Hormel's Spiced Ham. Production started in 1937. Apparently a competition was held with customers to find a new name, and the winner was *Spam*. Thanks for pointing out the mistake.

Alan Winstanley

I too recall Spam gracing my childhood plate, usually fried in butter. Half a memory also tells me there was a TV program some moons ago which featured a conglomerate of Spam addicts who had formed a club to celebrate its virtues! And who can forget the infamous Monty Python *sketch?*

XLR SOLDERING

Dear EPE,

I work for Doyle Technology Consultants in Redmond, Washington, USA and I'm putting together a training manual for our new employees on connector soldering techniques and would like any information you could send my way on where I could find clear photos or drawings of soldering techniques on XLR and RCA and TRS connectors.

Bradley J. Luther, via the Net

The query was sent to our On-line Editor, Alan, who replied:

I really don't know of anywhere at the moment. This is similar to something I've been asked for in the past and is something I could maybe attempt to photograph in the future.

Techs often develop their own technique so I'm not sure there is a totally right way of soldering connectors. I need to do some research in this respect to get a consensus.

However, I anticipated photographing the soldering of D-type connects etc. using a reflow soldering technique. (Also, jack plugs, RCA/phono plugs and so on.)

My biggest concern is that my own preferred way of soldering these items may not be seen as the preferred way by others, but hopefully there will be enough common ground to produce a definitive resource. It would also be handy if someone like Cannon gave me some expensive XLRs to play with!

You may be interested to know that I have recently released my first CD-ROM of 200+ colour photos of electronic components which can be used as an educational/training resource. The images are royalty-free for printed projects.

More on my home page at **http://homepages.tcp.co.uk/~alanwin**.

Alan Winstanley

ICEBREAKER DISPLAY

Dear EPE,

I recently purchased the kit for Mark Stuart's *ICEbreaker* (Mar '00). It is an excellent way to get started with PICs. However, the example program sent with it to introduce the l.c.d. module has thrown up a slight problem.

I have found that the R/W pin on the l.c.d. needs to be held low whilst writing to the module otherwise spurious errors occur with the display, garbage being written to the screen. I corrected this by hardwiring the R/W pin to 0V – obviously it would be better to code it in – and this corrected the problem.

David Perks, Head of Electronics,
Graveney School, London, via the Net

We forwarded David's query to Mark Stuart, who replied:

Have you fitted R1? It is a pull-down resistor for the display R/W line and is shown in Fig.4. It is underneath the l.c.d. I think it will solve your problem. It is necessary to pull down this pin – but unless you need to read from the display memory there is no need to have it connected to a port pin.

Mark Stuart

World Radio History

QBASIC AND MICROSOFT

Dear EPE,

I would like to say that, in my opinion, QBasic is probably the best choice for electronic projects. Its ease of use, wide availability and backward compatibility, make it my first choice for most programming problems. It can be run on very old computers, and I find this very useful because I use an 80386 for electronic work.

I suggest that while QBasic does what you want, use it. If some more advanced features are required, then another language would have to be used, but this would put projects out of the range of some readers who do not want to, or cannot (as is my case) upgrade. Getting new commercial software can cost a lot of money, and can put development and adaptation of code out of reach. If you must change language, at least use one that is free!

Another point is that in QuickBASIC, not QBasic, you can compile the files into standalone executables, then if the target people do not have QBasic, they can run the software anyway. My point is, we should stick with QBasic for now, and until such time as we can see what is going to happen, or not, it is probably the best language.

It is also worth asking: if Microsoft is broken up, what will happen about their software? Will it be continued under other names, or will just some of it be sold off and Microsoft continue to exist in a smaller form? Please enlighten me!

Will we still be able to find a "standard" operating system? As well as my MS-DOS system, I have another 80386 running Linux perfectly happily. There are many other flavours of UNIX and Linux, and this could cause compatibility problems if Microsoft goes under.

Another point about Microsoft software is that it is becoming too "helpful". If a new version of Visual Basic does come about, will it try to format the screen, or put in bits and pieces the way it wants, just like Word 2000? I find this the most annoying feature of Microsoft: it thinks it knows what you want to do, and then treats you like an idiot. It defeats its own object. If the idea of it is to help a new user, which I think it is, it makes things even more complicated.

I have been reading *EPE* for four years now, and have loved every issue. It has been, and still will be, the best place from which to learn electronics. Incidentally, I could not find an E-mail address for *Readout*, so I sent this letter to Editorial. Some guide would have been nice (not meant nastily!).

Ian Liverton (16),
Sidcup, Kent, via the Net

Thank you for contributing to the QB debate. Regarding Microsoft, it is concerning how its breakup might affect standardisation. I have welcomed what the company appears to have done to standardise so much in the way of software functionality. When I first began program writing in the late '70s, there were many systems vying for acceptance and none that I swapped between during the next few years were compatible with each other. Names like Commodore, Apple, Sinclair, Tangerine, Dragon, Amstrad and so on come to mind.

I do not know the ins and outs of the legal arguments or why in this instance the existence of a large organisation and its alleged monopoly status should be regarded as contrary to public interest, yet in other instances it should not. Why for example, should Cisco Systems be exempt from criticism? If I understand their TV ads correctly they carry the majority of the World's Internet traffic – is that not a near-monopolistic situation?

Like Ian, I too would like enlightenment. Knowledgeable readers are invited to comment.

On Ian's final point, Readout does not have a separate E-mail address, just write to ***editorial@epemag.wimborne.co.uk****. Any correspondence that comes in via E-mail or snail-mail is considered for* Readout *suitability.*

MORE QBASIC FOUND

Dear EPE,

As requested in *Readout* pages – this is just to confirm that I have found QBasic on the Windows 98 second edition CD. I've done a file compare with the version that came with Windows 3.1 and they're identical. The trouble is that it's in a folder called **D:\Tools\oldmsdos**. The **oldmsdos** bit worries me because I've been told that DOS disappears entirely with Win2000 so although everybody may have it now, that may not be true next year (month? week?). Note that the **oldmsdos** folder also has the old **fc.exe** which I used to compare.

Roger Warrington, via the Net

Thanks Roger, and to all others who have kindly told us that QBasic is on their Windows 95/98 CDs. Would anyone with Win2000 care to comment on QBasic's availability with that?

APPRECIATION

Dear EPE,

Can I through your *Readout* column, express my appreciation of the many contributions made by Messrs R.A. Penfold and Robert Penfold to your magazine.

I am a radio man myself, and have built every set in the three paperbacks that R. A. Penfold produced from the 1976 edition to the January 1991 edition. I ran out of space to house these many years ago. Every one of them lacks one attribute, however, that of frequency readout. I have tried numerous suggestions for this but without success.

Can I through your good offices ask that these two knowledgeable gentlemen produce a program and simple interface which I can attach to my radios that will show on my computer ('486 running Windows 95) screen where I am in the spectrum up to 30MHz. This would make my day.

Peter McBeath,
Morpeth, Northumberland

In fact, Robert and R. A. Penfold are one and the same, although with so many designs, articles and books to his credit, anyone could be forgiven for wondering how just one person could be so prolific. My own familiarity with Robert's work must date back to at least the early '70s. Over the years he has taught many electronics enthusiasts about how to get the best out of their hobby and we greatly respect his abilities and knowledge.

We are pleased to know that Robert's designs have inspired you as well, and have passed your letter to him.

LAPTOP AND TEACH-IN

Dear EPE,

I've been trying to test the parallel port on my laptop (Pentium II) running Windows 98 and I do not get any responses from the parallel port when testing it with *Teach-In 2000's* Parallel Port Data Display/Set routine.

I've built the interface and checked it thoroughly and the outputs stay at 0V regardless of what I select from the state shown on the Output Byte box on the computer screen. I have tried all three addresses for the printer port all unsuccessful. I checked the *Readout* column on some issues of *EPE* to see if anyone had encountered this problem but could not find any. Any help would be appreciated.

Alejandro Fubini, via the Net

I suggested to Alejandro that he should read Panel 9.5 of Teach-In Part 9, *July '00, asking him to let me know the outcome.*

He responded:

Thanks for your help, I can now get on with continuing the *Tutorial*, which is the best refresher I've had since completing my electronics engineering degree six years ago. It's amazing what you forget in that timespan.

WEB DATA SHEETS

Dear EPE,

Following your information in *Readout* May '00, I have in vain tried to access data sheets for Harris Semiconductors HA12017 and also the SSM2166P used in your *Versatile Mic/Audio Preamplifier* (May '00).

Please advise how it is possible to access a site with data sheets that I can print off as appropriate to the specific chip concerned.

Roger Nightingale, via the Net

Our webmaster Alan received this query, and gave Roger the following reply:

Links are stored on our *Net Work A-Z* web page, which also has a Google search engine. Entering "Harris Semiconductor" into the Google search engine (see *Net Work* May '00) brought up their address instantly (**www.semi.harris.com**). It says that Harris Semiconductor was taken over by Intersil. You could try searching **www.intersil.com** which is where Harris's web site will now send you.

Similarly, by typing "Analog Devices" into the Google search engine, the URL is immediately revealed (**www.analog.com**). Save any Adobe Acrobat PDF files by right-clicking over the file name, choose **Save Target As . . .** and save to your hard disk. If you haven't got it, you then need Adobe Acrobat Reader, which can be downloaded free from **www.adobe.com**.

Alan Winstanley

PIC F84 OR C84?

Dear EPE,

Keep up the wonderful work, especially with PICs. Could you tell me if the code for the *Multichannel Transmission System* (May/June '00) will fit/work on a PIC16C84 rather than the recommended PIC16F84, as I have a tube of 16C84s!

Gareth Evans, via the Net

In this instance the code will function just as well on either device.

As a reminder to you all, code written for a PIC16C84 will always work on a PIC16F84. In many cases the reverse is also true, but not always. The 'F84 has more registers and EEPROM capacity than the 'C84 which some authors (including myself) have sometimes taken advantage of. In such instances, only the 'F84 is suitable. Gareth was quite right to check with us.

KIND THANKS

Dear EPE,

Thank you for the prompt response and the accurate diagnosis of the cure for Error Number 76 when running *PIC Toolkit Mk2*. I have now created the **C:\ASMCNV** directory and my Toolkit Mk2 is assembling and disassembling code just fine.

I have been collecting *EPE* since June 1996 and would like to make use of this opportunity to thank you all for the many informative articles which you publish at regular intervals. The recent *Technology Timelines* series was great.

A special word of thanks for the free software that you give away for your PIC and other projects as well. Some of your competitors could take a leaf from your book.

Many thanks from darkest Africa.

Graham Jacobsen, Zambia, via the Net

We are glad to be of service! Best wishes from Historic Wimborne (at least 1000 years old – the location, not us personally!).

WRITEOUT

If you have something to say which might interest other readers and is loosely related to electronics, drop us a line, or send an e-mail or fax – addresses on the Editorial page.

World Radio History

New Technology Update

Micromagnetic techniques offer better circuit isolation for high speed data transfer.

Ian Poole reports

ISOLATING sections of circuitry can be a very important function in some applications. A variety of techniques and components can be used to achieve this. Which one is chosen depends on a variety of factors, and each technique has its own advantages and disadvantages.

With increasing demands for high speed data transmission, one of the major requirements of an isolator is to maintain a very high speed path. Speeds of many megabits per second are often required, and designers of these systems often find that the isolator limits the performance of the whole system.

As a result, companies are investigating new methods of providing cost-effective isolators. Typically these are integrated circuit solutions because they are able to provide the required speeds.

Opto-isolators

Opto-isolators have provided an ideal solution in many respects and many suitable devices have been available for some years. Being based around an l.e.d. and an optical detector (photo-detector) very high levels of isolation can be obtained, because there is no feedback from the output to the input, and the isolation depends upon the material that separates the l.e.d. and the detector. However, one of the drawbacks of these systems is that they may not have a sufficiently high bandwidth.

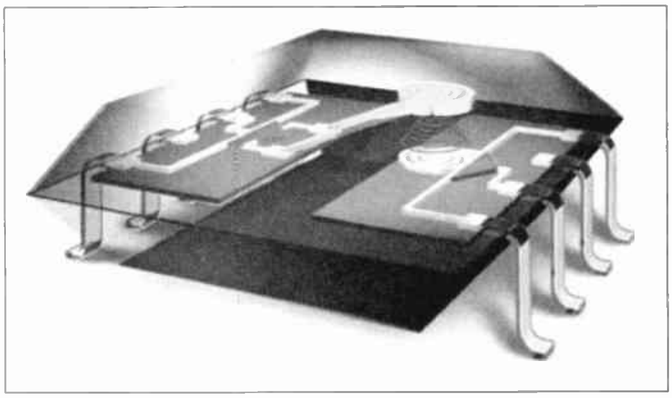
When a digital "one" is received by the opto-isolator's l.e.d., it emits light. This is received by the photo-detector that converts the incoming light into free electrons and holes, thereby allowing current to flow in the detector. However, when the l.e.d. is extinguished the photo-detector stops converting the light into electrons but it takes finite time for the charge to be dissipated. This is particularly so because the detector is generally operating into a relatively high impedance circuit and this slows down the rate at which data can be transferred.

Static Corruption

A further problem is that photo-detectors are particularly sensitive to electrostatic fields. Unfortunately, when driving large machines, these are often present. Often electrostatic transients appear and these manifest themselves as additional spikes on the output of the coupler. The resulting spikes can corrupt the data being transferred, providing an additional problem for the system designer.

Micromachined Magnetic Isolators

Another approach is to use a magnetic isolator. These are typically based around transformers and for digital solutions it is possible to integrate the driver and receiver circuitry together with the transformer onto the same die, making a very compact solution. The driver encodes the input signal into a suitable a.c. waveform that is fed into the transformer. This is very tightly coupled so that stray effects are minimised and the resilience to electrostatic and other transient effects is minimised. The output circuitry then receives the signal from the transformer and reconstructs it into the digital waveform required at the output.



MEMS devices offer circuit isloation using high speed magnetic techniques. (Illustration courtesy Analogue Devices)

As these magnetic digital isolators are fabricated using CMOS techniques they have short propagation delays coupled with high speeds of operation. In this way they are able to provide much higher data rates than their opto equivalents. Currently these devices are able to provide data rates of 100Mbps.

μmIntegration

A new process called μmIntegration has recently been announced by Analog Devices. This represents their latest approach to integrating MEMS (Microelectromechanical Systems) and semiconductor technology. It allows MEMS structures to be built on top of standard semiconductor wafers. By providing interconnections between the MEMS structure and the electronic device underneath they are able to provide very high-density circuits that incorporate both electronic and mechanical or electromechanical features.

The μmIsolation device consists of two CMOS die assembled into a common package. Wires then provide the connections to the coil on the output of the CMOS circuitry. This coil has a high Q and is fabricated on the top of the receiver die. A second coil is also fabricated with an insulating oxide layer between it and the first coil so that inductive coupling between the two coils enables the signals to be transmitted across the insulating layer. The circuitry connected to the second coil, again fabricated using CMOS technology, reconstitutes the signal in its original form.

The coil, insulation and circuitry are all contained within the same monolithic assembly. The design of the chip is such that there is sufficient isolation for operation up to 2500 volts r.m.s.

Advantages

The new μmIsolation integrated circuits offer many advantages to the electronics designer requiring high-speed data transmission over an isolated link. Not only is it possible to use a single chip to perform this function, but the fact that the coils are tightly coupled means that there are no cross talk and interference concerns. This aspect can be developed to allow several isolator channels to be incorporated within the same package, allowing a large number of data lines to be coupled. This provides further size and cost savings when it is compared to other opto-coupler implementations.

A further advantage is that because they do not require l.e.d.s, the magnetic solution consumes considerably less power. This can be of considerable importance in some applications.

Further Developments

The same basic technology has also been used to provide a solid state relay, the μmRelay, which provides another attractive option for some applications. Again cost, size and power consumption are lower than the mechanical counterparts, whilst reliability and performance are claimed to be better.

Further details about these devices can be found on the Analog Devices website at **www.analog.com/industry/umic/isolationtech.html**

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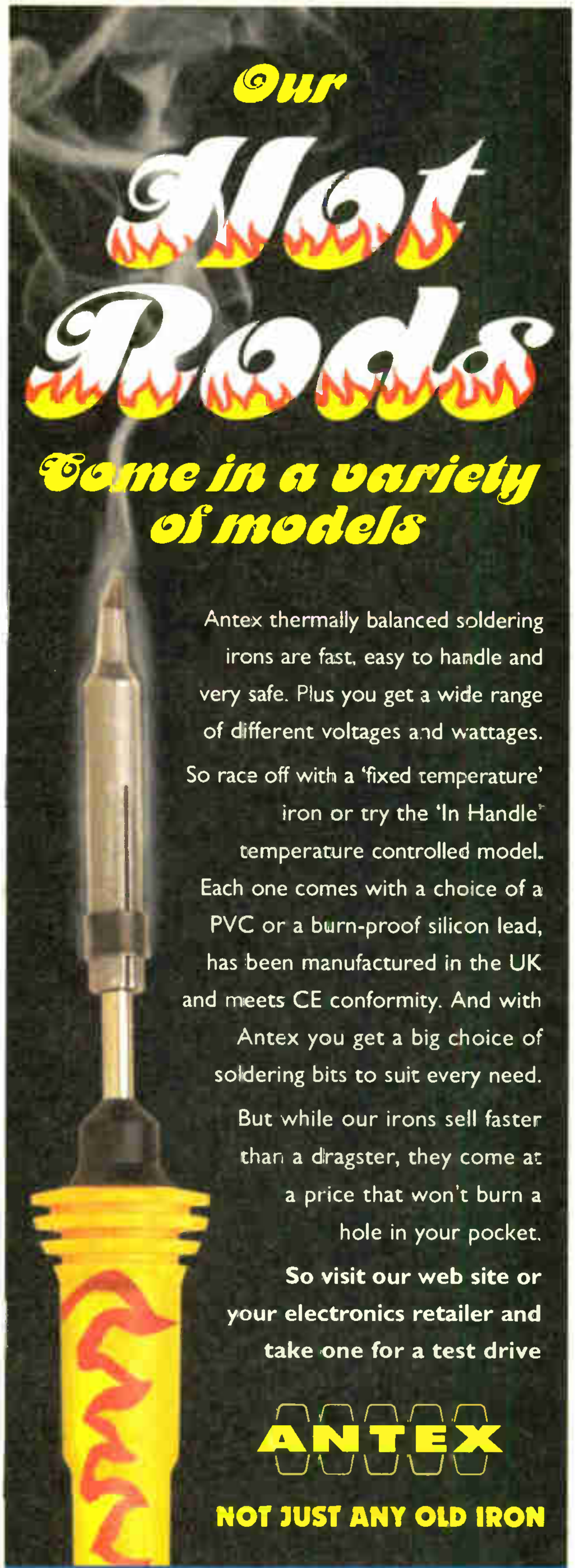

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World Radio History

EPE/ETI Tutorial Series

TEACH-IN 2000

Part Eleven – Voltage Regulation, Integration, Differentiation

JOHN BECKER

Transformers and rectifiers were the subject of the Tutorial in Part 10 last month, introducing you to the concept of safely obtaining power from the a.c. mains supply and converting it to a d.c. voltage suitable for use with electronic circuits. We illustrated the discussion with examples of the waveforms produced at various stages of the process, and how capacitors form an integral part of the final conversion to d.c.

We now take the subject a step further by discussing how d.c. voltages can be regulated so that they maintain a stable level even though the source voltage may fluctuate. We look, too, at how capacitor values can be optimised in order modify waveform shapes in this and other applications. We also describe a simple mains operated 5V d.c. power supply that you can safely assemble on your breadboard.

IN Part 10 we made the point that the voltage of the a.c. mains supply and that of a transformer's secondary windings can vary unpredictably, resulting in unstable rectified d.c. voltages. You will have also found that the voltage supplied by your (nominally) 6V battery has been progressively dropping since you started using it some months ago (you may even have had to buy a new one since then).

The answer you must be itching to know is how we ensure that d.c. supplies *do* maintain consistent voltage levels.

One answer lies in the use of *Zener* diodes, which were mentioned in Part 4. Let's examine them next.

ZENER DIODE

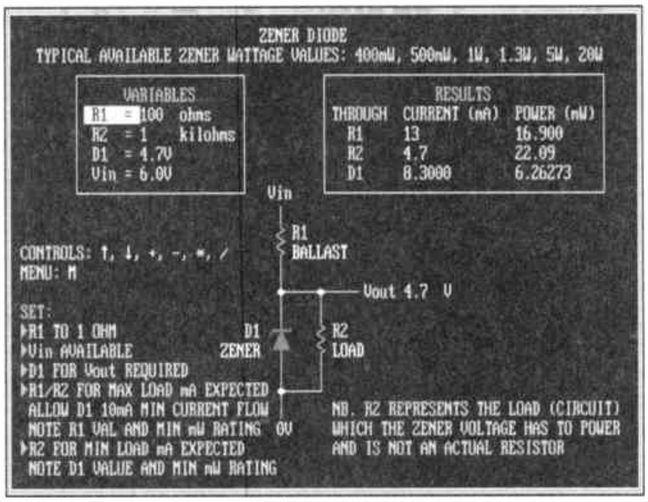
In Part 4 Panel 4.1 it is stated that all diodes have a maximum reverse breakdown voltage limit. In other words you normally only exceed that limit at the diode's peril.

The reverse breakdown voltage, however, is not always disastrous and there are ways in which it can be put to good use. Zener (or *reference*) diodes have their construction modified during manufacture so that the reverse current flow commences at a specific voltage.

Provided that the current flow is limited, this breakdown voltage can be used as a reference voltage. As such, a Zener diode can be used to restrict power supply voltages to a known maximum level.

As an aside, the term *Zener* really only applies to certain reference diodes which exhibit the so-called Zener effect (beyond our scope to define this here). It has become common usage, however, for any reference diode to be referred to as a Zener diode.

Commonly encountered circuit diagram symbols for Zener diodes were shown in Part 4 Fig.4.4. A symbol is also shown in the screen display accessible via the Zener Diode option of the main program menu. Select and run this option, and also see Photo 11.1.



```
                          ZENER DIODE
  TYPICAL AVAILABLE ZENER WATTAGE VALUES: 400mW, 500mW, 1W, 1.3W, 5W, 20W

         VARIABLES                          RESULTS
      R1  = 100  ohms             THROUGH  CURRENT (mA)  POWER (mW)
      R2  = 1    kilohms            R1     13            16.900
      D1  = 4.7V                    R2     4.7           22.09
      Vin = 6.0V                    D1     8.3000        6.26273
                           Vin

                            R1
 CONTROLS: ↑, ↓, +, -, *, /  BALLAST
 MENU: M
                                 Vout 4.7  V
 SET:
 ▸R1 TO 1 OHM            D1     R2
 ▸Vin AVAILABLE       ZENER     LOAD
 ▸D1 FOR Vout REQUIRED
 ▸R1/R2 FOR MAX LOAD mA EXPECTED
  ALLOW D1 10mA MIN CURRENT FLOW     NB. R2 REPRESENTS THE LOAD (CIRCUIT)
  NOTE R1 VAL AND MIN mW RATING  0V  WHICH THE ZENER VOLTAGE HAS TO POWER
 ▸R2 FOR MIN LOAD mA EXPECTED        AND IS NOT AN ACTUAL RESISTOR
  NOTE D1 VALUE AND MIN mW RATING
```

Photo 11.1. Interactive demo screen which illustrates voltage control using a Zener diode.

Reverse current flow through the Zener (D1) and to the load circuit (represented by R2) is normally limited by a ballast resistor (R1) in series between them and the power supply (Vin). The ballast resistor is not included in the Zener package, but needs to be connected as a separate item and having a value which depends on three factors:

- The *maximum* current that can be drawn by the load circuit it powers.

- The maximum current which is permitted to flow through the diode when the load circuit is drawing *least* current.

- A Zener diode requires a minimum current flow for the reverse voltage breakdown to occur at the correct voltage level.

The first factor depends entirely on the load circuit (R2), as we have discussed in previous parts. The other two factors are normally quoted in the Zener diode's data sheet, but also see later.

ZENER DIODE CHARACTERISTICS

Unlike "ordinary" diodes, Zener diodes are used in a circuit with their cathodes (k) *facing* the most positive voltage so that they only conduct when the supply voltage is above their stated reference value.

Zener diodes are commonly available having reference values from 2·4V to 75V, although for specialist applications diodes exist which provide much higher reference voltages. As with many other types of component, Zener voltage values have a tolerance factor, typically ±5%.

The current which a Zener diode can conduct in its "normal" (voltage limiting) direction is not usually quoted as such. Zeners are normally specified by wattage values which reflect the amount of power that the diode can safely dissipate. Typical values range from 400mW to 20W or more.

World Radio History

ZENER DIODE PROGRAM

To explore what happens with a typical Zener diode circuit, you can experiment by changing various values through the Zener demo program.

From the left-hand box you can change the values for R1, R2, D1 and the primary d.c. powering voltage (Vin), using the control keys stated on screen. The results produced by the different values you select are given in the right-hand box.

To use the program in a meaningful way, set the Vin voltage level available from a theoretical power supply and the value of D1 for the fixed (reference) voltage output required. The Zener values selectable are those normally available through major component suppliers, ranging from 2·4V to 10V. Note both voltage values.

With R1 at the minimum value that can be set (1Ω), i.e. as good as nil resistance, adjust the value for R2 (the load) until the right-hand box shows the estimated *maximum* current that will flow through it (more on this presently – choose an arbitrary value for the moment).

Next increase the value for R1 (ballast resistor) until the current flow through the Zener is at or just above 10mA. Make a note of the value for R1.

Now estimate the *minimum* current that is likely to flow through the load circuit. Adjust the value of R2 until this current is shown in the Results box. You will see that the current now estimated to flow through D1 will have increased.

From the Results box, read off the power that R1 and D1 are likely to consume when the load circuit of R2 is drawing the minimum current.

WATTAGE VALUES

As you discovered in Part 1, resistors are manufactured to handle specific maximum power values, e.g. 0·25W, 0·5W etc. Similarly with Zener diodes, whose typically available power ratings are stated near the top of the screen, e.g. 400mW, 500mW, 1W, etc. (but other values exist).

In a real life situation, from these available values you would select wattage values for R1 and D1 so that they can withstand the power that they are expected to handle. Choose power handling values that are well above the maximum at which the component is likely to be operated, at least 50%, and preferably more.

Be aware that if the load circuit consumes more current than allowed for by the resistance value of R1, the Vout value may drop below the Zener voltage and inadequate stability of the powered circuit may result.

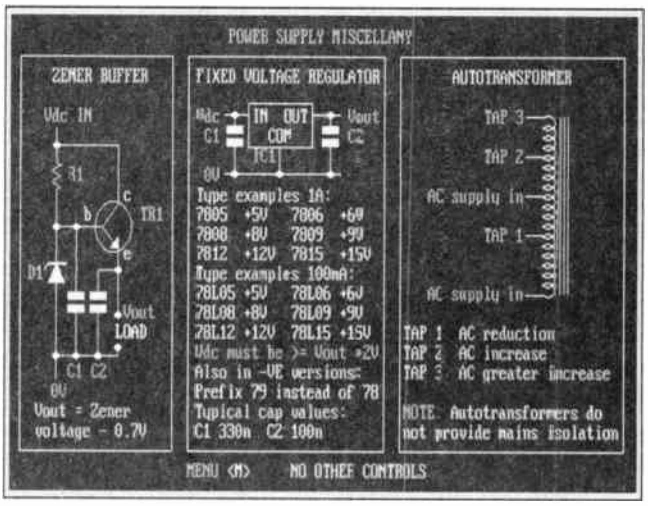
Note also that the example minimum current requirement through D1 may be higher or lower than 10mA in some Zener diodes – consult their data sheets for the recommended minimum current flow. Note that some Zener diodes are specifically manufactured to have a very low minimum current requirement.

OTHER VALUES

To establish the same value results without using the demo program, all the calculations can be done in simple stages using your knowledge of resistors in series (Part 1) and Ohm's Law (Part 3), tracing the steps we have just described.

Finding out likely minimum and maximum load currents is less straightforward. One way is to calculate them (not always easy – as we have said on previous occasions). Another is to first power the circuit from a variable power supply set to the required reference (Zener) voltage and to measure the currents.

However, it is not likely that you will normally need to use Zeners in circuits that draw particularly high currents, or currents that fluctuate significantly. There are better components (*voltage regulators*) to use in such circumstances.



```
Vout = Zener
voltage - 0.7V
```

```
Type examples 1A:
7805  +5V   7806  +6V
7808  +8V   7809  +9V
7812  +12V  7815  +15V
Type examples 100mA:
78L05 +5V   78L06 +6V
78L08 +8V   78L09 +9V
78L12 +12V  78L15 +15V
Vdc must be >= Vout +2V
Also in -VE versions:
Prefix 79 instead of 78
Typical cap values:
C1 330n  C2 100n
```

```
TAP 1  AC reduction
TAP 2  AC increase
TAP 3  AC greater increase

NOTE  Autotransformers do
not provide mains isolation
```

Photo 11.2. The power supply Miscellany screen. Autotransformers were described in Part 10.

Zeners are more likely to be used to set a fixed reference voltage to a low power circuit rather than to control high power.

The following section offers a midway option.

AMPLIFIED ZENER CURRENT

From much of the foregoing, it will be obvious that using a Zener is not necessarily too easy when the characteristics of the load circuit may not be fully known for any instant of time. The choice of ballast resistor and Zener wattage value can be critical in cases where higher currents are demanded by the load.

There is a simple way of improving the Zener control, by using a transistor to amplify the current available through the Zener's ballast resistor, and then to power the load circuit using that amplified current.

In Part 9 we demonstrated how a transistor could amplify current. That technique is used in the Zener buffer circuit shown at the left of Photo 11.2. Remember that the transistor connection letters of *c*, *b* and *e* are abbreviations for *collector*, *base* and *emitter*.

The Zener diode is chosen to have a reference value of 0·7V above the load's supply voltage required from the emitter of transistor TR1. This is to compensate for the 0·7V (or so, as discussed in Part 9) voltage drop between the (silicon) transistor's base and emitter.

The current which is required to flow through resistor R1 now only needs to be a fraction of that required by the load. In fact, it is typically chosen to be about the value of the load current divided by the gain of the transistor, allowing a bit of margin in case somewhat greater currents than anticipated are drawn by the load, and in case the gain is not necessarily known precisely (remember that there is a spread of values that it can be for any individual transistor). The minimum Zener current must also be taken into account.

Naturally, the transistor type (an *npn* device) must be chosen so that it can safely supply the current that is required by the load, and that it can handle the heat generated (its wattage value) when that current flows.

Note the use of capacitors C1 and C2 to smooth any slight fluctuations (caused by circuit noise, such as minor power line ripple, for example) in the supply to the base, and the supply taken by the load. Typical values are 100nF for C1 and between about 1μF and 22μF for C2.

Other values may be used if circumstances require greater smoothing. Be aware, though, that when power is first applied, C2 is fully discharged and thus the transistor initially sees a short circuit between the voltage on its collector and 0V at its emitter. This short circuit is only brief while the capacitor charges up to the full Zener controlled level, but for the first part of that charging the current might be greater than the transistor can safely handle. This will especially apply if C2 has a large value.

If C2 needs a large value, it can be prudent to insert a small value resistor between the full d.c. positive supply line (Vdc IN) and the collector, say a value of 10Ω, just enough to reduce the switch-on current flow through the transistor, but not so high as to significantly restrict current being supplied to the load.

ZENER AND OP.AMP BUFFER

A similar current buffering technique can be achieved using any normal op.amp, such as the LM358, or a type 741 (a single op.amp as opposed to a dual).

In Fig.11.1, the circuit is arranged so that the Zener regulated voltage is fed into the non-inverting input of the op.amp, which is connected in unity gain buffer mode (discussed in Part 7).

The op.amp thus outputs *the same voltage* as provided by the Zener, but with

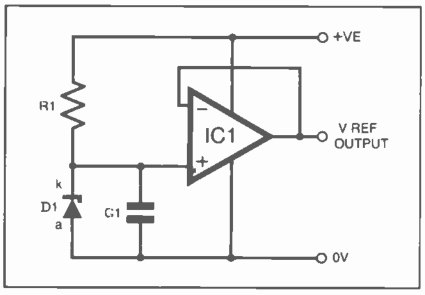


Fig.11.1. Zener and op.amp reference voltage buffer.

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much greater current available, although usually less than can be provided via a transistor. There is also the security of knowing that the op.amp is unlikely to die if too much current is drawn from it, unlike the transistor.

VOLTAGE REGULATORS

For situations where voltage regulation is required for the supply that powers one or more circuits, rather than just a sub-circuit, then a *voltage regulator* should used.

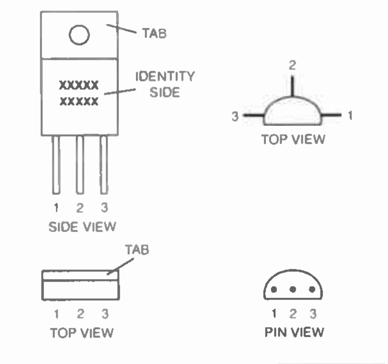
These are devices that contain circuitry which very accurately *regulates* their output voltage at a fixed level below the supply voltage being input to it. Various types offer output currents typically from about 100mA up to several amps.

Furthermore, within quite broad limits many types are practically indestructible. If more power is drawn from them than they are designed for, they start to overheat, their internal circuitry senses this and they shut down! Once they have cooled sufficiently, they start to function again.

Typical fixed voltage regulators you will come across are, for example, the types 78L05 and 7805. The 78 prefix indicates that they are *positive* voltage regulators. The final two digits (05 in this case) then indicate that they regulate the output voltage at +5V. The 7805 is designed to supply current up to 1A (some manufacturers allow 1·5A for their 7805). The 78L05 can output up to 100mA.

Negative voltage regulators are also available, typically prefixed 79 (as opposed to 78), as with the 79L05 and 7905. These are the negative equivalents of the 78L05 and 7805, both supplying –5V, again at 100mA and 1A, respectively.

A list of 78/79 series regulators is shown in the centre of Photo 11.2. Pinouts for the devices are shown in Fig.11.2.



PIN	78xx	79xx	PIN	78Lxx	79Lxx
1	INPUT	COMMON	1	INPUT	OUTPUT
2	COMMON	INPUT	2	COMMON	INPUT
3	OUTPUT	OUTPUT	3	OUTPUT	COMMON

Fig.11.2. Pinouts for the 78/79 series of voltage regulators.

These particular devices require that the input voltage is about 2V greater than the output voltage required. The maximum input voltage is about 35V (see data sheets or suppliers' catalogues).

Note, though, that the greater the differential between input and output voltages, the greater the power that is dissipated by the device. In other words, it will get hotter more quickly for a given current drawn if the voltage differential is large (it's the P = VA situation again).

The 1A (and greater) devices have metal tabs to help radiate/convect/conduct heat away from them. The tabs can be bolted to heatsinks to aid cooling (a subject beyond this series, but simply bolting the devices to the metal case containing the circuit can often provide a satisfactory cooling solution).

Note that the tab is usually electrically connected to the Common (0V) pin so they may need to be insulated from the heatsink. Suitable mica (or similar) washers are sometimes supplied with the device, although they may have to be purchased separately.

The basic circuit for using a fixed voltage regulator is also shown in the centre of Photo 11.2. The input voltage (Vdc) enters one pin and the regulated voltage (Vout) exits another, while a 0V connection is made to a third. That's all – just three pins to connect to provide an extremely well-regulated fixed d.c. voltage supply.

Obviously, such devices automatically remove the power supply ripple voltage referred to earlier, as long as the minimum ripple voltage does not drop below the minimum 2V (nominal) input/output differential.

However, such regulators are not *totally* immune to power line noise and other minor voltage fluctuations. It is advisable to precede their inputs and follow their outputs with non-electrolytic capacitors. Typical values are between about 100nF and 330nF for the input, and 100nF for the output. The input capacitor here is *in addition to* the power supply's electrolytic smoothing capacitor.

OTHER REGULATORS

Other voltage regulators exist for a variety of purposes. Some allow the output voltage to be varied by other component values, for example. There are also *low drop-out* regulators which operate with a voltage differential of less than 2V.

Still others consume less control current than the standard devices. There are also sophisticated *switch-mode* devices which regulate power supplies by other techniques.

SMOOTHING CAPACITORS

Capacitors were first discussed in Part 2. We demonstrated how they could be charged and discharged at different rates depending on their capacitance value and the value of the resistor in series with them, in other words, on the *CR* value of the circuit.

In both cases, it was assumed that the capacitor started off either fully charged or fully discharged and we quoted the formulae used to calculate the associated rate of voltage change.

Since then you have been using capacitors in circuits where the voltage applied to the current controlling resistor is repeatedly changing its value, i.e. it has been a waveform of some sort. In such situations, the capacitor does not necessarily attain its fully charged or discharged condition. This is especially so when the capacitor is used as the *smoothing* or *reservoir* component in a power supply.

As a result, the waveform which appears at the C-R junction may not retain the shape of the waveform applied to the resistor and, of course, in a power supply you do not want *any* waveform to remain. You have already seen a good example of waveform modification when examining the waveforms generated by the oscillator (and its variants) first discussed in Part 4, Fig.4.2.

In the oscillator, the waveform feeding into its resistance path is a square wave alternating between 0V and 6V (as supplied by the output of IC1a pin 2), yet the waveform at the junction of the resistance and the capacitor is approximately triangular and having an amplitude swing of much less than this.

With this oscillator, of course, as soon as the voltage on the capacitor reaches certain thresholds, so the inverting gate's output changes its logic state.

SLOPING OFF

Let's examine what happens if the oscillator gate's output is also fed into two separate resistance-capacitance circuits. Modify the oscillator circuit on your breadboard so that it matches the layout in Fig.11.3. The equivalent circuit diagrams and component values are given in Fig.11.4 and Fig.11.5 (later). It is the circuit of Fig.11.4 that we shall discuss first.

Connect the junction of C2 and VR2 (V Out Integrate) to the input of the ADC (IC2 pin 2) as indicated. Set the wiper of VR2 fully clockwise (minimum resistance). Adjust VR1 until the oscillator l.e.d. flashes at about once per second.

Run the Analogue Input Waveform Display program and observe the waveform displayed.

At this time, there is no (significant) resistance between IC1a pin 2 and capacitor C2 and the waveform seen will be the same square wave as output from IC1a.

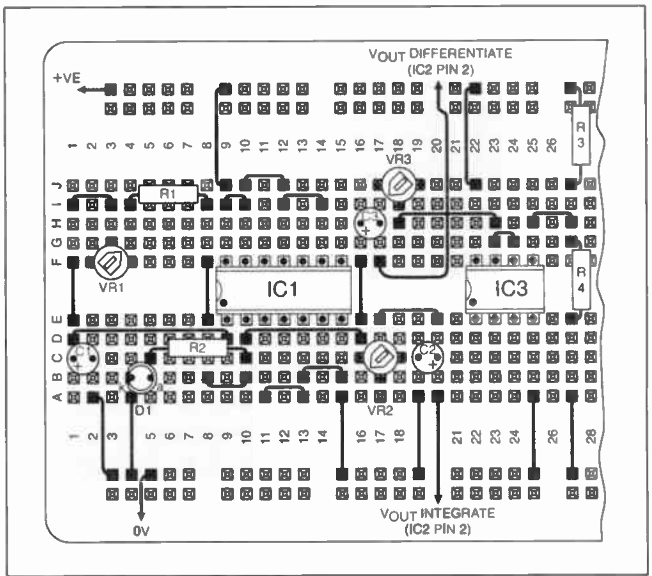


Fig.11.3. Breadboard layout for the waveform modification experiment circuits in Fig.11.4 and Fig.11.5.

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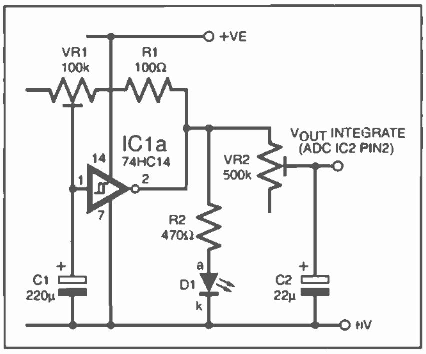


Fig.11.4. circuit diagram for the capacitor charge/discharge experiment (integration).

Note that the waveform may be a bit distorted because of being connected to a capacitor without a resistor in between.

Now slowly adjust VR2's wiper anticlockwise to increase the resistance between IC1a pin 2 and C2, observing the waveform display as you do so. Note how the waveform gradually loses its square shape, becoming more triangular and reducing in amplitude until it leaves an almost straight line in its place on the screen, roughly midway between the maximum and minimum points that the waveform reached while still a square wave.

What is happening as you increase VR2's resistance is that the *CR* ratio is progressively increasing and the capacitor has less and less time to charge or discharge between each change of voltage from IC1a pin 2.

Set VR2's wiper to a midway position. Now vary the setting of VR1, to change the frequency being generated. Again observe the screen while you do so.

You will see that the waveform regains some of its amplitude at lower frequencies, but loses it as the frequency rises. Again its all to do with the *CR* ratio of VR2 and C2, this time in respect of the rate of change of the controlling square wave.

Try the same tests with different capacitor values, e.g. C1 at 22µF and C2 at 2·2µF, so setting other *CR* ratios and frequency ranges.

There are many varied applications in which this simple resistance-capacitance (VR2/C2) configuration can be used, from setting an oscillator's frequency (as you've been doing), to changing waveform shapes (as you've just done), removing higher frequency signals whilst retaining those at lower frequencies (as in an audio tone control, for example) and smoothing a rectified power supply voltage, of course, although this is a special case since the discharge resistance is that of the load circuit and the charging resistance is virtually nil.

There is a term given to this simple circuit configuration, it is known as an *integrator*, and its action is known as *integration*. The term is not to be confused, however, with the term *integrated* when applied to a semiconductor integrated circuit (i.c.) – in this latter case the term loosely means "combined".

INTEGRATION DEMO

We can demonstrate further examples of waveform shaping using an integrator through program menu option Capacitors – Integration. Select and run it (and also see Photo 11.4).

On entry to the screen display a square wave is shown as the changing voltage being input via Vin to resistor R (see the circuit diagram at bottom right). With the *CR* and frequency values as shown at top right, the second screen waveform, representing that at the R-C junction (Vc), is shown as having a somewhat triangular shape.

Press key <W> a few times and observe how the input waveform shape changes between square, sine and triangle, and how the Vc output waveform also changes.

Note that the program has set the Vin square wave varying between 0V and a positive (unspecified) voltage, whereas the Vin sine and triangle waveforms are evenly swinging above and below 0V.

At certain *CR* values, you will see that the square and triangle inputs can both result in similarly shaped outputs, and at first sight the sine wave input and output shapes appear similar. Note, though, how the relationship between the peaks and troughs shifts with various *CR* values. In other words, a *phase shift* occurs (see Photo 11.5).

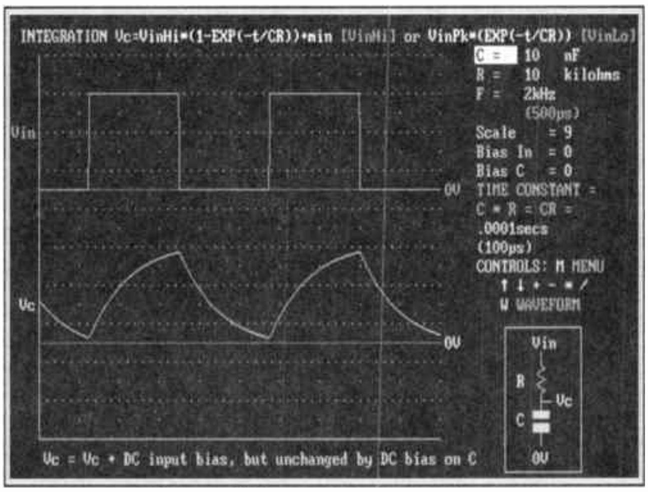
The program allows control over the R, C and F (frequency) values represented by the circuit. The Scale option changes the frequency range covered by option F and amends the C and R values appropriately in order to retain waveform shapes between range changes.

Positive or negative d.c. bias (not specified as a particular voltage, just a number) can be given to the input waveform and to the voltage level to which capacitor C is terminated (shown as 0V on entry to the program). The *CR* time constant in respect of the C and R values is also quoted.

Experiment with the various options, particularly C, R and F, and see how the Vc waveform is affected. You will see how the square wave input results in a Vc waveform that closely matches what you observed on your breadboard earlier.

FORMULATION

We have repeatedly referred to the waveform at IC1a pin 1 of the oscillator as being "triangular" (or nearly so). If you were to actually look at the waveform on an oscilloscope, you would see that its shape consisted of curved slopes, more like the Vc waveform you observed when you first



```
INTEGRATION Vc=VinHi*(1-EXP(-t/CR))+min [VinHi] or VinPk*(EXP(-t/CR)) [VinLo]
C =   10   nF
R =   10   kilohms
F =   2kHz
      (500µs)
Scale    = 9
Bias In  = 0
Bias C   = 0
TIME CONSTANT =
C * R = CR =
.0001secs
(100µs)
CONTROLS: M MENU
   ↑ ↓ + - * /
   W WAVEFORM
Vc = Vc + DC input bias, but unchanged by DC bias on C
```

Photo 11.4. Interactive integration demo screen illustrating how a square wave input is modified by a CR *ratio.*

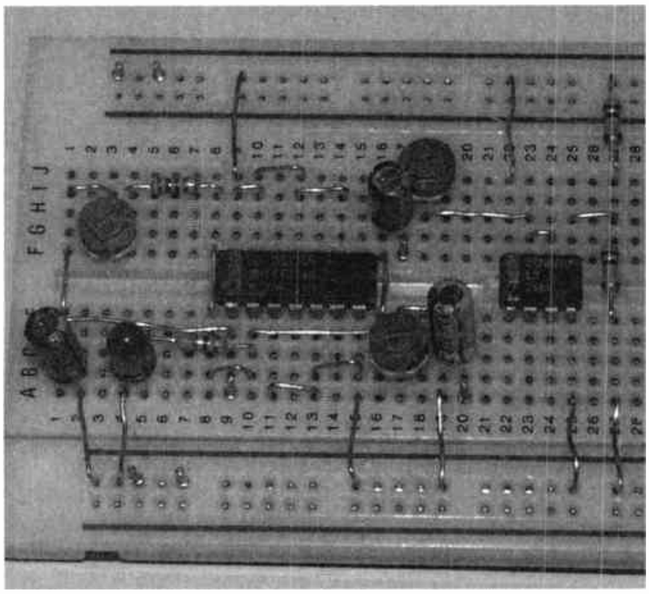
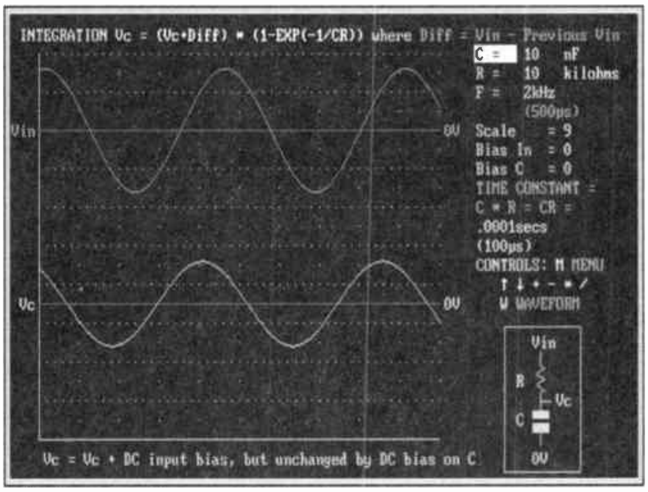


Photo 11.3. Detail of the breadboard layout in Fig.11.3.



```
INTEGRATION Vc = (Vc+Diff) * (1-EXP(-1/CR)) where Diff = Vin - Previous Vin
C =   10   nF
R =   10   kilohms
F =   2kHz
      (500µs)
Scale    = 9
Bias In  = 0
Bias C   = 0
TIME CONSTANT =
C * R = CR =
.0001secs
(100µs)
CONTROLS: M MENU
   ↑ ↓ + - * /
   W WAVEFORM
Vc = Vc + DC input bias, but unchanged by DC bias on C
```

Photo 11.5. Interactive integration demo screen illustrating how CR *ratios can cause signal phase shifting.*

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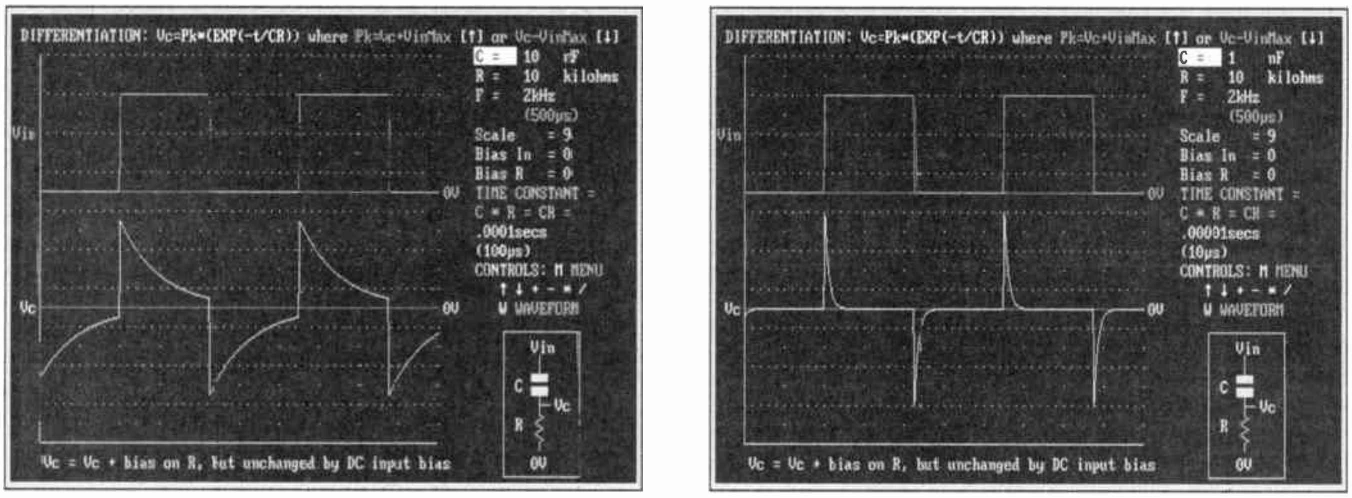

```
DIFFERENTIATION: Vc=Pk*(EXP(-t/CR)) where Pk=Vc+VinMax [↑] or Vc-VinMax [↓]
C =  10   nF
R =  10   kilohms
F =  2kHz
     (500µs)
Scale    = 9
Bias In  = 0
Bias R   = 0
TIME CONSTANT =
C * R = CR =
.0001secs
(100µs)
CONTROLS: M MENU
  ↑ ↓ + - * /
  W WAVEFORM
Vc = Vc + bias on R, but unchanged by DC input bias
```

```
DIFFERENTIATION: Vc=Pk*(EXP(-t/CR)) where Pk=Vc+VinMax [↑] or Vc-VinMax [↓]
C =  1    nF
R =  10   kilohms
F =  2kHz
     (500µs)
Scale    = 9
Bias In  = 0
Bias R   = 0
TIME CONSTANT =
C * R = CR =
.00001secs
(10µs)
CONTROLS: M MENU
  ↑ ↓ + - * /
  W WAVEFORM
Vc = Vc + bias on R, but unchanged by DC input bias
```

Photo 11.6 and Photo 11.7. Interactive differentiation screens showing how different CR values can drastically affect the shape of a square wave.

entered the Integration display screen (as in Photo 11.4). You will probably have seen similar curved slopes under some conditions of using your Analogue Input Waveform Display to monitor other breadboard waveforms in previous experiments earlier in the *Teach-In* series.

No doubt you will recognise that the slopes follow the graphs generated when using the Resistor-Capacitor Charging Graph displays in Part 2.

Indeed, the formulae which we pointed out to you then basically apply to integration calculations as well, but with a few extra factors taken into account. Again we do not expect you to learn the formulae, but the variants used to generate the integration demo displays are shown at the top of the screen. The calculations are more complex for a square wave than for the sine or triangle waveforms.

With experience at using the Integration demo screen, you will find that you can use its control options as a reasonable guide to selecting the waveform responses required for real-life circuit designing.

DIFFERENTIATION

In *integration*, as we have just been discussing, the waveform voltage/current flows between its source and the capacitor via a resistor. You have, though, been using several circuits over the last few *Teach-In* parts in which the waveform voltage is applied first to a capacitor and then to a resistor. Such a circuit is known as a *differentiator* and its action is called *differentiation*. It behaves very differently to an integrator. Run menu option Capacitors – Differentiation, and also see Photo 11.6.

At the bottom right will be seen a circuit representation of a differentiator, using the same terminology as before. You will also see the output waveform created by an input square wave with R, C and F shown at the top right. It is certainly not a square wave!

In fact, we are not sure it actually has a name, but it's the sort of shape that can be produced if too low a *CR* value is chosen in respect of a square wave input frequency.

Increase the screen *CR* value by using the control options available (same as before) and see how the output waveform shape improves.

Decrease the *CR* value and observe how spiky the waveform becomes (see Photo 11.7). This all confirms what we have said/implied in previous parts, that waveform shapes when fed through capacitively coupled circuits are modified by the *CR* values of those circuits.

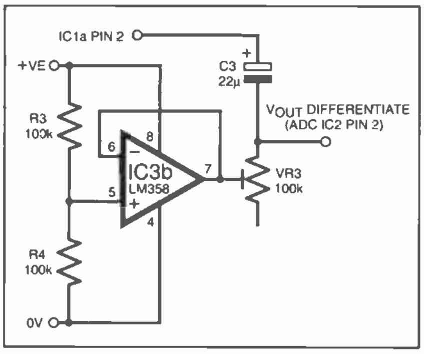

Fig.11.5. Circuit diagram for the differentiation experiment.

Use the <W> key to change the input waveform as before, and again observe how the *CR* relationship changes the shape and amplitude of the output for sine and triangle waveforms.

Again the *CR* relationship for a desired output result is difficult to calculate, but it is also based on the *CR* formulae used in Part 2. The variants used for the demo display are shown at the top of the screen.

This demo display can also be used as a guide for real-life circuit design value assessment. In many a.c. coupled circuits, of course, you will want to retain the signal shape across a particular frequency range, but there are other instances where shape change is desirable, such as in pulse generation or low frequency attenuation, for example.

Return to your breadboard and connect the output of C3 and VR3 (V Out Differentiate) to IC2 pin 2. It is the differentiation circuit shown in Fig.11.5 that is now to be monitored. Once more observe the Analogue Input Waveform Display as you experiment with different *CR* and frequency values.

An important point to note about the circuit in Fig.11.5 is that we have had to reference the waveform at C3/VR3 to a midway voltage of 3V (half the 6V battery voltage). This is provided by potential divider R3 and R4 and buffered by op.amp IC3b.

As discussed in Part 10, if the resistance (VR3) were to be connected to the 0V power line, the voltage at its junction with the capacitor (C3) would swing above and below 0V. The ADC cannot be fed with a negative-going voltage and so the waveform is referenced to 3V instead.

As you did with the integrator circuit, once more experiment with different values of capacitance, resistance and frequency and observe the waveforms on your computer screen.

Additionally, if you feel adventurous, use an op.amp to buffer/amplify the (now-you-know-it's-not!) triangular waveform from IC1a pin 1, and then experiment with the resulting output connected to the differentiator and integrator (in place of the square wave output from IC1a pin2). Op.amp IC3a (pins 1, 2 and 3) is currently unused on your breadboard and you can connect it in the fashion described when we discussed op.amps (Parts 7 and 8).

PANEL 11.1. THEY LEAK A BIT

In your various experiments using the oscillator around IC1a, you may have found that large values of capacitance and/or resistance can prevent the oscillator from functioning.

It's now opportune to comment on why large values of C and R may inhibit oscillation. An important thing to know about electrolytic capacitors is that they are a bit "leaky" – the charge on one plate tends to leak across to the other, progressively discharging the capacitor.

With large values of R, the rate at which the resistor allows the capacitor to charge up could be slower than the rate at which the capacitor self-discharges. Consequently, oscillation can never be sustained, and probably not even started.

There is a type of largish value capacitor, however, which has a much less leaky disposition than electrolytics, it is the Tantalum capacitor, see Part 2, Fig.2.7 and Table 2.2.

You will find Tantalums used in many circuits where lengthy or more accurately maintained timing is required. They are also smaller, value for value, than electrolytic capacitors.

Unfortunately, they are more expensive than electrolytics, and their maximum capacitance value is significantly lower, 330μF probably being the highest you'll readily find, whereas electrolytics are commonly available in many hundreds of thousands of microfarads, even up to 2 farads (2F).

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PANEL 11.2. VARIABLE CAPACITORS

Still on capacitors, but another subject – we promised in Part 2 that we would eventually give information on variable capacitors. Space is running a bit short, but here is a brief description.

In comparison with their resistive counterparts (potentiometers), variable capacitors are much less common. Unlike variable resistors, though, the term *variable capacitor* really *does* mean that the capacitance itself is variable; you cannot attach a slider to a capacitor to vary a fixed capacitance take-off point.

Variable capacitors are available in both preset (trimmer) and fully variable forms, but the values tend to be small (less than 1000pF). Schematic representations were shown in Part 2 Fig.2.6.

Various forms of variable capacitor construction are used, with dielectrics which are either "solid" (plastic film), mica, ceramic material, or air. Variable capacitors are generally very reliable although mechanical faults can occur with some of the cheaper solid dielectric types. Air-spaced variable capacitors can also be prone to problems through dust and other contaminants getting in between the interleaved plates.

In earlier days, the large air-spaced types were commonly used for tuning the reception frequency of radios; in many instances, they have been replaced by semiconductor devices whose capacitance value depends on the voltage applied to them, and known as *Varicap* or *tuning* diodes.

The preset types continue to be used for applications such as oscillator frequency correction.

Characteristics of the most commonly encountered variable capacitors are shown in Table 11.1.

Table 11.1. Characteristics of commonly encountered variable capacitors.

Type	*Air-spaced*	*Ceramic*	*Plastic film*
Range (pF)	5 to 500	2 to 200	10 to 750
Tolerance (%)	±10	±20	±10
Voltage (d.c.)	250V to 1kV	63V	63V to 150V
Stability	Excellent	Fair	Good
Applications	Transmitters, r.f. signal generators	Compensation, oscillator trimming	Radio tuning, oscillator trimming

TEACH-IN 2000 – Experimental 11

OPTIONAL 5V POWER SUPPLY

POWERFUL ARGUMENTS

When planning this *Teach-In 2000* series, it was felt that expecting you to experiment with different Zener diode values and voltage regulators was unrealistic.

The Zener values you could use with a 6V supply are few, and apart from checking with your meter that the Zener does indeed limit voltages to a particular value, you could not actually put this voltage control to good use.

Standard fixed voltage regulator devices are not available below 5V (e.g. 7805 and 78L05). These typically require a minimum input voltage of 7V, and so cannot be used with a 6V battery.

Consequently, no actual experiments with either of these device types are offered. We believe, though, that the Tutorial and demo programs provide you with enough information to understand their nature and how you might use them in some future designs of your own creation.

However (contrary to what we indicated earlier in the series), we now offer you the option to provide your breadboard with a mains powered 5V d.c. regulated supply – read on . . .

MAINS ADAPTION

It seems likely that many of you will already possess mains adaptors (battery eliminators) that are suitable for connecting to a few extra components in order to produce a fully regulated and safe 5V d.c. supply that can be used in place of your 6V battery.

Such adaptors are used, for example, with mobile phones, computer modems and personal audio equipment. The basic requirement is that the adaptor should have an output which falls into one the two following ranges (**other types are not suitable**):

- 6V a.c. to 9V a.c.
- 9V d.c. to 12V d.c. (see later).

The circuit with which *either* type can be used interchangeably is shown in Fig.11.6, with its breadboard layout given in Fig.11.7.

You will additionally need to obtain the following inexpensive components:

- Socket into which the adaptor can be plugged to connect to the breadboard.
- 78L05 100mA +5V voltage regulator (IC1).
- 220μF 25V electrolytic capacitor with radial leads (C1). It is possible you might already have one amongst the components you bought for Part 1. We specified that a minimum working voltage of 10V was required, but your supplier may have provided you with one rated at 25V, check your stock (ones rated lower than 25V are not suitable – re-read the Tutorial of Part 10 if you're not sure why!).

You should already have the 1N4001 rectifier diodes (D1 to D4), the 100nF capacitor (C2) and the 10kΩ preset (VR1).

Readers who do not have a suitable mains adaptor (and have no intention of getting one) should leave their existing breadboard assembly unchanged, ignoring the remainder of this Experimental section. Next month's experiments can be done using either the existing breadboard (with 6V battery) or the modified version about to be described.

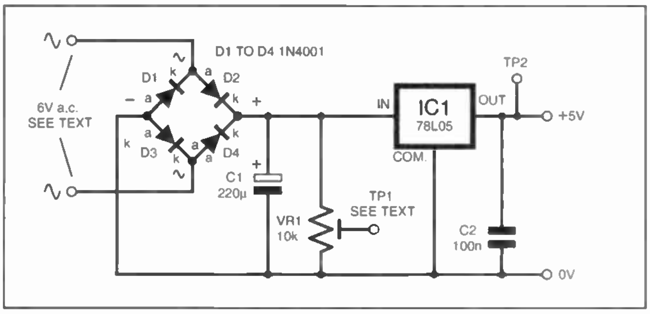

Fig.11.6. Suggested experimental +5V power supply.

POWER SUPPLY ASSEMBLY

Re-arrange the right-hand side of your breadboard to match the layout in Fig.11.7, ensuring that the orientations of IC1, C1 and D1 to D4 are correctly followed. Do *not* insert Link X (top right) until we tell you.

Note that the breadboard space available has prevented the use of a small value non-electrolytic capacitor in parallel with C2 (a recommendation discussed in the Tutorial).

You will notice that the computer interface resistors R1 to R10 (installed in Part 4) have been removed and the five data inputs (IN0 to IN4) are now linked directly to the printer port terminals on the printed circuit board. The revised circuit diagram is shown in Fig.11.8.

Because of this direct connection, from hereon your breadboard **MUST ONLY** be operated at 5V (as supplied by the circuit you are now assembling). To use the 6V battery instead could be damaging to your computer without those attenuating interface resistors in place.

It does not matter which way round the battery adaptor and its socket are connected to the breadboard. The diodes (D1 to

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D4) automatically route the voltage polarity correctly.

Before plugging in the adaptor, ensure that your 6V battery cannot be connected (remove its crocodile-clip connection pins from the breadboard). Turn the wiper of VR1 fully anti-clockwise.

With mains power supplied via the adaptor, use your multimeter to check that a voltage of +5V is present at test point TP2 (within a decimal point or so). A much higher or lower voltage will indicate that you have made an assembly error.

If the voltage is correct, Link X can now be inserted. This routes the fully regulated 5V supply to the rest of the circuits on the breadboard.

RIPPLE TEST

Also connect test point TP1 to the signal input of the ADC, IC2. Carefully rotating VR1's wiper clockwise, you can examine via your computer screen (Analogue Input Waveform Display option) whether any "ripple voltage" is present at the junction of diodes D2 and D4.

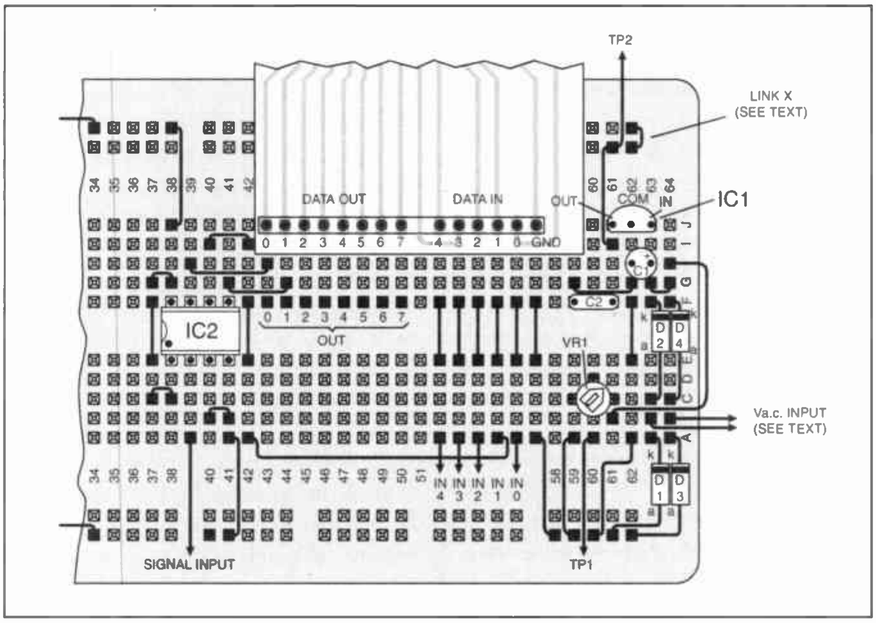
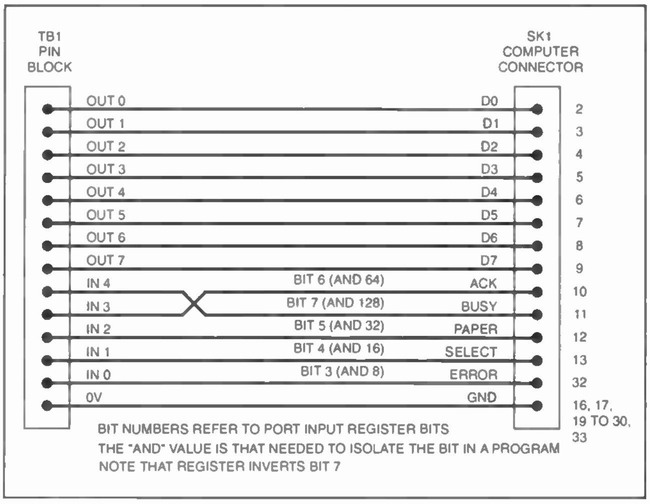


Fig.11.7. Breadboard layout for the 5V power supply circuit and the revised connections to the printer port board.



BIT NUMBERS REFER TO PORT INPUT REGISTER BITS
THE "AND" VALUE IS THAT NEEDED TO ISOLATE THE BIT IN A PROGRAM
NOTE THAT REGISTER INVERTS BIT 7

Fig.11.8. Revised circuit diagram for the printer port board connections.

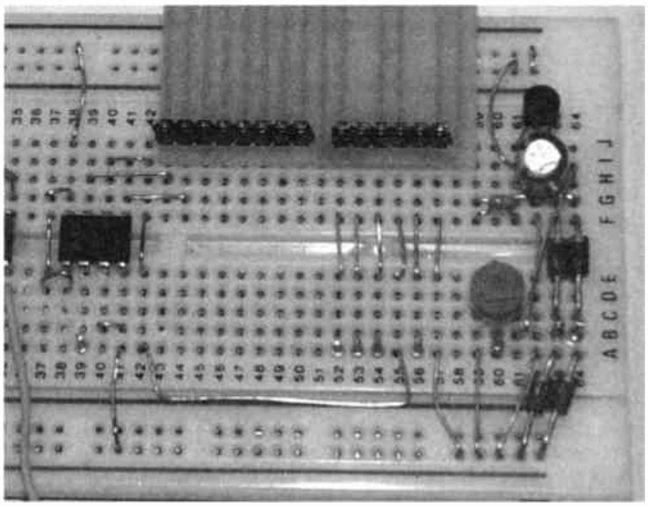


Photo 11.8. Detail of the breadboard layout in Fig.11.7.

Do not allow the voltage applied to IC2's input to exceed 5V (and do not try to monitor the output of an a.c. adaptor).

If a d.c. adaptor is used (and purely out of interest), temporarily remove smoothing capacitor C1 to see if ripple is present.

If an a.c. adaptor is used, lower capacitance values for C2 can be tried (**providing the capacitor has a working voltage of 25V or greater**), until a *minor* amount of ripple is present. Try 22μF in the first instance. Do not totally remove C2 otherwise IC2 will not function correctly (because of maximum 0V to 5V ripple being present on its power line).

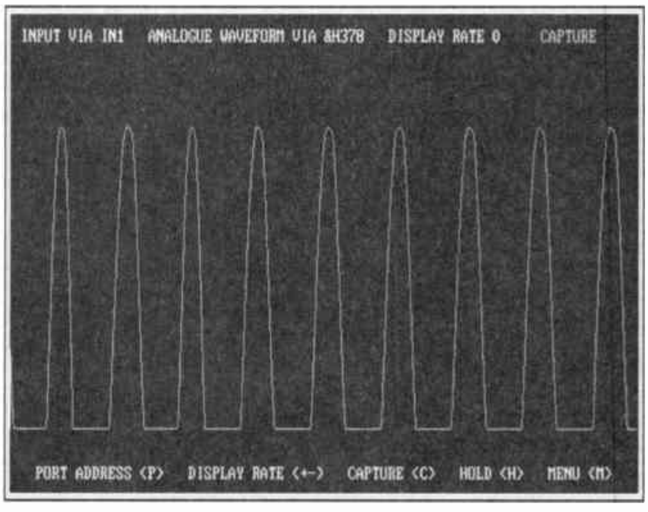


Photo 11.9. Screen dump of the rectified but unsmoothed voltage at the junction of diodes D2 and D4 (see text).

Don't forget to reinstate C2 as a 220μF component when you've finished!

The waveform monitored on the author's test model is shown in Photo 11.9.

ANOTHER OPTION

Some of you may have a 7V d.c. battery charger for your mobile phone (as has the author). This may be used as the power source if you remove the diodes D1 to D4 and connect the positive output to the input of regulator IC1, and the 0V output to the breadboard's 0V line. You must ensure that this polarity is correct!

WORKSHOP POWER SUPPLY UNIT

In a separate constructional article to be published in the November issue, a workshop power supply is described. In its full form it is only suited for construction by experienced hobbyists, but a simplified and shortened version is also described and is a supply suited for use by less-experienced experimenters. It can provide outputs between 5V and 15V d.c.

Note that the 13·2V supply described elsewhere in this issue is not suited for use with the *Teach-In* breadboard circuits.

NEXT MONTH

In the final part of *Teach-In 2000* next month (Part 12) we take a look at 7-segment displays, both light emitting diode (l.e.d.) and liquid crystal (l.c.d.), but without actually experimenting with them. We shall also experiment with a digital-to-analogue converter. There are a few loose ends yet to be tied up as well, which we shall try to do!

In the meantime, may the power be with you!

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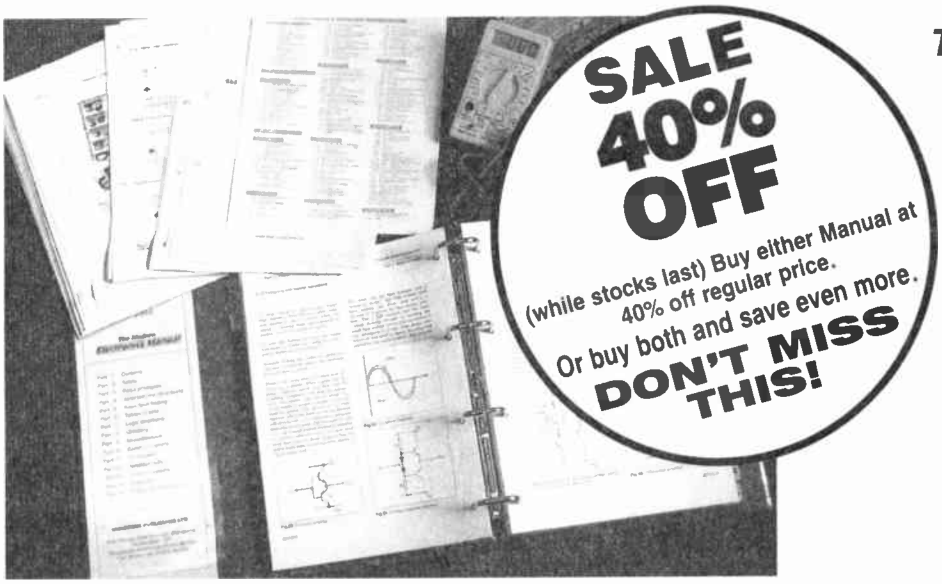

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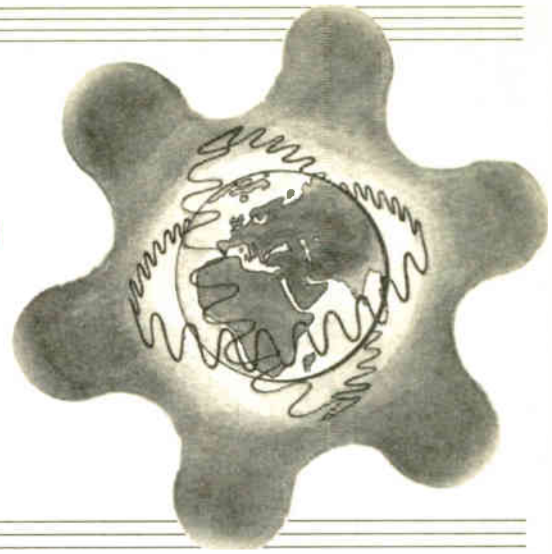
Constructional Project

ACTIVE FERRITE LOOP AERIAL



RAYMOND HAIGH

Whether you're a serious Medium Wave listener or just an inveterate band browser, this compact loop aerial will be an aid to better reception.

LARGE loop or frame aerials were a common part of the 1920s domestic radio scene, but their popularity waned during the thirties when an external wire became the normal means of signal pick-up.

A decade later, improved receiver sensitivity made it possible for small loops to be enclosed within the cabinets of portable and table sets. At the close of the fifties, in the twilight of the valve era, very high permeability ferrites were introduced. Rod-like cores of this material enable a tiny coil to pick up signals better than a small, air-cored loop, and ferrite aerials are now found in most domestic receivers.

TILT AND TURN

When the axis of the loop or coil is pointing towards the transmitter, the induced signal voltage falls, in theory, to zero. The two nulls, 180 degrees apart, are extremely sharp. They enable the operator to prevent interference reaching the receiver, and to separate stations operating on the same frequency.

It is this property which encouraged American Raymond S. Moore to re-introduce the large, air-cored loop, for serious Medium Wave listening, during the 1940s.

The need to rotate the aerial in a horizontal plane to optimise reception is evident to every owner of a transistor portable radio. What is not so widely appreciated is the need to tilt it in the vertical if the deepest possible nulls are to be obtained.

Medium frequency radio waves reach the receiver by line-of-sight (direct waves), travel to it around the curvature of the earth (surface waves), and, at night, are reflected down from the ionosphere (sky waves). The loop must, therefore, tilt as well as turn in order to point its axis precisely at the advancing wave front.

Another American, Gordon Nelson, was probably the first designer to incorporate tilting into his Medium Wave loops.

LOOPS AND WIRES

Transmitting aerials radiate electrostatic and electromagnetic fields which coexist at right angles to one another. Long wire and whip aerials, in conjunction with some form of earthing, are acted upon by the electrostatic field. Signal voltages are induced in loop aerials by the magnetic field.

Signal pick-up by a long (20 metres plus), high (8 metres plus) wire and a decent earth will usually exceed that from even a large loop. A coil wound on a 150mm × 9mm diameter ferrite rod will develop signal voltages around 18dB below those induced in a one metre square air-cored loop.

A loop of these dimensions, mounted so that it can tilt and turn, is cumbersome and more than a little out-of-place in a domestic setting. However, by increasing the size of the ferrite rod, amplifying the output, and multiplying the Q of the coil, a ferrite loop can be made to outperform its bigger, air-cored brother.

This approach has been adopted in the design of the very compact unit which is described here.

FERRITE RODS

Because of the high permeability of the ferrite, the magnetic field radiated by the transmitter is concentrated in the rod and the signal induced in the coil wound around it greatly increased.

Bigger rods provide more signal pick-up. Some early ferrite loops produced for Medium Wave listening had rods more than a metre long. This rather defeats the advantage of compactness, and experiments have shown that bundling the rods together to increase the overall diameter is as effective as placing them end-to-end to increase length.

Loops incorporating up to thirty rods have been produced. Signal pick-up increases with each additional rod, but the rate of improvement seems to fall off after about ten or so. Weight and cost are also limiting factors, and this design incorporates seven rods. Fewer or more rods can, of course, be used, and guidance on this is given later.

HIGH-Q

Tuned circuits incorporating coils wound on ferrite rods have a high Q. This restricts bandwidth and can result in side-band cutting which reduces treble response.

The application of positive feedback to the tuned circuit increases Q and signal output. The price paid for this is a further reduction in bandwidth. Sideband cutting becomes severe and treble response heavily attenuated. Moreover, with high levels of Q multiplication, loop tuning becomes critical.

High selectivity ahead of a receiver covering a congested and noisy band can be very useful, however. Careful operation can restore the treble response, and

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measures can be taken to overcome the problem of critical tuning.

GOING ASTRAY

The Medium Wave band extends from 527kHz to 1620kHz in Europe. In the USA, stations operate up to 1700kHz, and Australia has low-powered transmitters working at 1720kHz.

United Kingdom coverage is from 558kHz to 1602kHz, the region beyond 1602KHz being taken up by cordless 'phone channels. In Europe, Dutch, Greek and Serbian pirate stations invade the segment above 1600kHz.

Stray capacitance can be relatively high with circuits of this kind, and the tuning capacitor should have a swing of at least 10pF to 450pF to ensure coverage from 1720kHz down to 527kHz. Air-spaced variables of this value are no longer readily available and currently listed polythene dielectric types (as used in transistor portables) have a lower value, even when two gangs are connected in parallel.

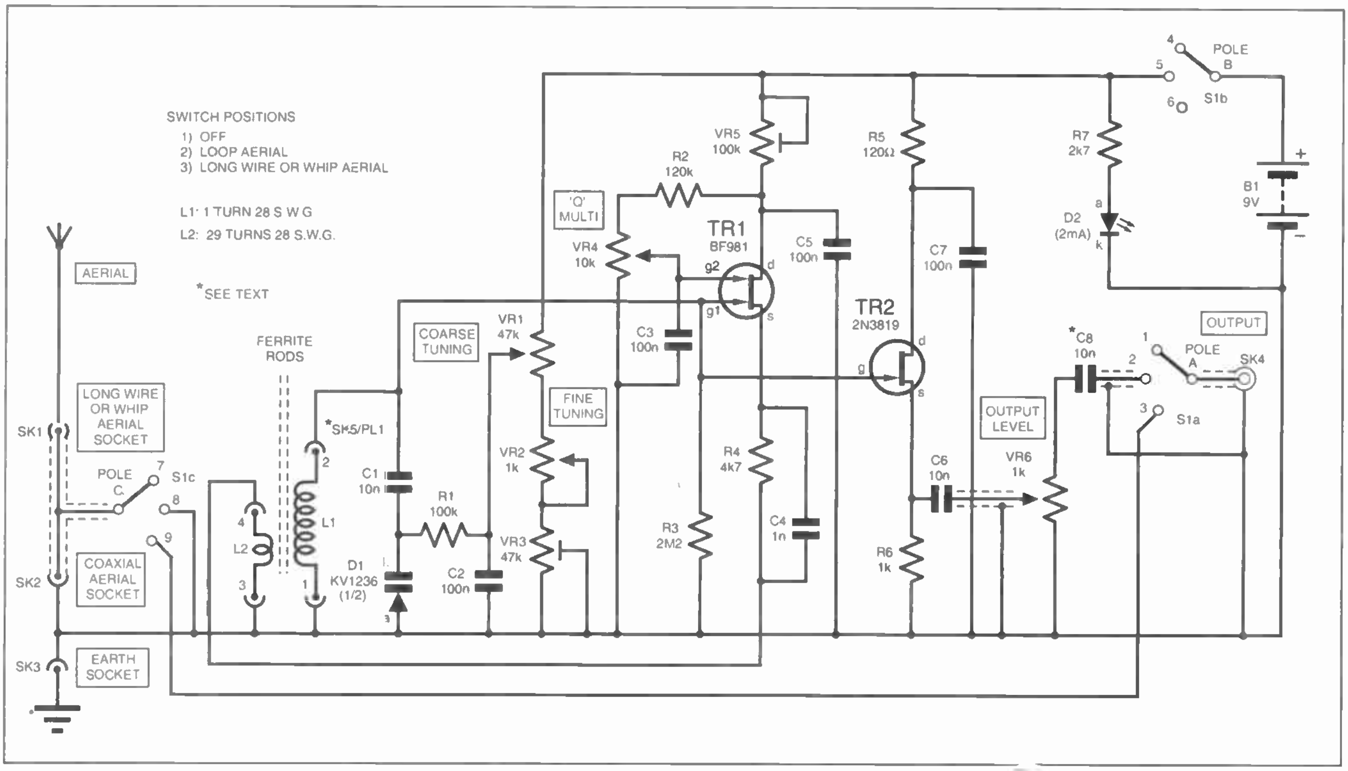


Fig. 1. Complete circuit diagram for the Active Ferrite Loop Aerial.

VARICAPS

Varicap diodes intended for M.W. tuning are widely retailed. Although the minimum capacitance of these devices is higher than that of their mechanical counterparts, they have a big enough maximum capacitance to ensure the required coverage.

Varicaps exhibit a tuning rate which reduces as frequency increases, and this makes loop adjustment easier. Moreover, the provision of vernier or fine tuning involves no more than an additional potentiometer. They are also relatively inexpensive. Quite apart from the question of availability, therefore, electronic tuning has much to recommend it.

These semiconductor devices have a lower *Q* than a mechanical capacitor, particularly at low bias settings when the capacitance is close to maximum. However, the inclusion of *Q*-multiplying circuitry avoids any loss of efficiency because of this.

Concern is sometimes expressed at the possibility of strong signal voltages disturbing the diode bias and introducing cross modulation. No problems of this kind have been encountered with the loop design described here.

CIRCUIT DETAILS

The full circuit diagram for the Active Ferrite Loop Aerial is shown in Fig.1. The main components of the circuit are a dual-gate MOSFET (TR1), a field effect transistor (TR2), a varicap diode (D1) and, of course, the multi-rod ferrite "loop" aerial.

Sockets SK1, SK2 are provided for external aerials and SK3 is the common Earth socket. Switches S1a and S1c permit an instant comparison between loop and wire aerials. Another switch, S1b, connects the battery into circuit. Low current l.e.d. D2 with its dropping resistor R7 forms an economical on/off indicator.

TUNING

The loop's main winding L1 is tuned by varicap diode D1, which is connected to it via d.c. blocking capacitor C1. Tuning bias is applied through signal isolating resistor R1.

Potentiometer VR1 adjusts the bias voltage and acts as the Coarse, or main tuning control. Fine tuning is provided by VR2 which produces a much smaller voltage change. Preset potentiometer VR3 sets the minimum bias voltage, fixing the maximum capacitance of the varicap and the low frequency limit of the tuning range. Bypass capacitor C2 eliminates any potentiometer noise.

Q-MULTIPLIER

Dual-gate MOSFET TR1 amplifies the signal voltage developed across coil L1 in order to provide *Q* enhancing positive feedback. The gain of TR1, and hence the *Q* multiplication, is controlled by VR4, which determines the voltage on gate g2.

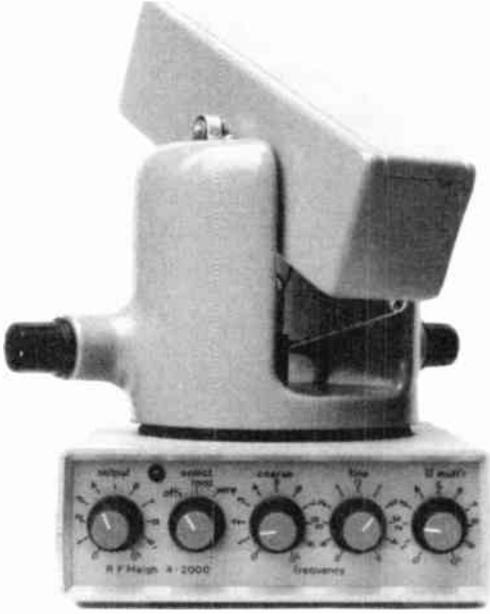
The stage is decoupled from the supply by preset VR5 and capacitor C5. Making the decoupling resistor variable enables the operating conditions to be adjusted to suit different dual-gate MOSFETs.

Positive feedback is applied, via source bias resistor R4 and its bypass capacitor C4 to coil winding L2.

BUFFER

The impedance of the tuned circuit is very high at resonance and most communications receivers have a low input impedance, typically 50 ohms. Source follower stage TR2, with its high input and low output impedance, matches the loop aerial to the receiver. The voltage gain of a source follower is slightly less than unity. There is, however, a significant power gain.

Decoupling of the source follower stage is provided by resistor R5 and capacitor C7, and the output is developed across source



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load resistor R6. Output level control VR6 could be connected as the source load. However, the arrangement shown ensures that the impedance presented to the receiver is reasonably constant. Capacitors C6 and C8 block the flow of d.c.

COMPONENTS

Resistors

R1	100k
R2	120k
R3	2M2
R4	4k7
R5	120Ω
R6	1k
R7	2k7

See SHOP TALK page

All 0·25W 5% carbon film

Potentiometers

VR1	47k rotary carbon, lin.
VR2	1k rotary carbon, lin.
VR3	47k enclosed carbon preset, horizontal
VR4	10k rotary carbon
VR5	100k enclosed carbon preset, horizontal
VR6	1k rotary carbon (log law, if obtainable).

Capacitors

C1	10n polycarbonate or Mylar.
C2, C3, C5, C7	100n disc ceramic (4 off)
C4	1n disc ceramic
C6, C8	10n disc ceramic

Semiconductors

D1	KV1236 dual varicap diode (½ of)
D2	3mm or 5mm red l.e.d., low current (2mA)
TR1	BF981 *n*-channel dual-gate MOSFET
TR2	2N3819 *n*-channel field effect transistor

Miscellaneous

L1, L2	ferrite loop aerial, wound using 28s.w.g. enamelled copper wire – see text
S1	3-way 4-pole rotary switch (plastic cased Lorlin)
SK1, SK3	screw terminal post, with 4mm socket top (2 off)
SK2, SK4	coaxial socket, chassis mounting (2 off)
SK5/PL1	stereo jack socket and plug, for linking ferrite aerial to main unit (optional)

Printed circuit board available from the *EPE PCB Service*, code 274; ferrite rod, 9mm dia. at least 150mm long (7-off – see text); instrument case for control unit, size 170mm x 150mm x 50mm; diecast screening box for p.c.b. (optional), size 120mm x 90mm x 30mm; l.e.d. holder; plastic control knob (5 off); 9V battery with connectors and box; single-core screened cable; multistrand connecting wire; plastic pipe for aerial coil former; materials for ferrite loop aerial housing/mounting; fixing nuts and bolts; solder tag; solder etc.

***Approx. Cost Guidance Only* £35**
excl. case and "mechanics"

COMPONENTS

Most dual-gate MOSFETs, including the BF960, BF961, 3SK81, 3SK85, MFE201 and 40673 will prove satisfactory in this circuit. Likewise, most j.f.e.t.s, including the BF244, BF245, J310, MPF102, TIS14 and 2SK168 will be suitable for the source follower stage TR2. Case styles and leadouts vary and must be checked if these and other alternatives are substituted.

Most varicaps designed for Medium Wave tuning with a 9V maximum bias should prove suitable. Plastic pipe for the coil former for L1/L2 is available from DIY outlets, and plastic and metal spindles and bushes for the loop aerial mounting are stocked by model shops.

CONSTRUCTION

Dealing with the control box first. Most parts are assembled on a small printed circuit board (p.c.b.), which is available from the *EPE PCB Service*, code 274.

The topside component layout, off-board wiring and a full-size underside copper foil master pattern are shown in Fig.2. Note that one lead of capacitor C8 is soldered directly on to one tag of VR6 and the other to the solid, centre core, lead of the coax cable running to pin 2 of the rotary switch section S1a. Provision is not made for this component on the p.c.b.

Commence construction by mounting the smallest components first, and solder the semiconductors into circuit last. The use of tweezers or a crocodile clip as a heat shunt is a wise precaution when soldering the f.e.t.s.

Solder pins inserted into the board beneath the specified MOSFET leads will permit TR1 to be mounted on the component side of the board. Pins inserted at the p.c.b. lead-off points will ease the task of interwiring.

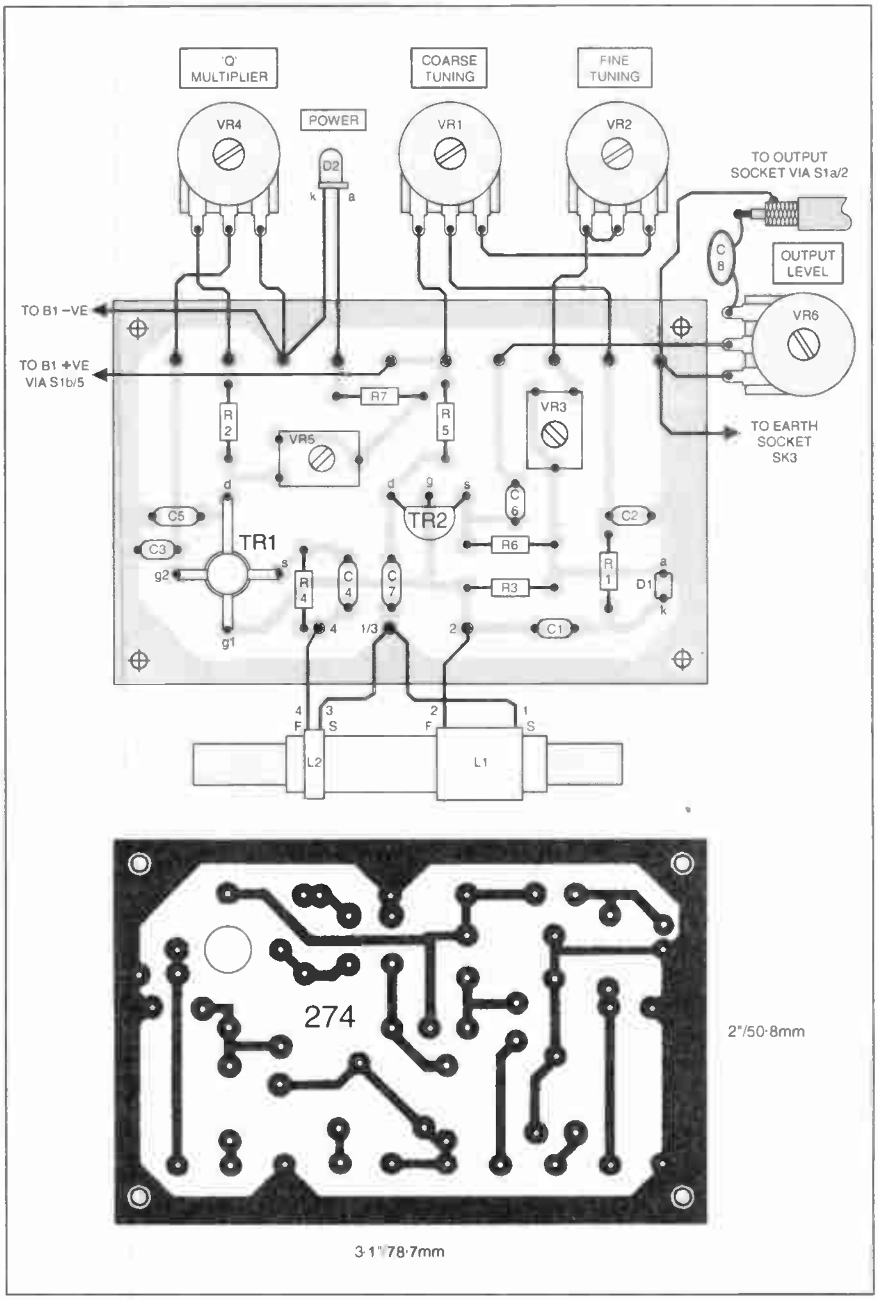


Fig.2. Printed circuit board topside component layout, off-board wiring and full-size copper foil underside master. Note capacitor C8 is mounted directly on one outer tag of VR6 and soldered to the centre core of the output screened lead.

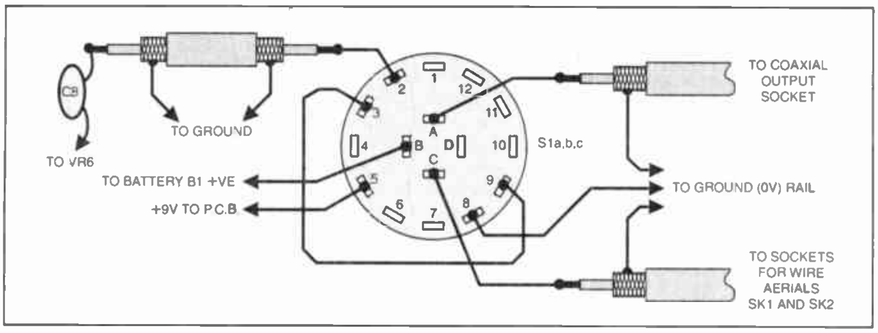


Fig.3. Wiring to the on/off and aerial selector switch. Pole letters and tag numbers match specified switch.

Use screened cable (ordinary audio type cable will suffice for this purpose) between the wire aerial input sockets, the rotary switch, and the loop output socket. Connect the metal cases of the potentiometers to ground (0V rail). Details of the Selector switch wiring are given in Fig.3.

HOUSING THE CONTROLS

The photographs show how the controls and p.c.b. are housed in a plastic instrument case which also acts as the base of the unit. The p.c.b. and jack socket SK5 are screened within a diecast box which also strengthens the case beneath the loop. Screening the p.c.b. is not essential; the entire enclosure can be of wood or plastic.

RODS AND TURNS

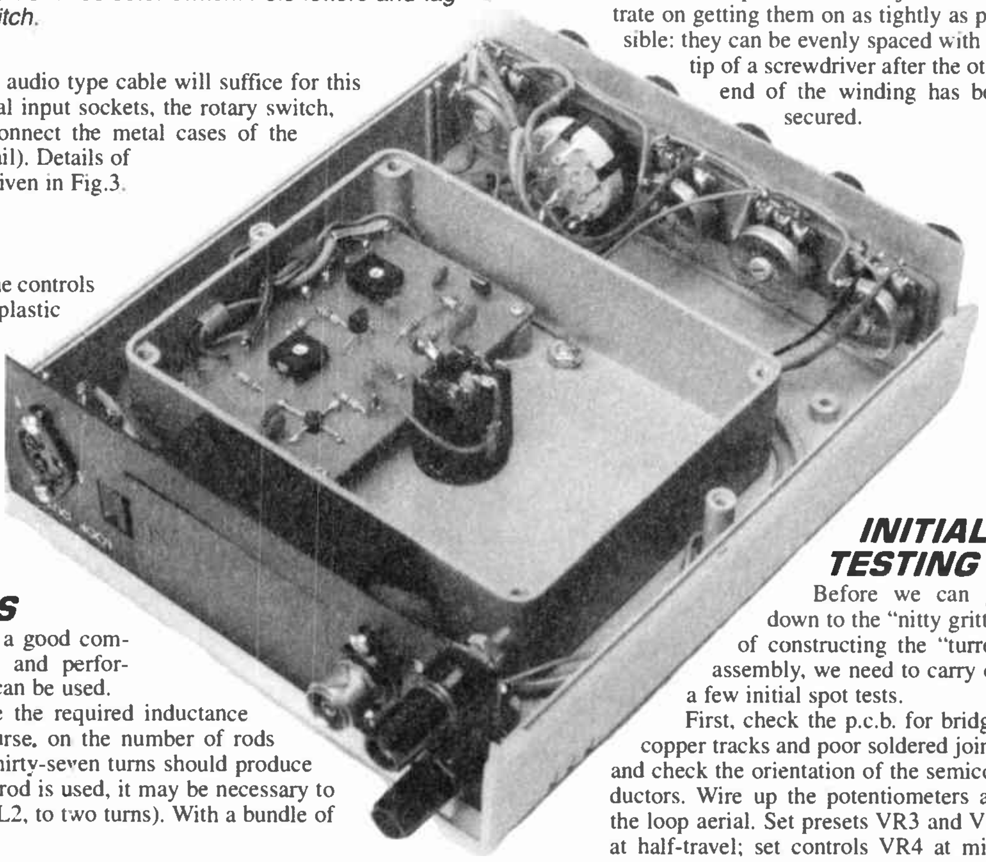
Seven ferrite rods represents a good compromise between cost, weight and performance, but fewer or more rods can be used.

The number of turns to give the required inductance (about 160μH) depends, of course, on the number of rods finally used. For a single rod, thirty-seven turns should produce the required value. (If only one rod is used, it may be necessary to increase the feedback winding, L2, to two turns). With a bundle of thirty rods, twenty turns will be about right.

FERRITE LOOP

Moving on to the loop assembly, Fig.5, tightly bind the seven ferrite rods together with masking tape, winding on sufficient material to ensure that the plastic coil former is a tight sliding fit.

Secure the wire to the former with a narrow strip of tape and wind on the specified number of turns – 29 turns of 28s.w.g. enamelled copper wire. Don't try too hard to space the turns, just concentrate on getting them on as tightly as possible: they can be evenly spaced with the tip of a screwdriver after the other end of the winding has been secured.



INITIAL TESTING

Before we can get down to the "nitty gritty" of constructing the "turret" assembly, we need to carry out a few initial spot tests.

First, check the p.c.b. for bridged copper tracks and poor soldered joints, and check the orientation of the semiconductors. Wire up the potentiometers and the loop aerial. Set presets VR3 and VR5 at half-travel; set controls VR4 at minimum and VR6 at maximum.

Connect the unit to the receiver by a short length of coaxial cable, then connect a 9V battery. Current consumption should be approximately 5mA.

Assuming you are using a receiver with an in-built signal strength meter, proceed as follows. With receiver and loop tuned to a strong transmission, the receiver's signal strength meter should be driven hard over. Turn down Level control VR6 until the signal strength meter reads about half-scale. Advancing the Q-multiplier control VR4 should now drive the pointer hard over again.

Loop tuning has to be very precise at high Q levels, and it may be necessary to use Fine tuning control VR2 to bring loop and receiver into perfect alignment.

Check that the loop can be tuned over the required frequency range, and adjust preset VR3 until the low frequency limit is reached with VR2 at minimum resistance. Set preset VR5 so that the loop just glides into oscillation, with Q-control VR4 at maximum, when tuned to a station near the low frequency end of the band.

Sliding the coil along the ferrite rods will change its inductance, and coverage can be adjusted in this way. If it has to be located very close to the end, remove a

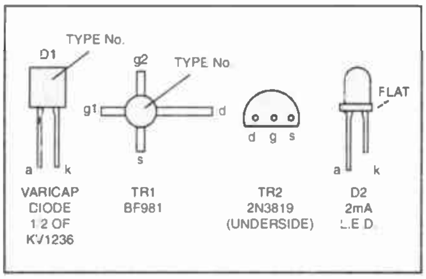
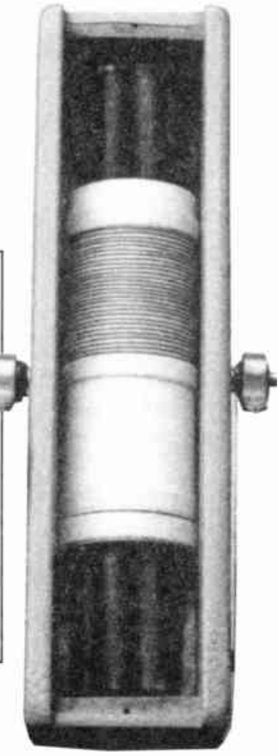


Fig.4 (left). Semiconductor pinout details. (Right) Completed ferrite loop aerial housed in a pivot box.



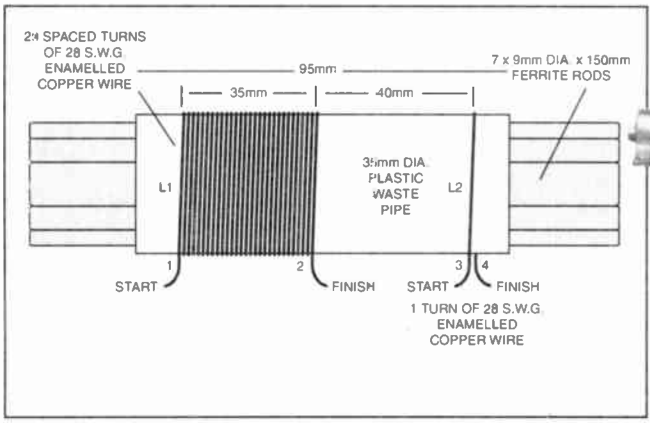


Fig.5. Ferrite rod (7 off) loop aerial winding details and dimensions. The coil former is made from a piece of 35mm outside diameter plastic waste pipe.

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ACTIVE FERRITE LOOP AERIAL

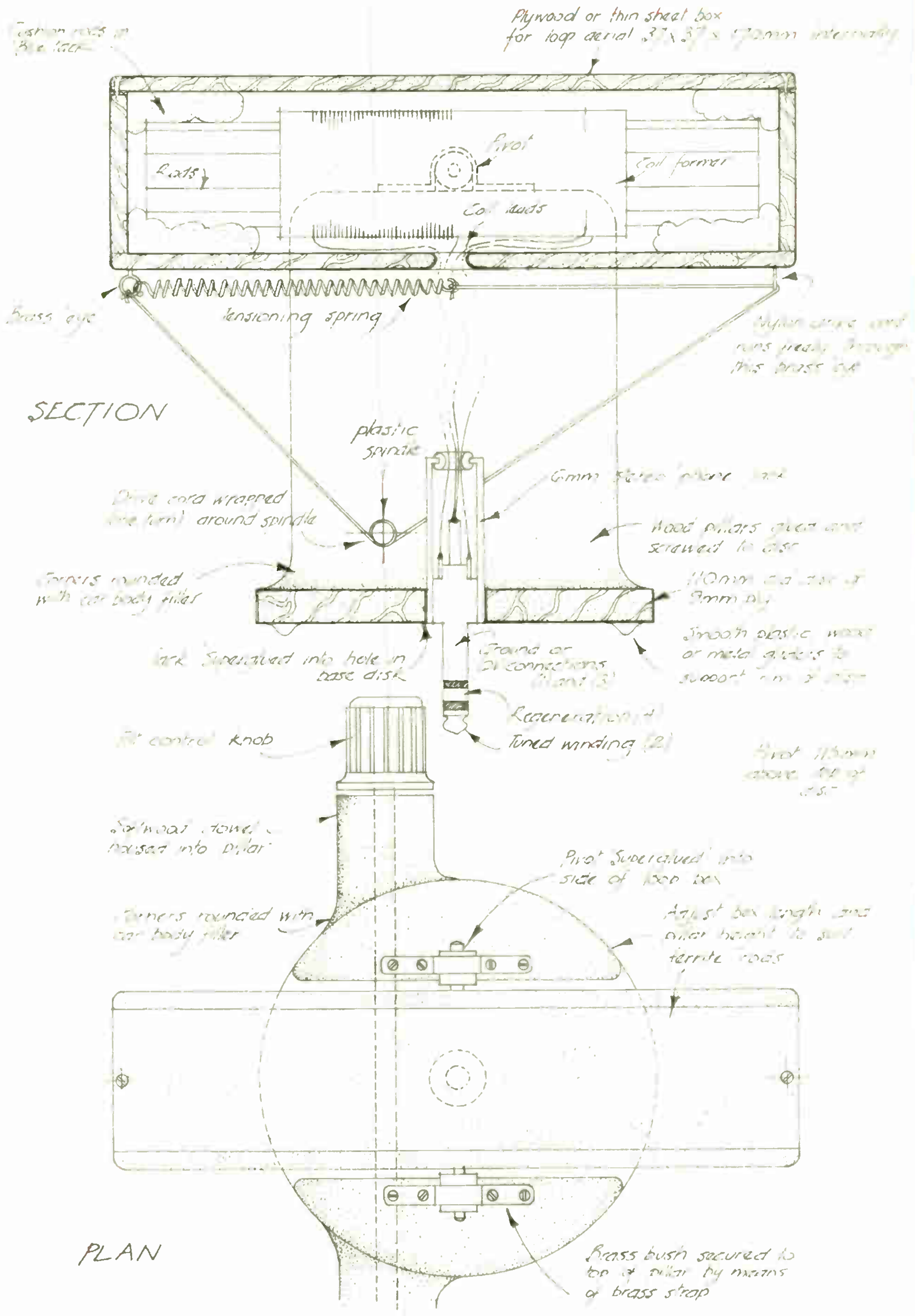
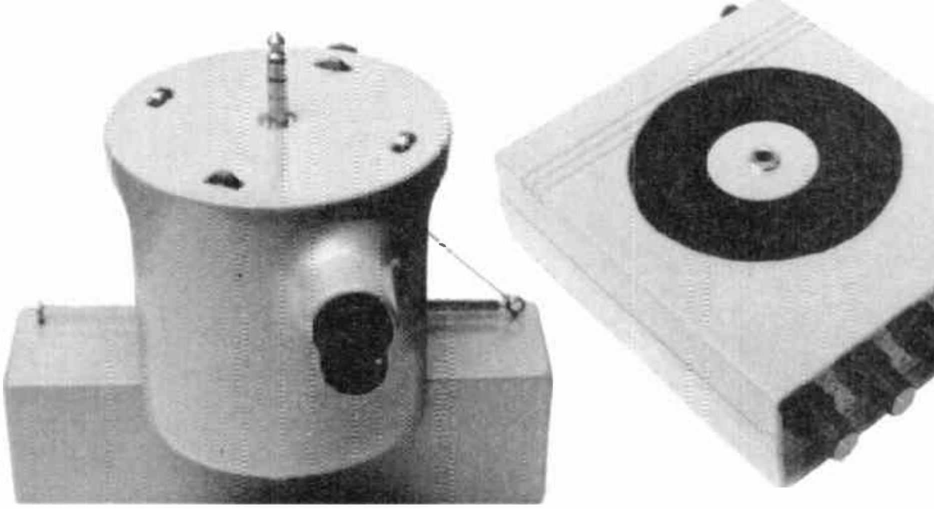


Fig.6. Details of the tilt and turn assembly.



Underside of the "turret" assembly showing four wheels set in the plywood base to relieve the strain on the jack plug. The wheels are taken from curtain runners and mounted on spindles cut from a wire coat hanger. The wheels are cushioned on a disc of thin leather, above right, to allow the turret to glide around freely and silently.

turn. If the lowest frequencies cannot be covered even when the coil is central, a turn or two should be added.

LOOP MOUNTING

Now for the task of putting everything together to give a neat finish. Two suggestions are put forward, one fairly basic and the other almost a professional "work-of-art", but not so hard to achieve as it looks.

Simple System

The mounting of the aerial section must allow the loop to rotate and tilt, and readers will have their own ideas for this.

It can consist simply of a 25mm square wooden post, secured by a screw driven through the top of the control unit case, and free to rotate. The bundle of ferrite rods can then be attached with rubber bands to a cross arm, fixed by a central screw, close to the top of the post and, again, free to rotate. The coil leads are taken through a hole in the top of the case.

Although extremely basic, this arrangement works quite well, especially if a few washers are used to make the pivots turn smoothly.

Prototype System

A more complicated mounting, and the one adopted by the author, is shown in Fig.6 and the photographs. Built up from ply and wood blocks, the internal angles are rounded with car body filler and the unit is finished with "spray-can" paints.

The rods are enclosed in a pivoted box and tilt is controlled by a cord drive. A spring keeps the cord under constant tension.

The plastic spindle which drives the cord is extended a little beyond the body of the unit in order to minimise hand capacity effects. This problem is experienced with *all* loops when critical null adjustments are being made.

A 6mm stereo 'phone jack plug and socket form the vertical pivot and connects the aerial loop leads to the p.c.b.

Coil connections 1 and 3 go to the jack shank, 2 is wired to the tip, and 4 to the jack's centre band. This arrangement minimises stray capacitance.

OPERATING THE LOOP

Communications receivers and, indeed, any Medium Wave receiver with aerial and earth sockets can be used with the loop. (Salvaged car radios often perform extremely well). Connection between the Active Ferrite Loop Aerial and receiver should be by means of a length of coaxial cable.

This loop is not balanced with respect to ground, and the two nulls are not equal or symmetrical. The unit cannot, therefore, be used for direction finding. There is one position for maximum signal, and one for the deepest null, not two 180 degrees apart, as is the case with balanced loops.

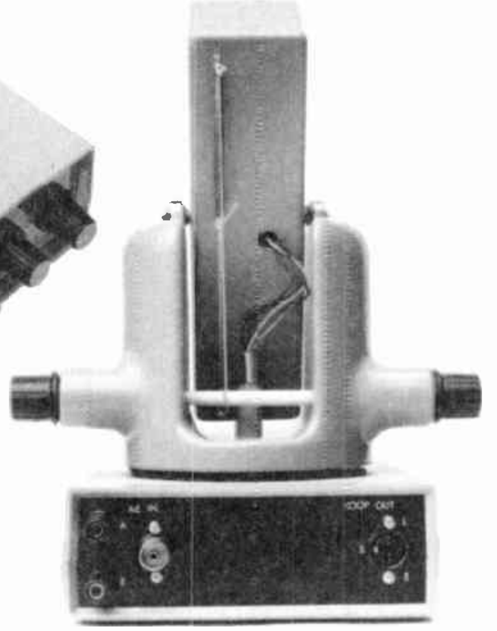
The a.g.c. (automatic gain control) system of a sensitive radio will tend to mask the null, but turning loop output well down will usually expose it. Bearing and tilt can then be adjusted until the null is as deep as possible.

Null depth will vary from station to station and from time to time. Some programmes are transmitted from different locations on the same frequency, and a combination of ground and sky waves also results in multi-path reception, making it impossible to achieve deep nulls.

Notwithstanding this, interference from unwanted stations, and man-made electrical interference, can always be greatly reduced and usually eliminated. To have one station completely disappear and be replaced by another as the loop is rotated can be magical. It certainly makes the construction of the unit very worthwhile.

Advancing the Q-control (VR4) will dramatically increase sensitivity at the expense of bandwidth. At high settings the audio quality is muffled, and the loop can be tuned across the received signal and centred on one or other of its sidebands. Not only will this restore the treble response, it can also shift the tuning to the side of the signal furthest from a source of interference.

The Selector switch S1 permits an instant comparison between the loop and the other aerial available at the listening station. Band searching is best carried out with some form of wire aerial. The loop can then be switched in for comparison when the station has been located. This avoids the need to keep loop and receiver tuning in step.



Rear of the prototype model, showing the tilt drive-cord arrangement.

PERFORMANCE

Performance was assessed by comparing the seven-rod active loop with other aerials. The receiver used for the test has a large signal strength meter, and its a.g.c. system was switched out.

The aerials used were as follows:

(1) A long (20 metres), high (10 metres) wire aerial with impedance matching transformer and screened downlead. The receiver was earthed when this aerial was in use.

(2) A passive, one metre diameter air-cored loop with a single turn coupling winding and no provision for tilting; i.e., a traditional loop or frame aerial.

(3) A thirty-rod version of the ferrite loop described here.

The test was carried out, during daylight, in a room "caged" by the usual house-wiring and plumbing (this distorts nulls). It involved ten stations spread across the Medium Wave band. Loop output was set at maximum, and the Q-multiplier control at zero.

CONCLUSIONS

Results were as follows:

With the exception of one station, the signal level from the seven-rod loop always matched that from the long wire.

The seven-rod Active Ferrite Loop Aerial consistently outperformed the air-cored passive loop, the signal delivered being from 3dB to 6dB stronger. The tilt facility made the nulls with the ferrite loop deeper than those displayed by the air-cored model; in some instances a decent null could be obtained with the ferrite aerial when the null with the traditional loop was barely discernible.

Output from the thirty rod loop was some 3dB greater than that from the seven-rod version.

The application of a modest amount of Q multiplication dramatically increased the output of the ferrite loops at the expense of bandwidth. For a given output, bandwidth with thirty rods was always greater than with seven. ☐

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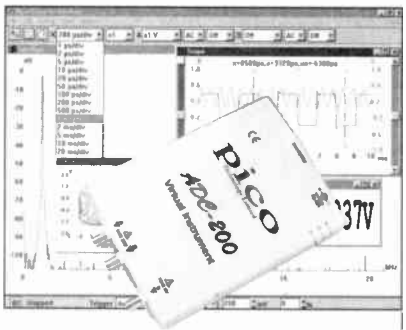

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PIC UPS – Keep Your PIC Powered

THE purpose of the simple UPS (Uninterruptible Power Supply) circuit of Fig.1 is to provide a near-seamless battery backup power for a PIC-based circuit in the event of a mains failure. It allows the circuit to be powered from the mains under normal operating conditions, whilst charging a back-up battery at a reasonably constant current. In the event of a power failure the battery takes up the load with no spikes or delays as would be caused by a relay changing over.

The circuit uses a standard full wave mains power supply. Diode D5 and resistor R1 provide the charging current for battery B1 which is a standard 8·4 volt Ni-Cad (9V RX22 style) type. The purpose of D5 is to prevent the battery from discharging backwards following a mains failure. Transistor TR1 (BC178 or 2N3702) is a *pnp* type which combines with R2, R3 and Zener diode D7 to produce a low voltage cut-off to prevent deep discharge of B1.

Under mains power, current flows from the mains power supply through D5 and R1 which charges the Ni-Cad B1. Current also flows through TR1 to regulator IC1 which provides a 5V output for the PIC microcontroller. Following a power failure, as the voltage across C1 falls, D6 becomes forward-biased and D5 reverse biased, so now the regulator is powered by the battery instead. Should the battery voltage fall below approx. 6·2V (5·6V + 0·6V) as set by D6 and D7, then the Zener will come out of breakdown and turn off TR1, which cuts power to the regulator until mains power returns.

Damien Maguire,
Greystones, Co. Wicklow.

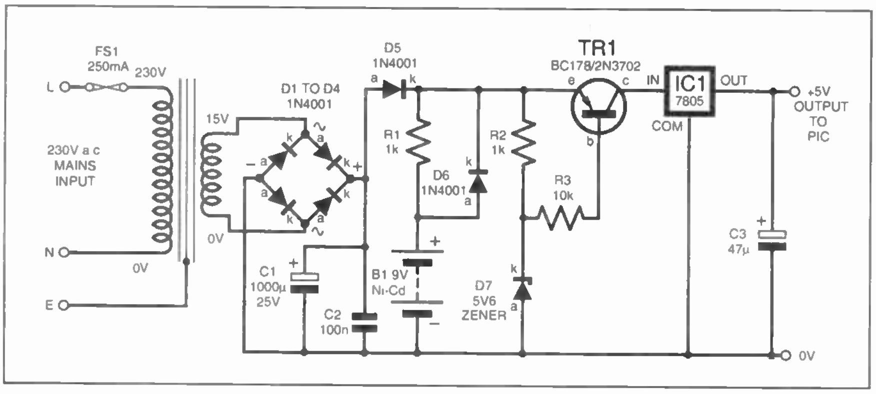

Fig.1. Circuit diagram for the uninterruptible PIC Power Supply.

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BE INTERACTIVE

IU is *your* forum where you can offer others readers the benefit of your Ingenuity. Share those ideas, earn some cash and possibly a prize!

Loudener – Sound-activated Bleeper

THE circuit depicted in Fig.2 is a sound-sensitive switch which will operate a bleeper whenever a microphone detects a sound. It could be used in monitoring systems or even as a novel form of doorbell. The input section contains an electret microphone (MIC1) followed by an amplifier circuit around Darlington TR1. The op.amp is configured as a comparator with the reference voltage applied to the inverting input (pin 2). The output of the op.amp powers a Darlington driver which operates an external audible tone generator. Detected sounds are transformed into a series of beeps or one long beep. Some experimentation may be needed as the circuit, when tested, produced noise with some op.amps but responded correctly with others.

M.N. Beg, Lenasia,
South Africa.

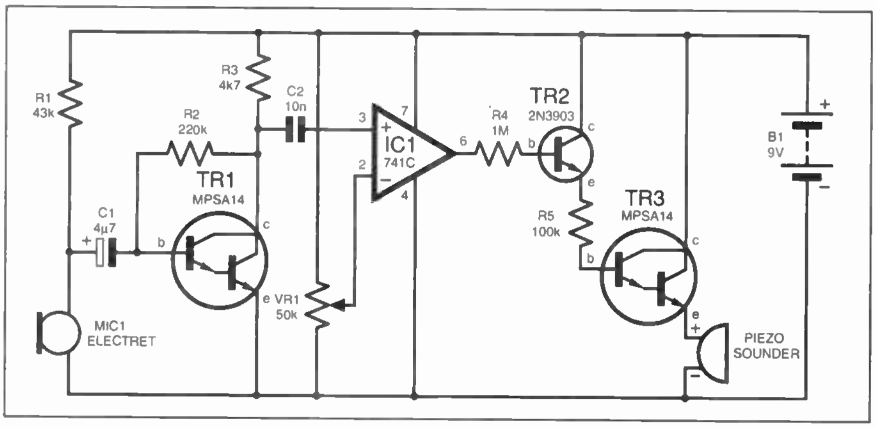

Fig.2. Circuit diagram for the Sound Activated Bleeper

World Radio History

Radio Sleep Timer – Snooze Time

The circuit diagram of Fig.3 was designed as a Radio Sleep Timer to be attached to a battery-operated radio. Its existence was necessitated by the very poor sound quality of bedside clock radios, and the realisation that "sleep" mode was the only use that the bedside clock was getting.

The circuit is based around a NOR gate R-S latch (IC1a and IC1b) which is operated by pushswitch S1. Its output drives transistor TR1 which sinks current and consequently turns on the radio. The latch's inverted output gates an astable oscillator made up of IC1c and IC1d. The oscillator provides pulses to the 14-stage binary counter/divider IC2, used here effectively as a divide by 16,384 (2^{14}) counter. Having reached that figure, the counter resets both the latch and itself. The latch, and hence the timer, can be manually reset by switch S2.

Connection to the radio is achieved by a 3·5mm stereo socket (SK1). The "collar" or sleeve (A) is connected to the uninterrupted positive supply. The switched "ring" (B) interrupts the negative supply to the radio when the plug PL1 is inserted; power to the radio is restored when TR1's drain goes low. Negative power is supplied to the timer via the tip of the stereo plug (C). The circuit is switched on by plugging it into the radio, obviating the need for an on-off switch.

The period of timing is set by capacitor C3 and resistor R5. Values of 470nF and 560Ω give about an hour delay. A rotary switch could be used on IC2's unused outputs to select variable timing lengths, and the addition of another 4001 NOR gate could give touch control and a more reliable "ring-of-three" astable.

Driver transistor TR1 could be replaced by a junction transistor and relay, or could trigger other logic circuitry. If switching anything other than a low power battery radio, sturdier connections between the circuit and radio will be needed.

Andrew Fisher,
Hitchin, Herts.

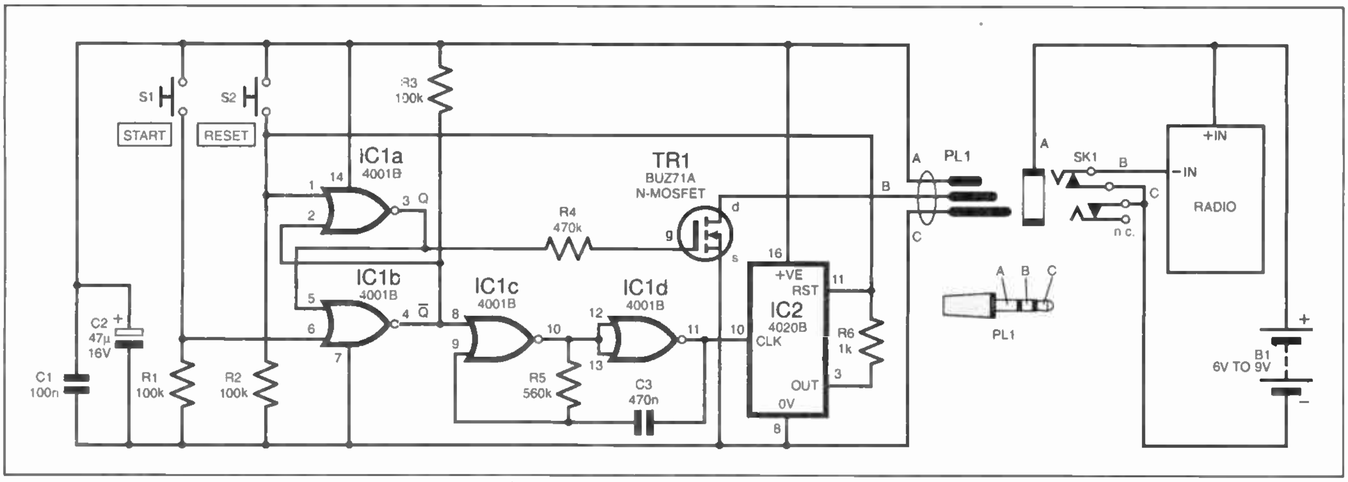

Fig.3. Circuit diagram for the Radio Sleep Timer.

'Scope Synchroniser – Patently a Good Idea

I am a graduate from the Ryazan Radio Engineering Institute of Russia. The circuit of Fig.4 was invented and tested as an additional synchroniser for a common oscilloscope to synchronise complex shaped signals. These signals could not be "stopped" on the screen with the plain (comparator based) synchroniser because they had 2nd and/or 3rd harmonics with amplitudes comparable or even higher than those of the 1st harmonic. The new synchroniser perfectly "stopped" these signals, and has the additional benefit of not needing any adjustment because it sets the threshold automatically. The design has also been used successfully as an input device for a frequency counter because it perfectly separated the 1st harmonic. I managed to obtain a Russian patent certifying this scheme as an invention.

The device consists of two peak amplitude detectors: one for the positive and one for the negative polarity. Their output voltages are reduced by a coefficient of 0.8 after which they are compared as reference voltages to the input voltage using two comparators. The first comparator IC3 gives out a high level if the input voltage is higher than the positive

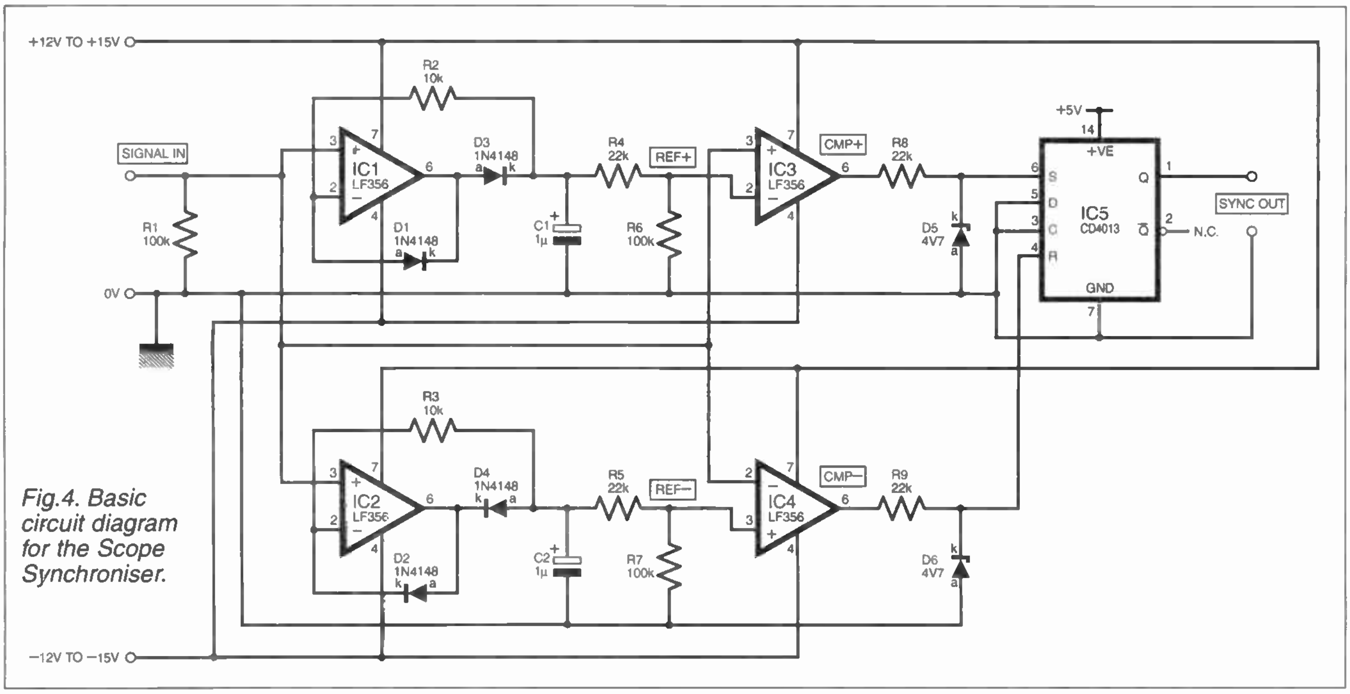

Fig.4. Basic circuit diagram for the Scope Synchroniser.

World Radio History

reference voltage, and the second one (IC4) gives out a high level if the input is lower than the negative reference voltage. The outputs of the comparators are connected to the R and S pins of the flip-flop IC5 which is a type 4013. Its Q output pin forms the output "sync" terminal of the circuit. Fig.5 shows how a dual comparator can be used instead.

The operation of the circuit can be explored by simulating it with MicroCAP or similar packages. Fig. 6 shows the waveforms generated in such a simulation. One can see that the device works properly even if the amplitude of the input signal alters.

To prove that it works properly when the phases of harmonics alter, the frequencies were specially selected to be not exactly 2*f* or 3*f*, where *f* is the frequency of the 1st harmonic. The values of the peak amplitude detector capacitors C1/C2 shown in Fig.4 are chosen to provide the lowest working frequency equal to 200Hz. This frequency also determines how much of the input signal harmonics can be frequency shifted from their values of 2*f*, 3*f*, etc.

Since this frequency shift is comparable to the lowest working frequency, a switchable capacitor is recommended. For example 0.1C, 0.33C, 1C, 3C could be used to increase the frequency range and to adjust the device for a certain signal if the frequencies of the harmonics are not exact multiples of the frequency.

Without switching the capacitors the working range is 200Hz to 20kHz when the amplitude of 2nd and 3rd harmonics are both equal to amplitude of the 1st harmonic, i.e. THR = 140%.

The upper frequency is approximately 20-40kHz, but the circuit can be used to synchronise high frequency signals up to 50-100MHz by replacing the op.amp-based detectors and using high speed comparators for IC3 and IC4.

Dmitry Moskalenko,
Ryazan, Russia.

(Our compliments to Mr. Moskalenko and greetings to our new-found readers in Russia – ARW).

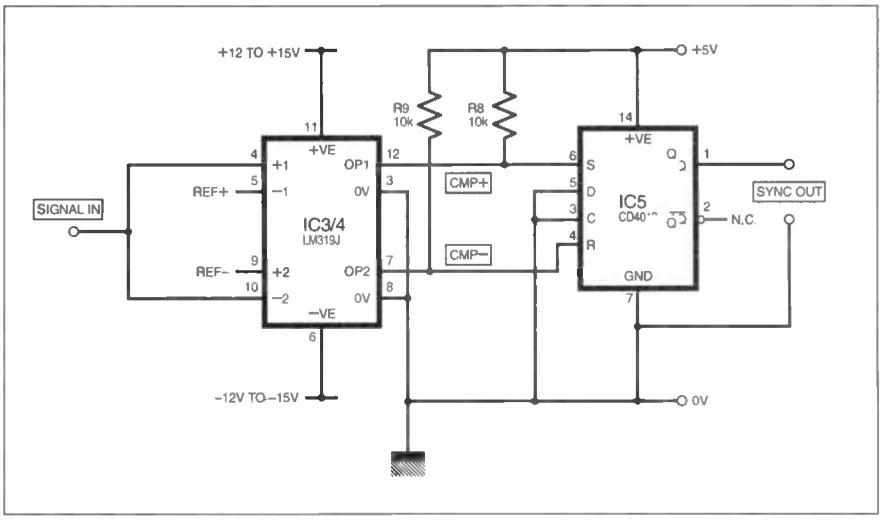

Fig.5. Using a dual comparator instead of IC3 and IC4 in Fig.4.

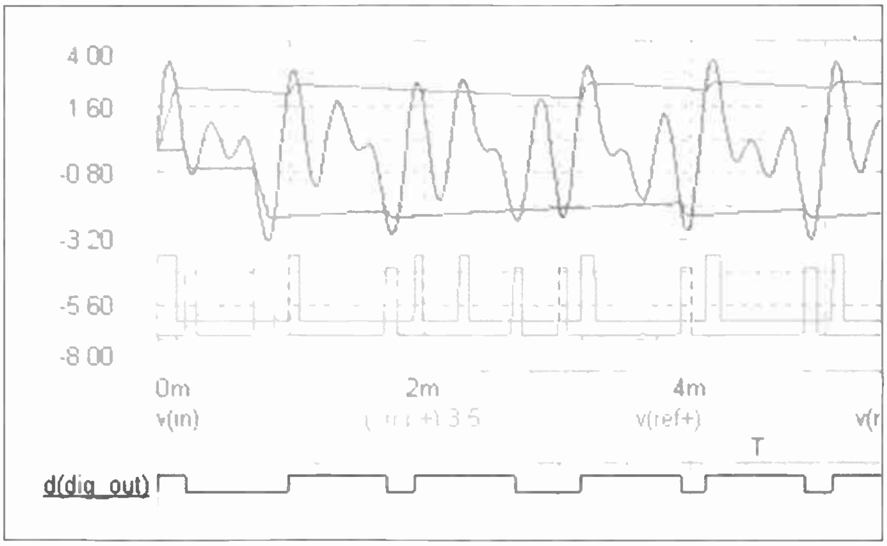

Fig.6. Waveforms generated to simulate the Scope Synchroniser operation using MicroCAP.

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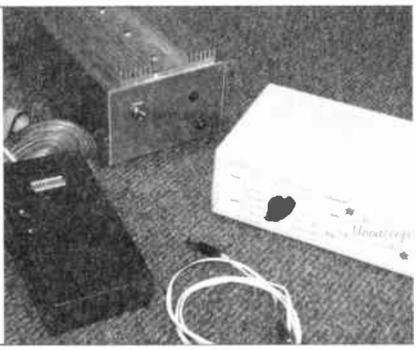
EPE MOODLOOP POWER SUPPLY



ANDY FLIND

A regulated 13·2V 1A supply which may be modified for 12V output.

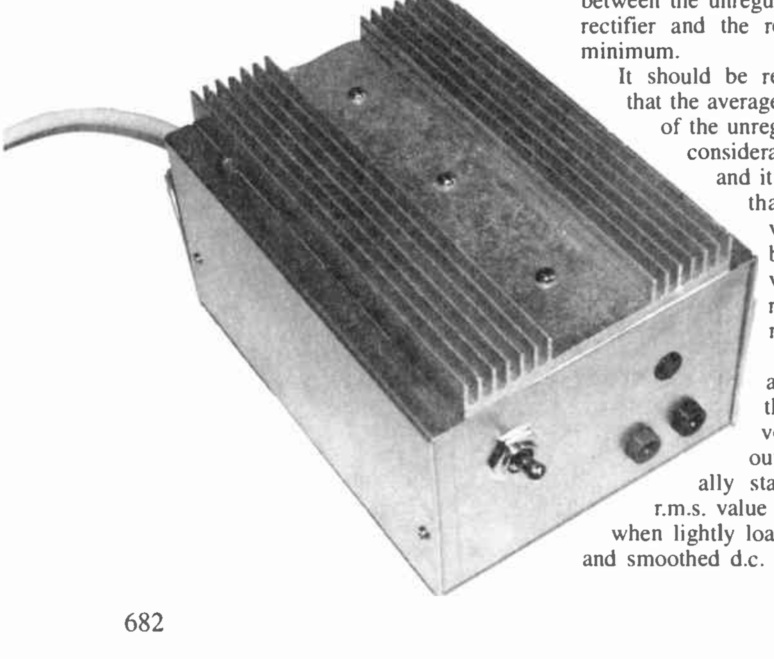
THIS power supply was designed to give a constant voltage output with sufficient current for the *EPE Moodloop* project described in last month's issue. The *Moodloop* may be operated from a supply anywhere between 9V and 15V, the only restriction being that the voltage of the supply should not vary.

Although the average supply current drawn at 12V is about 600mA, the peak value is closer to 1A and at 15V it will be even higher. Since the output frequency range of the *Moodloop* extends down to 1Hz, the use of large decoupling capacitors to supply these current peaks is impracticable. Instead, a power supply capable of delivering the peak current continuously is required.

In some cases a suitable regulated supply may already be available, but for *Moodloop* constructors without access to a suitable power source this project will fill the need. It is compact, simple and relatively inexpensive to construct and can also double as a useful source of d.c. power in the workshop for other applications.

HOTLY COMPROMISED

The design of a linear regulated power supply usually involves some compromise. Linear voltage regulators generate heat. The amount of this heat can be determined from the product of the output current and the voltage difference between the regulator's input and output, in watts. This is why experimenters are sometimes surprised to find regulators overheating or even failing despite not being run at anywhere near their full current rating, an excessive input voltage is often the culprit.



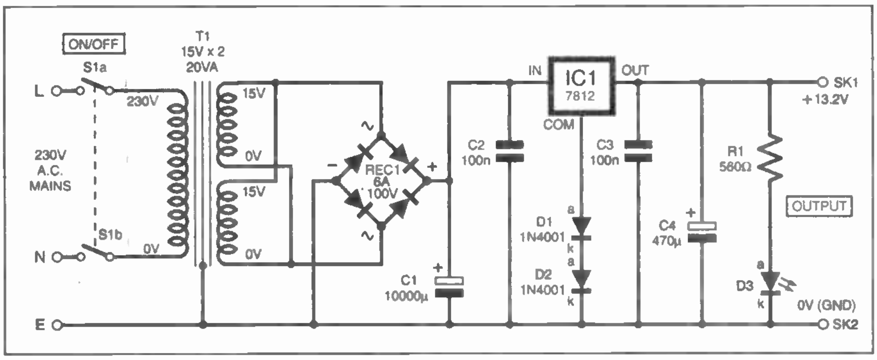


Fig.1. Complete circuit diagram for the EPE Moodloop Power Supply.

Keeping this to a minimum improves efficiency and reduces the heat output, which in turn allows the use of a smaller heatsink or even no heatsink at all in some cases. To minimise heat generation in a mains-operated supply, therefore, it is desirable to keep the voltage difference between the unregulated supply from the rectifier and the regulated output to a minimum.

It should be remembered, however, that the average and "ripple" voltage of the unregulated side both vary considerably with load current and it is essential to ensure that the instantaneous voltage does not dip below the minimum value required for correct operation of the regulator.

Typically this is about 2V to 3V above the regulated output voltage. Transformer output voltages are usually stated in terms of the r.m.s. value at full power but rise when lightly loaded, and the rectified and smoothed d.c. output is in any case closer to the peak value, which is about 1·414 times this.

The rectifier also introduces a small voltage drop, typically about 1·2V for a silicon bridge rectifier where two diodes are in series with the output at any point during operation. For a 15V transformer with a bridge rectifier and a smoothing capacitor the unregulated d.c. voltage is likely to exceed 20V with no load.

Ripple is usually reckoned to be about 700mV peak-to-peak for each 100mA of load current with a 1000µF smoothing capacitor, so it should be about the same for a 1A output if a 10,000µF capacitor is used. These were the basic factors considered when designing this power supply.

CIRCUIT DESCRIPTION

The full circuit of the project is shown in Fig.1. Transformer T1 is a 20VA type with two 15V outputs which are connected in parallel to provide a total current capacity of about 1.3A. This is full-wave rectified to d.c. by REC1 and then smoothed by the 10,000µF capacitor C1. This is used to supply regulator IC1, a standard 12V 1A positive supply regulator.

The output voltage is raised to 13·2V by the inclusion of the two silicon diodes, D1 and D2, between the regulator's common connection and the 0V supply rail. This serves two purposes as it both increases the output power from the *EPE Moodloop* and reduces the heat generated in the regulator.

Constructors requiring a 12V supply for workshop use can replace these two diodes with a link or even fit a switch to short them out in order to make both output voltages available.

World Radio History

Capacitor C4 provides additional decoupling for the output of IC1 whilst C2 and C3 provide high frequency decoupling for IC1's input and output. The l.e.d. D3, together with current limiting resistor R1, indicate that the unit is operating and the output is present.

UP TO MEASURE

A few measurements taken from the prototype confirm the design considerations just described. The r.m.s. a.c. voltage of the two parallel connected secondary windings of T1 was measured at 16·3V with no load and dropped to 15·5V with a load of about 1A. The unregulated voltage across C1 was found to be 20·9V when unloaded, but dropped to 17·6V with the 1A load.

Maximum ripple at this current was about 600mV peak-to-peak, so the lowest instantaneous voltage, at the bottom of the ripple waveform, was just over 17V. This leaves a minimum "headroom" of almost 4V for the regulator when it is delivering 13·2V, sufficient to ensure correct operation but low enough to minimise heat generation.

With a continuous load of 1A, the regulator will therefore produce about four watts of heat, whilst the rectifier will add a further one watt or thereabouts, so a heatsink of some kind is required. The transformer was also found to generate an appreciable amount of heat at this power level.

CONSTRUCTION

The prototype was constructed within an inexpensive aluminium box as shown in the photographs. Transformer T1, rectifier REC1 and the capacitor C1 were fitted into the bottom section of the box. REC1 is secured with a single screw and a dab of heatsink compound, no insulation being necessary.

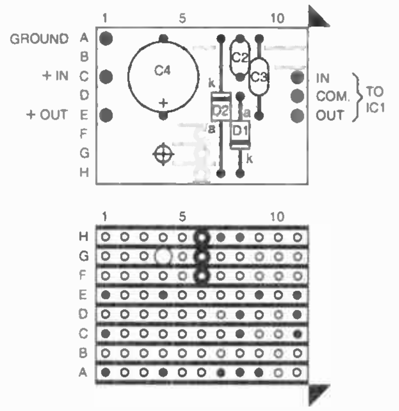


Fig.2. Stripboard component layout.

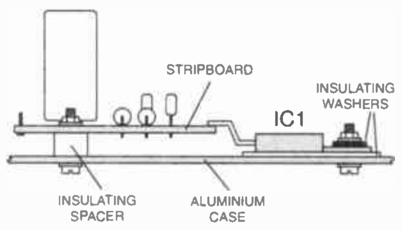


Fig.3. Suggested method of mounting the circuit board and regulator on the underside of the case cover.

Capacitor C1 is a "snap-in" type really intended for mounting on a printed circuit board, but here it is secured with a U-shaped bracket made from a scrap of aluminium and connections are made with soldered leads.

Capacitors C2, C3 and C4 with the two diodes D1 and D2 were assembled on a piece of 0·1-inch pitch stripboard having 8 strips of 11 holes as shown in Fig.2. This and the regulator IC1 were then fitted to the upper section of the box, well away from the transformer and rectifier to distribute the heat as evenly as possible.

The mounting tab of regulator IC1 is internally connected to the common lead so it was fitted to the aluminium sheet

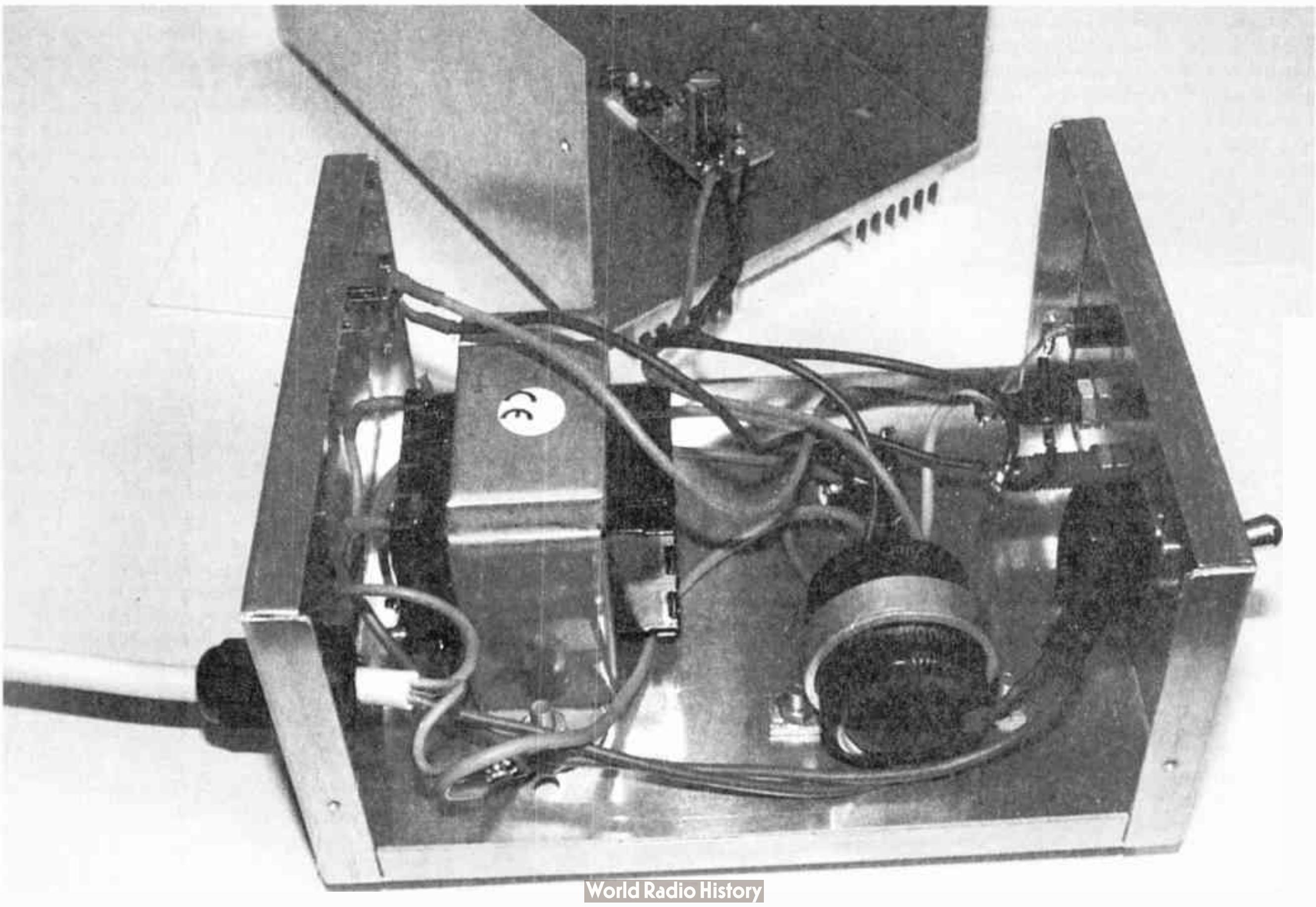
COMPONENTS

See SHOP TALK page

Resistor	
R1	560Ω
Capacitors	
C1	10,000μ radial elect, snap-in, 35V
C2, C3	100n ceramic, resin-dipped (2-off)
C4	470μ radial elect, 35V
Semiconductors	
D1, D2	1N4001 rectifier diode (2 off)
D3	red l.e.d., panel-mounting
REC1	6A 100V bridge rectifier
IC1	7812 1A +12V regulator
Miscellaneous	
T1	20VA mains transformer, 15V x 2 secondaries
S1	d.p.s.t. switch, mains rated
SK1	4mm socket, red (see text)
SK2	4mm socket, black (see text)

Stripboard, 0·1-inch matrix, 8 strips by 11 holes; insulating mounting kit for IC1; aluminium case 152mm x 114mm x 76mm; heatsink 152mm x 94mm x 14mm, plain aluminium.

Approx. Cost Guidance Only **£22** *excluding case*

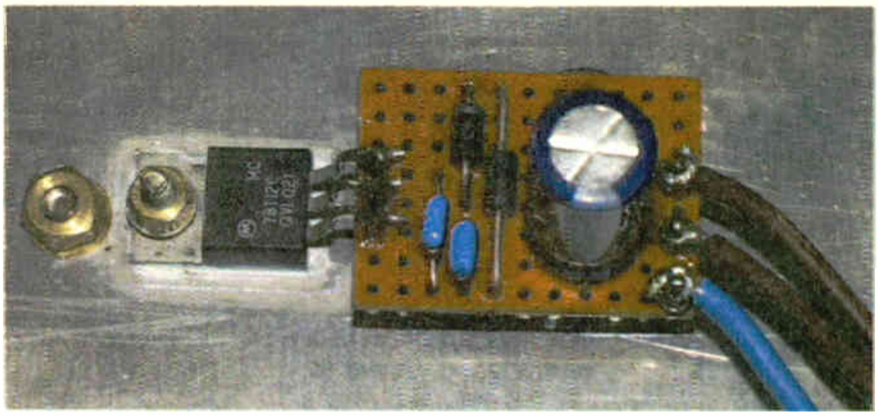


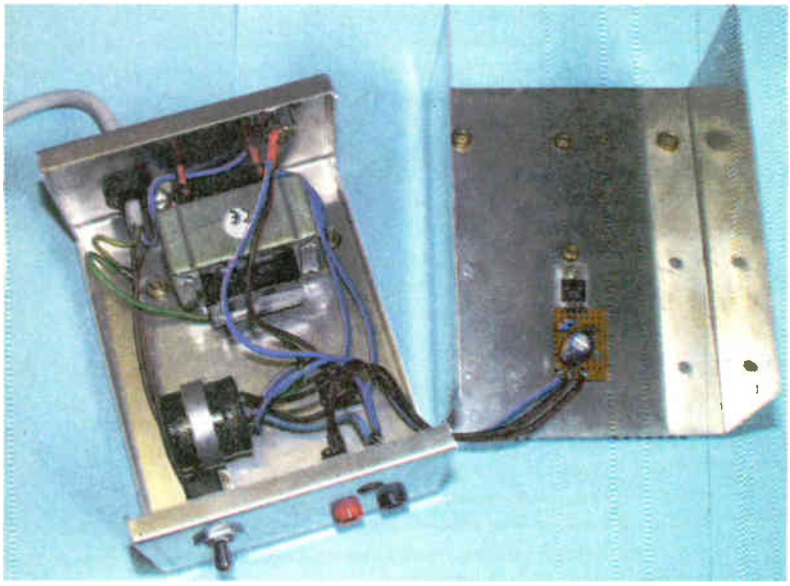
World Radio History

with an insulating washer and some heatsink compound. The leads were then bent to allow them to be soldered directly to their connections on the stripboard as shown in Fig.3. This keeps the decoupling capacitors C2 and C3 close to IC1.

A single mounting screw with an insulating spacer provides additional support for the stripboard. The components are connected together as shown in Fig.4.

Two 4mm sockets are fitted to the case for the output, and l.e.d. D3 and R1 are connected to these as shown. Although a single-pole switch was used for the mains input a double-pole type would be preferable for safety reasons so Fig.4 shows how this should be wired.


Enlargement showing the regulator (IC1) bolted to the underside of the aluminium case cover. It is mounted using an insulating kit and some heatsink compound.


General component layout within the aluminium case. Note the regulator and small circuit board mounted on the underside of the case cover.

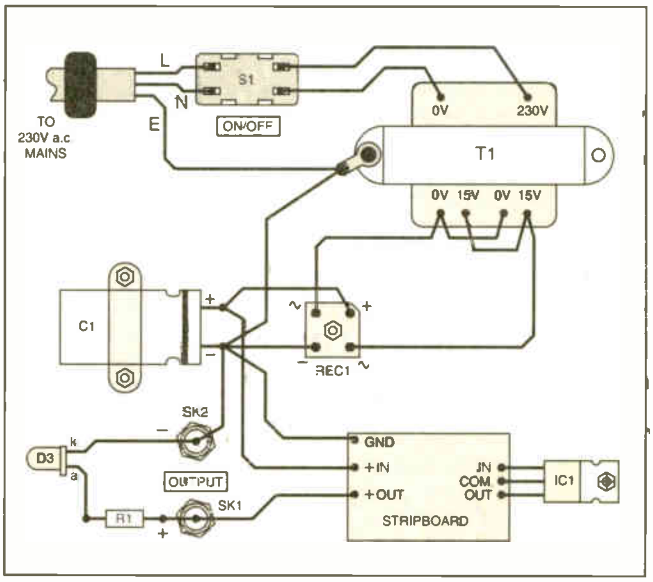


Fig.4. Details of the interwiring between components. The "heavyweight" components are mounted on the base of the aluminium box – see facing photograph.

MAINS SAFETY

Where possible, parts of the circuit connected to the mains supply, such as the switch and transformer connections, should be insulated or shrouded. Some heat-shrink sleeving proved useful for this. Where live parts are exposed, care **MUST** be exercised whilst testing or working on the unit. Temporary covering with insulating tape is often a good idea when working with such hazards.

It is essential to earth the metalwork of the case and it will be seen that the negative output rail (SK2) is also connected to earth. The prototype does not have any built-in fusing, instead it relies on a 3A fuse in the mains plug, but constructors wishing to add fuses to the input or the output for additional safety may easily do so.

If the unit is to be used as a source of power for the workshop a separate switch for the output would be a useful addition as capacitor C1 stores a considerable amount of power and rapid disconnection of this from a circuit on test might occasionally be required. It would also help to spare the unit from the stress of frequent power-up from the mains.

COMPONENT LAYOUT

Apart from keeping the stripboard close to the regulator, the layout of this unit is in no way critical. Built as described, it generates a moderate amount of heat, much of which seems to come from the transformer. To assist with dissipation a large heatsink was screwed to the top of the box, and overnight use with the *EPE Moodloop* results in it becoming quite warm but not too hot to touch, which is quite acceptable for modern electronic components.

If 4mm sockets are used as shown for the output, it is essential to ensure the leads are plugged in the correct way round when using it with the *Moodloop* as reversing the supply polarity would damage this.

A later addition to the prototype, which may be seen in the photographs, was a concentric type power socket wired in parallel with the 4mm output sockets. This was placed at the rear so that the cable was out of the way when in use.

The unit is capable of continuous output of up to about 1A, in fact most regulators of this type can actually supply a little more than their nominal 1A output for short periods. Momentary short circuiting of the output should not cause damage as they also generally have internal "fold-back" current limiting protection, although for longevity prolonged short circuiting and overload of the output should obviously be avoided. ☐

NEXT MONTH

We present a Magnetic Field Strength Checker. Ideal for indicating the presence (or absence) of "force fields" from the *EPE Mooodloop* relaxation project (Aug. '00) and other sources of magnetic "radiation".

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

HIGH POWER 3in. SPEAKER (1W 8ohm). Order Ref: 246.

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HEATING ELEMENT. Mains voltage 100W, brass encased. Order Ref: 8.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

COMPONENT MOUNTING PANEL, heavy Paxolin 10in. x 2in., 32 pairs of brass pillars for soldering binding components. Order Ref: 7RC26.

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

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

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

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

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

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

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

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

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

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

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

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

RECHARGEABLE 12V JELLY ACID BATTERIES. Yuasa 12V 2.3AH. These are 7in. long, 3in. high and 1½in. wide with robust terminals protruding through the top. Price £3.50. Order Ref: 3.5P11.

DITTO, but 12V 18AH. This is 7in. long, 7in. high and 3in. wide. Brand new with 12 months guarantee, price £12.50 or pack of 4 for £48, including VAT and carriage. Order Ref: 12.5P3.

Note – This battery will start a car and is ideal for golf trolleys, etc.

CHARGER for these batteries and other sealed lead acid batteries, £5. Order Ref: 5P269.

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

ANSWER-PHONE UNIT. Brand new, suitable for connection to any BT line, has been currently sold for around £25. You can have one at £12. Order Ref: 12P38.

LIGHT ALARM. A circuit for this appears in the February issue, however, we have a rather less complicated model already made up and in a nice case, price only £3. Order Ref: 3P155.

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

1MA PANEL METER. Approximately 80mm × 55mm, front engraved 0-100. Price £1.50 each. Order Ref: 1/16R2.

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

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

TWIN TELEPHONE PLUG. Enables you to plug 2 telephones into the one socket for all normal BT plugs. price £1.50. Order Ref: 1.5P67.

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

FLASHING BEACON. Ideal for putting on a van, a tractor or any vehicle that should always be seen. Uses a Xenon tube and has an amber coloured dome. Separate fixing base is included so unit can be put away if desirable. Price £5. Order Ref: 5P267.

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

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

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

12V 8A DC POWER SUPPLY. Totally enclosed with its own cooling fan. Normal mains operation. Price £11. order Ref: 11P6.

TWIN 13A SWITCHED SOCKET. Standard in all respects and complete with fixing screws. White, standard size and suitable for flush mounting or in a surface box. Price £1.50. Order Ref: 1.5P61.

INSULATION TESTER WITH MULTIMETER. Internally generates voltages which enable you to read insulation directly in megohms. The multimeter has four ranges AC/DC volts, 3 ranges DC milliamps, 3 ranges resistance and 5 amp range. Ex-British Telecom but in very good condition, tested and guaranteed, probably cost at least £50 each, yours for only £7.50 with leads, carrying case £2 each. Order Ref: 7.5P4.

REPAIRABLE METERS. We have some of the above testers but faulty, not working on all ranges, should be repairable, we supply diagrams, £3. Order Ref: 3P176.

BIG 12V TRANSFORMER. It is 55VA so that is over 4A which is normal working, intermittently it would be a much higher amperage. Beautiful transformer, well made and very well insulated, terminals are in a plastic frame so can't be accidentally touched. Price £3.50. Order Ref: 3.5P20.

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1030	Light dimmer	2.53
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1043	Loudness stereo unit	3.22
1047	Sound switch	5.29
1048	Electronic thermostat	3.68
1050	3-input hi-fi stereo preamplifier	12.42
1052	3-input mono mixer	6.21
1053	Electronic metronome	3.22
1054	4-input instrument mixer	2.76
1059	Telephone amplifier	4.60
1062	5V 0·5A stabilised supply for TTL	2.30
1064	12V 0·5A stabilised supply	3.22
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ULTRASONIC MOVEMENT DETECTOR. Nicely cased, free standing, has internal alarm which can be silenced. Also has connections for external speaker or light. Price £10. Order Ref: 10P154.

CASED POWER SUPPLIES which, with a few small extra components and a bit of modifying, would give 12V at 10A. Originally £9.50 each, now 2 for £9.50. Order Ref: 9.5P4.

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0-110V + 0-110V at 120VA would give you 110V at just over 1A or 220V at ½A, price £8. Order Ref: 8PG3.

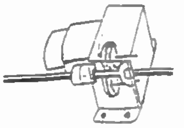
0-35V + 0-35V at 150VA would give 35V at 4A or 70V at 2A, price £8. Order Ref: 8PG9.

0-35V + 0-35V at 220VA would give 35V at 6½A or 70V at 3¼A, price £10. Order Ref: 10PG4.

0-110V + 0-110V at 220V would give 110V at 2A or 220V at 1A, price £12. Order Ref: 12PG5.

0-110V + 0-110V at 500VA would give 110V at 5A or 220V at nearly 3A, price £25. Order Ref: 25PG8.

1·5-6V MOTOR WITH GEARBOX. Motor is mounted on the gearbox which has interchangeable gears giving a range of speeds and motor torques. Comes with full instructions for changing gears and calculating speeds, £7. Order Ref: 7P26.



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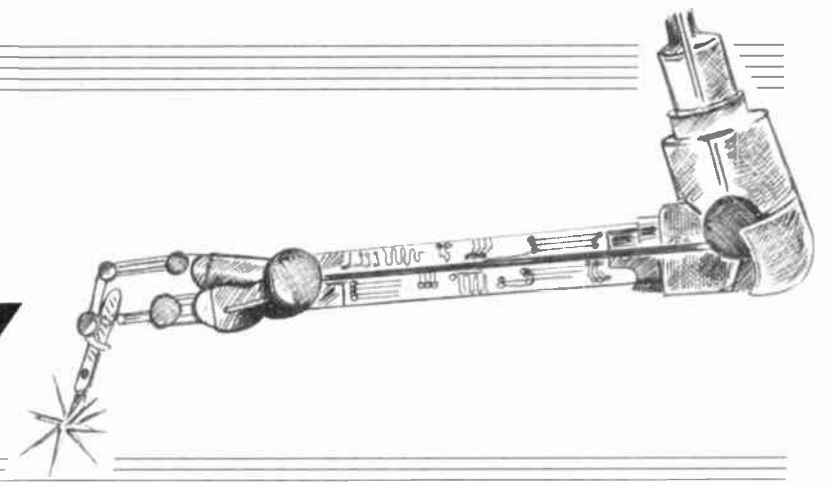


ALAN WINSTANLEY
and IAN BELL

Our surgeons round up a variety of readers' queries and examine choices for rechargeable batteries, including the latest Rechargeable Alkaline Manganese (RAM) and Nickel-Metal Hydride cells.

Common ground

I'm a beginner in electronics and have an idea for a project using a microcontroller to interface with some components including some pumps. I've made a start by purchasing a PIC Programmer and assembler. I need to know how to integrate a PIC into a circuit which will be powered by a 12V rail, and also how to switch a 12V pump from the PIC I/O Ports. I would like to know how to bring a 12V supply down to 5V (to power the microcontroller) and also how to switch on a 12V device from a 5V output. Thanks, **David Nash** (by E-mail).

All you need is an ordinary three-terminal 5V regulator such as the 7805 to reduce the 12V rail to 5V. The regulator has an advantage of being short-circuit proof, having a thermal shutdown function to prevent overheating (caused by inadequate heatsinking for instance). For an example, see the *Interior Lamp Delay* project in Oct'99 *EPE*.

You can interface your 5V PIC microcontroller output to a higher voltage load by ensuring that the PIC and load circuits both have a common ground as a reference. Then use say an *npn* transistor to interface (or buffer) the PIC to the load, with the emitter connected to 0V. The PIC output drives the transistor through a base resistor of say 4·7 kilohms (4k7) or so. One side of the load is connected to the collector but the other side can be "returned" to a higher voltage (+12V say). A 1N4001 diode should be connected across the pump, anode on collector, to prevent back-E.M.F. spikes.

As long as the PIC circuit and transistor all use the same 0V rail everything will be fine – you just have to keep an eye on the voltages appearing across which components. Also consider using a MOSFET power transistor, which being voltage operated will draw next to no current from the PIC. *ARW.*

Beginner's Questions

I'm building an l.e.d. flasher circuit on stripboard and have a few questions. What is the best way to cut the copper strip? How do I know which way round to connect l.e.d.s? Even under a magnifying glass the leads look the same all round to me.

One of my resistors (a 4,700 one) has got FIVE stripes – yellow, violet, black, brown, brown! How do I read it? Is there somewhere with a good description of the 555 timer i.c.? Lastly, what's a good source of 3V for the circuit? **Peter** (via the Internet).

Use a twist drill bit to break the copper strips. Something like a 3 or 3·5mm diameter, held in a pin vice (a handheld "chuck") is fine, or buy the proper tool called a "spot face cutter". Avoid drilling right through the board. Much practical advice for constructors will be found in Robert Penfold's *Practically Speaking – Techniques of Actually Doing It* column.

Most l.e.d.s. have a flat on the "body" circumference to mark the cathode (k) lead. Sometimes, especially with miniature types, the l.e.d. leads may be designated only by their *length* so you'd need to check the connection data in a catalogue. Personally, I look inside the l.e.d. body; almost always the cathode is the reflector cup.

The resistor: yellow = 4, violet = 7, black = 0, brown = × 10, brown = 1%, so it's a 4k7 1% resistor. When you've more experience, as soon as you see yellow and violet stripes together you'll know it's a "47 something" resistor, which will tell you which end to read the colour code from, but even I have to get the data books out to check those bothersome five-band types sometimes!

Data sheets on the 555 timer abound, try downloading one from the National Semiconductor or Texas Instruments web sites (I commend the National Semiconductor data CD ROM which I bought on-line for a few dollars). The manufacturer Zetex produces an interesting low-voltage variation of this timer, the ZSCT1555 which operates down to 2V.

You can easily obtain 3V d.c. by placing two 1·5V cells in series using a suitable battery holder and clip. Or try the idea of using a 3V lithium manganese coin cell, e.g. the CR2450.

Lastly, this seems as good a time as any to introduce my new Electronic Components Photos CD-ROM, which contains over 200 colour JPG images of electronic components divided into categories. It's in HTML format and runs from your web browser, but you don't need an Internet connection to view it. Both thumbnail and high-resolution colour images are included, along with a demo copy of *Paint Shop Pro* image editing software.

The CD ROM is intended for further education, presentations, parts catalogues, handouts, industry training, personal projects and web sites, and it is available from the publishers of *EPE* for only £19.99. (See the CD ROM advert elsewhere in this issue.) You'll find all sorts of photos of resistors, light-emitting diodes, chips and more, included on the CD ROM. *ARW.*

Shocking Stuff

Fernando Bentes de Jesus in Portugal is a regular reader and enquires about the use of Residual Current Devices (RCDs or Ground Fault Circuit Interrupters (GFCIs) in the States).

If it only takes a current of 20mA to cause uncontrollable spasms, perhaps rendering a person unable to release a live wire and electrocuting them, how can an RCD offer protection if it typically only trips at 30mA? Incidentally, I have a dishwasher which causes a worrying and tingling electric shock – yet the RCD checks out OK and does not trip in use.

This was prompted by a two part feature on electricity generation and distribution (*EPE* Aug.'99 to Sept.'99). I haven't heard of any cases whereby anyone has suffered electrocution before an RCD has managed to trip. The level of leakage current flowing through the body is unstable because it depends on so many factors, including skin moisture and the body's contact with the earth.

Even if a fault current of (say) 20mA was received, this is very likely to

World Radio History

increase and as soon as the RCD threshold is reached, the device must trip. There is no question of someone clinging on to a live apparatus and suffering a constant 20mA shock, because in practice that figure just couldn't be constant. If they lose muscle control and therefore grip something tighter, the current would rise and trip the RCD. A trip time of 40 milliseconds is typical, far too rapid to allow the current to cause any real damage, so hopefully I can put your mind at rest.

We can't really cover electrical repairs, but your dishwasher may have developed an insulation fault (perhaps in the wiring loom near the door hinge) made worse by condensation or water leakage. You were unable to pinpoint the problem, so my advice is to get it looked at by a professional or treat yourself to a new one instead! *ARW.*

Ferric Disposal

If you're looking to dispose of highly corrosive Ferric Chloride etchant safely at home, there is a problem. (In some countries the use of this etchant by the public is banned altogether.) You can't put it in the waste disposal, nor bury it, nor are you supposed to flush it down drains or toilets (and definitely don't pour it down a sink!).

I'm told that it can be rendered safe by mixing it with Sodium Hydroxide (caustic soda). The sodium and chloride will combine to make salt whilst the iron and copper will settle, but I haven't confirmed this. Sodium Hydroxide is itself already useful as a developer for UV-exposed boards but as a caustic product it has its own share of handling hazards.

An alternative suggestion is to mix Sodium Carbonate (common washing soda crystals) with the Ferric Chloride, then mix the result in with cement or Plaster-of-Paris, which can then safely be thrown away. Comments from chemists would be welcomed! *ARW.*

Assault and Ni-Cad Battery

From **Mr. D.E. Gardner**, of Yateley, Hants came a query in respect of the correct use of Nickel-Cadmium (Ni-Cd) batteries. The increased use of digital cameras, camcorders and radio-control means that there are ever more Ni-Cads in circulation. Their life will be extended if treated properly, but how do you do that? Let's look at rechargeable battery options, including the latest rechargeable alkaline types.

I would like to know how best to treat rechargeable Ni-Cad batteries. I guess I must have five different battery systems for my radio-control models, each battery needing a specific time for charging. How far must a battery discharge before recharging? There seem to be no proper facilities for discharging these battery packs, so is there a simple way to do it?

Whilst queuing in an electronics store, a customer walked in with a cordless phone which had suddenly stopped working. The phone looked like new but it wouldn't work at all. Dodgy rechargeable batteries were diagnosed, and with a new set installed, the phone sprang into life. All the previous two week's missed calls suddenly came in! (Ahem.)

Constant trickle-charging coupled with light use in between times, is a sure way of shortening the working life of a Ni-Cad, which is the main reason why there is a thriving trade in replacement cordless phone batteries. Ni-Cad cells dislike repeated shallow discharges, and, of course, everyone knows about the so-called "memory effect", which is defined by Eveready as the "characteristic attributed to nickel-cadmium cells wherein the cell retains the characteristics of the previous cycling. That is, after repeated shallow depth discharges the cell will fail to provide a satisfactory full depth discharge."

Ni-Cads are strange because they enjoy being treated somewhat badly, not gently. Generally, it's best to let the gadget fully discharge occasionally (several times a year), rather than partially discharge the Ni-Cad before recharging. Cordless phone, electric toothbrush, rechargeable torch or razor owners should take note. Unfortunately Ni-Cads tend to self-discharge over an extended time (say 10 to 20 weeks), and they are useless for low-drain applications such as clocks or L.C.D. calculators.

If, like me, you use many sets of cells, a good tip is to number your cells in sets using a Dymo or Brother label maker, so that you know which sets are ready and which have been discharged. This helps to ensure that the cells are treated consistently and aren't mixed up. Also to avoid a fire hazard, always store charged batteries safely, so that they cannot be shorted out by metal objects.

As for "when is a Ni-Cad considered flat" the consensus is when the voltage across a cell is approximately 0·9V it is time to recharge. A 3·6V or 7·2V pack has three or six cells respectively, so they are "flat" when they have about 2·7V or 5·4V on-load. There is no point continuing beyond that because the Ni-Cad's capacity has already been spent. You run the additional risk of causing polarity reversal if the cells are discharged too much.

Gas gauge chips

It's nothing to do with spiralling gasoline prices – knowing how much power remains is a big headache for laptop computer and mobile phone manufacturers. In the industry, a variety of so-called "gas gauge" chips are available from the likes of Texas Instruments, who recently joined forces with specialist battery controller makers Unitrode and Benchmarq Microelectronics. If you're looking for data on their current range of battery controller chips, go to **www.benchmarq.com.**

Radio control models that use 7·2V racing packs are notoriously abusive of Nickel-Cadmium cells. Battery packs can become too hot to handle after just a few minutes of hard driving but elevated temperatures are a potential source of internal battery ruin. In racing applications, ensuring that the battery has fully discharged is not a problem (it usually happens just as you're winning!), as the batteries are subject to a complete discharge over a 10 minute cycle or so.

There is probably less risk of "memory effect" arising but the high temperatures caused by self-heating are of concern. Eveready suggest a maximum temperature of 45°C when discharging before cutting the load.

You cannot measure the remaining capacity of a Ni-Cad by reading its off-load voltage. If you want a simple method of measuring when they are nearly flat, you could maybe measure the voltage at which point a particular light bulb filament ceases to glow and, using that as a guide, discharge a battery pack down to a known voltage that way, or place a load across the battery and use a voltmeter. Avoid merely connecting a bulb and letting it run flat.

Internet users can fetch a couple of interesting old documents from our FTP site which describe some of the chemistry behind the so-called "memory effect". Go to **ftp://ftp.epemag.wimborne.co.uk/pub/docs.**

Down with heavy metal

Today my advice would be to choose **Nickel Metal Hydride** (NiMH) types instead, which are a development of the Nickel Cadmium cell. They are more environmentally friendly, eliminating the use of heavy metals (Cadmium). Better still, size-for-size NiMH cells have up to 40 per cent extra capacity, though their discharge characteristics are broadly the same as Ni-Cd cells – their terminal voltage runs along a plateau and then plummets suddenly.

I find NiMH cells indispensable for heavy loads such as my digital camera and flashguns. The elimination of Cadmium also vastly reduces the cell's susceptibility to memory effect (more correctly called voltage depression, where the cell cannot "return" to the original voltage).

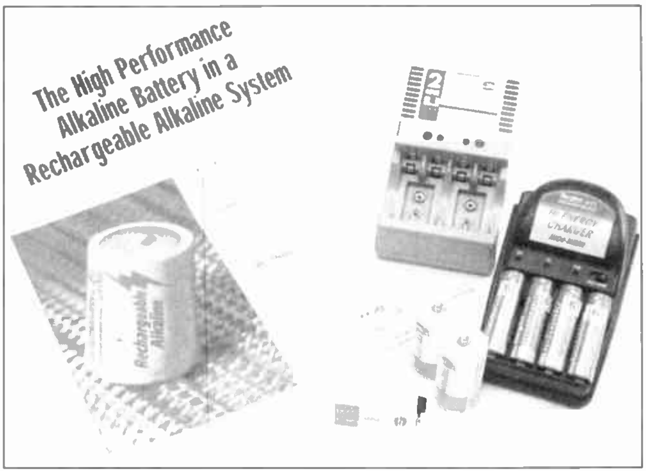
However, it is strongly recommended that you *never* leave a NiMH battery connected to a load such that it is allowed to completely discharge the battery, or (as with NiCads) it may suffer voltage reversal. Always remove the load from a NiMH battery before it is too late. I find this slightly disconcerting as I need to leave a set of NiMH cells in my digital camera to keep its clock running in between times, but I have not noted any ill effects so far.

The best charging techniques are designed to avoid overcharging and possible damage, and they use a three-stage process: a fast recharge to restore up to 90 per cent capacity, an intermediate timed charge completely restores full capacity followed by a trickle charge to balance the cells and compensate for self-discharge.

The electronics industry has a lot of experience of the fifty-year old Ni-Cd but the newer NiMH cell is now creeping on to the consumer market. One wall recharger (the Energiser ACCU Hi Energy Charger, from Argos 982/6852 – also see the identical-looking/priced Uniross CHX2 from Maplin, UG31J) will charge four cells of either type or a 9V battery, at the flick of a switch. I must say that the first example of this model I purchased got alarmingly hot during charging and failed altogether after a few uses, but its replacement is going strong.

RAM your batteries

The latest arrival on the battery scene is the **Rechargeable Alkaline Manganese** (RAM) cell, in which Rayovac leads the way (see photo) although they are not very widely available. Rayovac claim that they have a higher initial capacity than either Ni-Cd or NiMH cells, though not as much as an ordinary alkaline cell, which have a lower internal resistance. Importantly, much better self-discharge parameters are claimed.



Choosing a rechargeable battery is very much like choosing horses for courses – there may be times when a RAM battery would be ideal for loads where ordinary alkaline types are used but have a moderate turnover. Cost-effectiveness is often the most critical factor which determines what type of cell to use. Rayovac particularly recommends RAM cells for applications needing high capacity and low self-discharge uses. I would consider them for flashlights or radios.

The charging method is complex, and TI/Benchmarq have developed some chips for recharging RAM batteries. More advanced systems, including microcontroller-based chargers, require expert advice.

I strongly recommend reading Rayovac's superb on-line battery data, available as a PDF file from **www.rayovac.com/busoem/oem/specs/download.shtml**. This is probably the best resource available, and although it's intended for Original Equipment Manufacturers (OEMs), there is plenty of technical data there of interest to the constructor or engineer.

Also have a look at **http://data.energizer.com/batteryinfo** for the low-down on Ni-Cd and NiMH cells. Both this and the Rayovac web sites have good technical data and performance curves the publication of which has been long-awaited, and you will also find charging and discharging advice on-line. *ARW.*

Help us to help you

Circuit Surgery has always been *your* column and it tries to maintain the widest possible appeal. Queries from beginners are welcome, and you can rely on us for practical and responsible advice. We try to help with general electronics-related queries and offer pointers where we can, but we cannot design custom circuits to order, help with spares or repairs, nor does this column deal with microcontroller programming (sorry).

We know that *Circuit Surgery* is amongst the magazine's most popular columns. There is however an increasing dearth of what we would term "sensible" questions – many queries received are simply unanswerable, and some readers hope a complete chapter will be written specially for them (and faxed/E-mailed by return). We welcome queries from education (including further and higher education) although we cannot always promise a reply unless we intend to use it in the magazine.

So if you have a "sensible" question that you think would be of interest to other readers, please write to us at the Editorial address or ask by E-mail to **alan@epemag.wimborne.co.uk** and we'll do our best to help through the medium of this column.

SHOP TALK

with David Barrington

Active Ferrite Loop Aerial

One or two components needed for the *Active Ferrite Loop Aerial* require further comment and could possibly give some readers local sourcing problems.

As pointed out by the author, most varicap diodes designed for Medium Wave tuning with a 9V maximum bias should be OK in this circuit. The one specified in the article is the KV1236 dual type. Our latest information is that this is to be replaced by the KV1235 type. Both devices will, of course, function in this project.

The specified varicap and transistors are available from **Bonex Ltd** (☎ ***01753 549502*** or ***www.bec.co.uk***) and **JAB Electronic Components** (☎ ***0121 682 7045***).

Finding a source for the ferrite rods proved a little more problematic as they seem to have been dropped from many components catalogues. One very good deal we came across was from **J&N Factors** (☎ ***01444 881965***) who are offering a pack of two ferrite rod aerials from their "bargain packs" for just £1, code Ref D53A. At that price you can discard the coils and use the rods. Another ferrite rod source is **Squires Model & Craft Tools** (☎ ***011243 842424***), code 882-000. This one has a slightly flattened profile, measures 100mm long, and costs £1 each.

If you intend to use the 6·3mm stereo jack socket and plug arrangement to link the top aerial "turret" to the base control unit, the socket came from **Maplin** (***www.maplin.co.uk***), code BW80B. They also supplied the Lorlin, plastic cased, 3-way 4-pole rotary switch, code FF76H.

The single-side printed circuit board is available from the *EPE PCB Service*, code 274.

EPE Moodloop Power Supply

As far as we can tell the 6A 100V bridge rectifier, called up in the *EPE Moodloop Power Supply* component listing, is an International Rectifier device and their code for this part is KBPC6-01. This is currently listed by **Farnell** (☎ ***0113 263 6311*** or ***www.farnell.com***), code 438-029 and **Maplin** (☎ ***0870 264 6000*** or ***www.maplin.co.uk***), code AR80B.

The 20VA mains transformer, with two independent 15V secondary windings, is an RS product and can be ordered through any *bona-fide* RS stockist or through **Electromail** (☎ ***01536 304555*** or ***http://rswww.com***), their "mail order" outlet. It carries the order code 805-079.

Any readers who experience difficulty finding a suitable 10,000μF 35V working radial electrolytic capacitor will find one stocked by Maplin under their HC series, code AU23A. At nearly £4 it seems a bit on the high side, but capacitors do appear to be more expensive nowadays. The same company also supplied the "flat type", undrilled, aluminium heatsink, code FL42V. Most of our components advertisers should be able to supply a suitably sized, two-piece aluminium box.

Remote Control IR Decoder

We have only been able to trace one source for the IS1U60 sensor used in the *Remote Control IR Decoder* project.

This is a complete 3-pin infra-red remote control receiver, complete with integral lens and EMI shielding, manufactured by Sharp, and was purchased from **Electromail** (☎ ***01536 204555*** or ***http://rswww.com***), code 577-897. It can also be ordered through any *bona-fide* RS Components stockists. The chip also contains enough processing circuits to convert the incoming modulated signal to a logic pulse train output.

Unprogrammed PIC16x84s are now quite plentiful and should be easy to obtain. However, for those readers unable to program their own PICs, a ready-programmed PIC16F84 can be purchased from **Magenta Electronics** (☎ ***01283 565435*** or ***www.magenta2000.co.uk***) for the inclusive price of £5.90 (overseas readers add £1 for p&p). For those who wish to program their own PICs, the software is available from the Editorial Offices on a 3·5in. PC-compatible disk, see *PCB Service* page. It is also available *free* via the *EPE* website: **ftp://ftp.epemag.wimborne.co.uk/pubs/PICS/IRdecoder**. The software is written in MPASM.

Steeplechase Game

We do not expect any component buying problems to be encountered when shopping for parts for the *Steeplechase Game*, this month's "Top Tenner" project.

PLEASE TAKE NOTE

Experimenter's Power Supply *I/U May '00*

Page 343. The two programmable Zener diodes (IC2, IC4) used in this circuit were wrongly identified as Texas TL431C parts. They should be **Zetex ZR431C** devices.

The Zetex device has a much lower excitation current than its Texas counterpart and is *essential* in this application.

World Radio History

PIC BASIC

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The PicBasic Compiler instruction set is compatible with the Parallax BASIC Stamp I. Stamp 1 programs can be compiled into PICmicro code and programmed directly into a PICmicro, eliminating the need for a BASIC Stamp module. These programs execute much faster and may be longer than their Stamp equivalents. They may also be protected so no one can copy your code. Other benefits include substantial cost savings over a BASIC Stamp

The PicBasic Compiler has many features beyond the BS1. Peek and Poke instructions let you use additional PICmicro features not available on the BASIC Stamp I. These include access to PORTA, B, C, D and E (if the particular PICmicro has them), A/D converters, hardware serial ports and other on-chip features in BASIC, foregoing the need to use assembly language.

But if you really want to use assembly language instructions, they may be mixed with BASIC instructions through the use of the PicBasic Compilers in-line assembler and Call instruction. Our PICmicro macro assembler is included and automatically invoked by the PicBasic Compiler.

The I2C commands let the PICmicro talk to external I2C devices, such as serial EEPROMs, using only a 2-wire interface. Two PORTA pins have been dedicated to the task (the particular pins assigned may be easily changed if desired so there is no need to tie up any of the special purpose PORTB pins

PBC has more user variables. The BS1 only provides variables from B0 - B13 and W0 - W6. The PicBasic Compiler allows variables from B0 - B79 and W0 - W39 when used with PICmicros having 96 RAM registers in bank 0 like the PIC16C622 and 16C74.

The PicBasic Compiler is a DOS command line application (it also works in Windows) and runs on PC compatibles. It can create programs for the PIC12C67x, PIC14Cxxx, PIC16C55x, 6xx, 7xx, 84, 92x and PIC16F8xx microcontrollers and works with most PICmicro programmers, including our EPIC PICmicro Programmer. A printed manual and sample programs are included to get you started

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The PicBasic Pro Compiler instruction set is upward compatible with the BASIC Stamp II and Pro uses BS2 syntax. Programs can be compiled and programmed directly into a PICmicro, eliminating the need for a BASIC Stamp module. These programs execute much faster and may be longer than their Stamp equivalents. They may also be protected so no one can copy your code

The PicBasic Pro Compiler is a DOS command line application (it also works in Windows) and runs on PC compatibles. It can create programs for the PIC12C67x, PIC12CE67x, PIC14C000, PIC16C55x, 6xx, 7xx, 84, 92x, PIC16CE62x, PIC16F62x, 8x, 87x, PIC17Cxxx and PIC18Cxxx microcontrollers and works with most PICmicro programmers including our EPIC Plus Pocket PICmicro Programmer. A printed manual and sample programs are included to get you started.

The PicBasic Pro Compiler can also be used inside Microchip's MPLAB ICE. This allows programs to be edited and simulated within Windows. It can also be used with our professional 16F877 in circuit emulator / programmer £149.95 see our web page for more info

Version 2.3 of the PicBasic Pro Compiler adds support for the 16-bit core PIC18Cxxx microcontrollers. If you are a current PicBasic Pro owner and would like the latest version, please contact us for an upgrade

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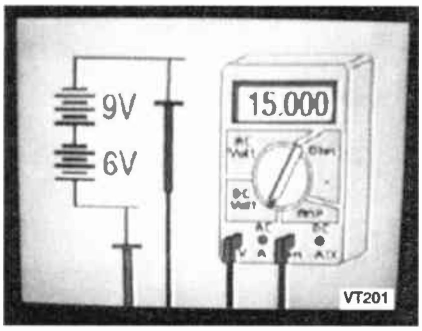

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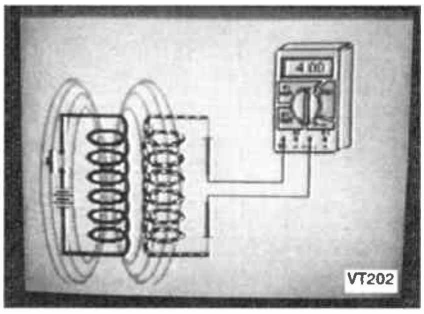

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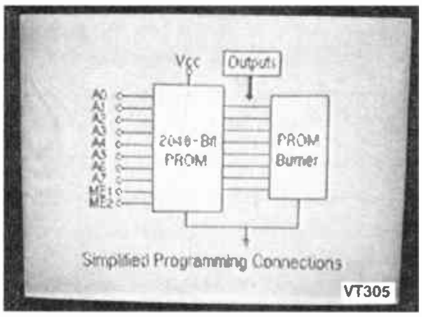

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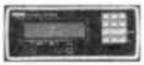

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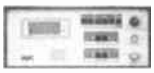

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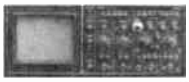

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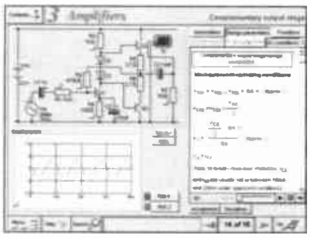

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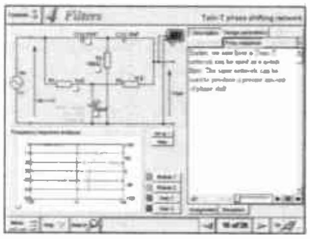
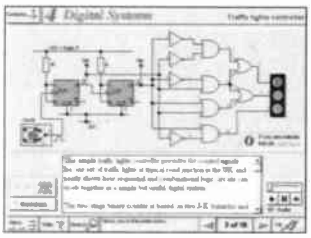


Twin-T phase shifting network

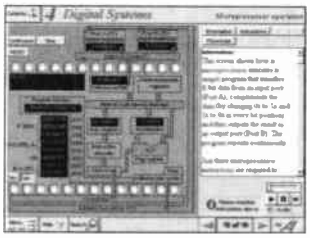
Analogue Electronics is a complete learning resource for this most difficult branch of electronics. The CD-ROM includes a host of virtual laboratories, animations, diagrams, photographs and text as well as a SPICE electronic circuit simulator with over 50 pre-designed circuits.

Sections on the CD-ROM include: **Fundamentals** – Analogue Signals (5 sections),Transistors (4 sections), Waveshaping Circuits (6 sections). **Op.Amps** – 17sections covering everything from Symbols and Signal Connections to Differentiators. **Amplifiers** – Single Stage Amplifiers (8 sections), Multi-stage Amplifiers (3 sections). **Filters** – Passive Filters (10 sections), Phase Shifting Networks (4 sections), Active Filters (6 sections). **Oscillators** – 6 sections from Positive Feedback to Crystal Oscillators. **Systems** – 12 sections from Audio Pre-Amplifiers to 8-Bit ADC plus a gallery showing representative p.c.b. photos.

DIGITAL ELECTRONICS



Virtual laboratory – Traffic Lights

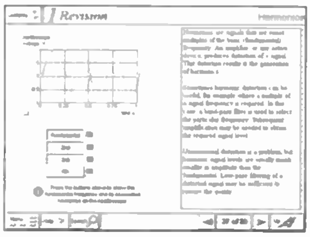


Microprocessor

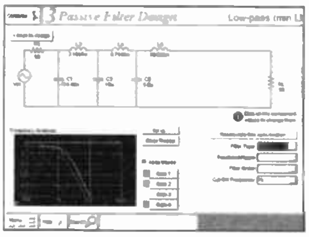
Digital Electronics builds on the knowledge of logic gates covered in *Electronic Circuits & Components* (opposite), and takes users through the subject of digital electronics up to the operation and architecture of microprocessors. The virtual laboratories allow users to operate many circuits on screen.

Covers binary and hexadecimal numbering systems, ASCII, basic logic gates and their operation, monostable action and circuits, and bistables – including JK and D-type flip-flops. Multiple gate circuits, equivalent logic functions and specialised logic functions. Introduces sequential logic including clocks and clock circuitry, counters, binary coded decimal and shift registers. A/D and D/A converters and their parameters, traffic light controllers, memories and microprocessors – architecture, bus systems and their arithmetic logic units.

FILTERS



Filter Theory

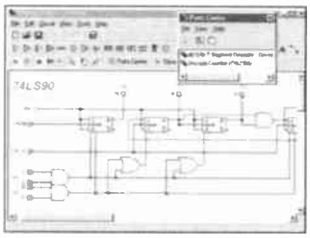


Active filter synthesis

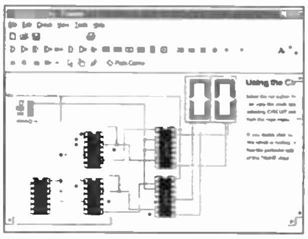
Filters is a complete course in designing active and passive filters that makes use of highly interactive virtual laboratories and simulations to explain how filters are designed.

It is split into five chapters: **Revision** which provides underpinning knowledge required for those who need to design filters. **Filter Basics** which is a course in terminology and filter characterization, important classes of filter, filter order, filter impedance and impedance matching, and effects of different filter types. **Advanced Theory** which covers the use of filter tables, mathematics behind filter design, and an explanation of the design of active filters. **Passive Filter Design** which includes an expert system and filter synthesis tool for the design of low-pass, high-pass, band-pass, and band-stop Bessel, Butterworth and Chebyshev ladder filters. **Active Filter Design** which includes an expert system and filter synthesis tool for the design of low-pass, high-pass, band-pass, and band-stop Bessel, Butterworth and Chebyshev filters based on the use of op.amps.

DIGITAL WORKS 3.0



Macro screen



Counter project

Digital Works Version 3.0 is a graphical design tool that enables you to construct digital logic circuits and analyze their behaviour. It is so simple to use that it will take you less than 10 minutes to make your first digital design. It is so powerful that you will never outgrow its capability.

- Software for simulating digital logic circuits
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World Radio History

Interested in programming PIC microcontrollers? Learn with PICtutor by John Becker

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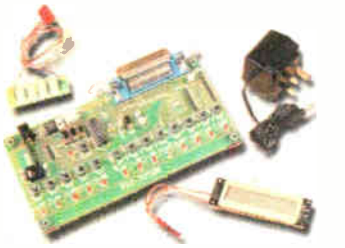

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Nearly 40 Tutorials cover virtually every aspect of PIC programming in an easy to follow logical sequence.

HARDWARE

Whilst the CD-ROM can be used on its own, the physical demonstration provided by the **PICtutor Development Kit**, plus the ability to program and test your own PIC16x84s, really reinforces the lessons learned. The hardware will also be an invaluable development and programming tool for future work.

Two levels of PICtutor hardware are available – Standard and Deluxe. The **Standard** unit comes with a battery holder, a reduced number of switches and no displays. This version will allow users to complete 25 of the 39 Tutorials. The **Deluxe** Development Kit is supplied with a plug-top power supply (the **Export** Version has a battery holder), all switches for both PIC ports plus l.c.d. and 4-digit 7-segment l.e.d. displays. It allows users to program and control all functions and both ports of the PIC. All hardware is supplied **fully built and tested** and includes a PIC16F84.

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Essential information for anyone undertaking GCSE or "A" level electronics or technology and for hobbyists who want to get to grips with project design. Over seventy different Input, Processor and Output modules are illustrated and fully described, together with detailed information on construction, fault finding and components, including circuit symbols, pinouts, power supplies, decoupling etc.

Single User Version £19.95 inc. VAT
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World Radio History

PRACTICALLY SPEAKING

Robert Penfold looks at the Techniques of Actually Doing It!

IN THEORY at any rate, summer should be nearing its end when this magazine is on the bookstalls, and thoughts should be turning away from outdoor pursuits towards indoor activities such as project building. Traditionally, this is the time of year when a lot of new recruits enter the hobby, and this feature often offers advice about getting started.

This time we work on the basis that learning from your mistakes is good, but learning from the mistakes of other people is even better, and we will consider how *not* to do it. By avoiding the pitfalls mentioned here new recruits should find this absorbing hobby relatively frustration-free.

Smart Buying

When building old projects we always advise checking the availability of all the components before buying any of them. Otherwise you risk purchasing 95 per cent of the parts only to discover that the other five per cent are no longer available.

Both manufacturers and retailers seem to have rationalised their ranges of components in recent years, resulting in many components suddenly disappearing. Short-lived components that failed to "make the grade" have always been a problem, but even some of the "golden oldies" have suddenly proved to be difficult or impossible to obtain in recent years.

Even with a project published a few months ago it is risky to start ordering parts without first checking that they are all still available. Be particularly careful about semiconductors, which seem to be the worst sufferers of here today – gone tomorrow syndrome.

Get as many catalogues and price lists as you can. This maximises your chances of being able to track down any vital but unusual parts that are needed to complete a project. Most component suppliers now have online catalogues at their web sites, and you should certainly pay these a visit if you have Internet access. Ignoring the *Shoptalk* feature is a common error. This gives at least one source of supply for any difficult to obtain parts used in *EPE* projects.

Mega-Projects

Building a large and exotic project is a good way to impress your family and friends, but only if it works! It is stating the obvious to say that beginners should choose beginners projects, but some succumb to the temptation to go for something more impressive.

Provided you choose simple projects to start with there is an excellent chance that they will all work. You may have to sort out one or two simple mistakes, but there should be no major difficulties. With larger projects there are more opportunities for things to go wrong, and it can be more difficult to sort things out if problems do occur. Only build a project if you fully understand its function and use.

Another good way to get into difficulties is to build a project that is not necessarily all that complex, but has a highly technical or obscure function that you do not really understand. At one time there was a steady trickle of letters from readers who were having problems simply because they had misunderstood the exact function of a project. Thankfully, this type of thing is relatively rare these days.

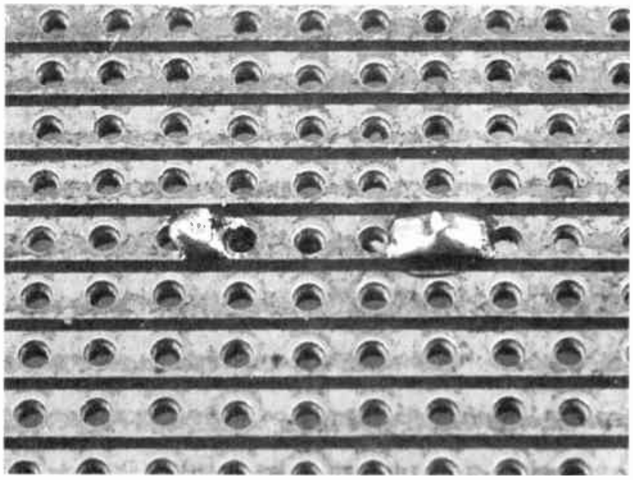

Fig 1. A 'dry' joint on the left and a good joint on the right.

Kid Gloves

When I start on some do-it-yourself jobs around the house it takes a while to adjust to doing things on a larger scale. I am used to producing and working on intricate circuit boards, not dealing with huge sheets of MDF and drilling large holes through walls.

Many people have the opposite problem when starting electronic project construction. Most project cases are made from thin and relatively soft aluminium, or plastics that are either soft or brittle. Fibreglass circuit boards are quite tough, but boards made from other materials are less durable. Some makes of stripboard are quite brittle.

Applying the "hammer and tongs" approach to project construction is a good way to end up with a collection of battered and cracked cases and circuit boards. Always proceed slowly and carefully, using no more than moderate pressure. For electronic project work hand tools or small cordless power tools are more appropriate than large power tools.

You also need to go at things in a restrained way when mounting components on a front panel. Most front panel components are mounted via a threaded bush and a fixing nut. Even with the larger components that have metal bushes, tightening the nuts as if they were wheel nuts on a car could cause damage.

With the smaller components and those that have plastic bushes it would certainly produce some sheared threads. Over-tightening the fixing nuts on smaller components can even result in the front section breaking off completely. Tighten mounting nuts enough to fix the components securely in place, but do not necessarily go on turning them until you cannot force them any further.

Bit of Advice

The *EPE* web site (**www.epemag.wimborne.co.uk**) is the place to go if you would like to know how to solder properly. There you will find a comprehensive and fully illustrated guide to soldering.

There are two common mistakes that newcomers tend to make when they first try their hand at soldering. The obvious way to solder is to first melt the solder on the tip of the iron, and to then transfer the molten solder to the surfaces that are to be joined. Unfortunately, in this case the obvious method is definitely the wrong way of doing things.

The type of solder used for electrical work has cores of flux which help the solder to flow over the wires, copper pads, etc., so that a good electrical connection and a physically strong joint are produced. The problem with applying the solder to the bit first and the joint second is that the flux tends to burn away before the solder reaches the joint.

Another problem is that the solder is applied to a cold joint, and it tends to solidify as soon as it touches any of the cold metal surfaces. This factor, plus the lack of flux, results in the solder not flowing over the surfaces properly, giving a weak and ineffective "dry" joint. The left-hand joint in Fig.1 was produced using the transfer method. It has actually produced a proper electrical connection, but the lack of solder has given a physically weak joint.

To avoid a "dry" joint the tip of the soldering iron must be applied to the joint first, and then some solder is fed onto the bit of the iron. The solder should then flow over the surfaces to produce a strong joint and a good electrical connection, as the right-hand joint of Fig.1.

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Modern components and solders make soldering much easier than it used to be, but you may still encounter a leadout wire or integrated circuit pin that is clearly covered with a large amount of dirt or corrosion. It is then a good idea to carefully scrape away the contamination with the blade of a penknife or using wire wool, rather than hoping that the flux will be able to deal with it.

Timeout

The second common soldering problem is simply taking too long over each joint. With experience you will be able to complete soldered joints very rapidly without having to give each one very much thought. Initially things will inevitably be slower and hesitant, but the bit of the iron must still be applied to each joint for no more than one or two seconds.

Some components are more heat resistant than others, but even the more simple components such as resistors and capacitors can be damaged by overheating. Semiconductors are much less tolerant of heat, and are easily damaged by "leisurely" soldering.

It is a good idea to buy some resistors and a piece of stripboard and use these to practice soldering before trying to actually build your first project. You will then "get up to speed" before you start building in earnest, and any "burnt sacrifices" you produce initially will be of no consequence.

Broken Wires

It is tempting for the beginner to improvise when it comes to cutting wires and stripping insulation from them. Homespun methods that involve sharp knives have to be regarded as decidedly dangerous. Scissors are a less dangerous option, but will soon be ruined if they are used to cut wires, and do not provide the sort of precision that is required.

A problem when using anything other than proper wire strippers is that the wires are almost invariably nicked slightly during the stripping process. This seriously weakens the wires, which then easily fatigue and break. Use multi-strand connecting wire rather than the single-core variety that is very prone to this breaking problem.

A cheap pair of combination wire cutters and strippers should last many years and will avoid a lot of problems. These have notches in the cutting blades (see Fig.2) so that they can be adjusted to cut through the insulation without damaging the wires within.

Always set wire strippers for the largest aperture that enables the sleeving to be removed. This minimises the risk of damaging the wires.

Holders

It is tempting to leave out integrated circuit (i.c.) holders, or d.i.l. (dual in-line) sockets as they are commonly referred to. Why bother with the expense of an i.c. holder when you can solder the components directly onto the board?

Fig 2. Inexpensive wirecutters/strippers can save a lot of problems and are safe.

As pointed out previously, semiconductors are vulnerable to overheating, a problem that is made worse if there are large numbers of pins to connect. Also bear in mind that many modern semiconductors are vulnerable to damage from static charges. It is not just large discharges that are the problem, and even quite modest voltages can "zap" the inputs of some devices.

Soldering this type of component direct to a circuit board increases the risk of static damage and is definitely not a good idea. Always heed any advice about avoiding static damage, including the use of i.c. holders.

Another good reason for using holders is that the occasional mistake will inevitably occur, with the integrated circuit being fitted the wrong way round. If the device is fitted in a holder there is no major problem. There are special tools for pulling integrated circuits from their holders, but it is usually possible to carefully lever one end free using a small screwdriver, and to then repeat the process at the other end. The device is then fitted the right way around.

If the component seems very reluctant to move, you are probably levering the socket away from the board rather than the chip from its holder! Look carefully at what you are doing when using low-profile holders.

A popular way of damaging integrated circuits is to pull them from their holders using your fingers. If you do manage to pull the devices free it is virtually certain that one end will pull clear of the holder well ahead of the other end. This produces a lot of severely bent pins.

The pins can usually be prised back into position with the aid of a screwdriver blade, but there is a real risk of one or more pins breaking off. There is also a strong possibility that as the chip comes free from the holder it will bury some of its pins into your finger.

Desoldering equipment is needed to remove an integrated circuit that is soldered direct to the circuit board. Even with the right equipment it can be difficult to remove multi-pin components. There is a real risk of damaging the component, but of more importance the circuit board can also come to grief.

Testing Time

When your latest masterpiece is finished it is tempting to immediately switch on and see if it works. It is also a popular mistake that will probably not have dire consequences, but costly damage cannot be ruled out.

It is a good idea to spend at least a few minutes looking for any wiring errors, semiconductors fitted the wrong way round, swapped over components, and this sort of thing. Be especially vigilant when looking for components that are fitted the wrong way round, and do not forget to check the battery clip as well.

In the past, semiconductors connected the wrong way round or fed with the wrong supply polarity had a life expectancy of about one microsecond. Modern devices are less easily damaged in this way, but they can still be "zapped" by the large supply currents that often flow as a result of incorrect connection.

You are usually left in no doubt when a semiconductor overheats, because it often explodes with a load "crack". Electrolytic capacitors connected the wrong way round often suffer the same fate. Always switch off at once if you detect the characteristic smell of hot components coming from a low power circuit.

Ignoring any notes on setting up and using a project is a good way of ensuring that it fails to perform properly even if it has been built properly. Always follow any setting up instructions "to the letter", and heed any advice about using projects.

Do It

The biggest mistake of all is to always be about to build a project, but to never actually get around to it. Getting started is the hardest part of any creative hobby, but once underway you are unlikely to have any regrets and should be at the start of countless hours of fun.

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PIC Programming Project

REMOTE CONTROL IR DECODER

ROGER THOMAS

Allows PIC programming enthusiasts to remotely control their designs.

THIS design was created to enable PIC microcontroller circuits to be enhanced by the addition of a low cost infra-red sensor and suitable decoding software. The operation of the PIC software can then be selected via a remote control handset. This control option may be preferable to interfacing external switches to the PIC.

The circuit and program could also be used just as a simple tester to show that a remote control is working.

BASIC FUNCTIONS

Referring to Fig.1, the Remote Control Decoder uses an infra-red sensor (IC2) the demodulated output from which is connected to a PIC16x84 microcontroller (IC1) for decoding.

Remote control handsets can use a variety of different protocols. The PIC software decodes either the RC5 (Philips) or SIRC (Sony) transmission protocol as these are most likely to be used to control equipment in the home. These protocols are described later so that the decoding software can be understood and incorporated as part of another program for a more elaborate circuit.

To help demonstrate the decoding process, and provide programming examples, the PIC circuit incorporates two light emitting diodes (D1 and D2) connected to Port B. Certain remote control key codes are recognised by the PIC software and used to switch these l.e.d.s on or off.

Resistors R1 and R2 limit the l.e.d. current from the PIC. Additional l.e.d.s with suitable current limiting resistors can be added but note that the PIC can only source a maximum current of 20mA per port pin, with a maximum current total of 100mA for Port B.

The circuit can easily be built on stripboard and requires a regulated +5V power supply. No constructional details are offered. Software is available as stated later.

SERIAL INTERFACE

It can be difficult to predict what command code a particular remote control handset key will generate. Instead of switching on or off l.e.d.s, the value of the command code generated by the remote control handset can also be serially transmitted to a PC-compatible computer.

To achieve this, R3 is a series current-limiting resistor and connects Port B pin RB3 to pin 2 of a 9-pin D-type serial port socket (SK1 in Fig.2) so that the data from the PIC circuit can be sent direct to the PC's serial port. In serial mode, the PIC software needs to be amended with the l.e.d. output routine replaced by the serial port emulation software.

By running the PC serial link version of the PIC software the command values of different remote control handset keys are displayed. The lists which illustrate various command codes are given later, but can only be used as a general guide to what command code a given key on the handset may generate.

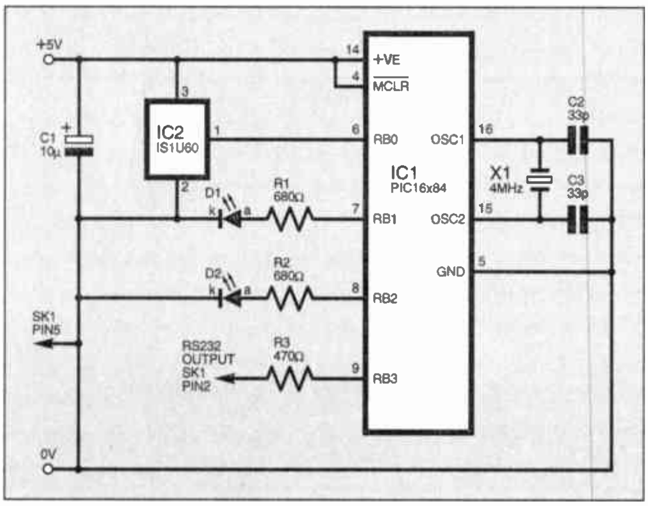

Fig.1. Circuit diagram for the Remote Control IR Decoder.

INFRA-RED SENSOR

The IS1U60 remote control infra-red sensor, IC2, is manufactured by Sharp. As can be seen from the block diagram in Fig.3, this device filters, amplifies and demodulates the infra-red signal. The final stage is a comparator circuit which gives a clean TTL output signal. Using this device is considerably easier (and cheaper) than building a circuit using a separate infra-red detector and amplifier. Pinouts are given in Fig.4.

Data output from the sensor is connected directly to the PIC at Port B pin RB0. (It could also be added to an existing PIC circuit with minimal additional wiring if a spare port pin is available.)

With no infra-red signal the output of the device is 5V (logic 1) and consumes a maximum current of 4·5mA (2·8mA typical). The recommended power supply range is 4·7V to 5·3V.

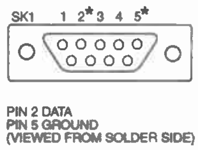

Fig.2. 9-pin D-type female serial connector.

COMPONENTS

Resistors

R1, R2	680Ω (2 off)
R3	470Ω

See SHOP TALK page

Capacitors

C1	10µF elect. 10V
C2, C3	33pF ceramic (2 off)

Semiconductors

D1, D2	red l.e.d. (2 off)
IC1	PIC16x84 microcontroller, preprogrammed (see text)
IC2	IS1U60 infra-red sensor

Miscellaneous

SK1	9-pin D-type serial connector, female
X1	4MHz crystal

Stripboard, size to suit; 5V power supply (see text)

Approx. Cost Guidance Only **£8** *excluding PSU*

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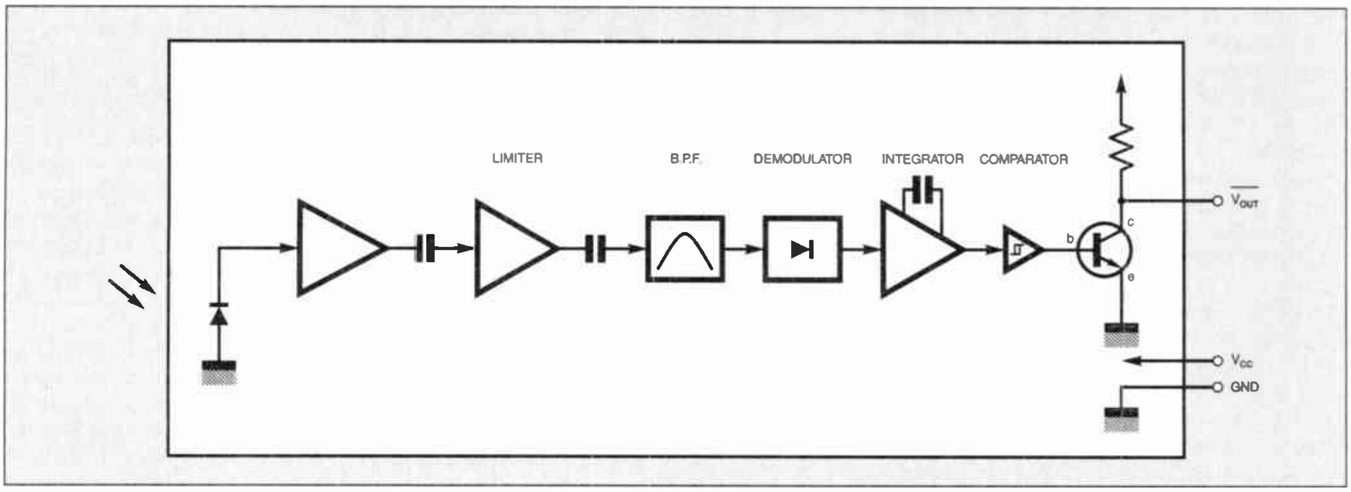

Fig.3. Block diagram for the IS1U60 remote control IR sensor.

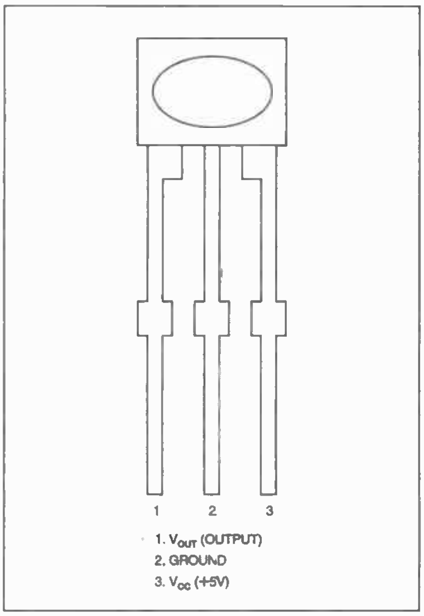

Fig.4. Pinouts for the IS1U60 sensor.

RC5 PROTOCOL

The RC5 remote control code protocol was developed by Philips and is used by several other manufacturers. However, it is worth noting that not all products manufactured by Philips use this protocol.

An RC5 transmission has a duration of approximately 25 milliseconds and contains 14 bits of data. A logic 0 is encoded by a high-to-low transition and a logic 1 by a low-to-high transition. This is called bi-phase coding, as illustrated in Fig.5.

The arrangement of the 14-bit code is given in Fig.6. The first two bits (S) of the transmission are Start bits and are always transmitted as logic 1. This allows the IR receiver to adjust its automatic gain control to suit the infra-red signal strength. The Control bit (C) toggles whenever a new key is pressed, or if a key is held down and a repeated transmission is made every 113 milliseconds.

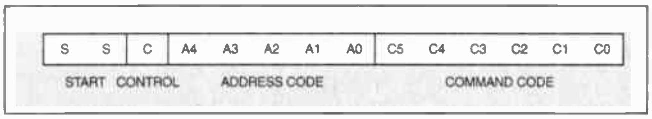

Fig.6. RC5 code format.

Next is the Address (A4 to A0) of the equipment that is to respond to the command transmitted. With five bits there are 32 different devices that can be addressed. Some of the more common addresses are given in Table 1. Note that the software of the decoder described here does not actually decode the device address but the program could be altered to do so.

After the address come the six Command code bits (C5 to C0), giving a total of 64 different commands that can be transmitted. Some of the more common commands are listed in Table 2. Commands 0 to 17 are used mostly to control a TV receiver, commands 41 to 46 are used for teletext, and 47 to 55 used to control a video tape recorder.

Table 1. Example RC5 device addresses.

Address	*Device*
0	TV receiver 1
1	TV receiver 2
2	teletext
5	video recorder 1
6	video recorder 2
7	experimental
8	satellite
16	preamplifier 1
17	tuner
18	audio tape recorder 1
19	preamplifier 2
20	CD player
23	audio tape recorder 2

Table 2. RC5 command codes.

Command	*Function*
0 - 9	numerals 0 to 9
10	digits
11	select
12	stand-by
13	mute
14	presets
15	display
16	volume +
17	volume –
41	page
42	timer
43	large
44	reveal
45	cancel
46	subtitle
47	store
48	pause
49	erase
50	fast reverse
51	fast forward
52	rewind
53	play
54	stop
55	record

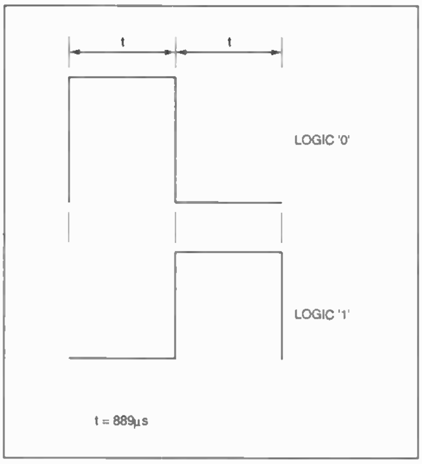

Fig.5. RC5 timing of logic 0 and logic 1 data.

RC5 DECODING SOFTWARE

RC5 transmissions are relatively slow in comparison to the operation of the PIC microcontroller. However, due to the bi-phase encoding, a more complicated decoding algorithm is needed than might be expected.

The decoding software works by using the falling edge of the RC5 signal to generate an interrupt. The 8-bit internal RTCC (Real Time Clock Counter) timer value is read (**TIMERVAL**) after every interrupt and the RTCC timer is then set to zero and begins to count up again. PIC software times the IR sensor output from falling edge to falling edge. With a 4MHz crystal clock and prescaler set to 16, the timer is incremented every 16 microseconds.

As can be seen from the various logic combinations in Fig.7, despite the number of different waveform permutations, the edge-to-edge timing can be one of only three different values.

The output from the infra-red sensor is high and goes low when a signal is received, so on the first interrupt the timer value is not valid. Program variable **BITS**

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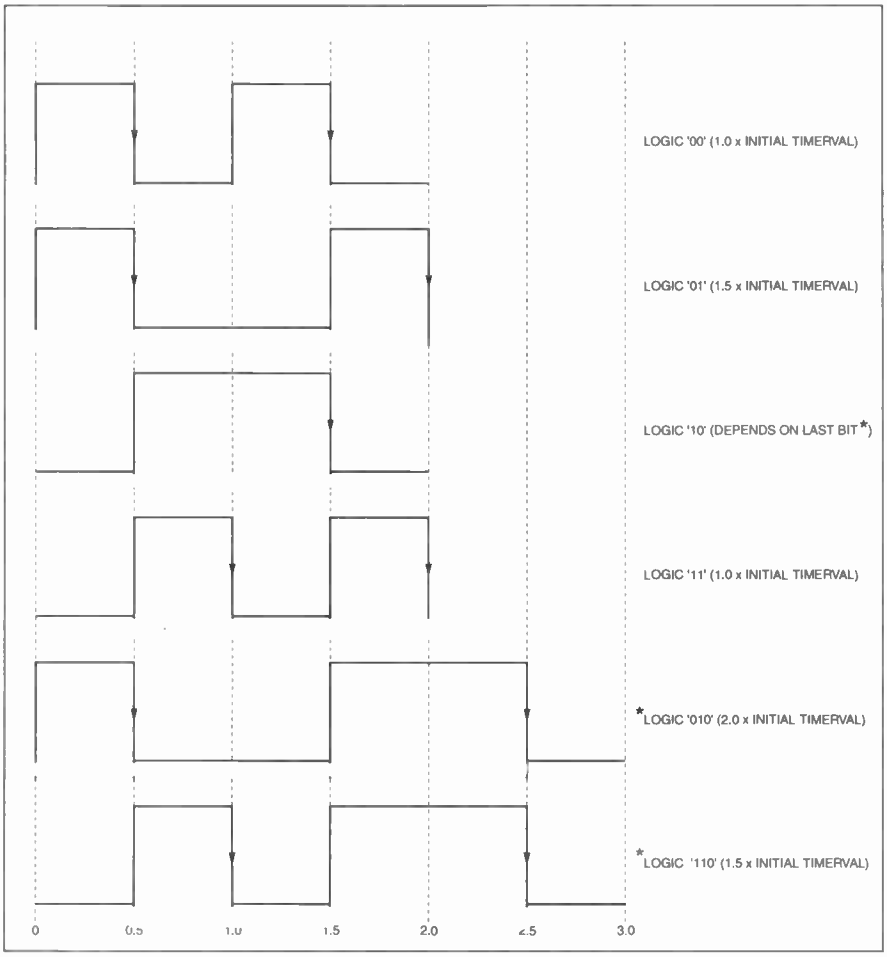


Fig.7. Example RC5 timing diagram.

is used to ensure that on the first interrupt (**BITS** = 1) the program variables are initialised but the RTCC timer value is not used.

On the second interrupt (**BITS** = 2) the RTCC timer value of the start bit is assigned to variable **TIMERVAL**. This value is used as a reference and all subsequent timer value calculations use it.

The **XVALUE** variables are used to set the three different **TIMERVAL** value ranges, this determines the waveform timing (see Listing 1). Using ranges of values rather than direct comparison to the first reading ensures that any timing discrepancy does not affect the operation of the program. Small variations in the RTCC value are inevitable due to PIC interrupt latency and tolerances between different remote controls.

Once the **TIMERVAL** comparison is made, the appropriate waveform time can be determined. If **TIMERVAL** = 1 then the result will be the same as the last bit (value of variable **LASTBIT**). If **TIMERVAL** = 1·5 then the result is to invert the last bit received. If **TIMERVAL** = 2 and the previous bit was 0 then the result is binary 10.

LISTING 1. Setting TIMERVAL values.

```
XVALUE1 = 0.5 x initial TIMERVAL
XVALUE2 = 1.25 x initial TIMERVAL
XVALUE3 = 1.75 x initial TIMERVAL
if (current TIMERVAL > XVALUE1 and
    < XVALUE2) then TIMERVAL = 1
if (current TIMERVAL > XVALUE2 and
    < XVALUE3) then TIMERVAL = 1.5
if current TIMERVAL > XVALUE3 then
    TIMERVAL = 2
```

The **ADDBINARY** routine is then called, which updates the value of the **CBINARY** (command binary) variable using the **THISBIT** variable value. The **BITS** value must be greater than eight so that only the command part of the RC5 sequence is decoded.

If **THISBIT** = 1 then the appropriate bit within the **CBINARY** variable byte is set to 1. This is done by logic ORing **BITVALUE** and **CBINARY**. Dividing **BITVALUE** by two sets the next bit within this variable to 1.

Initially the value of **BITVALUE** is 32 (binary 100000), so dividing **BITVALUE** by two gives 16 (binary 010000). Division by two is done by shifting the variable to the right by one place using the **RRF** instruction (Rotate Right File). If **THISBIT** = 0, only **BITVALUE** needs to be altered as the relevant bit within **CBINARY** is already zero.

An alternative decoding method considered was to use a timer-generated interrupt to sample the waveform every 889 microseconds, after detecting the initial waveform edge. However, if the RC5 transmission is faster or slower due to differences between remote handsets, then there is a possibility that accumulated timing error would cause either a pulse to be missed or the same pulse to be sampled twice.

Observation of the waveform will show that if the last pulse of an RC5 transmission is zero, then there is no final falling edge to enable an interrupt to read the timer. With no interrupts the RTCC timer will reach 255 (maximum byte value) and start counting from zero. This "roll-over" sets the timer overflow flag, which is used to indicate the end of transmission and the **LEDDISPLAY** output routine is called.

RC5 ASSEMBLER PROGRAM

Once the RC5 assembler listing is programmed into the PIC the decoding software can be tested. If the key marked "1" on the remote control is pressed one l.e.d. (D1) will come on, if the "2" key is pressed then the other l.e.d. (D2) will come on. If the "3" key is pressed then both l.e.d.s come on.

To change which key alters the l.e.d., change the **CBINARY** comparison value in the **LEDDISPLAY** routine. For example, using a VCR remote control, change the three comparisons to D'53', D'54', D'55' (to change from hexadecimal to decimal notation replace H'nn' with D'nnn' in the assembler program).

On the remote control handset pressing the VCR Play key should generate command code 53 and one of the l.e.d.s should light. Pressing the Stop key should generate code 54 and light the other l.e.d. Pressing the Record key should generate 55 and both l.e.d.s should be on.

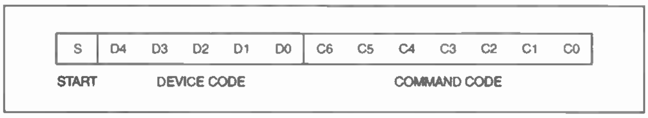


Fig.8. SIRC code format.

SIRC PROTOCOL

SIRC (Serial Infra-Red Control) protocol is the name given to Sony's IR remote control system. The 12-bit protocol is the most common format used with domestic products but there are others, including 15-bit and 20-bit versions. Control-S protocol is the hard-wired TTL version of the infra-red SIRC signal.

In most respects these transmissions are easier to decode than RC5. Several of the routines and variables used in the SIRC decoding program are similar to the ones used in the RC5 program. The command word is made up of 12 bits, and consists of a 5-bit device code followed by a 7-bit command code, see Fig.8. This SIRC format uses pulse width modulation of the infra-red signal to transmit the data.

The SIRC transmission is preceded by a single start bit, unlike the RC5 code. The SIRC decoding software waits for this start bit of 2·4 milliseconds. When it is correctly received the **START** variable is set to 1 to allow the rest of the transmission to be decoded.

Using a unique signal as a start bit helps prevent the software trying to decode an incomplete transmission. The infra-red sensor uses this start pulse to set its automatic gain control.

The SIRC command sequence is usually transmitted at least three times and, for some reason best known to Sony, the data is sent in reverse order. There is no equivalent to the control toggle bit as used in the RC5 protocol. Like the RC5 transmission there is no additional information transmitted to allow for error detection.

The SIRC data consists of either pulses of 0·6ms or 1·2ms duration, meaning logic 0 and logic 1 respectively. Each pulse is preceded by a 0·6ms pause. The pulse length is measured by the falling edge of the waveform generating an interrupt. The timer value is incremented every 16 microseconds and is read on every interrupt.

To work out the likely timer values, divide the expected pulse width by the timer "tick", illustrated in Fig.9 and Fig.11.

$$\frac{\text{pulse width}}{\text{timer}} = \frac{\text{start pulse}}{16\mu s} = \frac{2{\cdot}4ms}{16\mu s} = 150$$

Fig.9. SIRC timer formula.

2·4ms = 150 (start)
2·4ms + 0·6ms = 187 (start)
1·2ms + 0·6ms = 112 (logic 1)
0·6ms + 0·6ms = 75 (logic 0)

Fig.10. SIRC TIMERVAL for all pulse widths.

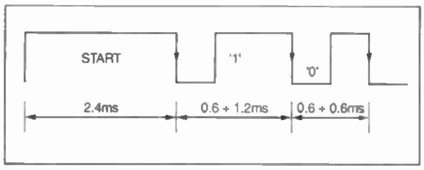


Fig.11. SIRC timing details.

The program uses the timer value to determine the waveform. For example, if the value is between 90 and 150 then a logic 1 is assumed and **THISBIT** = **1**. If the value is between 50 and 90 then a logic 0 is assumed and **THISBIT** = **0**. The **ADDBINARY** routine is called and the appropriate bit within **CBINARY** is set to the value of **THISBIT**.

SIRC ASSEMBLER PROGRAM

With the SIRC code running press the Increase Volume key on the Sony remote control and one l.e.d. (D1) will come on the other l.e.d. (D2) will be off. Press the Decrease Volume key and the l.e.d.s will invert.

To change which key controls the l.e.d., select the appropriate value for the key function and use that value in the **LEDDISPLAY** routine. Note that the remote control may generate different numbers for the same function so that the Sony equipment can distinguish between, for example, Play for the CD player and Play for the tape recorder. See Tables 3 to 5.

As there is no error detection or data verification with either of the IR protocols, errors can occur if the IR signal is not received correctly. Also, strong sunlight falling on the sensor can generate a signal.

Table 3. SIRC device code.

Command	*Device*
1	TV receiver
2	video tape recorder 1
4	video tape recorder 2
6	laser disk
12	surround sound unit
16	cassette deck/tuner
17	CD player
18	equaliser

Table 4. SIRC VCR FUNCTIONS

Command	*Function*
0 - 9	numerals 0 to 9
9	10/0
20	x2 play
21	power
22	eject
24	stop
25	pause
26	play
27	rewind
28	fast forward
29	record

Table 5. SIRC TV FUNCTIONS

Command	*Function*
0 - 9	numerals 0 to 9
9	10/0
16	channel +
17	channel –
18	volume +
19	volume –
20	mute
21	power
22	reset
23	audio mode
24	contrast +
25	contrast –
26	colour +
27	colour –
30	brightness +
31	brightness –
38	balance left
39	balance right
47	power off

SERIAL PORT

The PIC16x84 microcontroller does not have a built-in serial port but one can be implemented in software. Replace the entire routine **LEDDISPLAY** with the **TXDATA** code in the PIC assembler program. Add the two equates to the top of the assembler program and the **BCF PORTB,RS232** to the **MAIN** (SIRC) or **START** (RC5) procedure. This enables the RB3 port pin to be used as an output. In routine **LOOP** replace **CALL LEDDISPLAY** with **CALL TXDATA**.

The **TXDATA** routine works by ANDing each data bit with the relevant bit in **CBINARY**. This sets the output bit (called **RS232**), then the **OP** (output) routine is called and takes the pin RB3 high or low according to the value of bit **RS232**. Directly changing RB3 in the **TXDATA** routine would cause a timing error.

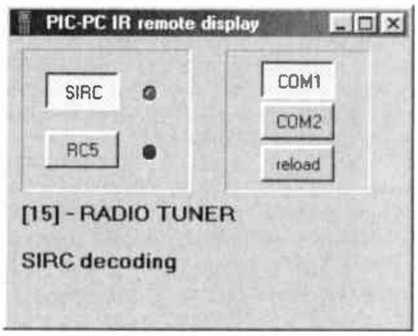
Once the RB3 output is set, this data output value has to be held, consequently several **NOP** commands are required to ensure correct timing. There is no handshaking or data transmission from the PC, therefore the connection from the PIC to the serial socket has only two wires.

PC SOFTWARE

The Windows 95/98 software does not decode the IR transmission but displays the value of the **CBINARY** variable sent from the PIC. The program also displays, if available, a text message describing the key pressed. This text is read from two text files, called RC5.TXT and SIRC.TXT, these files must be located in the same directory as the program.

The text can easily be altered using Notepad to coincide with the intended remote control handset. These files store the relevant text in ascending order. For example, the first line is text for **CBINARY = 0**, the second line is for **CBINARY = 1**, and so on.

Operation of the PC software is very simple, select the serial communications port that the PIC circuit is connected to and then select the required protocol. The Reload key reloads the text files if they have been changed while the program is active. The relevant protocol l.e.d. should flash when data is received from the PIC circuit.



[15] - RADIO TUNER

SIRC decoding

Fig.12. Example PC screen display.

REMOTE CONTROLS

A manufacturer using remote control of its equipment can allocate any command number to any key. Remote controls are not required to be compatible or exchangeable with equipment from another manufacturer, hence the plethora of remote controls and protocols found in most homes. The author has come across a remote control for a portable TV that uses RC5 coding for some of the keys and another protocol (not SIRC) for the remaining keys.

As neither PIC program decodes the device address then the result is a wider choice of remote controls being available. However, if a suitable remote control handset is not available then replacement remote controls are readily obtainable with a variety of functions and key layout. Most of these handsets are programmable and can replace many different models; therefore there is an implied choice of protocol.

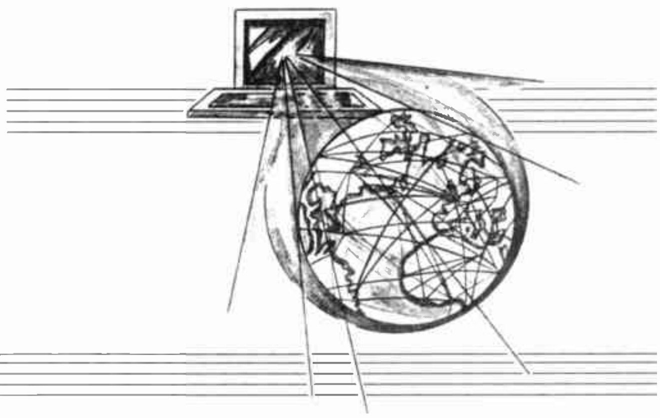
Clearly the IR decoding program could alter a variable value or the status of a Boolean flag or control a device attached to one of the PIC ports. A number of different functions could be added as the assembler code associated with the **LEDDISPLAY** routine can be increased as necessary. Numeric input to a PIC program via a remote control handset can easily be achieved.

RESOURCES

The software discussed in this article is available as stated on this month's *Shoptalk* page. ☐

World Radio History

SURFING THE INTERNET



NET WORK

ALAN WINSTANLEY

Check the Google box

IN previous months I mentioned Google (**www.google.com**), now the most talked-about search engine on the Internet. It has become a personal favourite since the end of 1999 and is strongly recommended to *EPE* readers as their prime search site. Google is a highly intelligent and focused database which claims to have indexed over 1000,000,000 web pages to date, a figure which has quadrupled since the beginning of the year. Google operates what is probably the world's largest Linux cluster which contains 80TB (terrabytes) of disk storage, with a claimed aggregate I/O bandwidth of 50 gigabytes per second.

For many serious Internet users, Google is a dream come true because it has a minimalist front end (a simple box) which belies its tremendously accurate searching and indexing capabilities. There are no distracting banner ads or other trimmings associated with typical portal sites such as Alta Vista, Lycos or Yahoo. Google also has a handy trick up its sleeve: if the web site to which it refers no longer exists, you may be able to check Google's own cached copy to view an earlier copy of the page.

All you have to do is type any topic into the search field and hit Enter. If your search query is distinctive rather than broad-based (perhaps "maxillo-facial surgeons" rather than "dentists") then you can usually hit the "I'm feeling lucky" button – the chances are high that Google will list the most relevant web pages straight away. My screen shot shows what happened when I searched on just "*EPE*" – we were listed as No.1. amongst 27,000 results (which took 0·04 seconds) even though there is an unrelated "*EPE* Home Page". Google is powerful and hugely fast.

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The Google database is a highly prized and marketable resource which works on the principle that if something is good, you'll tell people about it (just as I'm singing its praise here). If a web site is cool, hot or whatever, there is a good chance that there are many links already pointing to it. However, Google goes further by analysing the "quality" of these links rather than just counting the sheer number of them, so a link to a site from another high-ranking web site counts for a lot more than a link from somebody's lowly home page. Because of this, it is very difficult for a web site owner to influence Google's search engine results. You can however submit your own URL at **www.google.com/addurl.html**.

Yahoogle!

Search engines represent a whole industry technology in themselves. If Google doesn't carry advertising, why is it free? Apart from the streamlined front end with which many of us are familiar, its database is sold to firms who are looking for a search engine perhaps to embed within a portal site.

Yahoo (**www.yahoo.com**) is perhaps the best-known on-line directory (as distinct from an open search engine). Its contents are controlled by Yahoo editors who decide what is entered into the Yahoo database. Yahoo thinks highly of its users and wants them to have the best search "experience", so Yahoo prefers to index reliable and corporate-looking web resources rather than scrappy personal home pages that might disappear or completely change content overnight.

This reminds me of an E-mail from an American reader who informed me that one of the web links listed in my Net Work A-Z listing (**www.epemag.wimborne.co.uk/netwkaz.htm**) had changed from an electronics-related resource to one showing a photo of a topless blonde female, not that he was complaining. For the same sort of reason, Yahoo is choosy about the sites it enters in its directory, and web designers place considerable importance in the black art of getting a good placing in Yahoo.

What is less widely known is that apart from its own directory, Yahoo also uses a second database. You may have seen this in action when Yahoo offers you "other web page matches" in its search results, especially if it could not find anything in its main directory – so if you ever wondered why Yahoo offered "no results" and then proceeded to offer you a whole list of matches, the switch to the second database is the answer.

These "other matches" are maintained in a separate search engine which, until recently, was the Inktomi database (**www.inktomi.com**). Inktomi is another Internet search resource which sells its technology to others looking to place a search box in, say, a portal web site. In mid June, Yahoo announced that it was to buy its database from Google instead, and sure enough, some of my search engine queries are now redirected to **google.yahoo.com**.

Get your own Google box

There are some useful reader resources on the Google site, including a Help page; you are also shown how to add your own Google box to your web page if desired. Google searches for exact matches to your query only, but unlike Alta Vista, does not support Boolean expressions. Google will always add a logical "and" between all the words in your query.

Another option is Google Scout, which will retrieve the most relevant pages (i.e. the sites Google ranks as equal) that relate to a search result. This feature highlights Google's intelligence in indexing the web pages stored within its database. Sometimes Google may fail to return a result, though, the reason being that there are insufficient links to the target web site to enable Google to index it.

One interesting job for a spare minute is to check all the links that point to a page – perhaps I'm interested in all the links to the *EPE* page, so I would enter link: **www.epemag.wimborne.co.uk** in Google (Alta Vista does the same).

You can E-mail me at **alan@epemag.demon.co.uk**. See you next month.

World Radio History

SURVEILLANCE

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The book is divided into six basic sections: Units and Constants, Direct-Current Circuits, Passive Components, Alternating-Current Circuits, Networks and Theorems, Measurements.

256 pages **Order code BP53** **£4.99**

The books listed have been selected by *Everyday Practical Electronics* editorial staff as being of special interest to everyone involved in electronics and computing. They are supplied by mail order to your door. Full ordering details are given on the last book page.

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Computing

WINDOWS 95 EXPLAINED

P. R. M. Oliver and N. Kantaris

If you would like to get up and running, as soon as possible, with the Windows 95 operating system, then this is the book for you.

The book was written with the non-expert, busy person in mind. It explains the hardware that you need in order to run Windows 95 successfully, and how to install and optimize your system's resources. It presents an overview of the Windows 95 environment.

Later chapters cover how to work with programs, folders and documents; how to control Windows 95 and use the many accessories that come with it; how to use DOS programs and, if necessary, DOS commands and how to communicate with the rest of the electronic world.

170 pages **Order code BP400** **£5.95**

EASY PC INTERFACING

R. A. Penfold

Although the internal expansion slots of a PC provide full access to the computer's buses, and are suitable for user add-ons, making your own expansion cards requires a fair amount of expertise and equipment. The built-in ports provide what is often a much easier and hassle-free way of interfacing your own circuits to a PC. In particlar, a PC printer port plus a small amount of external hardware provides a surprisingly versatile input/output port. The PC "games" port is less useful for general interfacing purposes, but it can be useful in some applications.

This book provides a number of useful PC add-on circuits including the following: Digital input/output ports; Analogue-to-digital converter; Digital-to-Analogue Converter; Voltage and Current measurement circuits; Resistance meter; Capacitance meter; Temperature measurement interface; Biofeedback monitor; Constant voltage model train controller; Pulsed model train controllers; Position sensor (optical, Hall effect, etc.); Stepper motor interface; Relay and LED drivers; Triac mains switching interface.

179 pages **Order code BP385** **£4.99**

INTRODUCTION TO MICROPROCESSORS

John Crisp

If you are, or soon will be, involved in the use of microprocessors, this practical introduction is essential reading. This book provides a thoroughly readable introduction to microprocessors. assuming no previous knowledge of the subject, nor a technical or mathematical background. It is suitable for students, technicians, engineers and hobbyists, and covers the full range of modern microprocessors.

After a thorough introduction to the subject, ideas are developed progressively in a well-structured format. All technical terms are carefully introduced and subjects which have proved difficult, for example 2's complement, are clearly explained. John Crisp covers the complete range of microprocessors from the popular 4-bit and 8-bit designs to today's super-fast 32-bit and 64-bit versions that power PCs and engine management systems etc.

Contents: The world changed in 1971; Microprocessors don't have ten fingers; More counting; Mathematical micros; It's all a matter of logic; Registers and memories; A microprocessor based system; A typical 8-bit microprocessor; Programming, High level languages; Micros are getting bigger and faster; The Pentium; The PowerPC; The Alpha 21164 microprocessor; Interfacing; Test equipment and fault finding.

222 pages **Order code NE31** **£16.99**

World Radio History

Theory and Reference

Bebop To The Boolean Boogie

By Clive (call me Max) Maxfield

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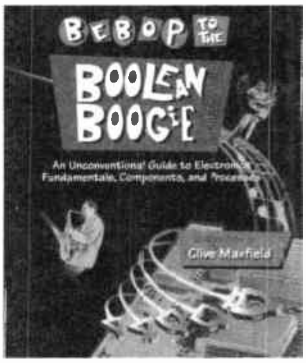
An Unconventional Guide to Electronics Fundamentals, Components and Processes



This book gives the "big picture" of digital electronics. This indepth, highly readable, up-to-the-minute guide shows you how electronic devices work and how they're made. You'll discover how transistors operate, how printed circuit boards are fabricated, and what the innards of memory ICs look like. You'll also gain a working knowledge of Boolean Algebra and Karnaugh Maps, and understand what Reed-Muller logic is and how it's used. And there's much, MUCH more (including a recipe for a truly great seafood gumbo!).

Hundreds of carefully drawn illustrations clearly show the important points of each topic. The author's tongue-in-cheek British humor makes it a delight to read, but this is a REAL technical book, extremely detailed and accurate. A great reference for your own shelf, and also an ideal gift for a friend or family member who wants to understand what it is you do all day. . .

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DIGITAL ELECTRONICS – A PRACTICAL APPROACH
With FREE Software: Number One Systems – EASY-PC Professional XM and Pulsar (Limited Functionality)
Richard Monk

FREE SOFTWARE

Covers binary arithmetic, Boolean algebra and logic gates, combination logic, sequential logic including the design and construction of asynchronous and synchronous circuits and register circuits. Together with a considerable practical content plus the additional attraction of its close association with computer-aided design including the FREE software.

There is a 'blow-by-blow' guide to the use of EASY-PC Professional XM (a schematic drawing and printed circuit board design computer package). The guide also conducts the reader through logic circuit simulation using Pulsar software. Chapters on p.c.b. physics and p.c.b. production techniques make the book unique, and with its host of project ideas make it an ideal companion for the integrative assignment and common skills components required by BTEC and the key skills demanded by GNVQ. The principal aim of the book is to provide a straightforward approach to the understanding of digital electronics.

Those who prefer the 'Teach-In' approach or would rather experiment with some simple circuits should find the book's final chapters on printed circuit board production and project ideas especially useful.

250 pages **Order code NE28** **£16.99**

DIGITAL GATES AND FLIP-FLOPS
Ian R. Sinclair

This book, intended for enthusiasts, students and technicians, seeks to establish a firm foundation in digital electronics by treating the topics of gates and flip-flops thoroughly and from the beginning.

Topics such as Boolean algebra and Karnaugh mapping are explainend, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.

No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.

200 pages **Order code PC106** **£8.95**

Bebop Bytes Back

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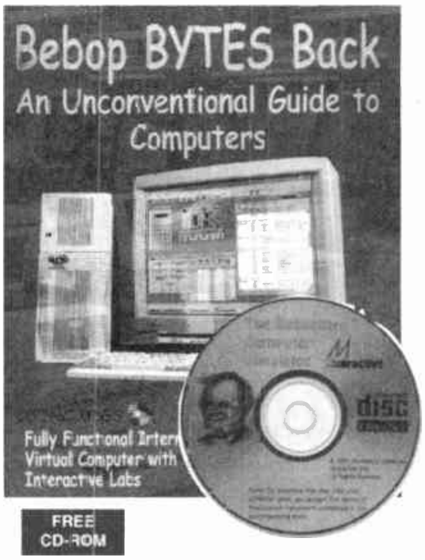

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This follow-on to *Bebop to the Boolean Boogie* is a multimedia extravaganza of information about how computers work. It picks up where "Bebop I" left off, guiding you through the fascinating world of computer design . . . and you'll have a few chuckles, if not belly laughs, along the way. In addition to over 200 megabytes of mega-cool multimedia, the accompanying CD-ROM (for Windows 95 machines only) contains a virtual microcomputer, simulating the motherboard and standard computer peripherals in an extremely realistic manner. In addition to a wealth of technical information, myriad nuggets of trivia, and hundreds of carefully drawn illustrations, the book contains a set of lab experiments for the virtual microcomputer that let you recreate the experiences of early computer pioneers. If you're the slightest bit interested in the inner workings of computers, then don't dare to miss this one!

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Edited by Owen Bishop

CD-ROM

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Newnes Interactive Electronic Circuits allows you to: analyse circuits using top simulation program SpiceAge; test your design skills on a selection of problem circuits; clip comments to any page and define bookmarks; modify component values within the circuits; call up and display useful formulae which remain on screen; look up over 100 electronic terms in the glosary; print and export netlists.

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Audio and Music

AN INTRODUCTION TO LOUDSPEAKERS AND ENCLOSURE DESIGN
V. Capel

This book explores the various features, good points and snags of speaker designs. It examines the whys and wherefores so that the reader can understand the principles involved and so make an informed choice of design, or even design loudspeaker enclosures for him – or herself. Crossover units are also explained, the various types, how they work, the distortions they produce and how to avoid them. Finally there is a step-by-step description of the construction of the *Kapellmeister* loudspeaker enclosure.

148 pages **Order code BP256** **£3.99**

PREAMPLIFIER AND FILTER CIRCUITS
R. A. Penfold

This book provides circuits and background information for a range of preamplifiers, plus tone controls, filters, mixers, etc. The use of modern low noise operational amplifiers and a specialist high performance audio preamplifier i.c. results in circuits that have excellent performance, but which are still quite simple. All the circuits featured can be built at quite low cost (just a few pounds in most cases). The preamplifier circuits featured include: Microphone preamplifiers (low impedance, high impedance, and crystal). Magnetic cartridge pick-up preamplifiers with R.I.A.A. equalisation. Crystal/ceramic pick-up preamplifier. Guitar pick-up preamplifier. Tape head preamplifier (for use with compact cassette systems).

Other circuits include: Audio limiter to prevent overloading of power amplifiers. Passive tone controls. Active tone controls. PA filters (highpass and lowpass). Scratch and rumble filters. Loudness filter. Audio mixers. Volume and balance controls.

92 pages **Order code BP309** **£3.99**

HIGH POWER AUDIO AMPLIFIER CONSTRUCTION
R. A. Penfold

Practical construction details of how to build a number of audio power amplifiers ranging from about 50 to 300/400 watts r.m.s. includes MOSFET and bipolar transistor designs.

96 pages **Order code BP277** **£3.99**

ELECTRONIC MUSIC AND MIDI PROJECTS
R. A. Penfold

Whether you wish to save money, boldly go where no musician has gone before, rekindle the pioneering spirit, or simply have fun building some electronic music gadgets, the designs featured in this book should suit your needs. The projects are all easy to build, and some are so simple that even complete beginners at electronic project construction can tackle them with ease. Stripboard layouts are provided for every project, together with a wiring diagram. The mechanical side of construction has largely been left to the individual constructors to sort out, simply because the vast majority of project builders prefer to do their own thing in this respect.

None of the designs requires the use of any test equipment in order to get them set up properly. Where any setting up is required, the procedures are very straightforward, and they are described in detail.

Projects covered: Simple MIDI tester, Message grabber, Byte grabber, THRU box, MIDI auto switcher, Auto/manual switcher, Manual switcher, MIDI patchbay, MIDI controlled switcher, MIDI lead tester, Program change pedal, Improved program change pedal, Basic mixer, Stereo mixer, Electronic swell pedal, Metronome, Analogue echo unit.

138 pages **Order code PC116** **£9.95**

World Radio History

Testing, Theory, Data and Reference

SCROGGIE'S FOUNDATIONS OF WIRELESS AND ELECTRONICS – ELEVENTH EDITION

S. W. Amos and Roger Amos

Scroggie's Foundations is a classic text for anyone working with electronics, who needs to know the art and craft of the subject. It covers both the theory and practical aspects of a huge range of topics from valve and tube technology, and the application of cathode ray tubes to radar, to digital tape systems and optical recording techniques.

Since *Foundations of Wireless* was first published over 60 years ago, it has helped many thousands of readers to become familiar with the principles of radio and electronics. The original author Sowerby was succeeded by Scroggie in the 1940s, whose name became synonymous with this classic primer for practitioners and students alike. Stan Amos, one of the fathers of modern electronics and the author of many well-known books in the area, took over the revision of this book in the 1980s and it is he, with his son, who have produced this latest version.

400 pages **Order code NE27** £19.99

ELECTRONICS MADE SIMPLE

Ian Sinclair

Assuming no prior knowledge, *Electronics Made Simple* presents an outline of modern electronics with an emphasis on understanding how systems work rather than on details of circuit diagrams and calculations. It is ideal for students on a range of courses in electronics, including GCSE, C&G and GNVQ, and for students of other subjects who will be using electronic instruments and methods.

Contents: waves and pulses, passive components, active components and ICs, linear circuits, block and circuit diagrams, how radio works, disc and tape recording, elements of TV and radar, digital signals, gating and logic circuits, counting and correcting, microprocessors, calculators and computers, miscellaneous systems.

199 pages (large format) **Order code NE23** £12.99

TRANSISTOR DATA TABLES

Hans-Günther Steidle

The tables in this book contain information about the package shape, pin connections and basic electrical data for each of the many thousands of transistors listed. The data includes maximum reverse voltage, forward current and power dissipation, current gain and forward transadmittance and resistance, cut-off frequency and details of applications.

A book of this size is of necessity restricted in its scope, and the individual transistor types cannot therefore be described in the sort of detail that maybe found in some larger and considerably more expensive data books. However, the list of manufacturers' addresses will make it easier for the prospective user to obtain further information, if necessary.

Lists over 8,000 different transistors, including f.e.t.s.

200 pages **Order code BP401** £5.95

ELECTRONIC TEST EQUIPMENT HANDBOOK

Steve Money

The principles of operation of the various types of test instrument are explained in simple terms with a minimum of mathematical analysis. The book covers analogue and digital meters, bridges, oscilloscopes, signal generators, counters, timers and frequency measurement. The practical uses of the instruments are also examined.

Everything from Oscillators, through R, C & L measurements (and much more) to Waveform Generators and testing Zeners.

206 pages **Order code PC109** £8.95

GETTING THE MOST FROM YOUR MULTIMETER

R. A. Penfold

This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.

In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.

96 pages **Order code BP239** £2.95

NEWNES ELECTRONICS TOOLKIT – SECOND EDITION

Geoff Phillips

The author has used his 30 years experience in industry to draw together the basic information that is constantly demanded. Facts, formulae, data and charts are presented to help the engineer when designing, developing, evaluating, fault finding and repairing electronic circuits. The result is this handy workmate volume: a memory aid, tutor and reference source which is recommended to all electronics engineers, students and technicians.

Have you ever wished for a concise and comprehensive guide to electronics concepts and rules of thumb? Have you ever been unable to source a component, or choose between two alternatives for a particular application? How much time do you spend searching for basic facts or manufacturer's specifications? This book is the answer, it covers resistors, capacitors, inductors, semiconductors, logic circuits, EMC, audio, electronics and music, telephones, electronics in lighting, thermal considerations, connections, reference data.

158 pages **Order code NE20** £14.99

PRACTICAL ELECTRONIC FAULT FINDING AND TROUBLESHOOTING

Robin Pain

This is not a book of theory. It is a book of practical tips, hints, and rules of thumb, all of which will equip the reader to tackle any job. You may be an engineer or technician in search of information and guidance, a college student, a hobbyist building a project from a magazine, or simply a keen self-taught amateur who is interested in electronic fault finding but finds books on the subject too mathematical or specialized.

The book covers: **Basics** – Voltage, current and resistance; Capacitance, inductance and impedance; Diodes and transistors; Op-amps and negative feedback; **Fault finding** – Analogue fault finding, Digital fault finding; Memory; Binary and hexadecimal; Addressing; Discrete logic; Microprocessor action; I/O control; CRT control; Dynamic RAM; Fault finding digital systems; Dual trace oscilloscope; IC replacement.

274 pages **Order code NE22** £18.99

AN INTRODUCTION TO LIGHT IN ELECTRONICS

F. A. Wilson

This book is not for the expert but neither is it for the completely uninitiated. It is assumed the reader has some basic knowledge of electronics. After dealing with subjects like Fundamentals, Waves and Particles and The Nature of Light such things as Emitters, Detectors and Displays are discussed. Chapter 7 details four different types of Lasers before concluding with a chapter on Fibre Optics.

161 pages **Order code BP359** £4.95

UNDERSTANDING DIGITAL TECHNOLOGY

F. A. Wilson C.G.I.A., C.Eng., F.I.E.E., F.I. Mgt.

This book examines what digital technology has to offer and then considers its arithmetic and how it can be arranged for making decisions in so many processes. It then looks at the part digital has to play in the ever expanding Information Technology, especially in modern transmission systems and television. It avoids getting deeply involved in mathematics.

Various chapters cover: Digital Arithmetic, Electronic Logic, Conversions between Analogue and Digital Structures, Transmission Systems. Several Appendices explain some of the concepts more fully and a glossary of terms is included.

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Project Building

ELECTRONIC PROJECT BUILDING FOR BEGINNERS

R. A. Penfold

This book is for complete beginners to electronic project building. It provides a complete introduction to the practical side of this fascinating hobby, including:

Component identification, and buying the right parts; resistor colour codes, capacitor value markings, etc; advice on buying the right tools for the job; soldering; making easy work of the hard wiring; construction methods, including stripboard, custom printed circuit boards, plain matrix boards, surface mount boards and wire-wrapping; finishing off, and adding panel labels; getting "problem" projects to work, including simple methods of fault-finding.

In fact everything you need to know in order to get started in this absorbing and creative hobby.

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R. Bebbington

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Most of the projects can be simply screwed together, by following the layout diagrams, in a matter of minutes and readily unscrewed if desired to make new circuits. A theoretical circuit diagram is also included with each project to help broaden the constructor's knowledge.

The projects included in this book cover a wide range of interests under the chapter headings: Connections and Components, Sound and Music, Entertainment, Security Devices, Communication, Test and Measuring.

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R. A. Penfold

Deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.

80 pages **Order code BP121** £3.99

IC555 PROJECTS

E. A. Parr

Every so often a device appears that is so useful that one wonders how life went on before without it. The 555 timer is such a device. It was first manufactured by Signetics, but is now manufactured by almost every semiconductor manufacturer in the world and is inexpensive and very easily obtainable.

Included in this book are over 70 circuit diagrams and descriptions covering basic and general circuits, motor car and model railway circuits, alarms and noise makers as well as a section on 556, 558 and 559 timers. (Note. No construction details are given.)

A reference book of invaluable use to all those who have any interest in electronics, be they professional engineers or designers, students of hobbyists.

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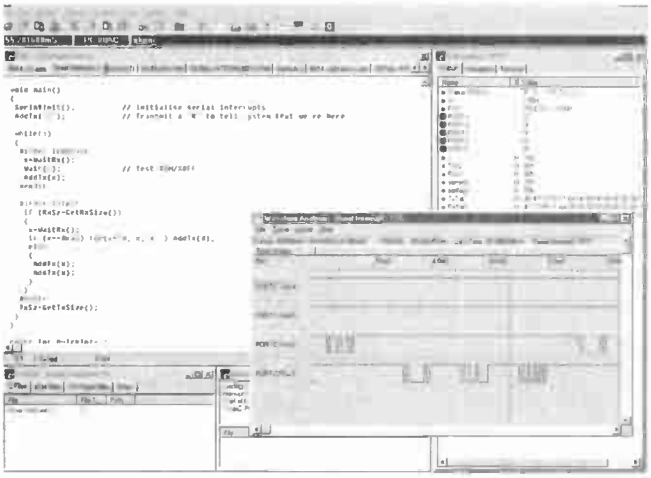

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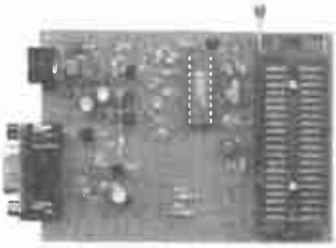

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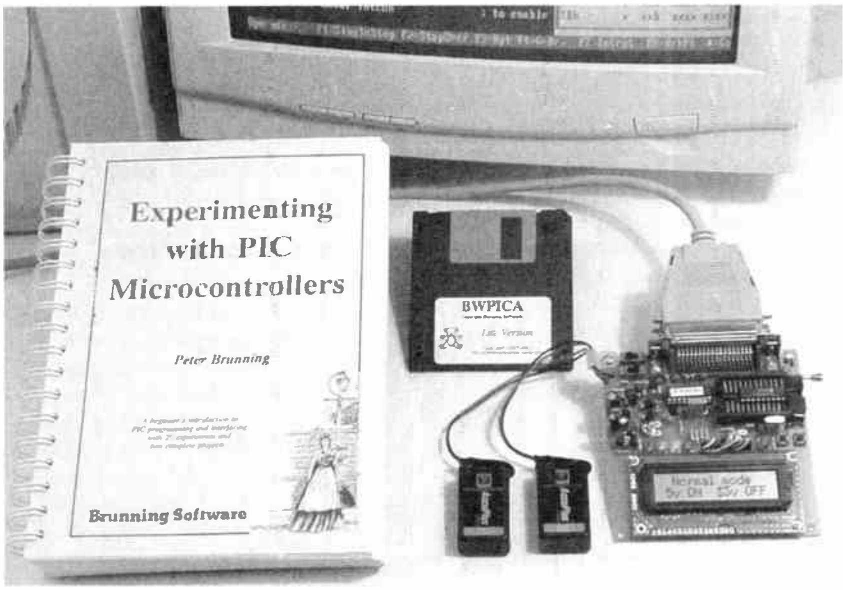

Experimenting with PIC Microcontrollers

This third release in our series teaches how to programme and interface to the PIC16F84 and PIC16C711 microcontrollers, and consists of the book, an integrated suite of programmes to run on a PC, and a programmer/experimental module.

The book with its abundance of flow diagrams and circuit diagrams is the heart of the system, and the software is the brains. A text editor with word processing power is the key stone supporting the assembler, disassembler, simulator, and programming software. As the text is typed in the assembler works in the background testing each line so that errors are immediately highlighted. When the typing is done the simulator can be used to single step or run the programme. Boxes pop up showing the contents of registers and the result of any text written to a standard 2 line by 16 character display. If it works correctly plug the programmer/experimental module onto the end of your printer lead and test it using a real live PIC. All operations work directly from the assembler text in the editor.

The experiments are all performed using the programmer/experimental module which is already wired with LEDs, push buttons, and an alphanumeric liquid crystal display. Flashing LEDs, text display, real time clock, period timer, beeps and music, including a rendition of Beethoven's *Für Elise*. Then there are two projects to work through; building a sinewave generator covering 0.2Hz to 20kHz in five ranges, and investigating measurement of the power taken by domestic appliances. In the space of 24 experiments, two projects and 56 exercises the system works through from absolute beginner to experienced engineer level.

Kit or Ready Built

The programming/experimental module can be purchased built, tested and ready to use, or in kit form. The ready built module verifies first at normal 5 volts then with ±10% volts applied, and uses the built in display to show programming messages. The kit version uses a simplified design which verifies only at normal 5 volts and where the display is dedicated to the test PIC (the status is indicated using 2 LEDs).

The kit consists of two parts. PIC3u-a contains the PCB, control PIC, 2 slide switches, software suite, and a booklet containing a full parts list and construction details. PIC3u-b contains all the other items to build the programmer/experimental module and includes a test PIC.

The system will also programme similar PICs (83, 710, 71, 620, 621 etc). The made up module is supplied with a test PIC fitted. Two PP3 batteries are also required, these are not supplied.

Assembler

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

C & C++

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

The Kits

The kits contain the prototyping board, lead assemblies, components and programming software to do all the experiments. The 'made up' kits are supplied ready to start the first experiment. The 'unmade' Kits require the prototyping board and leads to be assembled and soldered before you can start. The 'top up' kit CP2t is for readers who have purchased a kit to go with the first book, and contains all the components and programming software but not the prototyping board or leads.

Hardware required

All three systems assume you have a PC (386 or better) and a printer lead.

Mail Order Form

Please make your cheque/PO payable to *Brunning Software* and send with this form to Brunning Software, 138 The Street, Little Clacton, Clacton-on-sea, Essex, CO16 9LS. Your order will be processed as soon as your cheque arrives. Despatch is usually the same day. Software supplied on 3.5" HD discs. *The kits do not include the book.*

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Kit 1u 'unmade' needs assembling (Maplin code NV67)	£39.99	......
Book Experimenting with C & C++ (Maplin code NW47)	£24.99	......
Kit CP2a 'made up' and ready to start (Not from Maplin)	£46.00	......
Kit CP2u 'unmade' needs assembling (Maplin code NW48)	£39.99	......
Kit CP2t 'top up' to add to kit 1 (Maplin code NW49)	£22.99	......
Book Experimenting with PIC Microcontrollers	£23.99	......
PIC Programmer/experimental module & software	£74.00	......
Kit PIC3u-a: PCB, control PIC, switches & software	£30.00	......
Kit PIC3w-b: all other items required to build module	£25.00	......

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PCB SERVICE

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Back numbers or photostats of articles are available if required – see the *Back Issues* page for details.

Please check price and availability in the latest issue.

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PIC-project source code files: **/pub/PICS**

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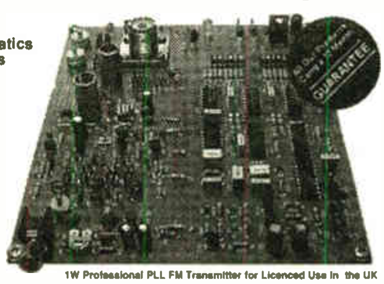

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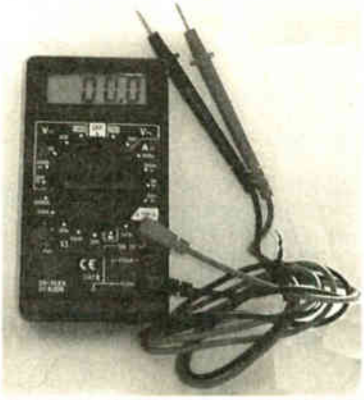

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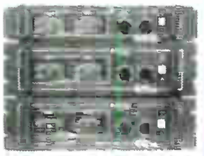

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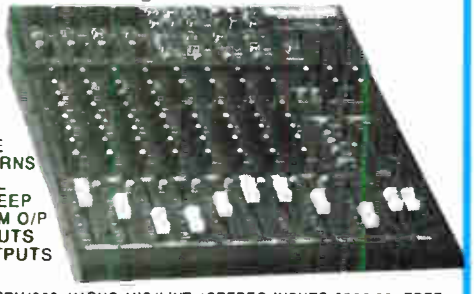

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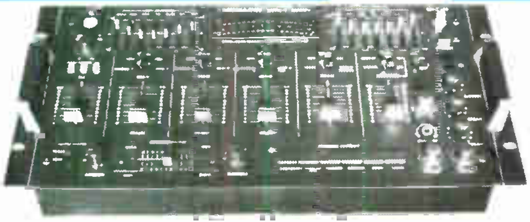

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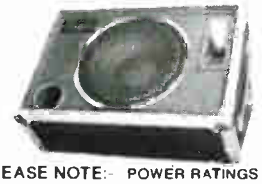

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PRICE:- £66.35 + £4.00 P&P

OMP/MF 300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, frequency response 1Hz 100KHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110dB. Size 330 x 175 x 100mm.

PRICE:- £83.75 + £5.00 P&P

OMP/MF 450 Mos-Fet Output power 450 watts R.M.S. into 4 ohms, frequency response 1Hz 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 385 x 210 x 105mm.

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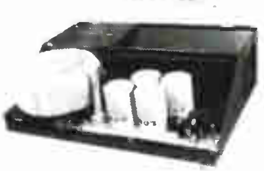

OMP/MF 1000 Mos-Fet Output power 1000 watts R.M.S. into 2 ohms, 725 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 422 x 300 x 125mm.

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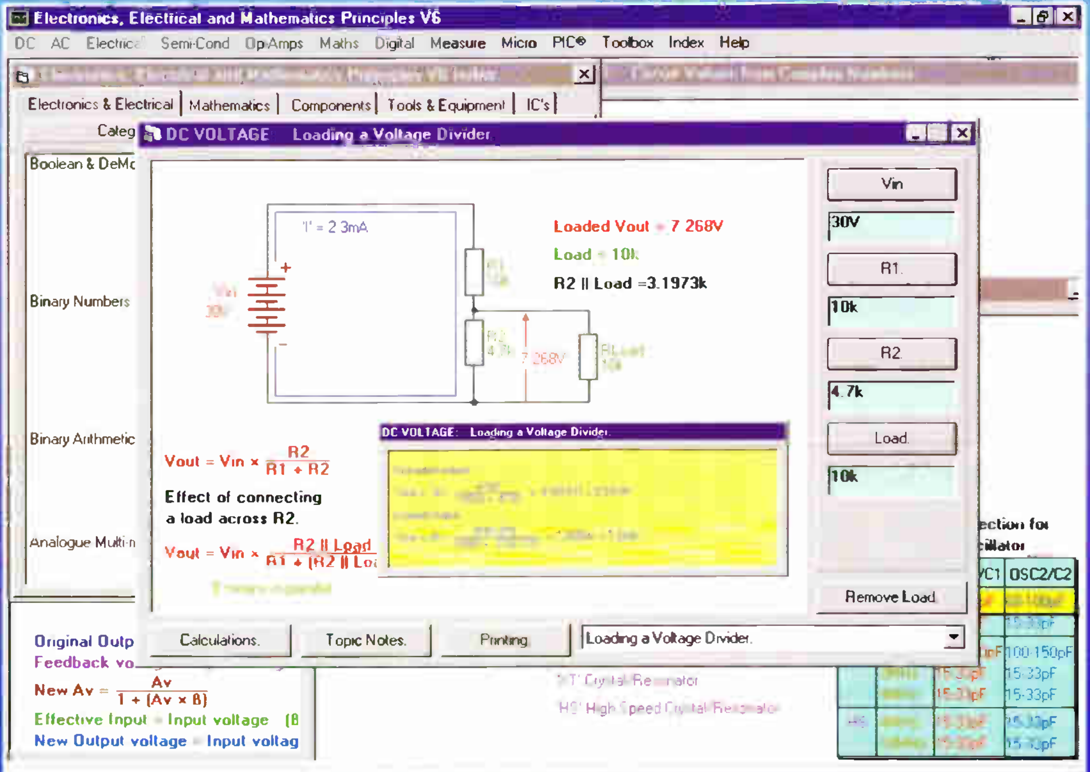

Electronics, Electrical and Mathematics Principles V6

DC VOLTAGE Loading a Voltage Divider

'I' = 2 3mA

Loaded Vout = 7 268V

Load = 10k

R2 || Load =3.1973k

Vin: 30V

R1: 10k

R2: 4.7k

Load: 10k

Vout = Vin × $\frac{R2}{R1 + R2}$

Effect of connecting a load across R2.

Vout = Vin × $\frac{R2 \parallel Load}{R1 + (R2 \parallel Lo}$

Loading a Voltage Divider.

Original Outp

Feedback vo

New Av = $\frac{Av}{1 + (Av \times B)}$

Effective Input = Input voltage (B

New Output voltage = Input voltag

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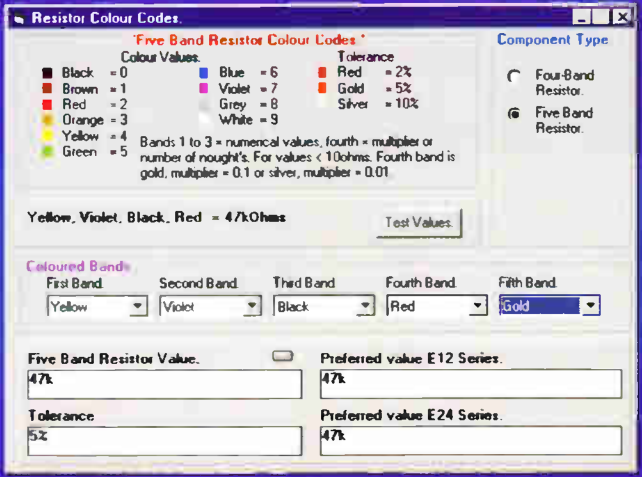

Resistor Colour Codes.

'Five Band Resistor Colour Codes.'

Colour Values.		Tolerance
Black = 0	Blue = 6	Red = 2%
Brown = 1	Violet = 7	Gold = 5%
Red = 2	Grey = 8	Silver = 10%
Orange = 3	White = 9	
Yellow = 4		
Green = 5		

Bands 1 to 3 = numerical values, fourth = multiplier or number of nought's. For values < 10ohms. Fourth band is gold, multiplier = 0.1 or silver, multiplier = 0.01

Yellow, Violet, Black, Red = 47kOhms

Component Type

○ Four-Band Resistor.

● Five Band Resistor.

Coloured Bands

First Band	Second Band	Third Band	Fourth Band	Fifth Band
Yellow	Violet	Black	Red	Gold

Five Band Resistor Value: 47k

Tolerance: 5%

Preferred value E12 Series: 47k

Preferred value E24 Series: 47k

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