EVERYDAY WITH PRACTICAL ELECTRONICS

JANUARY 1993

INCORPORATING ELECTRONICS MONTHLY

FULLY S.O.R. £1.80

FREE INSIDE

THE LATEST ISSUE OF DISPLAY NEWS

CONTINUOUSLY VARIABLE BALANCED P.S.U.

EMERGENCY LIGHTING UNIT

U.H.F. TV AERIAL AMPLIFIER

GUITAR SOFT EFFECTS UNIT

CAR ICE ALARM

PLUS CIRCUIT SURGERY, AMATEUR RADIO, TECHNIQUES, TECHNOLOGY UPDATE, INTERFACE, INNOVATIONS etc.

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THE No. 1 INDEPENDENT MAGAZINE for ELECTRONICS, TECHNOLOGY and COMPUTER PROJECTS

MICROWAVE CONTROL PANEL. Mains operated, with touch switches. Complete with 4 digit display, digital clock, and 2 relay outputs one for power and one for pulsed power (programmable). Ideal for all sorts of precision timer applications etc. Now only £4.00 ref 4P151. Good experimenters board.

FIBRE OPTIC CABLE. Stranded optical fibres sheathed in black PVC. Five metre length £7.00 ref 7P29R or £2 a metre.

12V SOLAR CELL. 200mA output ideal for trickle charging etc. 300 mm square. Our price £15.00 ref 15P42R. Gives up to 15v.

PASSIVE INFRA-RED MOTION SENSOR. Complete with daylight sensor, adjustable lights on timer (8 secs -15 mins), 50' range with a 90 deg coverage. Manual overide facility. Complete with wallbrackets, bulb holders etc. Brand new and guaranteed. Now only £19.00 ref 19P29

Pack of two PAR38 bulbs for above unit £12.00 ref 12P43R

VIDEO SENDER UNIT Transmit both audio and video signals from either a video camera, video recorder or computer to any standard TV set within a 100' range! (tune TV to a spare channel). 12v DC op. £15.00 ref 15P39R Suitable mains adaptor £5.00 ref 5P191R. Turn your camcorder into a cordless camera!

FM TRANSMITTER housed in a standard working 13A adapter (bug is mains driven). £26.00 ref 26P2R. Good range device.

MINATURE RADIO TRANSCEIVERS A pair of walkie talkies with a range of up to 2 kilometres. Units measure 22x52x155mm. Complete with cases and earpieces. £30.00 ref 30P12R

FM CORDLESS MICROPHONE. Small hand held unit with a 500' range! 2 transmit power levels. Reqs PP3 battery. Tuneable to any FM receiver. Our price £15 ref 15P42AR.

12 BAND COMMUNICATIONS RECEIVER. 9 short bands, FM, AM and LW DX/local switch, tuning 'eye' mains or battery. Complete with shoulder strap and mains lead. £19 ref 19P14R. Ideal for listening all over the world.

CAR STEREO AND FM RADIO Low cost stereo system giving 5 watts per channel. Signal to noise ratio better than 45db, wow and flutter less than .35%. Neg earth. £19.00 ref 19P30

LOW COST WALIKIE TALKIES. Pair of battery operated units with a range of about 200'. Our price £8.00 a pair ref 8P50R. Ideal for garden use or as an educational toy.

7 CHANNEL GRAPHIC EQUALIZER plus a 60 watt power ampl 20-21KHZ 4-8R 12-14v DC negative earth. Cased. £25 ref 25P14R.

NICAD BATTERIES. Brand new top quality. 4 x AA's £4.00 ref 4P44R. 2 x C's £4.00 ref 4P73R. 4 x D's £9.00 ref 9P12R. 1 x PP3 £6.00 ref 6P35R Pack of 10 AAA,s £4.00 ref 4P92R.

TOWERS INTERNATIONAL TRANSISTOR SELECTOR GUIDE. The ultimate equivalents book. New ed. £20.00 ref 20P32R.

GEIGER COUNTER KIT. Complete with tube, PCB and all components to build a battery operated geiger counter. £39.00 ref 39P1R

FM BUG KIT. New design with PCB embedded coil. Transmits to any FM radio. 9v battery req'd. £5.00 ref 5P158R. 35mm square.

FM BUG Built and tested superior 9v operation £14.00 ref 14P3R

COMPOSITE VIDEO KITS. These convert composite video into separate H sync, V sync and video. 12v DC. £8.00 ref 8P39R.

SINCLAIR C5 MOTORS 12v 29A (full load) 3300 rpm 6"x4" 1/4" O/P shaft. New. £20.00 ref 20P22R. Limited stocks.

As above but with fitted 4 to 1 inline reduction box (800rpm) and toothed nylon belt drive cog £40.00 ref 40P8R. 800 rpm.

ELECTRONIC SPEED CONTROL KIT for c5 motor. PCB and all components to build a speed controller (0-95% of speed). Uses pulse width modulation. £17.00 ref 17P3R. Potentiometer control.

SOLAR POWERED NICAD CHARGER. Charges 4 AA nicads in 8 hours. Brand new and cased £6.00 ref 6P3R. 2xC cell model £6.00.

ACORN DATA RECORDER ALF503 Made for BBC computer but suitable for others. Includes mains adapter, leads and book. £15.00 ref 15P43R

VIDEO TAPES. Three hour superior quality tapes made under licence from the famous JVC company. Pack of 10 tapes New low price £15.00 ref J15P4

PHILIPS LASER. 2MW HELIUM NEON LASER TUBE. BRAND NEW FULL SPEC £40.00 REF 40P10R. MAINS POWER SUPPLY KIT £20.00 REF 20P33R READY BUILT AND TESTED LASER IN ONE CASE £75.00 REF 75P4R.

12 TO 220V INVERTER KIT As supplied it will handle up to about 15w at 220v but with a larger transformer it will handle 80 watts. Basic kit £12.00 ref 12P17R. Larger transformer £12.00 ref 12P41R.

VERO EASI WIRE PROTOTYPING SYSTEM Ideal for designing projects on etc. Complete with tools, wire and reusable board. New low bargain price only £2.00 ref B2P1

25 WATT STEREO AMPLIFIERIC. STK043. With the addition of a handful of components you can build a 25 watt amplifier. £4.00 ref 4P69R (Circuit dia included).

BARGAIN NICADS AAA SIZE 200MAH 1.2V PACK OF 10 £4.00 REF 4P92R, PACK OF 100 £30.00 REF 30P16R

FRESNEL MAGNIFYING LENS 83 x 52mm £1.00 ref BD827R.

12V 19A TRANSFORMER Ex equipment £20 but OK.

ULTRASONIC ALARM SYSTEM. Once again in stock these units consist of a detector that plugs into a 13A socket in the area to protect. The receiver plugs into a 13A socket anywhere else on the same supply. Ideal for protecting garages, sheds etc. Complete system now only £19 !!!

286 MOTHER BOARDS. Brand new and tested complete with technical manual. £34.00 ref L34P1

UNIVERSAL BATTERY CHARGER. Takes AA's, C's, D's and PP3 nicads. Holds up to 5 batteries at once. New and cased, mains operated. £6.00 ref 6P36R.

IN CAR POWER SUPPLY. Plugs into cigar socket and gives 3,4,5,6,7.5,9, and 12v outputs at 800mA. Complete with universal spider plug. £5.00 ref 5P167R.

RESISTOR PACK. 10 x 50 values (500 resistors) all 1/4 watt 2% metal film. £5.00 ref 5P170R.

QUICK CUPPA? 12v Immersion heater with lead and cigar lighter plug £3.00 ref 3P92R. Ideal for tea on the move!

LED PACK .50 red, 50 green, 50 yellow all 5mm £8.00 ref 8P52

IBM PRINTER LEAD. (D25 to centronics plug) 2 metre parallel. £5.00 ref 5P186R. 3 metre version £6.00 ref 6P50.

COPPER CLAD STRIP BOARD 17" x 4" of .1" pitch "vero" board. £4.00 a sheet ref 4P62R or 2 sheets for £7.00 ref 7P22R.

STRIP BOARD CUTTING TOOL £2.00 ref 2P352R.

WINDUP SOLAR POWERED RADIO! FM/AM radio takes rechargeable batteries. Complete with hand charger & solar panel 14P200R. Set of 2 AA nicads £2 ref L2P9

PC STYLE POWER SUPPLY Made by AZTEC 110v or 240v input. +5 @ 15A,+12 @ 5A,-12 @ .5A,-5 @ .3A. Fully cased with fan, on/off switch, IEC inlet and standard PC fly-leads. £15.00 ref F15P4

AMSTRAD MP3

UHF/VHF TV RECEIVER/CONVERTER

CONVERTS COLOUR MONITOR INTO A TV!

£9.00

TELEPHONE HANDSETS
10 brand new handsets with mic and speaker only £3.00 ref 3P146R

BENCH POWER SUPPLIES
Superbly made fully cased (metal) giving 12v at 2A plus a 6V supply. Fused and short circuit protected. For sale at less than the cost of the case! Our price is £4.00 ref 4P103R

SPEAKER WIRE
Brown twin core insulated cable 100 feet for £2.00 REF 2P79R

DISC DRIVES
Customer returned units mixed capacities (up to 1.44M) We have not sorted these so you just get the next one on the shelf. Price is only £7.00 ref 7P1R (worth it even as a stripper)

MICROSCOPE 1200X MAGNIFICATION
Brand new complete with shrimp hatchery, shrimps, prepared slides, light etc. £29.00 ref J29P4.

LIGHT ALARM SYSTEM
Small cased alarms that monitor a narrow beam area for sudden changes in light level. Complete with siren that sounds for a preset time when unit is triggered. £7.00 ref J7P1

JOYBALLS
Back In stock popular Commodore/Atari equiv (replace standard joystick) £5.00 ref J5P8

AMSTRAD 1640DD BASE UNITS

BRAND NEW AND CASED

TWO BUILT IN 5 1/4" DRIVES

MOTHER BOARD WITH 640K MEMORY

KEYBOARD, MOUSE & MANUAL

OUR PRICE JUST

£79!!!!

CAR BATTERY CHARGER
Brand new units complete with panel meter and leads. 6 or 12v output £7.00 ref J7P2.

CUSTOMER RETURNED SPECTRUM +2
Complete but sold as seen so may need attention £25.00 ref J25P1 or 2 for £40.00 ref J40P4

CUSTOMER RETURNED SPECTRUM +3
Complete but sold as seen so may need attention £25.00 ref J25P2 or 2 for £40.00 ref J40P5

SCART TO D TYPE LEADS
Standard Scart on one end, Hi density D type (standard VGA connector) on the other. Pack of ten leads only £7.00 ref 7P2R

OZONE FRIENDLY LATEX
250ml bottle of liquid rubber sets in 2 hours. Ideal for mounting PCB's fixing wires etc. £2.00 each ref 2P379R

VIEWDATA SYSTEMS
Brand new units made by TANDATA complete with 1200/75 built in modem infra red remote controlled qwerty keyboard BT appproved Prestel compatible, Centronics printer port RGB colour and composite output (works with ordinary television) complete with power supply and fully cased. Our price is only £20.00 ref 20P1R

AC STEPDOWN CONVERTER
Cased units that convert 240v to 110v 3" x 2" with mains input lead and 2 pin American output socket (suitable for resistive loads only) our price £2.00 ref 2P381R

CURLY CABLE
Extends from 8" to 6 feet! D connector on one end, spade connectors on the other Ideal for joysticks etc (6 core) £1.00 each ref CD44R

COMPUTER JOYSTICK BARGAIN
Pack of 2 joysticks only £2.00 ref 2P382R

BUGGING TAPE RECORDER
Small hand held cassette recorders that only operate when there is sound then turn off 6 seconds after so you could leave it in a room all day and just record any thing that was said. Price is £20.00 ref 20P3R

NEW SOLAR ENERGY KIT
Contains 8 solar cells, motor, tools, fan etc plus educational booklet. Ideal for the budding enthusiast! Price is £12.00 ref 12P2R

286 AT PC
286 MOTHER BOARD WITH 640K RAM FULL SIZE METAL CASE, TECHNICAL MANUAL, KEYBOARD AND POWER SUPPLY £139 REF 139P1 (no i/o cards or drives included) Some metal work req'd phone for details.

BULL ELECTRICAL

250 PORTLAND ROAD HOVE SUSSEX BN3 5QT TELEPHONE 0273 203500

MAIL ORDER TERMS: CASH PO OR CHEQUE WITH ORDER PLUS £3.00 POST PLUS VAT.

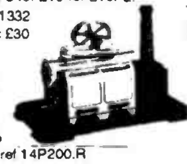
PLEASE ALLOW 7 - 10 DAYS FOR DELIVERY

FAX 0273 323077

VISA

CAMERAS Customer returned units. 3 for £10 ref L10P2.

STEAM ENGINE Standard Mamod 1332 engine complete with boiler piston etc £30 ref 30P200



TALKING CLOCK
LCD display, alarm, battery operated. Clock will announce the time at the push of a button and when the alarm is due. The alarm is switchable from voice to a cock crowing! £14.00 ref 14P200.R

HANDHELD TONE DIALLERS
Small units that are designed to hold over the mouth piece of a telephone to send MF dialling tones. Ideal for the remote control of answer machines. £5.00 ref 5P209R

AMAZING TALKING COINBOX!
Fully programmable talking, lockable coinbox BT approved, retail price is £79 ours is just £29! ref J29P2.

ANSWER PHONES £15
Customer returned units with 2 faults one we tell you how to fix the other you do your self! £18 ref J18P2 or 4 for £60 ref J60P3 BT approved (retail price £79.95!! each)

COMMODORE 64 MICRODRIVE SYSTEM
Complete cased brand new drives with cartridge and software 10 times faster than tape machines works with any Commodore 64 setup. The orginal price for these was £49.00 but we can offer them to you at only £25.00! Ref 25P1R

90 WATT MAINS MOTORS Ex equipment but ok Good general pupose unit £9.00 ref F9P1

HI FI SPEAKER BARGAIN Originally made for TV sets they consist of a 4" 10 watt4R speaker and a 2" 140R tweeter. If you want two of each plus 2 of our crossovers you can have the lot for £5.00 ref F5P2.

EMERGENCY LIGHTING SYSTEM
Fully cased complete with 2 adjustable flood lights. All you need is a standard 6v lead acid battery. Our price is just £10 ref J10P29

AMSTRAD 464 COMPUTERS
Customer returned units complete with a monitor for just £35! These units are sold as faulty and are not returnable.

WOLSEY DMAC DECODERS
Made for installation in hotels etc as the main sat receiver no data but fully cased quality unit. £20 ref K20P1. Suitable psu £8 ref K8P3.

SWITCHED MODE PSU
Fully cased unit 215mmx145mmx55mm giving +5, +12 and +20v well made case complete with mains lead. £8 ref K8P3.

REMOTE CONTROLS
Brand new infra red CONTROLS originally made for controlling WOLSEY satellite receivers. £2 ea ref K2P1 or 20 for £19 ref K19P1.

TELEPHONES
Modem 1 piece phones BT approved. Last no redial. £8 ref K8P1.

386 TOWER SYSTEMS
Tower case 52cmx40cmx20cm. 2 fans, speaker, 275w psu, IEC I/L and O/L, 386 m/board with onboard disc controller, ethernet, display driver, parallel and serial ports. **There are several IC's missing from the m/board plus no data! £79 ref K79P1.**

DOS PACKS
Complete set of PC discs with MS DOS 3.2, Locomotive basic, gemdesktop and gem paint. No manuals, 5 1/4" discs. £10 ref K10P2

CORDLESS TIE CLIP MICROPHONE
transmits between 88-108MHZ FM 5.2cm x 2cm, uses LR44 watch battery. Complete with wire aerial & battery. £16 ref K16P1.

CHASSIS MOUNT TRANSFORMERS
240v primary, 12v secondary 20VA £2 ref K2P2
240v primary, 16v secondary 10A (split winding). £10 ref L10P1

100 RED LED PACK (5MM) £5 REF K5P2

12V STEPPER MOTOR Ideal for models etc. 3" dia. £2 ref J2P14.

INFRA RED BEAM SWITCH 24v DC 5m range source & sensor housed in plastic case. £12 ref J12P1.

CAPACITOR BARGAIN PACK 100 CERAMICS £2 REF J2P2.

SPECTRUM JOYSTICKS TWO FOR £5 REF J5P2.

AMSTRAD PC CASE, POWER SUPPLY AND 1.44MEG FLOPPY DRIVE ALL THIS FOR £44 REF L44P1

BUMPER PACK NO 1 10 of our popular £1 packs for just £5 our choice of contents.

BUMPER PACK NO 2 25 of our popular £1 packs for just £12. Our choice of contents.

LCD 1 X 32 DISPLAY Bargain price of just £3 complete with loads of data for a similar display. £3 ref L3P1.

USEFUL POWER SUPPLIES. 18v 900mA dc output (regulated) fully cased with mains cable and DC out cable. £6 ref K6P1.

UNCASED PC POWER SUPPLIES. Standard PC psu without case, fan etc. Good for spare or low cost PC!. £4 ref L4P6.

RADAR DETECTORS. Detects X and K bands (ie speed traps). Not legal in the UK so only available if you intend to 'export' it. £59 ref J59P1.

100 WATT MOSFET PAIR. Same spec as 2Sk343 and 2SJ413 (8A,140v, 100w) 1 N channel and 1 P channel. £3 a pair ref J3P9.

LOW COST CAPS. 1,000 capacitors £3 (33uf,25v) ref J3P10.

VELCRO. 1 metre length 20mm wide, blue. £2 ref J2P16.

JUG KETTLE ELEMENTS. Good general purpose heating element just £3 ea ref £3P8 or 5 for £10 ref J10P3.

VERY BIG MOTOR. 200v induction 1.1kw 1410 rpm 10"x7" GEC 1" keyed shaft. Brand new. £95 ref J95P1.

BIG MOTOR. 220-240v 1425rpm 2.8A 5/8th" keyed shaft GEC 6.5" x 8" complete with mounting plate. £38 ref J38P1.

SMALL MOTOR. Electrolux 160 watt 3,000 rpm, 220-240v 5/8" shaft precision built £18 ref J18P1.

EPROMS 27C64 PACK OF 10 £7 REF M7P1.

EPROMS 27C256 PACK OF 10 £9 REF M9P1.

EPROMS 27C512 PACK OF 10 £10 REF M10P1.

MODEMS FOR £1.25? These modems are suitable for stripping only hence they are only 4 for £5 ref J5P3.

SOLAR POWERED WOODEN MODELS. Complete with solar panel, motor and full Instructions. £9 ref J9P2. 3 diff £20 ref J20P3.

TV SOUND RECEIVER Fully cased, mains powered, that need a speaker for stand alone use or could be wired into hifi. £12 ref 12P22.

SOUND OPERATED LIGHT. Clap your hands and light comes on. Turns after preset delay. (4 AA's req'd). £2 ref J2P3.

FERGUSON SRB1 REMOTE CONTROLS. Brand new units ideal for a spare or have two remotes! £4 each.

IN SUSSEX? CALL IN AND SEE US!

SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

VOL. 22 No. 1 JANUARY 1993

EVERYDAY WITH PRACTICAL ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

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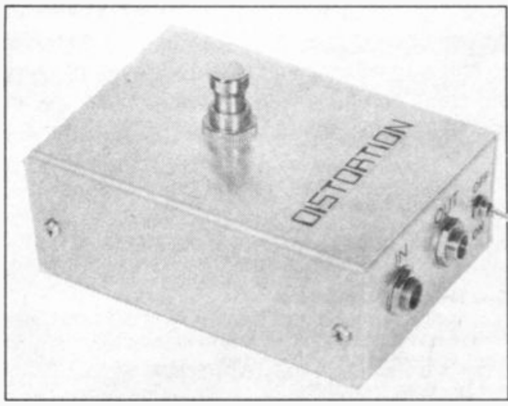
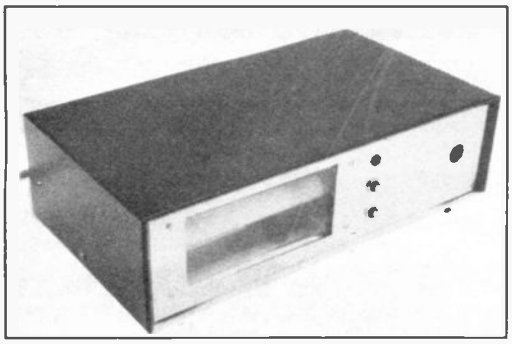
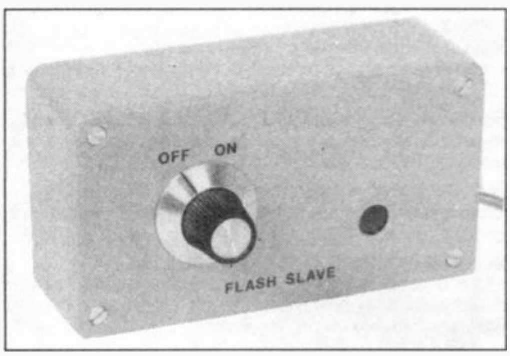
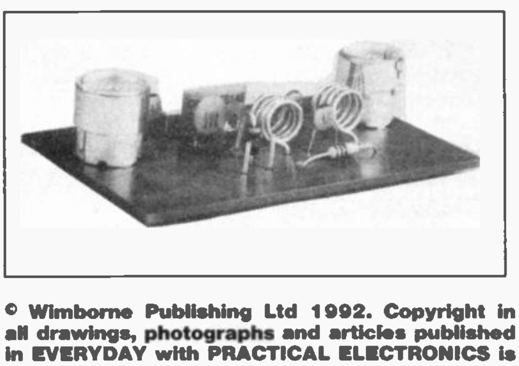
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .









Our February '93 issue will be published on Friday, 8 January 1993. See page 3 for details.

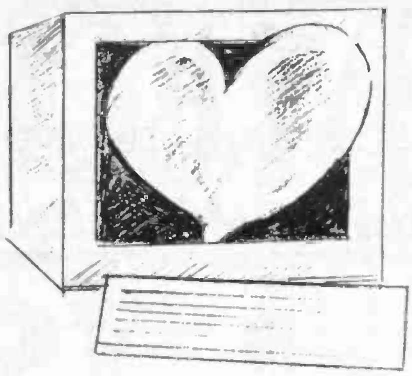
Projects

Series

Features

BIOMET

Probe the rhythm of life



The Biomet is a heart and pulse rate monitor which can be used on its own or in conjunction with a computer. The computer screen displays heart rhythm waveforms and pulse rates. Pulse rates are also shown on the Biomet's liquid crystal display screen.

Two forms of monitoring are available. With the first, the electrical impulses generated by the heart are sensed by two monitoring electrodes attached to the chest. In the second, less precise, method a finger or thumb is placed across a probe containing a light dependent resistor.

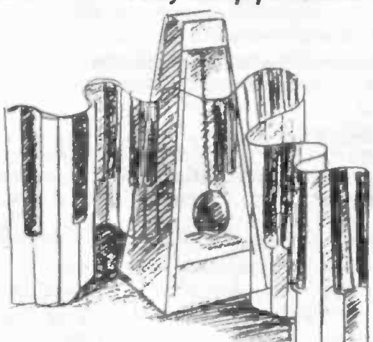
SIMPLE RADIO CONTROL SYSTEM

This extermely simple radio control system operates on the 27MHz band, and provides short range operation (up to about 6 metres). It provides simple on/off operation, with a relay in the receiver switching in sympathy with a push-button switch on the transmitter. This equipment is suitable for the control of models used indoors (or outdoors provided the limited range is borne in mind), or an application such as the remote control of doors or a camera which has an electric release socket etc.

RECHARGEABLE HAND LAMP

Most commercially available rechargeable lamps use NiCad cells since they are relatively easy to charge. Unfortunately this often results in a short output period and the need for almost continuous charging. This design employs a sealed lead acid battery which will hold its charge for a long period and provides light output over a useful length of time.

A standard Ever Ready lamp provides the basis of the unit.



METRONOME

We had hoped to bring you this simple and inexpensive metronome design this month but lack of space prevented it – sorry. We will now feature it in next month's issue.

EVERYDAY WITH PRACTICAL ELECTRONICS

FEBRUARY '93 ISSUE ON SALE FRIDAY JANUARY 8th, 1993

NEXT MONTH

EVERYDAY WITH PRACTICAL ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

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See notes on **Readers' Enquiries** below – we regret that lengthy technical enquiries cannot be answered over the telephone.

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DISCONTINUED

Maybe it's a sign of the times – just lately we have had problems with component availability. A number of items, mainly i.c.s, have simply disappeared. Although there is no particular pattern to the demise of various parts we believe it may be due to rationalisation of product lines during the recession. If the sales are low or you cannot compete with your competitors' prices then, in difficult times, it is often economically sensible to simply discontinue manufacture.

This has affected a few of our projects and we are still looking for any remaining supplies of one or two semiconductor devices. Unfortunately we have also suffered a similar problem with the Veroblock used on the *Mini Lab* (our *Teach-In '93* demonstration and development board). Vero have stopped making this product, supplies of boards are fast running out and we have been unable to locate any other remaining boards in Europe.

This has forced us to find an alternative that will accommodate the various test circuits and fit on the *Mini Lab* p.c.b. – details are in *Shop Talk*. Fortunately in this case a replacement is possible, when dealing with dedicated i.c.s this is nearly always not the case. If the dedicated i.c. disappears then repair of the equipment becomes impossible. We wonder just how many commercial products are now throw away items once they fail?

BLOWN OUT

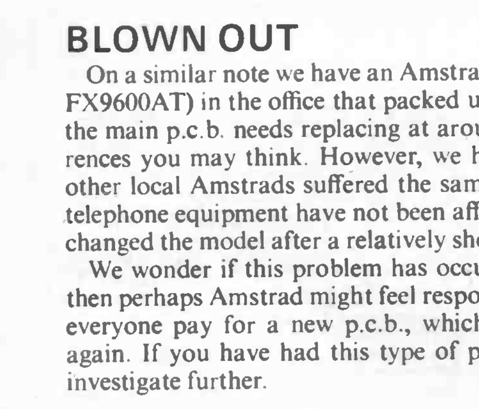
On a similar note we have an Amstrad telephone answering machine/fax (Model FX9600AT) in the office that packed up following a storm, investigations showed the main p.c.b. needs replacing at around £250. Just one of those unlucky occurrences you may think. However, we have subsequently found that half a dozen other local Amstrads suffered the same problem, while our Sharp fax and other telephone equipment have not been affected. We also find that Amstrad have now changed the model after a relatively short product time span.

We wonder if this problem has occurred to others? If it is a basic design fault then perhaps Amstrad might feel responsible enough to sort it out without making everyone pay for a new p.c.b., which could presumably suffer similar damage again. If you have had this type of problem please let us know so that we can investigate further.

Mike Kenward

SUBSCRIPTIONS

Annual subscriptions for delivery direct to any address in the UK: £20. Overseas: £26 (£43.50 airmail). Cheques or bank drafts **(in £ sterling only)** payable to Everyday with Practical Electronics and sent to EPE Subscriptions Dept., 6 Church Street, Wimborne, Dorset BH21 1JH. Tel: 0202 881749. **Subscriptions start with the next available issue.** We accept Access (MasterCard) or Visa payments, minimum credit card order £5.



BACK ISSUES

Certain back issues of EVERYDAY ELECTRONICS and PRACTICAL ELECTRONICS are available price £2.00 (£2.50 overseas surface mail) inclusive of postage and packing per copy – **£ sterling only please.** Visa and Access (MasterCard) accepted, minimum credit card order £5. Enquiries with remittance, made payable to Everyday with Practical Electronics, should be sent to Post Sales Department, Everyday with Practical Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH Tel: 0202 881749. In the event of non-availability one article can be photostatted for the same price. *Normally sent within seven days but please allow 28 days for delivery.* **We have sold out of Jan, Feb, Mar, Apr, June, Oct, & Dec. 88, Mar & May 89 & Mar 90 Everyday Electronics and can only supply back issues from Jan 92 to Oct 92 of Practical Electronics.**

BINDERS

Binders to hold one volume (12 issues) are available from the above address for £5.95 (£6.95 to European countries and £8.00 to other countries, surface mail) inclusive of post and packing. *Normally sent within seven days but please allow 28 days for delivery.*

Payment in £ sterling only please.
Visa and Access (MasterCard) accepted, minimum credit card order £5. Send card number and card expiry date with your name and address etc.

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READERS' ENQUIRIES

We are unable to offer any advice on the use, purchase, repair or modification of commercial equipment or the incorporation or modification of designs published in the magazine. We regret that we cannot provide data or answer queries on articles or projects that are more than five years old. Letters requiring a personal reply must be accompanied by a **stamped self-addressed envelope** or a **self addressed envelope and international reply coupons.**

All reasonable precautions are taken to ensure that the advice and data given to readers is reliable. We cannot however guarantee it and we cannot accept legal responsibility for it.

COMPONENT SUPPLIES

We do not supply electronic components or kits for building the projects featured, these can be supplied by advertisers.

We advise readers to check that all parts are still available before commencing any project in a back-dated issue.

We regret that **we cannot provide data or answer queries on projects that are more than five years old.**

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EMERGENCY LIGHTING UNIT

MARK DANIELS

Provides up to 8 watts of "fluorescent" lighting should you suffer a power cut. Will not operate during "daylight" conditions, saving on unnecessary use of the battery.

WITH winter upon us once again, bringing with it the threat of snow and power cuts like we had during the winter of 1990/91 some form of emergency lighting would seem to be essential. The usual alternatives to mains electricity for lighting purposes include candles, torches and gas lamps, which are all very well, but try finding them in the dark when a power cut occurs unexpectedly.

A full blown emergency power system comprising a generator, or inverter and batteries with automatic start-up in the event of a power failure would be the ideal system. Unfortunately, the cost of such an ideal set-up is highly prohibitive under most normal circumstances and is probably also far from essential.

There are several self-contained emergency lighting units on the market which are suitable for domestic use, but they do suffer from one significant drawback: they normally come on immediately the power fails and remain on for the duration of the power failure. This is fine if the power is only off for a relatively short period of time, but if, as during the power cuts of winter 1990/91, it remains off for more than a few short hours the back-up batteries will completely discharge before power is restored.

Obviously if the power fails during the night the batteries will be flat when needed most during dark winter mornings, and the emergency lighting will have performed no useful service. The unit described in this article all but completely removes the problems associated with conventional emergency lighting systems by automatically switching the light on only when it is needed.

HOW IT WORKS

The Emergency Lighting Unit has two sensing circuits, one of which monitors the mains voltage, while the other monitors the ambient light level. The sensing circuits are connected to trigger short period monostable timers, one for each of the above two conditions.

A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

AND GATE TRUTH TABLE

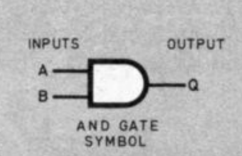
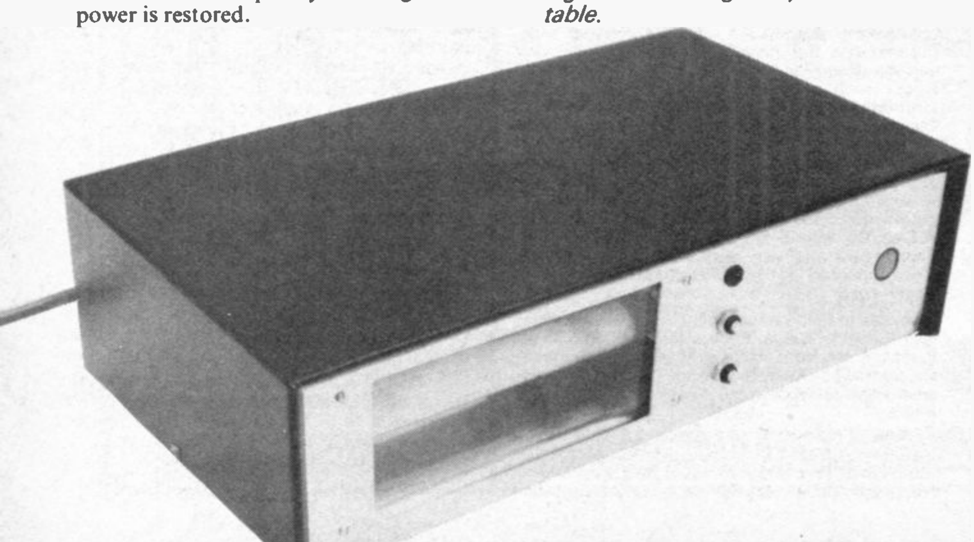


Fig. 1. An AND gate symbol and truth table.

The outputs from the monostables are connected to the inputs of a two input AND gate, and as may be seen from the Truth Table in Fig. 1 the output is only high (logic 1) when both inputs are also high. Thus, from the above it may be seen that the output may only be high very briefly if both the power and light fail at practically the same instant in time.

The brief output from the AND gate is then used to trigger a bistable latching circuit, which once triggered remains latched until it receives a turn-off signal. The circuit therefore only switches on the emergency light if a power failure is accompanied by a simultaneous reduction in light level, as would occur in an occupied room at night when the power fails.

The circuit also has facilities which permit manual operation of the light as may be required when returning home in the evening after the power has already failed earlier in the day.



CIRCUIT DESCRIPTION

The Emergency Lighting Unit, the circuit diagram for which is provided in Fig. 2, is powered by a single 12V lead acid accumulator, B1. (A small sealed type, fitted internally, was used in the prototype, but any larger battery such as a car battery may be connected externally instead as described in the Modifications section).

The battery is kept in a constant state of charge by a mains powered charger. The charger provides a constant output voltage, which is essential for charging sealed lead acid accumulators, and is based around IC1, a 7812, 12V 1A voltage regulator i.c. which is operated in a boosted voltage mode to give 13.8V for charging the battery.

A potential divider network consisting of resistors R2 and R3 is connected between the output of IC1 and supply ground (0V). The common terminal of IC1 is connected to the mid-point of this potential divider, which then provides the reference ground for IC1.

Since this point is at a fixed potential above the supply ground the regulator maintains its output at 12V above this point instead of the supply ground and gives a higher than normal output voltage which may be calculated as follows:

$$\text{Output Voltage} = \frac{R2+R3}{R2} \times 12V = 13.76\text{volts}$$

The regulator circuit is fed from a mains transformer T1 and bridge rectifier arrangement D1 to D4.

Capacitors, C3 to C6 and C9 are included for the purposes of supply decoupling, and protect the CMOS circuitry from the copious quantities of high voltage, high frequency spikes superimposed on the supply by virtue of the fast switching action of the fluorescent tube inverter. Diode, D7 protects the electronics from the potentially disastrous effects of incorrect battery connections being made!

Transistor, TR1 monitors the mains voltage via the rectified secondary output of the mains transformer, T1. Diode, D6 blocks the voltage on capacitor C2 and allows transistor, TR1 to respond rapidly to loss of mains power, having only the small charge on C1 to dissipate in the l.e.d. D5 and its series resistor, R1.

With mains present transistor TR1 is turned on and pulls pin 8, the trigger pin of the monostable, IC4 down to ground. When the mains fails TR1 turns off allowing the voltage on pin 8 of IC4 to be taken positive via resistor, R5. This initiates the timing period of the monostable which has a duration of approximately 500mS.

LIGHT SENSING

The light sensor circuit uses a cadmium sulphide (CdS) light dependent resistor (l.d.r.), R6 in a potential divider network which is used to provide an input voltage to the inverting input of op.amp, IC2, at pin 2. The non-inverting input of this amplifier is biassed to half the supply voltage by a potential divider circuit consisting of resistors, R7 and R8.

When the light level falls, the resistance of the l.d.r. (R6) rises, causing the voltage at the inverting input of IC2 to rise. When this voltage exceeds that at the inverting input the op-amp's output, pin 6, falls from its current value of about 12V to zero, thus turning off transistor TR2 and consequently triggering monostable IC3, which has a timing period of approximately 25mS.

The outputs from IC3 and IC4 are fed to the inputs of one of the AND gates in IC5. The output of this gate is buffered by transistor TR3 and provides a brief trigger pulse on the gate (g) of thyristor CSR1 almost immediately after the simultaneous failure of light and mains power. Once triggered the thyristor remains conducting, even after the gate signal has been removed, thus providing the desired latching action.

There are basically two methods of commutating a thyristor once it has been fired: one is to disconnect the load, thus reducing the current flowing in the thyristor to zero. The other is to reduce the potential at its anode (a) to the same as its cathode (k), which again causes the thyristor current to reduce to zero. A modified version of the second method is used here, whereby a second thyristor, CSR2 is used in conjunction with capacitor C13 and a resistor, R19 to turn off CSR1.

Assuming CSR1 to be conducting, a pulse applied to CSR2 gate triggers it into conduction, discharging C13, the commutation capacitor, to ground (0V). This rapid movement of the charge on C13 pulls the anode of CSR1 to ground, causing the thyristor to turn off, or commutate.

Resistor, R19 is the load resistor for CSR2 and keeps this thyristor latched, whilst also allowing C13 to charge up in the opposite direction. The above process is reversed when CSR1 is re-triggered.

Switch, S2 permits manual off-switching of the lamp LP1 by shorting the (a) and (k) connections of CSR1, thus reducing the voltage across the device to zero. Likewise switch, S1 connected across TR3 collector and emitter permits the fluorescent lamp to be turned on manually.

The fluorescent tube inverter is a conventional flyback converter, consisting of just four components, R18, C11, TR4 and a high frequency transformer, T2 which is wound on a ferrite pot-core. This arrangement gives a lightweight, compact circuit having good efficiency at very low cost.

Resistor, R18 and capacitor C11 set a high oscillation frequency of around 40kHz, which is utilised by transistor TR4 in switching the primary of T2. Due to the inductive nature of the circuit and the fast

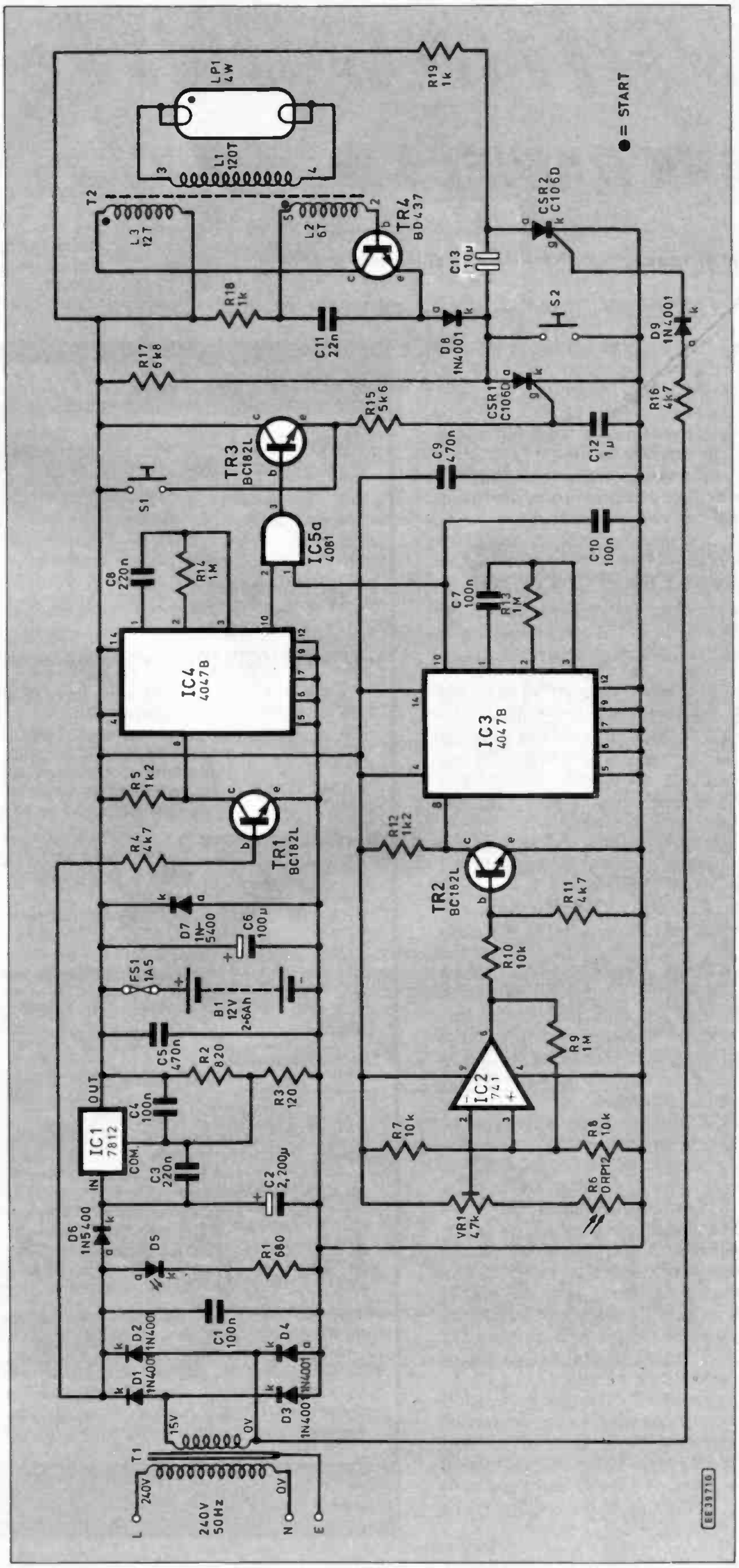
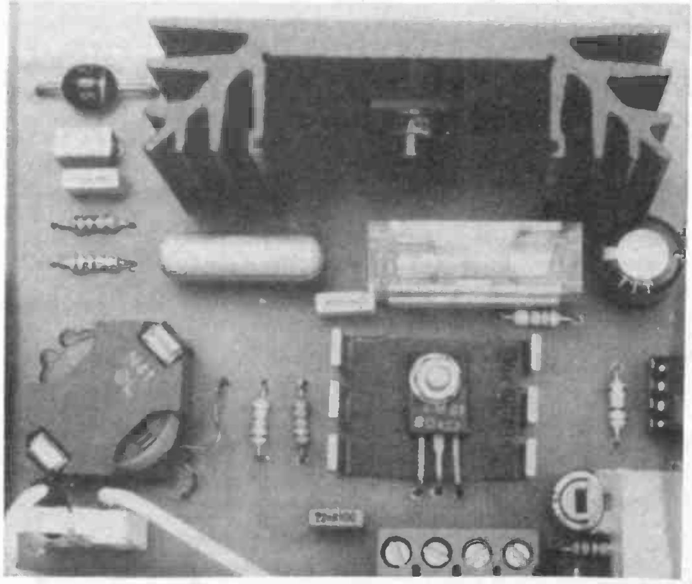


Fig. 2. Complete circuit diagram for the Emergency Lighting Unit. Capacitor C13 must be a non-polarised or reversible electrolytic. Note windings L2 and L3 are wound in an anti-clockwise direction when viewing the transformer T2 bobbin from the pin side, see Fig. 3. IC5 pins 5, 6, 8, 9, 11, 12, 14 = +V; pin 7 = 0V



Close-up showing pot-core transformer and heatsink mounting.

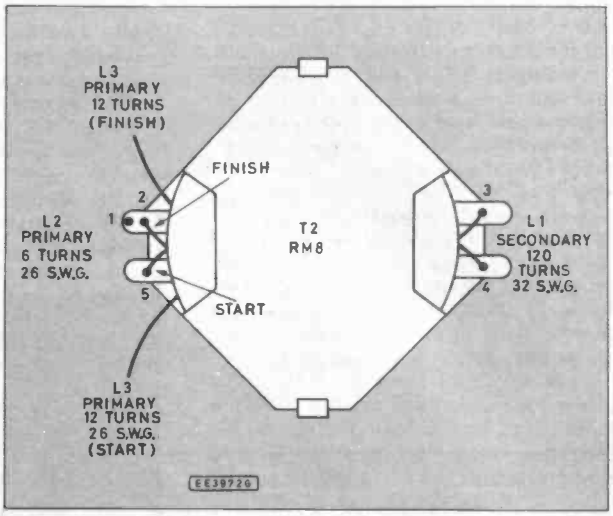


Fig. 3. Winding details for the h.f. pot-core transformer T2. Core viewed from pin side. Winding L2 and L3 are wound in an anti-clockwise direction when viewing bobbin from pin side.

switching action a high voltage is induced in the primary winding and stepped up even higher in the secondary, in fact sufficiently high as to "strike" the tube without using the heaters. Once the tube is running the voltage across it will settle down to a somewhat lower value, but still sufficiently high as to maintain ionisation of the rarefied gas inside the tube.

TRANSFORMER CONSTRUCTION

Before commencing construction of the printed circuit board it is suggested that the ferrite pot-core, high frequency transformer, T2 is wound.

The transformer is wound on an RM8 pot-core, which consists of a bobbin, two core halves and two clamps. The coils are wound on the bobbin, starting with the 120-turn secondary winding L1 which is connected between pins 3 and 4 on the bobbin (see Fig. 3).

Wind the turns evenly and in uniform layers to prevent turns from upper layers dropping down into lower layers and placing high stresses on the thin insulation of the enamelled copper wire. It is recommended that 32s.w.g. wire be used for the secondary winding, being easy to handle but sufficiently thin to allow the turns to be accommodated. The direction of this winding does not matter in relation to the other two windings, so may be wound in any direction, so long as all its windings are in the same direction.

The polarity of the next two windings, L2 and L3, is very important, and after applying a couple of layers of P.T.F.E. pipe thread tape (available from d.i.y. stores and plumbers merchants) on top of the finished secondary winding L1 a further six turns of 32s.w.g. wire are wound on between pins 2 and 5 to make up coil L2. This winding *starts* at pin 5 and is wound in an anti-clockwise sense, viewing the bobbin from the pin side, finishing at pin 2. A further couple of layers of P.T.F.E. tape are then applied.

Make up coil L3 by attaching a label to the end of a piece of 26s.w.g. enamelled copper wire and mark it "start". Now wind on twelve turns in the same direction as the last winding L2 and leave the ends free on the same side of the bobbin as the six turn winding.

COMPONENTS

Resistors

R1	680	R7, R8, R10	10k (3 off)
R2	820	R9, R13, R14	1M (3 off)
R3	120	R15	5k6
R4, R11, R16	4k7 (3 off)	R17	6k8
R5, R12	1k2 (2 off)	R18, R19	1k (2 off)
R6	ORP12 light dependent resistor	All 0·25W 5% carbon, except R6	

Potentiometer

VR1	47k sub-min. preset, horizontal

Capacitors

C1, C4, C7, C10	100n 5mm pitch boxed polyester (4 off)
C2	2,200µ axial elect., 25V
C3, C8	220n polyester layer (2 off)
C5	470n polyester
C6	100µ radial elect., 25V
C9	470n monolithic ceramic
C11	22n 5mm pitch boxed polyester
C12	1µ monolithic ceramic
C13	10µ non-polarised radial elect., 100V

See SHOP TALK Page

Semiconductors

D1 to D4, D8, D9	1N4001 50V 1A rect. diode (6 off)
D5	5mm red light emiting diode (l.e.d.)
D6, D7	1N5400 50V 3A rect. diode (2 off)
TR1, TR2, TR3	BC182L *npn* silicon transistor (3 off)
TR4	BD437 *npn* 4A power transistor
CSR1, CSR2	C106D 400V 5A thyristor (2 off)
IC1	7812 12V 1A voltage regulator
IC2	741N op.amp
IC3, IC4	4047B multivibrator (2 off)
IC5	4081 quad 2-input AND gate

Miscellaneous

T1	20VA mains transformer: 250V a.c. primary; 15V secondary
T2	RM8 ferrite pot-core transformer (see text): pot-core: B65811-JR41 (AL 4100); bobbin: B65812-J1005D1 (5-tag); clamps: B65812-A2203 (2 off)
L1	120 turns 32s.w.g. enamelled copper wire for T2 (see text)
L2	6 turns 32s.w.g. enamelled copper wire for T2 (see text)
L3	12 turns 26s.w.g. enamelled copper wire for T2 (see text)
LP1	4W fluorescent tube, with two connectors.
B1	12V 2·6Ah sealed lead/acid battery (see text)
S1, S2	Pushbutton switch, push-to-make (2 off)
FS1	1·5A 20mm fuse and p.c.b. mounting holder

Two-part aluminium and steel case, approx size 279mmx 152mm x 76mm; 4-way p.c.b. mounting screw-terminal block (3 off); 3-way p.c.b. mounting screw-terminal block (2 off); sheet of stainless steel, size approx. 160mm x 150mm x 0·8mm (22s.w.g.), for tube reflector; 7·2°C/W heatsink, 50mm x 50mm x 14mm; small heatsink for TR4; multi-coloured connecting wire; self-adhesive feet (4 off); double-sided self-adhesive pads for mounting battery B1; 3-core mains cable; solder, etc.

Printed circuit board available from *EPE PCB Service*, code 816.

Approx cost guidance only **£35** *(excluding Batt.)*

About 25mm of free ends will be sufficient for connecting to the p.c.b. Insulate L3 winding as before and, to give some protection to the windings and a neat finish, a single layer of transformer paper may be applied, gluing the two ends together to hold it in position.

Cut two pieces of ordinary writing paper to fit in the centre of the wound bobbin, then fit the bottom core piece and place both pieces of paper on its centre-pole before fitting the second core piece. The two core pieces are clamped together using the two snap-fit metal clamps, ensuring that the "earth" spikes on the clamps are on the underside of the completed transformer with the bobbin pins.

CIRCUIT BOARD

Most of the components are mounted on a single-sided glass-fibre printed circuit board (p.c.b.). The full size copper foil pattern and component layout are provided in Fig. 4. This board is available from the *PCB Service*, code 816.

The following order of assembly for the board is recommended: i.c. sockets, resistors, preset, capacitors (C13 will need to be mounted vertically), fuseholder and p.c.b. connectors (if used). Next the inverter transformer T2 can be mounted on the board, taking care to connect the primary correctly.

The semiconductors should be the last components to be fitted, starting with the eight diodes followed by CSR1 and CSR2. Transistors TR1 to TR3 may be fitted next, followed by TR4 and the voltage regulator, IC1.

These last two components are both fitted with heatsinks, which, in the case of the regulator, needs to be fitted before soldering it into place. No isolating kit is necessary since only IC1 is mounted on this heatsink, but a small quantity of

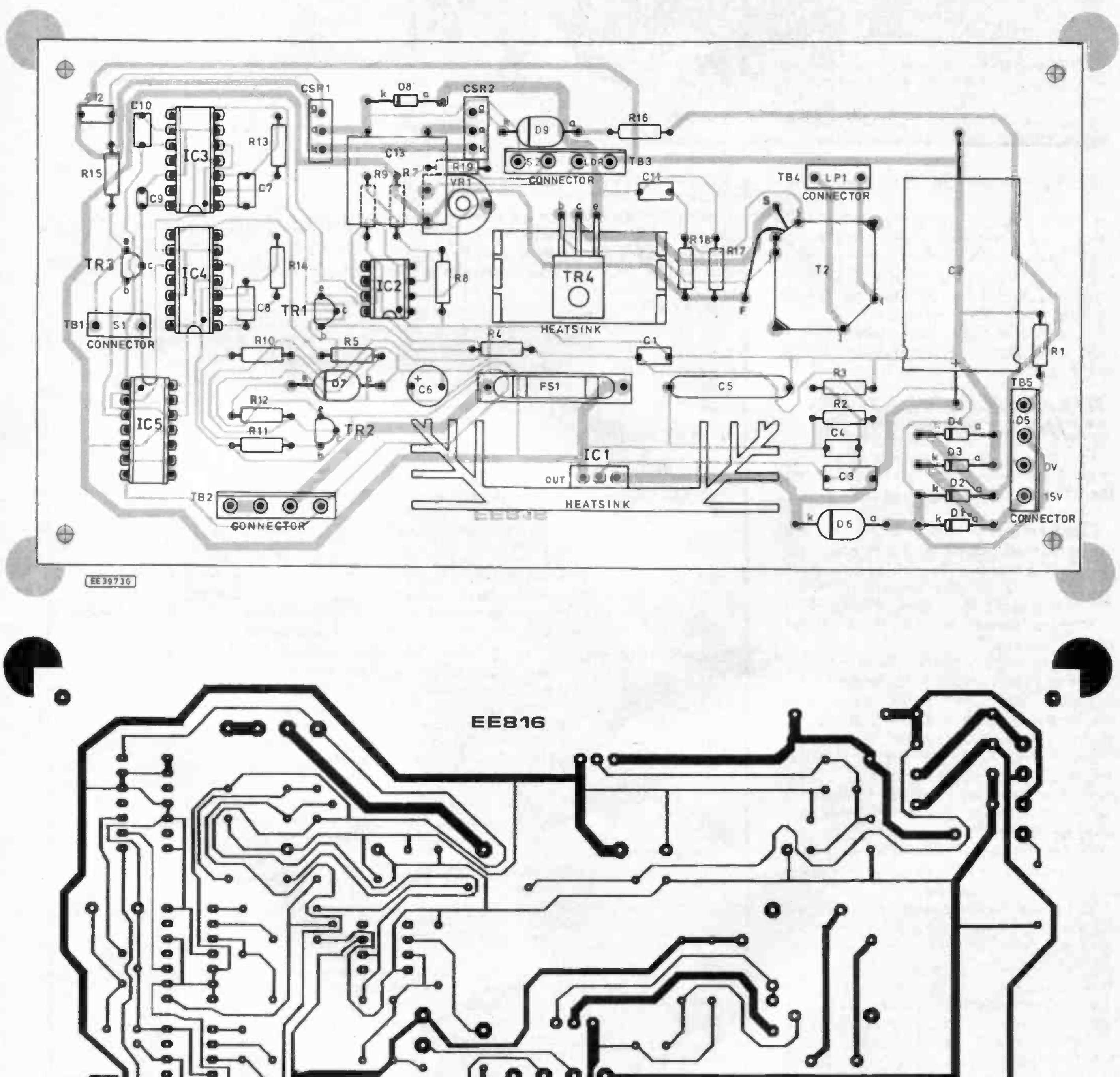
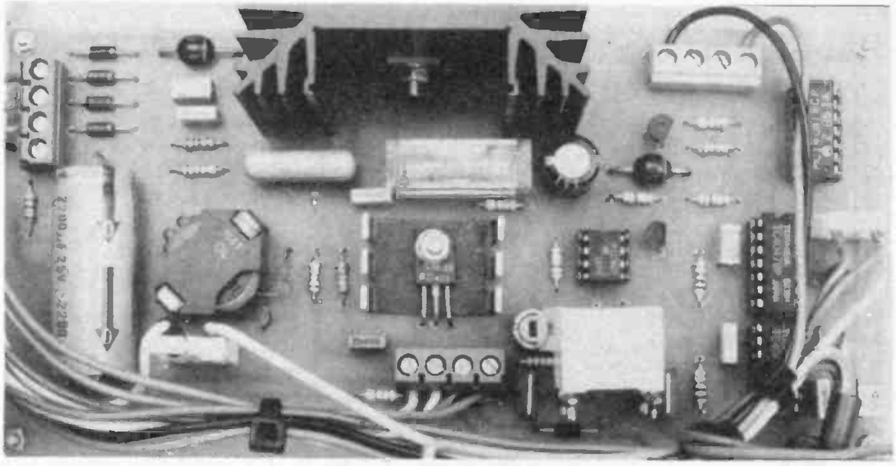


Fig. 4. Printed circuit board component layout and full-size copper foil master pattern. The heatsink for the voltage regulator should be fitted before it is mounted on the board – see text.



heatsink compound must be applied to the mounting tab of the device. The heatsink may be bonded to the p.c.b. using a good quality cyanoacrylate adhesive ("Superglue") if desired.

WARNING:- Under NO circumstances WHATSOEVER should the adhesive be allowed to come into contact with a hot surface, such as a soldering iron, as this will cause HIGHLY TOXIC fumes to be liberated by the cyanoacrylate solvent. Therefore use only the smallest possible quantity and avoid getting any on the copper side of the p.c.b.

The voltage regulator IC1 and its heatsink are mounted vertically to aid cooling. TR4 is laid flat on top of its heatsink and both are bolted to the board using a single M3 × 12 screw and nut.

Note, the metal side of TR4 must face the p.c.b. with the heatsink in between the two. Again, a small quantity of heatsink compound, although not essential this time, may be used to aid heat transfer.

CASE PREPARATION

The case needs a fair amount of preparation work before the electronics may be fitted. A *metal* case *MUST* be used for safety reasons and will also help prevent any radio frequency interference produced by the tube inverter from propogating strongly outside of the case.

A two part aluminium and steel case size about 275mm × 150mm × 75mm is recommended. These are available from most component suppliers fairly cheaply.

The cutouts to be made in the front panel of the case are shown in Fig. 5. The main task is the cutting of the aperture for the fluorescent tube and is probably best tackled by drilling an 8mm hole at each corner of this cutout, inside the marked lines and then using a coping saw frame fitted with a junior hacksaw blade to make the cuts. The hole should then be tidied up and de-burred using a flat file. The rest of the holes may be made using suitable size drills and in the case of the hole for the light dependent resistor (R6) finished to size with a round file.

Cut a piece of 4mm thick clear Perspex, size 160mm × 70mm and mount the tube connectors at either end on the centre line, contersinking the mounting screws. The distance between the inner faces of the tube connectors should be 135mm. A tolerance of +0.5mm is acceptable, but must not be less than 135mm or the tube will not fit.

Using the p.c.b. as a guide, drill the four mounting holes for the board in the back left hand corner of the case (see Fig. 7) and fit four M2 × 12 screws in the holes securing them with M2 nuts. Fit another nut on each of these screws, about 5mm from the end of the thread and temporarily sit the p.c.b. on top of these to enable a suitable position to be found on the inside of the back panel for the mains transformer to be mounted, with the battery in position.

Mark and drill the main transformer T1 mounting holes with the p.c.b. and T1 out of the case. Finally drill a hole in a suitable position in the back panel, above the p.c.b. for the mains lead and fit a rubber grommet.

A suitable profile for the tube reflector is shown in Fig. 6. This is reproduced full size to enable a piece of reflective material to be bent to match. For the specified 4W tube the reflector needs to be 160mm long and the prototype version was bent from a piece of 22s.w.g. (0.8mm) polished stainless steel measuring 160mm × 150mm.

The Perspex complete with tube connectors may now be fitted to the case immediately behind the front panel aperture. The recommended method of fixing is with a contact adhesive, which should be used in accordance with the manufacturers directions. It is suggested that the Perspex be masked off in the large central area first to avoid adhesive contact in areas which will be seen when assembled. An alternative, though less attractive method, as used on the prototype, is to use machine screws and nuts.

The reflector, fitted immediately behind the tube, and in contact with the Perspex, is secured through the bottom of the case using two small self-tapping screws.

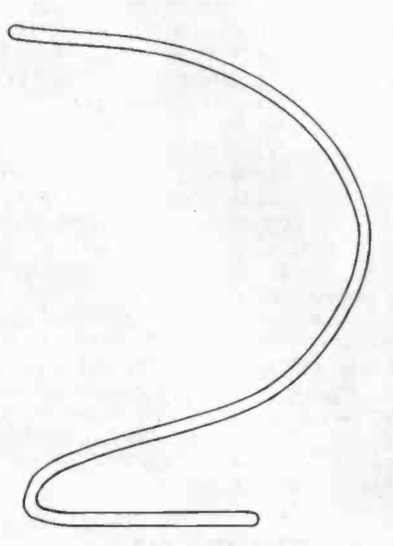


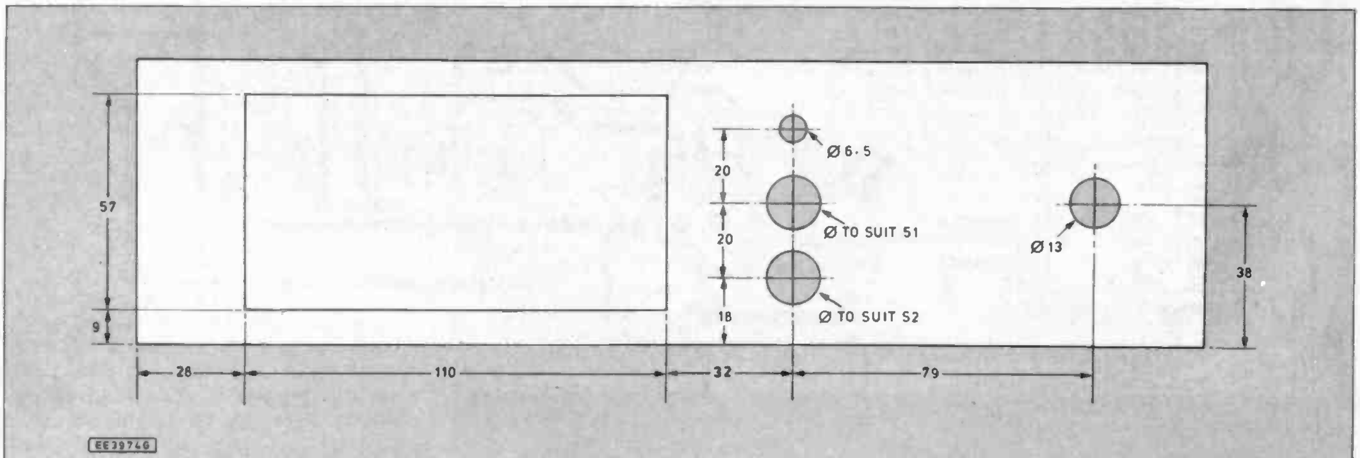
Fig. 6. Full size tube refelector profile.

FINAL ASSEMBLY

All the metal working should, by now, have been taken care of and all that remains is to fit the parts to the case and wire them all up before testing and adjusting the unit.

The light dependent resistor R6 is secured in its mounting hole by bonding it in place with cyanoacrylate adhesive. Alternatively a tight fitting rubber grommet may be used in a larger hole and the l.d.r. simply pushed into this. Fit the two pushbutton switches S1, S2 and the l.e.d.

Fig. 5. Front panel cutout and drilling dimensions. All dimensions are in millimetres.



D5 in its mounting clip, in their respective positions.

Connect suitable leads to the mains transformer secondary winding connections *before* fitting it to the back panel above the p.c.b., as now is the last time these terminals will be readily accessible. Any connections which the transformer will obscure on the p.c.b. should also be made at this stage.

The transformer is fitted after the p.c.b. and with its primary connections facing away from the p.c.b. for reasons of safety. The mains Earth connection to the case is made under one of the transformer securing nuts and must *NOT* be omitted under any circumstance.

The internal battery (when installed) is fitted at the right-hand end of the case and may be secured in position using double-sided self-adhesive pads.

The internal layout of the case and all interwiring is shown in the "folded flat" drawing of Fig. 7. There is a fair amount of wiring to be done and care should be taken to follow the wiring diagram accurately.

All high voltage connections should be adequately insulated – this includes the connections to the tube. Push on receptacle connections are recommended for the internal battery's connections (do not solder directly to the battery terminals) and these should be correctly crimped or soldered to the appropriate leads.

Stranded 7/0·2mm wire is suitable for all low voltage connections and sensible use of colour coding is recommended. Do *not* forget the wire link between the two centre connections of screw terminal block TB2 as this (or a switch, see under "Modifications") connects the battery to the rest of the circuit.

SETTING UP AND TESTING

Fit a 3A (maximum) fuse to the mains plug and connect the unit to a 240 volt a.c. supply. With any luck the power indicator l.e.d. should glow (if not it is probable that it has been incorrectly connected, but this should not interfere with further testing and may be corrected later).

Press the On switch, S1 and check that the tube lights brightly and immediately. Next, check that pressing S2, the Off switch, turns the lamp off.

A room which can be readily darkened is required for the next stage of testing. Using a two-way 13A adaptor (or other multi-way connector), connect the Emergency Lighting Unit and a bedside lamp to the *same* socket outlet. Switch on the bedside lamp and the Emergency Lighting Unit and switch off the ceiling light.

Turning off the power to the lamp and the Emergency Lighting Unit simultaneously, via the socket switch, should cause the fluorescent tube to light. If not, try adjusting the sensitivity control, VR1 and testing again.

Turning the two appliances off independently of one another, or one after the other should not trigger the circuit and the tube should remain off. Restoration of just the power after a power failure will turn the tube off.

The setting of the preset light sensitivity control VR1 is best done at dusk, but may be done in a room where the ceiling lamp is fitted with a dimmer. At dusk or in a dimly lit room try triggering the unit by switching off the mains power to it

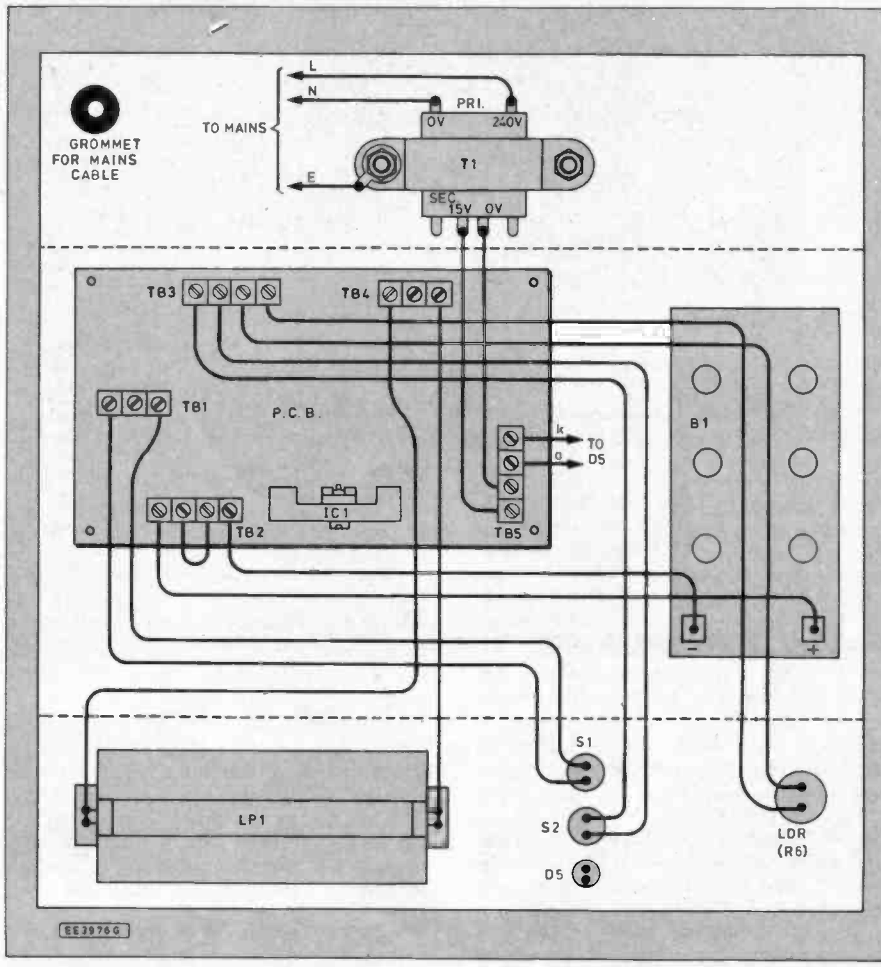
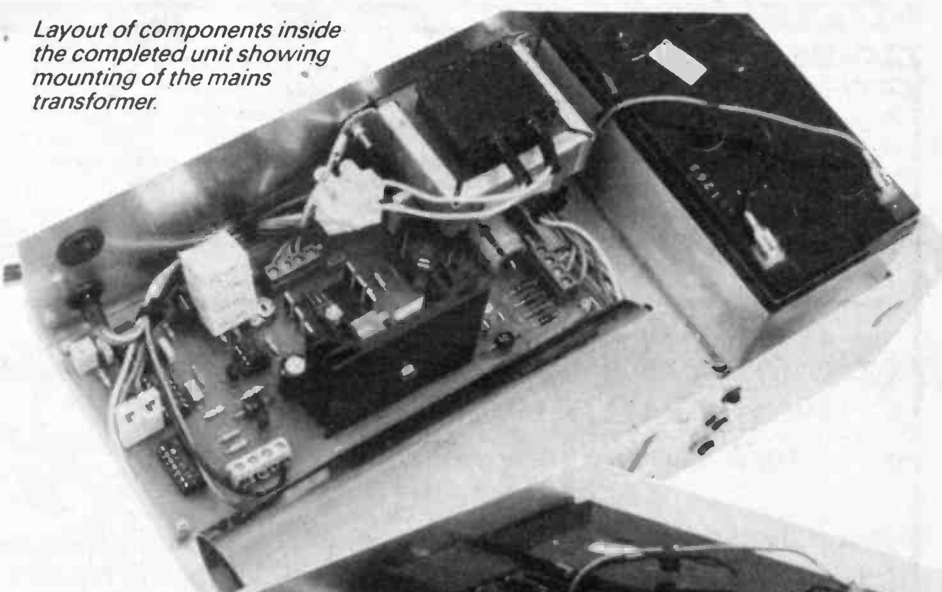
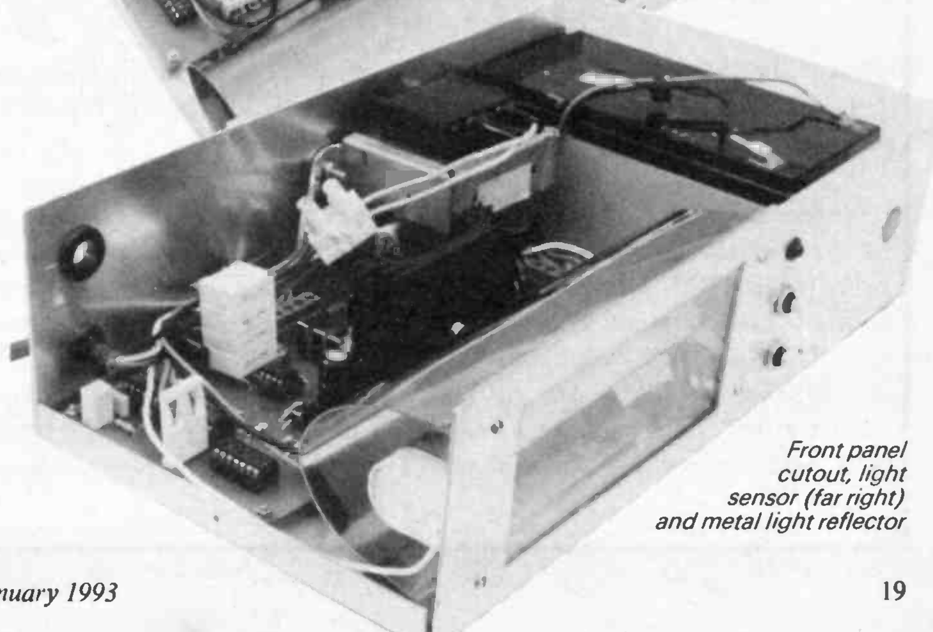


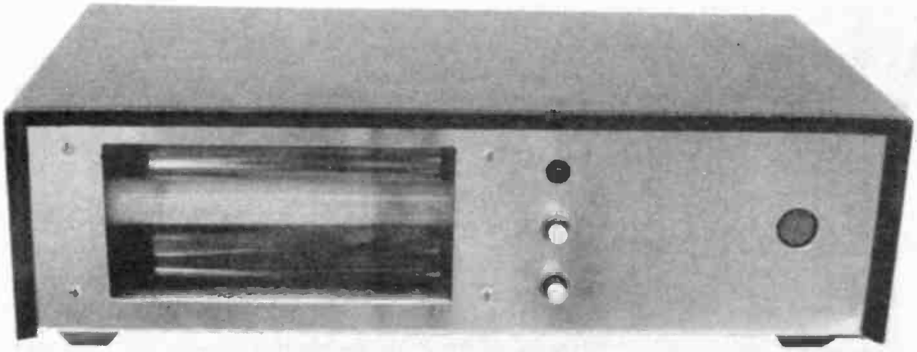
Fig. 7. Internal layout of components and interwiring from circuit board.



Layout of components inside the completed unit showing mounting of the mains transformer.



Front panel cutout, light sensor (far right) and metal light reflector



and the bedside lamp simultaneously, as above. Adjust preset, VR1 so that the Emergency Lighting Unit will only trigger below the required low light level.

This completes the setting up and calibration of the unit and the case may be finally assembled. If desired, some decals and lettering may be applied to the case to indicate functions of the front panel switches and give an indication as to the use of the completed project.

FAULT FINDING

The main area where problems are likely to occur is in the fluorescent tube inverter part of the circuit. If great care is not taken when winding transformer, T2 catastrophic problems may easily occur here, possibly resulting in the destruction of TR4 and CSR1.

It is more likely, however that the twelve-turn primary winding has been wound in the wrong direction and this will manifest itself as a failure of the tube to illuminate. If this happens, simply try reversing the connections to this winding and try again. If this does not cure the problem assume it was correct in the first instance and look for another fault.

Bad solder joints and solder bridging adjacent tracks can cause all manner of problems and is the reason for many, otherwise good, projects being discarded! Faults of this nature are normally very easy to find, in most instances simply requiring a visual check.

Check the condition of fuse FS1. If it has ruptured, perform a quick check for any obvious causes such as above before replacing it. Do not use a fuse larger than 2A as a replacement, since the circuit should draw considerably less than 1A.

Semiconductors fitted the wrong way round can cause many and varied problems and should obviously be checked before testing them for faults. The thyristors are prime candidates for this type of error and would certainly prevent the lamp from lighting if inserted incorrectly. Both devices are fitted with their gate (g) connections towards the bottom of the board.

If, when the power returns, the lamp fails to turn off automatically, it is most likely that the value of the capacitor C13 is too small. Placing another capacitor in parallel with it, of around half to twice its value, should effect a cure.

There is no real limit to the value which C13 may have, other than that imposed by its physical size, but the component *must be non-polarised*. This is very important as the capacitor is subjected to voltages in both directions, and an electrolytic capacitor used here may well explode!

MODIFICATIONS

Although the Emergency Lighting Unit as it stands would cover most requirements there are one or two useful modifications which may be made.

The circuit presented is designed to be capable of driving up to an eight watt tube without any alteration, and during prototyping was used with a 13 watt tube! Such a large tube is *not recommended* for *extended* use, but it does illustrate the rugged nature of the inverter circuit.

A useful modification would be to connect an l.e.d. and one kilohm series resistor across the "back-up" internal battery to make the unit easy to find in a dark room.

Use with an external automotive type battery during extended power failures, such as those of winter 1990/91, is possible and the charger is quite capable of charging large batteries without suffering any harm.

The wire link fitted to TB2 may be removed to allow a single-pole switch to be fitted, enabling the circuit to be isolated from the battery for storage purposes etc. This option has been ignored in the prototype as it was not felt to be essential. □

Innovations

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

"Gogglevox" Breaks New Ground

by Hazel Cavendish

A LYMINGTON micro-electronics enthusiast has scored a bulls-eye with the world's first portable television mounted in goggles and operated from a control box the size of a cigarette packet weighing less than 16 ozs. The viewer can operate three channels or play a video, and reception equals that of any standard television in the area. It has a brilliant picture, excellent colour and perfect sound.

With a combination of sophisticated electronics and novel use of the microchip, William Johnson's "Gogglevox" is worn like a pair of light ski-goggles bringing instant TV to a viewer on the move, much as the Sony Walkman relays music to the ears of itinerant young. In fact, it has the Sony corporation worried.

No sooner had news of Johnson's invention leaked out than Sony promptly announced a similar product in the pipe-line – but Sony's will not be on the market for at least a year, and then with a specification which offers great cheer to Johnson, as it covers ground long since overtaken by the Gogglevox team.

"Microsharp"

Gogglevox uses two l.c.d. solour screens just 25mm in front of the eyes, its secret lies in the use of a patented paper thin transparent strip of "Microsharp" material which transformes the pixels into a perfect picture.

Now American and Japanese firms are vying with one another to obtain a licence to produce Johnson's mini-wonder for their markets. He flew off to the United States in mid-November to present his brainchild to a number of keenly interested electronics companies, and continued on to Hawaii to meet a cluster of experts from Japan, all equally anxious to secure this miracle gadget for their industry. An early enquiry from Hong Kong also took Johnson on there, an he rounded up his tour with a visit to Japan's company boardrooms, as a stream of enquiries has been coming in from Japanese manufacturers.

Amazingly, the Hampshire inventor says he never had a science lesson in his life, and that everything he knows about electronics is self-taught. He claims to have been a dud at school, and became an inventor because he could not do anything else. "I have always been in the ideas business," he says. "I was utterly fascinated when micro-electronics were developed, as the concept of miniaturisation and making things happen in a small way seemed to me to be the way to advance in the future. The Gogglevox has developed from that belief."

William Johnson wearing the "Gogglevox".
Photo Piers Cavendish.

His fertile imagination has produced many innovations – and lucrative products for the home market over the years, but his first major success was his invention of a miniature computer that fitted onto a sports shoe. Called the "Micropacer", it sold immediately to an international manufacturer of sports shoes for use in the Olympics in the 1980s. The athlete running in that shoe had all the information needed at the end of the race; how fast he had travelled, the distance covered, and how long it took.

The Gogglevox is the result of six years of intensive development with the assistance of a brilliant team from Loughborough University under the leadership of Physics Professor Nicholas Philips. "I was fortunate in having that team of geniuses who made it all possible," says Johnson, "I was merely the igniter of the flame; they were the high achievers. Their physics enabled us to take out the pixels and produce the faultless picture we now offer; before that all you saw were little tiles of colour. We travelled a long journey together before we got there."

Tragic Death

The tragic death in a motor cycle accident of Jonathan Heaton, a post-graduate student who was one of the most brilliant members of the team, slowed them up considerably in the development of the invention. "For months we just couldn't seem to get things right," said Johnson, "There is always a moment when one begins to think one has made a terrible mistake – then suddenly out of the blue you pick up the line again and off you go. But it is a lot to do with Jonathan that it has all come right in the end."

His only disappointment has been his inability to launch his invention in this country, but his approach to the electronics industry in the UK has been discouraging. "With our vast unemployment problem I felt it would have been wonderful to be able to open a British factory and offer jobs to hundreds of skilled electronic workers, but when I looked for a company capable of taking it on here there was nowhere to go. One just had to accept the fact that our electronic firms are no longer interested in the retail side. I have had to face up to the fact that the real future of my product lies in the United States and the Far East.

BRITAIN'S SHRINKING MANUFACTURING BASE

ANNUAL SURVEY reveals manufacturing sites down by 13 per cent and employee population down by 10 per cent.

A large-scale survey of manufacturing in England, Scotland and Wales has revealed a 13 per cent drop in the number of manufacturing sites, and a 10 per cent drop in the number of people employed in them, over the past 12 months.

The survey of manufacturing companies in consumer electronics, d.i.y., telecommunications, electronic data processing, office equipment, automotive, and industrial equipment sectors, showed that the number of manufacturing sites had fallen from 3,705 a year ago, to 3,201. The number of employees at these sites had fallen from 455,527 a year ago to 407,868.

The telephone survey was undertaken during July and August by Remploy Manufacturing Services, the national contract manufacturing company, as part of an annual update of its own database of manufacturing concerns.

According to Remploy, the drop in the number of manufacturing sites is the result of rationalisations, closures, mergers, and companies quitting particular market sectors.

The d.i.y. sector was worst hit, with over one in five jobs lost and a 25 per cent decline in the number of manufacturing sites. The telecommunications sector has also been hit, with nearly 16 per cent fewer manufacturing sites than in June 1991, and a workforce almost 23 per cent smaller.

PIRATE FINES

STIFFER penalties for pirate radio stations were welcomed recently by Trade and Technology Minister Edward Leigh.

Mr Leigh said: "Pirate radio creates anarchy on the airwaves. The fine that can now be imposed in a magistrates court is increased from £2,000 to £5,000. In Crown Courts the fine continues to be unlimited.

"Pirate radio is theft, threat and throughtlessness – theft of spectrum, threat to life, and mindless disdain for ordinary viewers and listeners.

"In one instance a pirate radio station was raided after it had interfered with the communications of an airport, the police, a bus company, the local authority, a legitimate community radio station and spoilt reception for many law abiding people."

In the first 10 months of 1992 the Radio Investigation Service carried out 401 raids on 99 stations in Britain. There have been 38 prosecutions and 38 convictions.

Low Cost Datalogger

A NEW addition to the Pico Technology range of PC-based data acqisition products has been announced recently. The ADC-16 is a high resolution data logger that plugs directly into the serial port, requiring no external power. It features 8 channels of analog input at 16 bit + resolution.

Unlike plug-in cards, it uses no expansion slots making it easy to install and ideal for use with portable PC's. The use of a serial connection cable means the unit can be positioned near the experiment to minimise noise pick-up.

It is supplied with PicoLog datalogging software which offers full use of the ADC-16's features: you can select the resolution for each channel from 8 to 16 bits and

either single ended or differential inputs. Each recorded sample can be the maximum, minimum or average of a number of readings, collected over a period of a few milliseconds to a day. The samples can be processed using a range of scaling techniques. The software also includes a comprehensive range of graphical and text reporting tools.

The ADC-16 costs £99 + VAT which includes software drivers and a manual. Pico Technology Ltd, Dept EPE, 149-151 St. Neots Road, Hardwick, Cambs CB3 7QJ. Telephone 0954 211716. Fax 0954 211880.

GREEN PROJECTS

A 10 in 1 projects kit has been introduced by Greenweld Electronics. Using the kit and breadboard supplied the following projects can be constructed: Signal Injector; Battery Tester; Audio Amplifier; Continuity Tester; Light Activated Switch; Siren; Morse Buzzer; Organ; Reaction Game and a Metronome.

A circuit diagram and wiring diagram plus a brief description is given for each project and the 10 in 1 leaflet also provides a component list and component identification information.

The complete kit costs £9.95 plus £2.75 for post and packing from Greenweld Electronics Components, Dept EPE, 27 Park Road, Southampton SO1 3TB. Tel: 0703 236363, Fax: 0703 236307. Details of many offers, competitions, free gifts and new products are given in Greenweld's monthly newsletter, *Greenweld Guardian*, available by post for £6 per year.

ELECTRONIC CAR IMMOBILISER

DESIGNED to stop vehicles going missing, "Active 8" is inexpensive and easy to fit, It works by cutting out two electrical circuits, normally starter motor and ignition, to make it doubly safe and secure.

Another major benefit is that it is fully automatic: once the ignition key is removed it is activated in eight seconds, hence the name Active 8. Simple and convenient to use, with no remote controls to be carried, it works whenever the car is left – even when paying for petrol.

The system is de-activated by turning on the ignition and pressing a virtually invisible micro thin pad, positioned for the driver's convenience. A new company, Active 8 Ltd has been established to market and distribute the immobiliser via car security specialists and other automotive outlets.

For further information contact UK Electronics Ltd, Dept EPE, Parkside House, Edge Lane Street, Royton, Oldham OL2 6DS. Tel: 061 626 4117, Fax: 061 627 4870

CONTINUOUSLY VARIABLE BALANCED POWER SUPPLY

STEVE KNIGHT

Provides balanced positive and negative outputs, variable from ±4V to ±16V at 300mA

It is often necessary, particularly for experimental purposes, to have balanced positive and negative voltages to hand, and many power units have been described in the past which have been capable of providing such outputs.

In nearly all cases, however, the output levels of these units have been *fixed* at such "standard" values as ±5V or ±12V; occasionally it has been possible to switch from, say, ±5V to ±12V, so providing two output levels. In general, such units have usually incorporated the popular 78XX and 79XX series of integrated fixed voltage regulators.

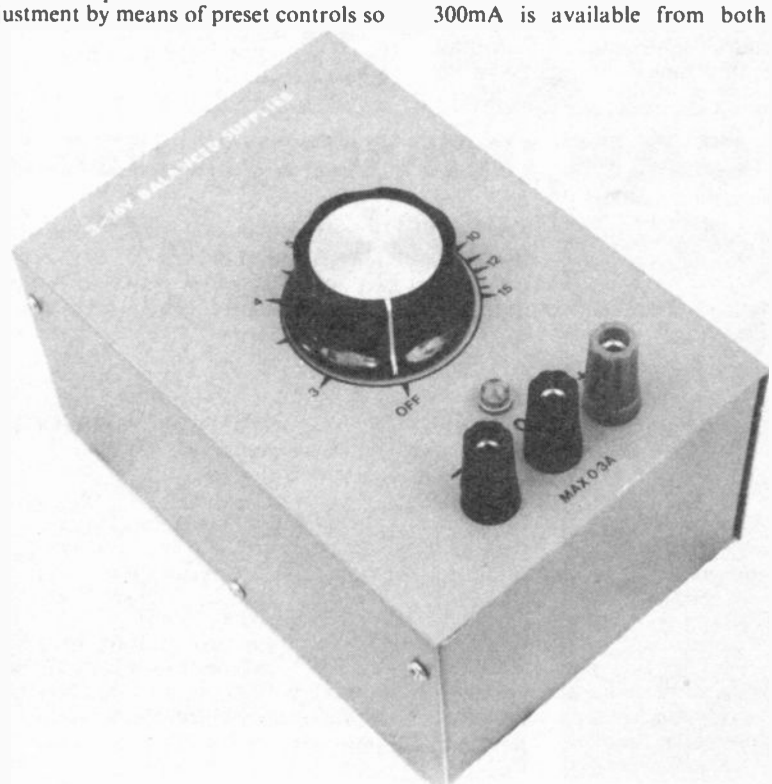
However, a disadvantage of such designs becomes clear when intermediate voltage levels are needed. It is, of course, possible to provide a limited internal adjustment by means of preset controls so that, say, a 5V regulator will turn out, perhaps, a 6V to 9V supply, but to set up *both* the positive and the negative rails and balance them for every different situation is a tedious and time consuming operation.

SPECIFICATION

The design offered here overcomes these disadvantages and permits a *continuous* and *simultaneous* variation in both the positive and negative regulated output voltages by the operation of a single potentiometer control. The circuit is simple and inexpensive and provides a voltage range of ±4V to about ±16V, so covering most of the voltage requirements for experimental and test purposes.

A useful maximum load current of 300mA is available from both output lines. The two outputs track within a maximum error of ±50mV throughout the range and the regulation is adequate to hold the output within 200mV between the limits of no-load and full-load conditions.

Provision is made for a switched voltmeter to monitor both output lines, but this is completely optional, and by calibrating the control potentiometer (a simple procedure), the balanced outputs can be immediately determined without consulting a meter.



CIRCUIT OPERATION

The complete circuit diagram of the unit is shown in Fig. 1 where its simplicity is immediately obvious. Bridge rectifier REC 1 is used in a conventional circuit along with mains transformer T1, which has a centre-tapped secondary winding.

The common (earth or 0V) rail comes from the centre-tapping point of the transformer. This arrangement provides both positive and negative output rails of about 22V d.c. each which are smoothed by capacitors C1 and C2 respectively.

These rails, besides going to the output pass transistors TR1 and TR2, provide the supplies to the two operational amplifiers IC1 and IC2 and are stabilized to 18V by Zener diodes D1 and D2. The op-amps are used in a "master" and "slave" arrangement.

The slave, IC2, is a unity gain inverter with input resistor R9 and feedback resistor R10, and is forced to produce as output identical voltage levels but of *reversed* polarity to that of the master IC1. Resistors R9 and R10, for this reason, have to be identical in value and one per cent types (or better) *must* be used here or the tracking (which depends upon their ratio) will deteriorate. Capacitors C7 and C8 provide output decoupling.

The gain of IC1 is varied by the output adjustment control VR1 giving feedback to the inverting input, and this controls in turn the base bias of emitter follower TR1. Control is also applied to the slave regulator which similarly operates on the base bias of the negative pass transistor TR2.

This single control arrangement maintains the tracking of the two outputs of the op-amps and hence the supply levels

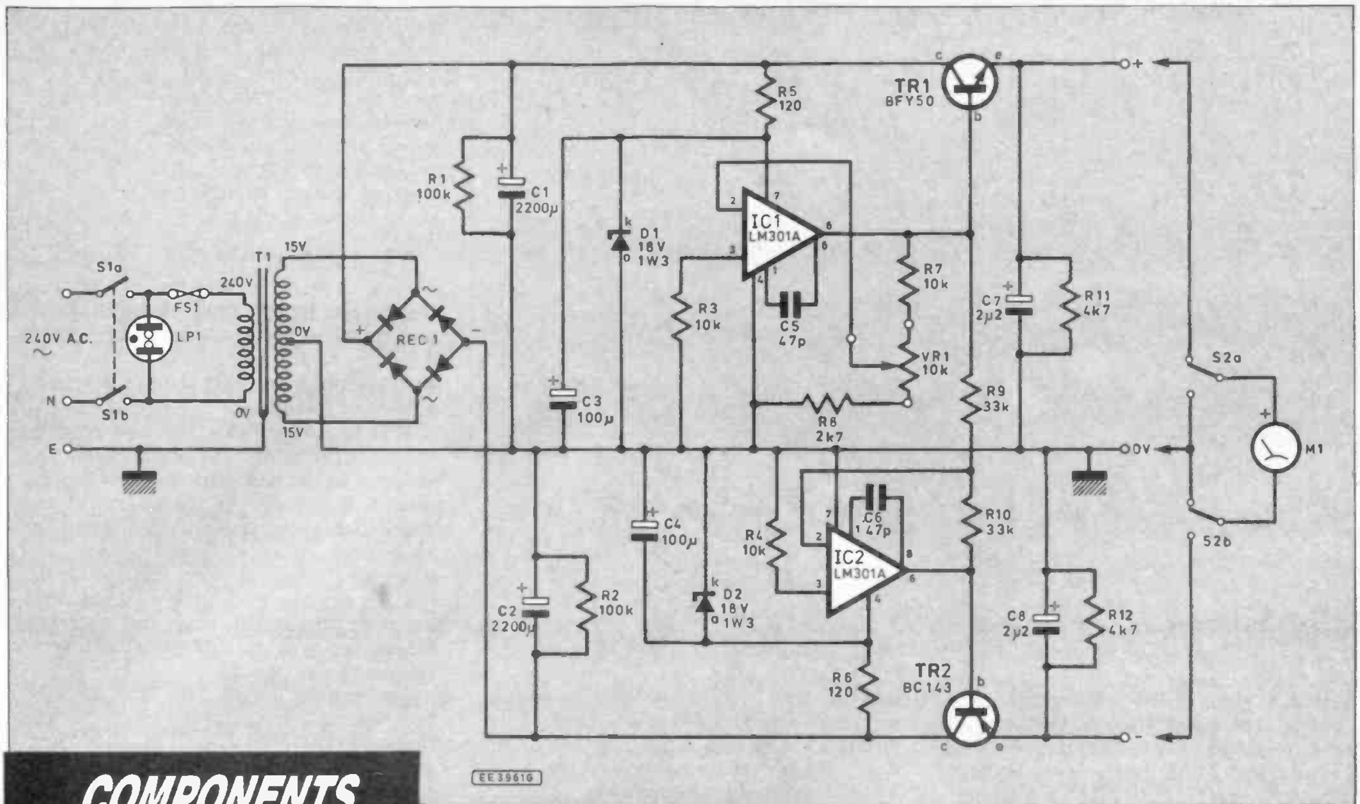


Fig. 1. Circuit diagram of the Balanced Power Supply. The meter system shown on the right is optional.

COMPONENTS

See SHOP TALK Page

Resistors

R1, R2	100k (2 off)
R3, R4	10k (2 off)
R5, R6	120 (2 off)
R7	10k 1%
R8	2k7 (but see text)
R9, R10	33k 1% (2 off)
R11,R12	4k7 (2 off)

All 0·25W 5% carbon film, unless stated otherwise.

Potentiometer

VR1	10k rotary carbon, linear with d.p. mains switch.

Capactiors

C1, C2	2200μ radial elect., 35V (2 off)
C3, C4	100μ axial elect., 25V (2 off)
C5, C6	47p ceramic (2 off)
C7, C8	2μ2 axial elect., 25V (2 off)

Semiconductors

D1, D2	18V 1·3W Zener diode (2 off)
REC 1	50V 1A in-line bridge rectifier
TR1	BFY50 *npn* silicon
TR2	BC143 *pnp* silicon
IC1, IC2	LM301AN op.amp (2 off)

Miscellaneous

T1	Mains transformer: 240V primary; 15V-0V-15 0·5A centre tapped secondaries
S1	Mains On/Off switch, part of VR1
LP1	Mains neon indicator lamp

Printed circuit board available from *EPE PCB Service*, code 815; metal or ABS plastic case, see text; 4mm terminals (3 off), 1 red, 1 black, 1 brown; 0·5A fuse and clip type holder; control knob, 28mm dia. skirt; T05 "crinkle" type heatsink (2 off); coloured connecting wire; 3-core mains lead, grommet and clamping clip; solder, etc.

Approx cost guidance only £16

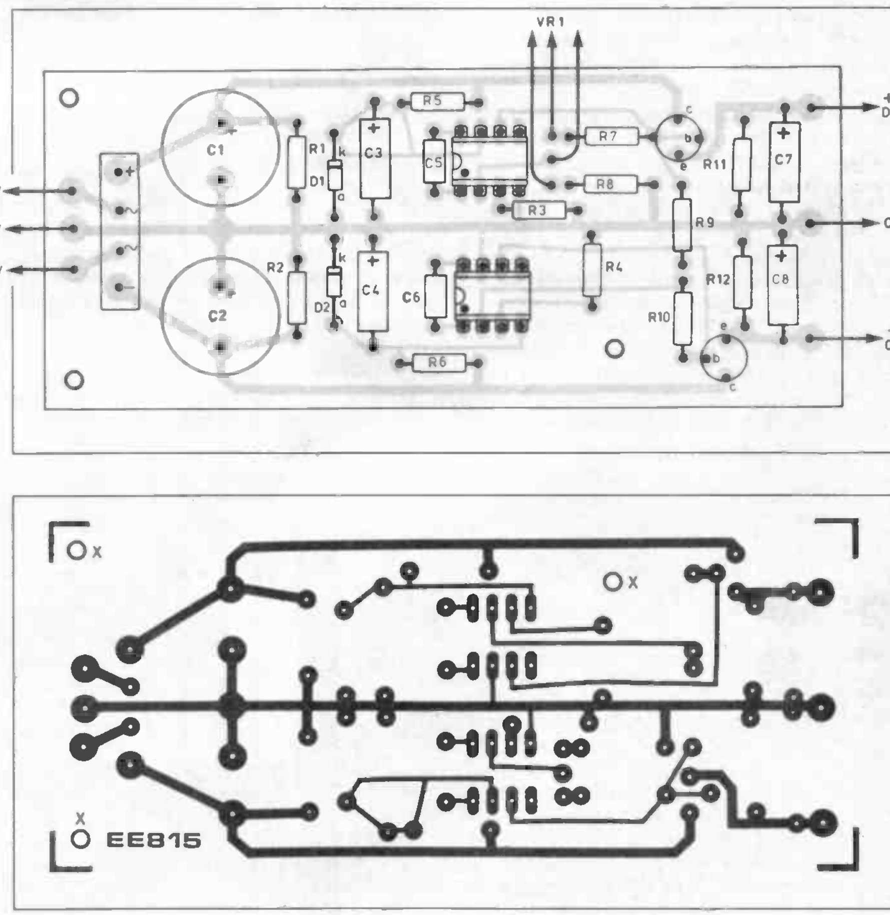
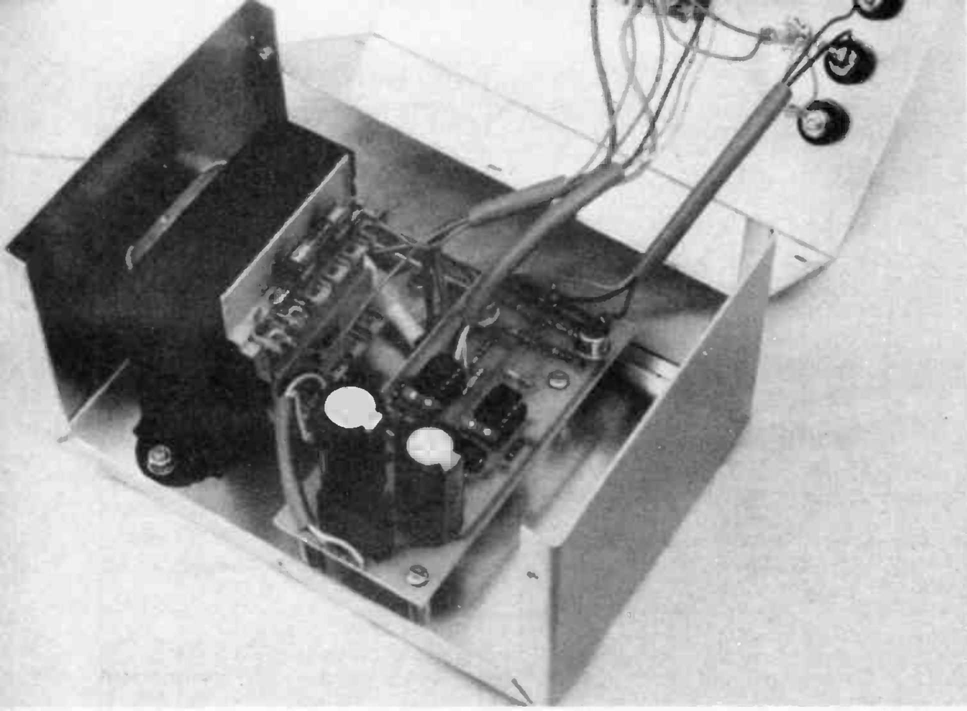


Fig. 2. P.C.B. layout and wiring.

at the emitters (e) of TR1 and TR2. Notice that the two transistors are a complementary pair, one *npn*, the other *pnp*.

CONSTRUCTION

With the exception of the mains transformer with its fuse and switch, and the control potentiometer VR1, everything goes on to a small printed circuit board (p.c.b.) measuring (as a minimum) 100mm by 45mm. The topside component layout, together with the full size copper foil master pattern is shown in Fig. 2. This board is available from the *EPE PCB Service*, code 815.



All the parts used are readily obtainable; type LM301AN i.c.s were used in the prototype because they happened to be available in the author's stock. There is no reason why 741's or any functional equivalents of these op-amps cannot be employed, although these have not been tried in the model.

The usual care in soldering must be taken, as must the polarity orientation of the bridge rectifier, the electrolytics and the Zener diodes, particularly on the negative side of the board for these last two items, where the electrolytic positive terminals and the Zener cathode (k) go to the zero or common line.

The bridge rectifier is a four-pin in-line type; make sure that the order of these pins is + ~ ~ − and not + ~ − ~ which would be unsuitable for this layout.

The control potentiometer VR1 is connected to the board by suitable lengths of wire from the copper pads indicated; when this control is turned fully clockwise (its maximum output state), the appropriate terminal should connect to resistor R8. In other words, maximum output is obtained when the slider of the pot is at the R8 end of the track. No harm will come if you do happen to get it the wrong way round to begin with.

MONITORING

A voltmeter for monitoring and setting the two outputs was mentioned earlier. If you wish to build such a meter into the unit, a full scale deflection of 20V-25V is suitable, and the circuit connections to the output terminals of the power unit via a 2-pole changeover switch (toggle or slide type) are shown on the right of Fig. 1.

This does avoid the necessity of calibrating the voltage control but analogue meters do tend to be pricey and unless you have one to hand, such a metered system is not really vital. The control potentiometer calibration is quite easy and will be described later.

CASE

The prototype unit was built into a two-piece aluminium box measuring 153mm by 102mm by 76mm, but an ABS plastic box measuring 165mm by 120mm by 75mm is available, which, though on the large size, does give additional room for the inclusion of a voltmeter if you plump to use one. The actual layout you use can be a matter of personal choice, there being nothing critical in this matter, and the panel layout of the prototype is shown in Fig. 3.

If you already have a box, it is best to obtain the mains transformer first because this is the largest (and clumsiest) component, then make sure you have room for this and the p.c.b. Fig. 4, along with the photograph(s) shows the general scheme of things.

With the lid off the box, first position the transformer at one end of the box and secure it to the base with a couple of 4BA screws. If you use the plastic box, it is a good idea to fit a piece of Bakelite or aluminium, of about 2mm thickness, underneath the transformer; this avoids the risk of any slight distortion which may occur in the plastic base and generally makes for a more substantial fitting of this heavy component.

The printed board can then be similarly fitted using the three suggested fixing holes marked *X* in Fig. 2, as a template. 6BA screws are adequate here; use 10mm spacers to hold the board off the box floor to avoid any possible shorting to the case.

The only holes needed in the lid portion of the box can now be drilled; these are for the control potentiometer VR1 (which includes the mains on-off switch S1), the three output terminals and a neon indicator lamp. These must be positioned so that they do not foul the mains transformer when the lid is finally fitted.

CHECKS AND CALIBRATION

The unit can be checked before fitting into the case; wire the three input terminations from the board to the mains transformer T1, using long leads so that the transformer is safely out of reach while you do your checks on the board itself. Make sure the mains earth lead is firmly connected to the case and transformer mounting using a solder tag.

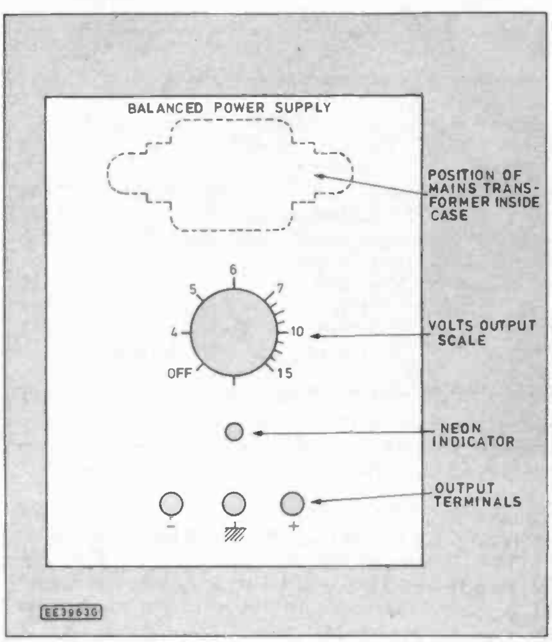


Fig. 3. Front panel layout of the supply.

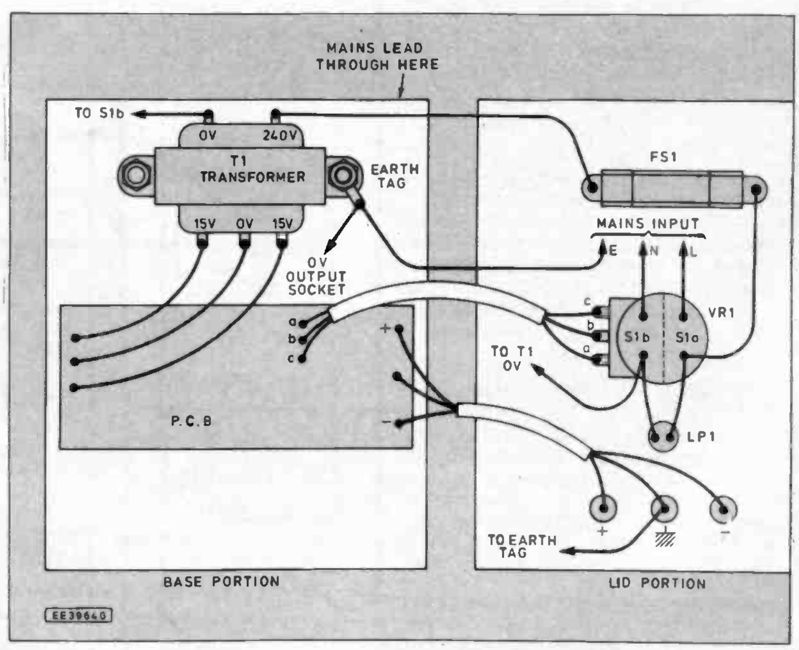


Fig. 4. Interwiring of p.c.b. and other components.

There are exposed mains connections on the mains transformer, on/off switch S1 and the fuse FS1, these should be covered with insulation sleeving. For safety, extreme care must be exercised when working on the unit.

With control VR1 fully anticlockwise, check the output across both the positive and negative output points using a reliable voltmeter; this should read between 3V and 4V. Turn VR1 fully clockwise and again check the outputs; these should now be about 16V.

Now, if all is well, check at a number of intermediate points along the potentiometer track to ensure that the two outputs remain in step throughout the range. If they do not (within about 0·1V), check on IC2 and particularly resistors R9 and R10 which must be within one per cent tolerance.

Now it may happen that you *either* cannot reach 16V at maximum output or you *exceed* it before reaching the end of the track. This comes about because of the wide tolerances found in carbon potentiometers, often as much as 20 per cent.

The output will *not* go beyond about 16·5V in any event because the i.c.s are operating with a supply voltage of 18V, but what you have to aim for is to get the 16V output within the last few degrees of the maximum pot position. This can be done by adjusting the value of R8 which is nominally 2·7 kilohms; if you *exceed* 16V by a large rotation, increase R8 to, say, 3 kilohms; if you cannot reach it, reduce R8 to, say, 2·2 kilohms.

The purist in these things might care to replace R8 with a 4·7 kilohm preset pot and adjust it accordingly, but whatever you do, the object is to get the control potentiometer VR1 to cover the range 3V (this need only be approximate) to 16V with *no wasted rotation* at the top end. Getting this right makes the calibration of the control a lot easier at the maximum output end where non-linearity which follows from the characteristics of the i.c.s tends to cramp the scale a little.

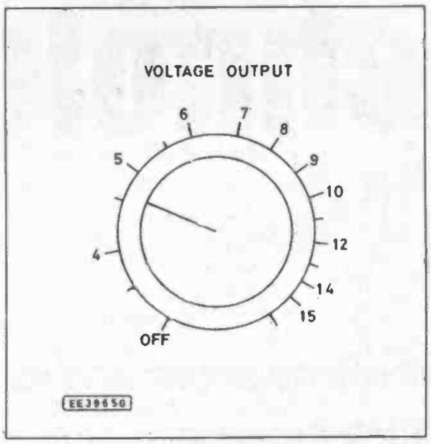


Fig. 5. Appearance of the scale when calibrated. It is suggested that the "standard" voltage i.e. 5V, 9V, 12V and 15V positions are marked with a different colour lettering.

FINAL CALIBRATION

This calibration can be done when the unit is assembled in its box and a suitable knob fitted to the spindle of VR1. Don't use a small knob; make it as least 28mm diameter, and ensure that it has a clear pointer marking.

Set VR1 fully anticlockwise, turn the control until the output (either will do) reads 4V, then using a suitable pen or pencil (a fibre-tipped pen is best) mark the pointer position on the panel with a small dot. Repeat this process for each 1V increment up to a maximum of 15V.

The result should look like the scale shown in Fig. 5; the scale is *non-linear*, but when annotated with rub-down lettering will look quite attractive. A single dot at the fully anticlockwise position is useful as it acts as a marker should the knob ever be removed and need replacing accurately. This point also corresponds to the supply OFF position.

MODIFICATIONS

Constructors of this project may have a number of their own ideas about the assembly, and this is a good thing. The mains switch need not be incorporated with VR1 for instance; if you have a good wirewound 10k potentiometer, this is likely to have a much better tolerance than a carbon type. The switch can then be a separate component mounted on another part of the panel.

Higher current output can be obtained by using the existing transistors as drivers to a higher power pair, these being fed from a higher voltage line in place of the present 20V or so. Output currents up to 1A or more could then be obtained. □

New Technology Update

Ian Poole reports on improved op.amps. and magneto-optic data storage

TWO IDEAS this month, the first will be of particular interest to hi-fi addicts as it may improve the performance of equipment being produced today. With digital methods being used increasingly nowadays, it is the analogue circuitry in the system which is the weak link. Fortunately there is a new idea to help overcome it.

The other new development is a new form of storage. It could have far reaching effects not only for the computer industry, but also the consumer market as well.

Analogue I.C.s

Operational amplifiers have long been the basic building blocks for designers of analogue circuits. Of them, the 741 must be one of the most successful i.c. designs ever, having been on the market for over 20 years and still going strong. However, many high performance op.amps. are on the market now. They boast much higher input impedances, lower noise, wider bandwidths and so forth. In fact without these higher performance circuits, equipment like the CD would not be able to reach its full potential.

One of the major problems found when developing an i.c. is that it is not easy to achieve all the required parameters in a single chip and a compromise has to be made. The reason is that to achieve a good performance in terms of noise and low signal distortion the input stage should use bipolar junction transistors. If a large bandwidth and high input impedance are required then JFETs are far superior.

To achieve all these parameters in one package Analog Devices have devised a very novel solution. They use both types of transistor in the input stage. In this way it is possible to make use of the advantages of the JFET and the bipolar transistor.

A conventional long tail pair is shown in Fig. 1, this is the basic input stage of any differential or operational amplifier. This has been modified by Analog Devices as in Fig. 2 to adopt both types of transistor. In this configuration the JFET handles eight times the current of the bipolar transistors. For the FETs to operate satisfactorily they are made very large. In fact they are larger than the output devices.

The performance of the i.c. is a distinct improvement on previous devices. An input noise level of 7nV per $\sqrt{Hz}$ is achieved. In addition, the total harmonic distortion and noise is better than 0·001 per cent from below 7Hz to above 15kHz driving a 600 ohm load with a signal of 3V r.m.s.

Analog Devices are currently marketing the device as their OP-275 dual operational amplifier. In view of its specification it is likely to be widely used in a variety of applications including the hi-fi industry.

High Capacity Mini-Discs

New improved methods of data storage are constantly being investigated. One which shows great promise uses a magneto-optic system. Using the new technique it is expected that it will be possible to store up to 300 times as much data when compared with conventional magnetic storage.

In essence the system uses a laser beam to heat a minute area of the recording surface. By doing this the heated area becomes magnetised in the opposite direction to its surroundings. To detect the magnetisation another laser is used. It focuses on the area where the data is recorded, and dependent upon the magnetisation the polarisation of the light may be changed.

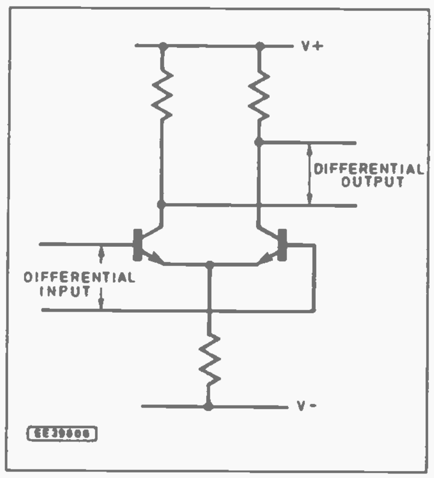


Fig. 1. Conventional long-tailed pair configuration. The basis of the operational amplifier.

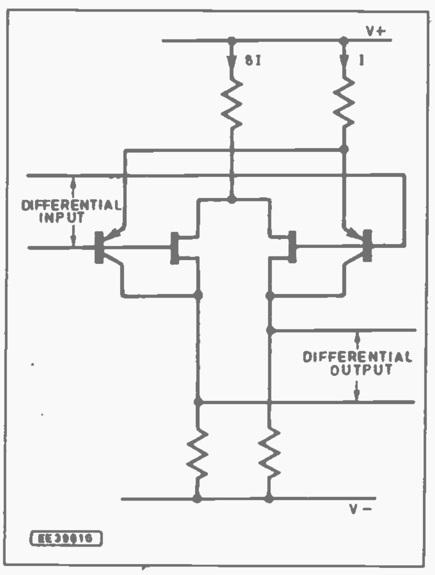


Fig. 2. New input circuit combining bipolar transistors and JFETs.

The lasers used run at very low power levels. About 20mW is used for writing and slightly less than half this for reading. The light from the laser is guided to the recording surface along an optical fibre. This fibre is tapered to bring the light down to a very fine spot. In fact it is the size of this spot which governs the density of the data stored.

Flying Heads

Like the conventional magnetic recording heads the optical fibre tip has to be placed very close to the media without actually touching it. This is done by actually making the heads "fly" over the surface of the disc as it rotates. To do this very careful design of the actual shape and aerodynamics of the head is required. For conventional disc drives it is not difficult to produce a head which can maintain the correct distance above the disc without crashing into it.

In the case of the magneto-optical disc the gap has to be only about a tenth the distance away from the surface that a normal head is. This requires more development and some very careful design.

A major part of the development has been taken up in finding the correct media. This is just as important as the rest of the equipment. A multi-layered film of cobalt and platinum has been used. This was chosen because it does not corrode or need any protective layer, and it also supports some very high data densities.

It is expected that in the foreseeable future such a system will be able to store over 40 gigabits (a gigabit is one billion bits) of data in a square inch. It is estimated that the maximum limit for data density using this technique will eventually reach several hundred gigabits per square inch, well above anything which can be achieved today.

Read/Write Speed

The main problem dogging the researchers at the moment is the read and write speeds. As writing depends upon heating an area of the media a data rate of 10k bits per second is all that can be achieved. Reading speeds are similarly slow. However it is expected that these figures will rise quite rapidly before too long.

Once the problems of this method of storage have been overcome, the possibilities for its use are almost endless. Obviously the computer industry is very excited about it. In addition to this it could be used as a domestic storage medium if it can be made cheaply. With storage densities of even 40 gigabits per square inch CDs and video tapes would be a thing of the past.

FOX REPORT

by Barry Fox

Germany has cornered the market for mammoth shows. One year Berlin stages the* Funkausstellung *or Radio Show, the next year Cologne hosts* Photokina. *Both are autumn events, timed to coincide with the run-up to Christmas and both are open to the pubic as well as the trade.

The Radio Show is now an International Audio and Video Fair, and Photokina has grown from a photographic show to a "world fair of imaging and sound". Barry casts his inquisitive eyes over some new developments seen in action for the first time in Europe at Photokina '92.

THIS YEAR (autumn 1992) it was Colonge's turn, with the 22nd Photokina. A total of 1569 exhibitors from 44 countries spread through twelve hanger size halls covering 230,000 square metres of floor space. The show grounds are so large that they have two separate press offices and the organisers provide a shuttle service for the press between them.

The city of Cologne knows the value of the exhibition. Anyone with an admission tickets bought for 15DM (around £5) or anyone who has an exhibitors' or press card or who works for one of the construction firms, can use all public transport in the city free, even out to the airport. This concession extends for the two days before and after the show. It is hard to imagine London Transport giving a similar concession. Small wonder that Germany has cornered the showmarket.

DIGITAL RUMBLE

Both Philips and Sony held press conferences with heavy emphasis on their new home digital recording systems, DCC and Mini Disc (MD). Both left time at the end for a lively question and answer session - in marked contrast to press conferences staged by Polaroid and 3M which wasted far too much time on audio/visual slide shows, and in the case of Polaroid even a live pop group. Scores of journalists walked out, they just do not have time for such sessions.

The battle between Philips and Sony on DCC and Mini Disc is already showing signs of the extreme nastiness which will be inevitable because each side has staked more than it can afford to lose. Karsten Frank, Head of Philips Audio in Germany claimed that all the major record companies, including the big five BMG, EMI, Polygram, WEA and Sony Music had "signed a cooperation agreement" on software support for DCC. Asked how many of these majors would have titles in the launch catalogue, Frank had to admit - not Sony.

The Philips stand put up a big DCC display, with 40 machines on working demonstration. But although Philips makes much of Matsushita's support, the Japanese company had only a token show of DCC. Most of Matsushita's vast stand was devoted to Panasonic VCRs and a new range of compact 35mm still film cameras. There were just three Technics RS-DC10 DCC prototype decks tucked away in a corner, working with headphones and quiet loudspeakers.

Panasonic's press conference was in German with no translation and concerned mainly with market figures, and no thrust on DCC. (Both Philips and Sony conferences were in English, with simultaneous translation). Just prior to the show Matsushita issued a press release announcing a bet-hedging cross licence with Sony which lets Matsushita make Mini Disc as well as DCC.

The September issue of Matsushita UK's trade magazine *Panarama* contains 16 glossy pages of Panasonic and Technics news, but not a mention of DCC. And all this in the month that DCC is supposedly launched with Matsushita's support.

A REVALATION

In contrast, Sony's stand at *Photokina* was an enormous mock-up of New York streets with Mini Disc heavily featured under the banner "It's a revolution... Announcing the disc format that everyone has been waiting for. It's digital. It's recordable. It's mobile. It's a Sony".

Philips showed the first portable DCC, the size of an analogue Walkman. Although claimed to be a working model, the unit had no battery, and was available only for posed photographs.

Sony clarified launch plans for Mini Disc in Europe. Sales will begin in Germany, France, Italy, The Netherlands and the UK before Christmas, with the rest of Europe following early in 1993. The first products will be a record/playback portable costing 1200 DM, a playback-only portable for 900 DM and a car unit costing 1800 DM. Sony was attacked by one German journalist for setting higher prices for Mini Disc than promised at the Salzburg briefing in June.

The portables are chunky units, which will fit in an overcoat pocket, certainly not a vest pocket. Significantly all the portables on demonstration were powered by a d.c. line from a mains adaptor. None had the large and heavy nickel cadmium batteries that they would need for portable use. Sony claims two hours playback or 1·5 hours recording. In future Sony may use lithium batteries.

ON THE EDGE

The first blank discs will run for only one hour and cost around 20DM. The 74 minute version will not be available until next year, with no price yet fixed. Why, is the obvious question which the technical press asked.

As with CD, the speed at which the disc rotates varies as the disc plays and the laser moves from the short inner turns of the track spiral to the longer outer turns, to maintain a constant linear tracking velocity. As with CD the fixed linear speed can be either 1·4 metres/second for shorter playing times (under one hour) or 1·2 m/s for longer times (over one hour). But to get 74 minutes on the tiny 64mm MD, even with the five-fold data compression used, the laser must track right out to the edge of the disc. It is harder to make discs which will track accurately to the edge. Hence the delay on sales of 74 minute MD blanks.

Pre-recorded MDs will be pressed, just like CDs, on modified CD presses. Sony promises a launch list of 300 titles (a reference in the English language press release to 3000 titles was acknowledged by Sony as a mistake). Prices, says Jack Schmuckli, President of Sony in Europe, will be "around the same as for CD".

Minoru Morio, Senior Managing Director of Sony in Tokyo predicts a market for Mini Disc running at ten million units by 1995.

At Sony's press conference in Cologne, Sony implied software support from all companies and Schmuckli drew attention to the hardware licences signed by Matsushita and Thomson, adding mysteriously "There are other companies, like Bosch and Blaupunkt, and other software companies in Europe, who for technical reasons cannot be on the list but would like to be on the list".

When pushed, Sony admits it can only count on software support from Sony Music, EMI (including Virgin) and Warner.

Over the last year Warner has swung hot and cold on its support for Mini Disc. Says Schmuckli: "We have assurances from Warner that they will participate. The sample record contains music from both Sony Music and Warner. That proves Warner's interest".

A package of software and hardware will go to a thousand dealers in Germany this December. "The future belongs to discs, both CD and MD", says Wolfdieter Griess, Managing Director Sony Germany, "The issue of pre-recorded software has been over-stressed. It will not decide success or failure. MD's ability to record is what matters".

This may be true, but it is not be what the record companies want to hear.

MEMORY LAPSE

Sony has now upgraded the solid state memory in the portable player to four megabits to give ten seconds buffering against jogs. Previously the buffering was one megabit and three seconds. But still Sony's demonstration of portable Mini Disc is unrealistic, the portable is only very gently moved, and the disc taken out while playing to prove the capacity of the buffer. Incidentally, shock protection works only during playback, not during recording.

On copyright issues, Schmuckli says, "This has already all been agreed with the software companies, there is no discussion. SCMS is very safe".

Sony continues to tie the launch of MD in with the tenth anniversary of the launch of CD. This is not accurate. Although there were plans to launch CD in Europe in 1982, these were delayed by the lack of software for Europe from Polygram's factory. Although CD went on sale in Japan in October 1982, the format was not launched in Europe until spring 1983.

INSTANT VISION

For ten years electronics companies have been demonstrating electronic imaging systems at Photokina, and predicting the end of film photography. But there is still no sign yet that the end is nigh.

Kodak has now been selling Kodacolour snapshot film for fifty years. Leo Thomas, President of Eastman Kodak's Imaging division, estimates that photographers will this year shoot 60 billion still images, compared with 40 billion in 1986. Seven out of ten are on colour negative film, which equates to nearly ten colour prints for every person on the planet. "We know that quality hard copy colour will be in demand for ever" says Thomas. Bruce Henry, Vice-President of the Polaroid Corporation predicts "By the year 2000 there will be more hard copy prints than now. Remember how computers were supposed to create the paperless office, in reality they have created just the opposite. We believe in hard copy"

Polaroid has now developed a compact version of the instant print cameras it has been selling for many years. However, it is doubtful if they can make a camera as small as the new generation of compact, fully automated 35mm cameras from Japan. An instant picture camera must contain a pack of large film print paper, and a mechanism to move it through a developing cycle and out of the camera. Polaroid's new Vision camera [secretly developed for five years under the code name Joshua], plays clever tricks to make it small enough to fit in a jacket pocket.

The shape of the print has been changed, from 4:4 aspect ratio to 4:3. Instead of ejecting the developing print, Vision bends it round rollers in a 180 degree U-turn and stores all ten developed prints in a compartment in the camera back. The photographer can either leave the prints there or remove them. Developing chemicals are released from a pod as the print starts moving, and is spread over its surface by the guide rollers. New film was needed, to let the 23 layer coating cope with such a tight mechanical turn.

The mechanics take up so much room that there is none left for the light path. So for use the camera opens up into a larger unit, with mirrors defining an optical triangle.

Because Polaroid film is very sensitive, the lens can have a small aperture (f 12), which gives a large depth of focussing field. To sharpen focus, Vision also switches automatically between long and short distance photography. As the shutter button is pressed the flash gun emits a pulse of infra-red light, and a sensor detects the level of light coming back. If the level is below a threshold, this signals that the view is distant and a solenoid puts a far focus correcting lens into the optical path.

The sensor also reads ambient light and refers to a look-up table of 100 exposure scenarios stored in four kilobytes of read only memory. An 8-bit microprocessor running at 10MHz chooses the best compromise between shutter speed, aperture size and flash light.

Polaroid launched Vision in Germany this winter, and will launch in

The Sony MD-Walkman portable mini disc digital recorder.

Philips DCC900 digital compact cassette (DCC) player.

Polaroid's new compact Vision camera, with on-board picture storage chamber and viewing window.

the UK next spring. The camera will cost around 80 pounds and the film, like current Polaroid film, 10 pounds for a ten shot pack. If sales are good Polaroid will switch production from Massachusetts to its factory in Scotland.

STILL IMAGES

Japanese company Canon has now given up trying to sell its Ion, electronic still image camera, as a domestic product. Canon has now repositioned Ion, which records up to 50 TV images on a small magnetic floppy disk, as an industrial tool, for use with computer graphics programs.

Sony, which started electronic photography with its Mavica disk camera ten years ago, has decided against lanching it in Europe. Sony's bitter rival, Panasonic has announced a wide range of compact 35mm film cameras. Fuji has now demonstrated a new system which stores up to 40 images in a 16 megabit flash memory card. But Fuji has no firm plans for marketing the card camera.

At *Photokina* Canon gave the first demonstration of a remarkable new 35mm camera, the EOS5. This boasts "eye-controlled auto-focus". Although the technology is so far used only on a still camera, there seems no reason why it should not be modified and developed for use with video camcorders.

In a conventional auto-focus camera split beam optics sense the sharp transitions between objects in the picture which signify sharp focus. Usually the camera takes its reading only on objects in the centre of the picture. This means that the camera will not be focussed on any object off centre, for instance if the centre of the picture is distant sky. This in turn limits artistic composition.

The only option so far has been either to switch off the auto-focus system and focus manually, or point the camera direct at the off-centre object, then lock the focus and move the camera back for artistic composition of the picture. Canon's new system plays the almost unbelievable trick of detecting where the eye is looking through the view finder, and focussing on only that part of the picture.

When a photographer looks through the new view finder there are five small squares in a horizontal line across the image area. An infra-red light beam from inside the eye piece shines on the photographer's pupil, and reflects back onto a sensor. The sensor detects the position of the photographer's pupil, and puts a red marker dot in whichever of the five horizontal points the photographer has been looking at. The camera then focusses on whatever object coincides with these five points.

Because different people have different eye sight, some people will need to "train" the camera to match their vision. This is done with a brief training sequence. And once trained, the camera remains matched to the user's eye.

The only inherent problem with the system is that it only works horizontally. There is no facility to lock the focus onto objects above or below the centre line.

High-Speed 3M Colour Laser generates photographic quality prints on overhead transparancies from digital data, including Photo CD.

PAPER SANDWICH

Affirming faith in hard copy photography, both Fuji and 3M have separately developed new machines which photo labs can use to make paper prints from electronic images. Fuji's Pictrostat technology can also be used to make clone copies or enlargements of prints, as for instance delivered by an instant picture camera, for which no negative exists.

Pictrostat looks like a floor-standing photocopy machine. It takes in any digital picture signal, whether from computer or electronic camera, and drives three laser diodes which expose silver halide photographic print paper. Although the diodes represent the yellow, magenta and cyan picture content, there are no laser diodes yet available which can produce these colours. So the three diodes generate infra-red light of three different wavelengths. The light sensitive paper is sensitive to these "pseudo colours", but develops to produce visible colours.

Processing is dry. All the chemicals are stored in the light sensitive paper and are activated by light moisture. Because the spent chemicals would dull the image, the Pictrostat sandwiches the chemical "donor" paper with a blank sheet. The sandwich is heated and peeled apart, leaving the image on chemical-free paper.

A modification of the Pictrostat printer, which Fuji will next year offer to High Street processing laboratories for around 100,000 pounds, uses the same paper sandwich technology, but photo-copier optics. It forms an image of any existing colour photograph or, even solid object up to 3cms thick, on the paper, to make a perfect copy. The optics can be adjusted to enlarge an image up to 200 per cent or reduce it by 50 per cent, with a maximum print size of A4 paper.

Both Pictrostat machines take less than a minute to produce dry prints.

A DRY PROCESS

For ten years now, 3M has been trying to make a dry process printer which avoids the need to use peel apart paper, because peeling doubles print material costs to around $2 each. 3M admits it is still looking for chemicals which can remain in the print sheet without dulling the image.

So 3M is now selling a printer and copier which, like Fuji's, uses three infra-red diodes to write the cyan, yellow and magenta signals onto silver halide paper. The difference is that 3M's processing is "wet", with conventional chemicals, but they are sealed in 25 litre tanks and circulated in a closed loop without the need for a water rinse or external plumbing. 3M will charge laboratories $150,000 for the laser printer, with raw print material costing $1 a sheet. Print quality from both the Fuji and 3M laser printers matches traditional photographic enlargement.

PHOTO CD

Kodak now sells a add-unit for a Nikon still film camera which records images digitally, on magnetic disk. But it costs $20,000 each. Kodak's faith for the future is in Photo CD which functions as a "digital negative".

Photographers shoot their pictures on film, have it processed in the usual way and then a Kodak Photo CD centre transfers a hundred or more images onto compact disc as digital code. Kodak is now working on the missing link in the Photo CD chain, a printer that will produce high quality images from a digital negative, at low cost.

Philips showed CD-I, but also had a demonstration of Full Motion Video using both clips from music videos of Pavarotti and Bon Jovi. These were screened on direct view monitors. Although Philips' choice of the Bon Jovi clip still puzzles (because the source material is poor), the Pavarotti clip looked excellent, even when viewed from very close to the screen. There was very little sign of digital artefacts, just a slight trace of mosaic "blocking" on moving edges of the singer's face. Philips now promises the full motion video upgrade before the end of 1993 in Germany for under 500DM. Korean company Goldstar was demonstrating CD-I, too,

SPECIAL EFFECTS

Until now people with video camcorders have been able to make only relatively amateur-looking home movies. They can edit by copying slected sequences from one tape to another, and add simple effects like fades in and out. But only professionals have been able to afford the equipment needed to add the exotic special effects now seen on all TV progammes and commericals.

Next month a German specialist electronics company, Fast Electronic

Kodak's DCS200 professional add-on digital camera, combined with a Nikon still camera body, records images digitally, on a magnetic disk and is claimed to be compatible with Mackintosh and other PCs.

of Munich, will start selling the Video Machine, an extra circuit board that plugs into a 386 or 486 IBM PC or Apple Mac. The board and control software will cost around 2000 pounds, and turn a home or office computer into a video editing and effects system which mimics professional equipment costing many tens of thousands of pounds.

The PC board and software work with Microsoft Windows software. The Mac board works with the Mac's own windows system. Two playback video recorders plug into the board and a third connects to its output.

The electronics on the board convert each analogue video input signal into digital code which matches the internationally agreed professional standard and captures the full broadcast signal bandwidth of 5·5MHz. 24 bit coding of red, green and blue signals gives a range of 16·7 million colours. Picture quality is thus limited only by the tape sources and recorders used.

There is automatic adjustment between European PAL and North American NTSC video formats. The signals are converted back into analogue form at the output.

The computer screen displays windows depicting the picture content of the input signal, with "time lines" running across the screen and indicating the length of each sequence. With a conventional computer mouse, the operator breaks and joins the time lines to create an edited sequence.

Most video recorders give video signals which have unsteady picture synchronization pulses. When these signals are mixed or cut together the pictures are often unsteady on screen. The Video Machine does as all professional video equipment does and restructures the pulses. This lets it mix and cut cleanly between the inputs to produce a seamless edited sequence. Cuts and mixes are rehearsed by storing the control decisions in memory and watching the sequence on screen before copying onto tape.

The board also has three Megabytes (24 megabits) of extra memory, which is enough to store at least two full quality video pictures. This is what lets the Video Machine add special effects. Control software manipulates each image as it moves through the computer, with subtle changes of shape between each picture creating a mobile effect on screen.

The system comes with a library of over a hundred pre-programmed effects, which can make pictures tumble, fly in and out of the frame, shrink, zoom, spin and dissolve. When users get familiar with the system they can modify the library effects or can make their own completely new ones.

The memory can also store, manipulate and blend still pictures with motion sequences. The stills are sourced from any video camera or document scanner.

Cleverly, Fast Electronic has made its control software compatible with any word-processing program which will run on the Mac or under Windows. This lets an editor add titles, direct from a text file and with any font supported by the word-processor.

Demonstrations given at the exhibition by Fast and major video firms including JVC and Pioneer, back Fast's claims that a Video Machine will give serious amateur video photographers, or small businesses, the chance to produce video programmes which look as if they have been polished in a broadcast studio. Whether they do actually look as good will however depend on the artistic skill of the operator.

3D IMAGES

Finally, watch out for a very impressive new 3D still picture system unveiled in prototype form by Kodak. The US company readily acknowledges that its Depth Imaging System is far too complicated and expensive for domestic use, but sees it as ideal for eye-catching advertising displays, for instance publicity pictures outside a theatre or cinema.

Depth Imaging was developed by Roland Schindler and Bud Taylor and Kodak may very well be justified in describing it as "the best stereo imagery ever seen without glasses". The first demonstration of Depth Imaging, given at the show seems to justify their claim.

The Depth Image is formed from a large colour transparency which is back-illuminated in a conventional photographic display light-box. Without needing to wear special spectacles, viewers see a very bright, natural colour image which appears to extend both behind and in front of the light-box. The effect on some pictures is so real that if someone near the light-box puts their finger in front, it appears to blend with the perspective of the 3-D photograph.

For their first experiments Schindler and Taylor mounted a conventional single lens camera on a horizontal track, and took twelve colour pictures of the same stationary object. Each shot was taken from a slightly different position, and thus each image has a slightly different perspective.

The pictures were developed normally. The inventors then used one of Kodak's Photo CD scanners (designed to transfer photographic pictures to a compact disc) to convert each picture into digital code. The twelve sets of code were then combined, to produce a composite digital image, of very high resolution, with each picture point or pixel made from up to twelve sub-pixels.

The composite code is used to drive a light value printer. This scans photographic film with a light beam which is continually switched under control of the pixel code. So the result is a colour transparency with each pixel of the picture represented by a cluster of sub-pixels. Because sub-pixels are so small, there is no overall loss of resolution.

The transparency is bonded to a transparent sheet of plastics, embossed with a vertical raster of fine ridges which serve as lenticular lenses. The

Demonstrating the Kodak Photo CD disk the company's latest player onto a TV screen.

first pictures have a raster of just over 50 lenticules per inch. The use of lenticules is not new. The trick is how to align the sub-pixels with the lenticules, so that a viewer's left eye always sees one perspective while the right eye sees another. Kodak will say only that it has deeloped a computer program to control the distribution of the sub-pixels.

Because the image is effectively replicated up to a dozen times, each with a slightly different perspective visible only from one angle, a viewer can walk past the picture, seeing an apparently smooth transition from one perspective to another. This simulates real life vision. Holograms give a similar "see round" effect, but only in a single, unnatural colour, usually a ghostly green.

Kodak's transparencies measure 28cm x 35·5cms but the size can be 41cm x 51cm images, with the capacity of the printing device the only limiting factor. Although the first images are on Ektachrome transparency film they can also be reproduced as prints. Anything between six and 24 images can be combined. Where the object is moving, one camera with many lenses will be used.

The 3D system was unveiled at a lecture given by Dr. Leo Thomas, Group Vice-President and President Imaging at Eastman-Kodak in Rochester. Thomas also quoted Gerhard Popp, Head of Kodak's colour negative research team, as estimating that there are a billion silver halide crystals per square centimetre of colour negative film. But still only around one light photon in ten that hits the emulsion is captured and used. And the average image forming efficiency of those photons which are caught is only one quarter the theoretical limit. So the resolution of photographic negative film can be improved by at least a factor of ten.

To get the electronic equivalent of a single frame of Ektar 100 film would require around 324 million bits of computer data, equivalent to several dozen of the highest density floppy disks currently used with home computers.

National press photographers are now starting to use colour print film, instead of colour slide or black and white. They find that definition is good enough, and one negative can be used to produce either colour or black and white pictures.

All this backs Kodak's now well-worn epigram - that if electronic photography and video had come first, and somebody invented silver halide film photography tomorrow, everyone would hail it as the biggest breakthrough since the invention of electronic imaging.

POSTSCRIPT

The *Photokina '92* show was notable for being "green". Stand after stand carried stickers explaining that the materials used had been recycled and would be recycled after use. Both Kodak and Fuji printed their press information packs on recycled paper. Kodak even used recycled card folders, which were works of art. "But don't take them in the rain" warned Kodak's publicity officer.

In this area, Polaroid could and should learn a lot from Kodak and Fuji. The information pack given to the press on Vision was an inch thick and contained 33 separate papers, totalling 129 pages. That was in addition to many more general press releases, for instance quoting speeches.

The Vision press releases say the same thing over and over again, in the same or similar words, but in slightly different context. It was a nightmare to try and read them and write a crisp synopsis for publication. Worse still, despite this absurd overkill, there was no clear description of vital integers, for instance the principle behind the range finder. I can only hope that my interpretation is correct.

Polaroid's classic press pack reads like an examination paper answer written by someone who does not understand what they are writing about but hopes that by writing the same thing over and over again at immense length, the examiner will not notice. Just a couple of sketches could have saved thousands and thousands of words.

And no, the paper on which Polaroid has printed this overkill, was not re-cycled. I will however do my bit and recycle it as soon as possible.

SHOP TALK

with David Barrington

Mini Lab (Teach-In '93)

We have just discovered that supplies of the Veroblocks specified for the *Mini Lab* have dried up and are no longer being manufactured. However, the good news is that the *"Eurobreadboard,"* equivalent to two blocks, will sit on the Lab p.c.b. It does mean that it will have to be positioned using double-sided self-adhesive pads. None of the proposed "experiments" will be affected.

This month's project includes a separate power supply and the components to build this unit should be widely available.

The mains transformer and the 2A thermal resettable trip are RS types (**Electromail** – ☎ *0536 204555*). A selection of kits has been put together by **Magenta Electronics** (☎ *0283 65435*), including the new Euroboard.

Emergency Lighting Unit

A couple of parts called for in the *Emergency Lighting Unit* look as though they will be hard to find locally. The main item(s) is the ferrite pot-core transformer. This was purchased from **Electrovalue** (☎ *0784 433603*) and the type numbers given in the "Comp list" should be quoted.

Small fluorescent tubes should be obtainable from various sources, but the 4W version seems in little supply. A 6 inch 4W "Mini Fluorescent Lantern", from **Maplin** (code ZC11M), seems to fit the bill nicely. (We understand that they are out of stock at time of going to press, but new supplies will arrive in Jan. '93). It comes in its own housing which you may be able to use.

The reversible or non-polarised electrolytic capacitor (C13-10 μF) should be stocked by most suppliers. The two companies above certainly list it. The 12V 2·6Ah sealed accumulator battery should be widely available but make sure it will sit in the chosen *metal* case.

We are not sure where readers can purchase the "stainless steel" sheet for the reflector. It may be cheaper to use sheet aluminium and polish it with some metal polish.

The printed circuit board can be purchased from our *PCB Service*, code 816 (see page 73).

TV/U.H.F. Filtered Aerial Amplifier

Surprisingly, the printed circuit board mounting type of 75 ohm coaxial socket needed in the *TV/U.H.F. Filtered Aerial Amplifier* is rarely listed in our range of catalogues. However, the new edition of the **Cirkit** (☎ *0992 444111*) catalogue lists one and carries the stock code 10-01100.

The special in-line u.h.f./v.h.f. wideband amplifier i.c. type OM2045 was purchased from **Maplin**, code UL77J. Do not forget to solder pins two and three to *both* sides of the board.

The small *double-sided* printed circuit board for the aerial amplifier is available from the *EPE PCB Service*, code 814 (see page 73). If you decide to house the board in a small diecast box, you should wrap insulating tape around the bodies of the two sockets to safeguard against the possibility of "shorting" to the metal case.

Car Ice Alarm

All components required to complete the *Car Ice Alarm* should be readily available from our components advertisers. The bead thermistor (4k7 at 25°C) should be available generally, the one in the model came from Maplin.

On a personal observation, it might be best to set the warning to come on at +4°C. Hazardous road conditions can still exist even when the temperature rises; ice patches take time to thaw.

Soft Distortion Effects Unit

There should be no problem with finding parts for the *Soft Distortion Effects Unit.* It is essential to use *germanium* diodes to obtain the "soft" effect.

The heavy-duty push switch is sold by many advertisers as a "footswitch" and may be a double-pole type. This is usable, you only need to use one set of contacts.

Flash Slave Unit

The components list for the *Flash Slave Unit* indicates three possibilities for the phototransistor. The BPX25 seems to be the most widely stocked. When ordering the rotary switch, you might find that it is designated as a "mains rotary" type by some suppliers.

The specified flash lead should be obtainable from any large photographic shop. It is important to heed the reference about connecting this lead with the correct polarities.

Variable Balanced Power Supply

We cannot foresee any component buying problems for those wishing to construct the *Variable Balanced Power Supply* project. However, before accepting the in-line bridge rectifier check that it complies with the contact arrangement in the diagrams and will fit on the board.

The printed circuit board is available from the *EPE PCB Service*, code 815 (see page 73).

Whistle Switch (Oct '92)

Supplies of the UM3763 have dried up in the UK. We are awaiting information from the manufacturers in Taiwan. If any readers know of a source for the UM3736 i.c. we will be please to hear from you.

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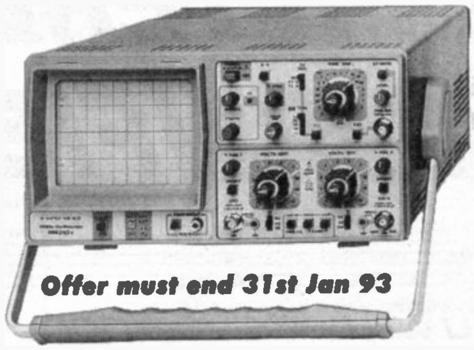

Offer must end 31st Jan 93

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TM 5375	Frequency range (20MHz) and HFE test	£36.95	**£31.49**
TM 115	AC & DC current (10A), HFE and continuity test	£32.50	**£30.99**
TM 175	Freq. (15MHz), capacitance ranges with HFE, diode, continuity & LED test	£53.60	**£45.00**
TM 8020	$3^3/_4$ digit display, freq. (4MHz) capacitance (40uF), AC+DC current to 20A	£54.76	**£49.95**
TM 8030	$3^3/_4$ digit display, freq (4MHz), temp. (inc probe), AC+DC to 20A	£59.96	**£55.49**
7705	Capacitance meter, 1pF to 20,000uF	£39.82	**£35.90**

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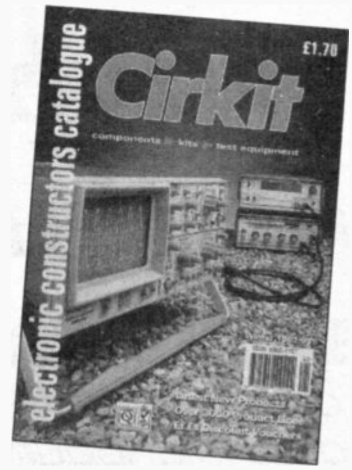

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Hardware - additions include new range control knobs, cabinet hardware and heatsinks.
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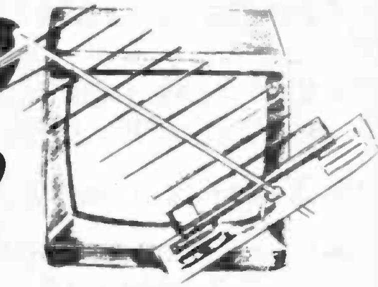
TV/U.H.F. FILTERED AERIAL AMPLIFIER



BRIAN WALKER

For a small outlay you will receive a good reception from your neighbours. No more unsightly aerial "stacks" on your roof if you use this customized chip. No more grotty pictures if you live in a bad reception area.

THIS circuit is intended for those suffering from bad TV reception either because they live in an area prone to such a disorder where interference is due to taxi radio, amateur radio, or unsupressed motors etc., or where the signal is just weak. It is also intended for use in caravans where the aerial itself may be a small, inefficient set top, or similar type with little or no gain, as it conveniently runs from 12V d.c.

HOW IT WORKS

The full circuit diagram for the TV/U.H.F. Aerial Amplifier is shown in Fig. 1. The circuit is based around the OM2045, a hybrid thick film i.c. designed as a single stage broadband amplifier. Using such a device simplifies construction, there being no alignment or adjustment difficulties.

Referring to the circuit diagram, the weak signal passes from the aerial through the input socket SK1 and has its h.f. (high frequency) and v.h.f. (very high frequency) interference removed by capacitors C1, C2, and coils L1 and L2, from both the inner core, and outer braid (screen) of the coaxial downlead. Coil L1 has a low reactance at h.f. or v.h.f. frequency, so bypassing them, but at u.h.f. (ultra high frequency) the reactance is so high it can be ignored.

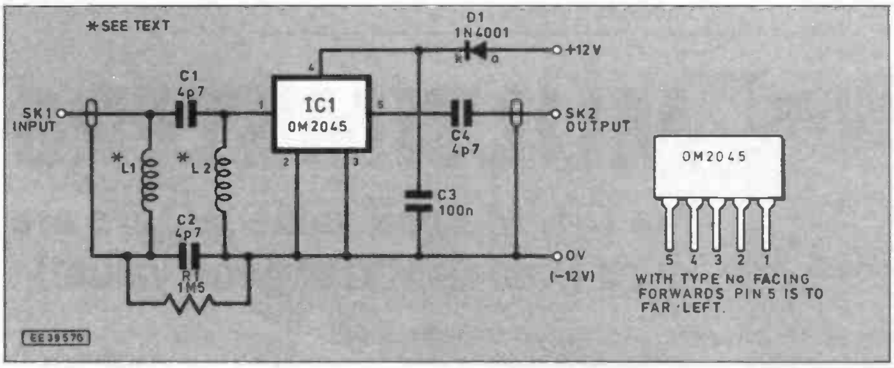
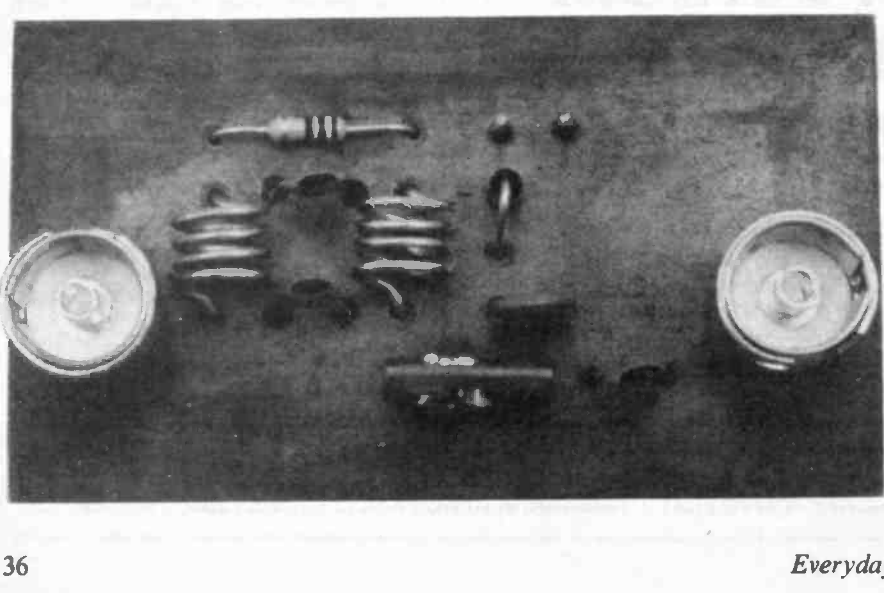


Fig. 1. Complete circuit diagram for the TV/U.H.F. Aerial Amplifier. Leadout identification for the broadband amplifier i.c. is shown inset.

The capacitors C1 and C2 have high reactance at h.f. and v.h.f. frequencies so blocking them, but let u.h.f. through easily. Coil L2 provides a further short circuit to h.f. and v.h.f. signals at the amplifier input.

The OM2045 gives a 12db of amplification and is coupled to the output socket SK2 by capacitor C4. The supply to IC1 is decoupled by capacitor C3 and diode D1 protects the circuit from reversed power connections. Resistor R1 grounds the braid of the aerial.



COMPONENTS

Resistors
R1 1M5
0·25W 5% carbon film

See SHOP TALK Page

Capacitors
C1, C2,
C4 4p7 metallised ceramic (3 off)
C3 100n ceramic

Semiconductors
D1 1N4001 1A 50V rec. diode
IC1 OM2045 wideband u.h.f./v.h.f. amplifier

Miscellaneous
SK1,
SK2 Standard 75 ohm, p.c.b. mounting coaxial socket (Belling-Lee) – 2 off
L1, L2 Coil 4-turns 20s.w.g. tinned copper wire, 6mm inside diameter and "stretched" to 6mm length – see text

Printed circuit board available from *EPE PCB Service*, code 814; aluminium case, preferably diecast, approx. 100mm x 50mm x 25mm; solder pins (2 off); connecting wire; solder, etc.

Approx cost guidance only **£17**

CONSTRUCTION

All components are mounted on a small double-sided printed circuit board (p.c.b.). This board is available from the EPE PCB Service, code 814.

The input and output of IC1 is a standard 75 ohm impedence, therefore the input and output connections need to be 75 ohm also. Standard Belling-Lee TV aerial sockets are used and for a standard 1·6mm fibreglass p.c.b., the tracks need to 1·5mm wide, with an earth strip either side of them, and an "earth plane" on the topside, to avoid any mismatch problems. For these reasons this circuit must be built on a p.c.b. not stripboard, tagstrips etc.

Before any components are soldered on the board, a circle of the earth plane (top side) copper needs to be removed from around each hole (Fig. 2), to stop any component lead-out wires from shorting to earth. This is conveniently done with a 3mm drill bit twisted round a few times between the fingers. Do not use a drill for this as it will most likely go all the way through!

The coils L1 and L2 can be wound from a few centimetres of 20s.w.g. tinned copper wire, as they are really little more than a spring of four turns with an inside diameter of 6mm and 6mm long. A 6mm drill bit's shank is a convenient temporary former and the four closewound turns can be carefully stretched out to a 6mm length, making sure no turns touch each other.

It is a good idea to solder the co-ax. sockets in position first as they require big joints and much heat – see Fig. 3. Other parts can then be mounted ensuring nothing metal touches the earth plane, leaving IC1 until last.

Note that pin 2 and pin 3 of IC1 need to be soldered to the earth plane *as well as* the "earth" (–12V) track on the bottom side. This means IC1 will have to be mounted well above the board to allow space for this joint. Its' pins are just long enough to allow this. Do not overheat the i.c. when soldering it in.

CASE

The p.c.b. should be mounted in an aluminium, preferably diecast, box with two 12mm diameter holes drilled for the sockets and a small hole for either the power supply wires, or a small switch, if a battery is fitted. Shakeproof washers should be used when mounting the p.c.b. as they will provide a good earth connection between the board and the box. It is necessary to wrap each socket in insulating tape as their metal sleeves are not electrically at the same potential, and may short out against the box.

TESTING

To test the finished unit connect a 12V d.c. supply or battery (8xAAA cells) and a milliammeter in series with the positive supply. A working amplifier should draw just over 2mA quiescent current, this will rise to 11·5mA when the amplifier is driven..

If a huge current is drawn, disconnect immediately and check for shorts (you did solder the i.c. in swiftly to avoid overheating, and destroying it, didn't you? Because it is very difficult to remove). If no current is drawn see if the diode is the correct way round!

If all is well so far, just connect in series with your television and say good riddance to your grotty picture! □

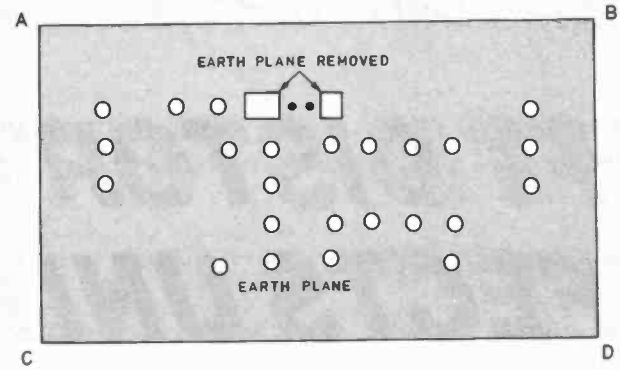


Fig. 2. Topside copper "earth plane" showing copper removed from around component holes and square cutouts around IC1 pins 1, 4 and 5. Note pins 2 and 3 are soldered to the earth plane and underside pads.

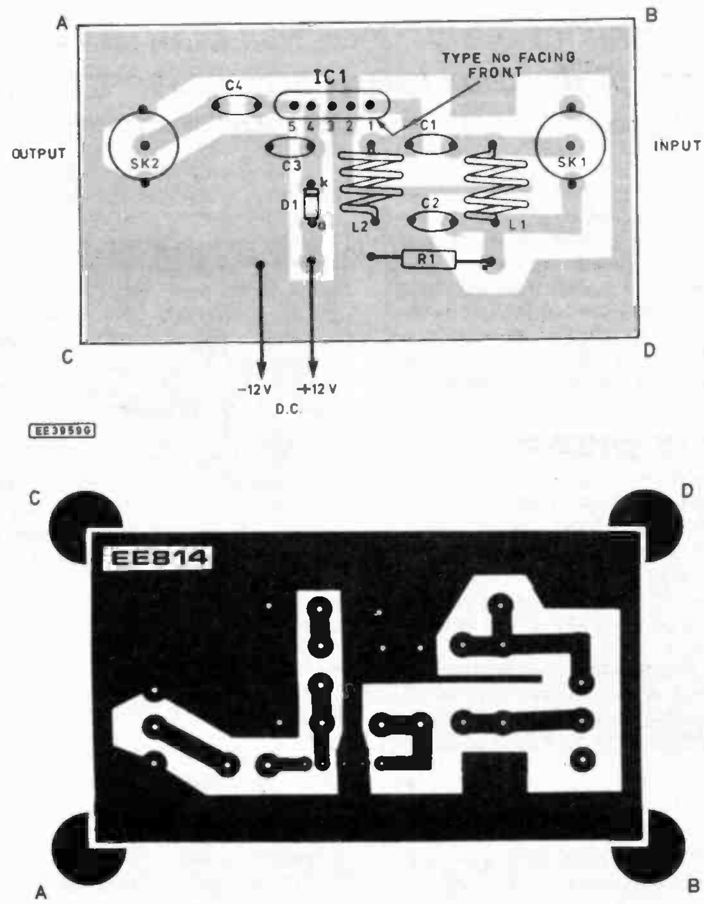
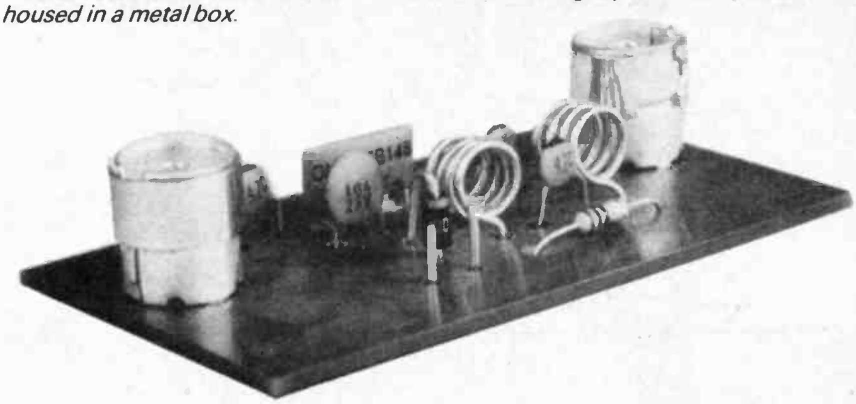


Fig. 3. Printed circuit board component layout and full size underside copper foil master pattern. The completed board is shown below. The outer bodies of the coaxial sockets will need to be covered with insulating tape if the board is to be housed in a metal box.



SOFT DISTORTION EFFECTS UNIT

ROBERT PENFOLD

A guitar effects "footswitch" that will extend your repertoire but still retain the basic guitar sound.

THE DISTORTION effect, or "fuzz" effect as it is also known, is probably the best known of all the standard electronic music effects. It is also one of the most simple to generate.

It is really a range of effects, since there are a number of ways in which the signal from the guitar can be distorted, and most of these methods have been used as the basis of "fuzz" effects units at one time or another. The sound produced by one distortion unit can therefore be distinctly different to that obtained from another box.

GOING SOFT

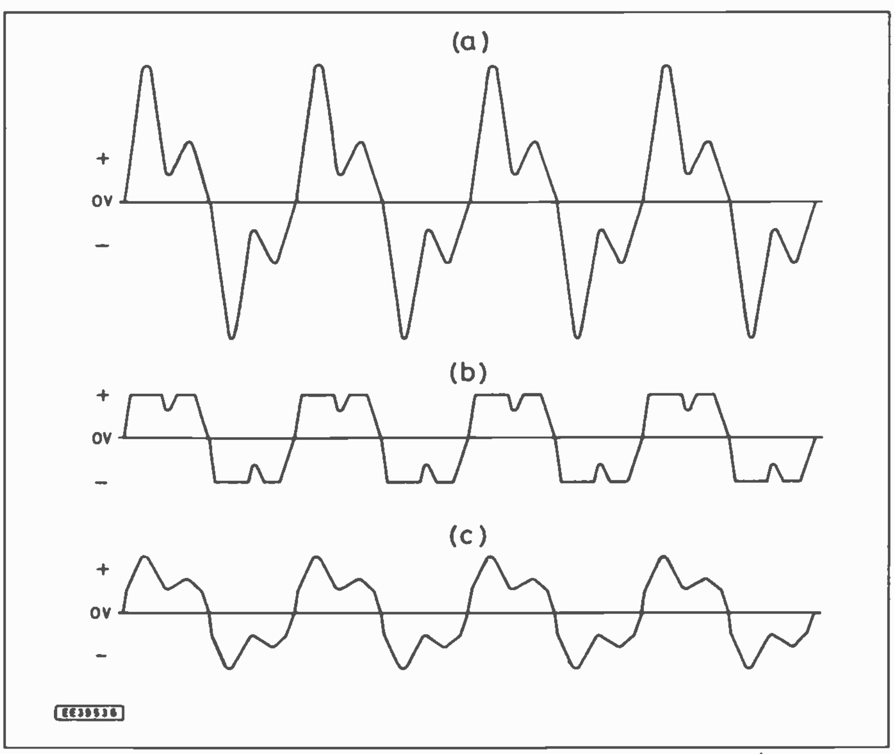
Some "fuzz" effects units are quite complex, but it is possible to obtain quite a good effect from a very simple circuit, such as the one described here. This unit provides a "soft" clipping effect, which is one that most people find more musical than the hard clipping effect used in many home constructor distortion unit designs.

A look at Fig. 1 should help to explain the difference between hard and soft clipping. In the top waveform (a) a typical input signal is shown. The waveform in (b) shows the effect of hard clipping.

With hard clipping distortion the waveform rises from the central zero volts level in the usual way, but only until it reaches a certain threshold voltage. Whether the input signal is positive or negative in polarity, it cannot force the output voltage above this threshold voltage. Eventually the input signal falls below the threshold voltage, and the output voltage then falls back towards zero in the normal way.

Soft clipping is less severe, and produces a waveform of the type shown in Fig. 1c. As before, the low voltage part of the waveform is unaffected. A degree of clipping occurs at higher voltages, but changes in the signal voltage are always reflected to some extent by changes in the output voltage.

Fig. 1. Difference between hard and soft "clipping": (a) typical input signal; (b) effect of hard clipping and (c) soft clipping of the signal.



There is more than one version of soft clipping, but in its normal form the higher the input voltage, the greater the compression of the waveform. This gives a sort of squashing effect on the waveform, rather than completely flattening the signal peaks.

STRONG ON HARMONICS

As far as the sound of the effect is concerned, hard clipping generates strong harmonic and intermodulation distortion, including many strong high frequency distortion products. This gives a very "bright" effect, but one which is also very harsh. The strong intermodulation distortion means that playing more than one note at a time is almost certain to produce some very discordant sounds.

A strong compression effect is produced as a byproduct of the hard clipping. Although the output level from the guitar varies considerably during the course of each note, the clipping ensures that the output level remains constant at the clipping level.

Soft distortion produces relatively weak high frequency harmonics, but generates strong harmonics at lower frequencies. This gives a "thicker" distortion effect. The intermodulation distortion is relatively weak, which means that it is safe to play more than one note at a time.

There is less compression because the output level does to some extent reflect variations in the input signal's amplitude. This results in the character of the guitar's basic sound being retained to some extent, but notes sustain much better.

Another point worth making is that as the input signal decays, so does the soft distortion effect. This gives quite a natural effect with the distortion gradually diminishing as notes are allowed to fade away.

There is a slight problem with hard clipping when notes are allowed to decay naturally, in that the distortion is removed suddenly as the signal drops below the clipping threshold. This gives a decay characteristic that is far from natural.

CIRCUIT DESCRIPTION

The circuit is basically just a standard clipping amplifier. The full circuit diagram for the Soft Distortion Effects Unit appears in Fig. 2. IC1 operates in the non-inverting mode, and its voltage gain is set at about 34 times by resistors R3 and R4.

However, diodes D1 and D2 are included in this negative feedback network, and these shunt resistor R3. Diode D1 is brought into conduction and shunts R3 on negative going half cycles – D2 conducts and shunts R3 on positive half cycles. This effectively reduces the value of R3 and gives lower voltage gain.

The resistance through the diodes depends on the amplitude of the output signal. The higher the output voltage, the lower their resistance and the voltage gain of the amplifier. This gives the required rounding-off on signal peaks.

In order to obtain the desired soft clipping effect it is essential to use *germanium* diodes for D1 and D2. These do not have well defined turn-on voltages, but instead have a resistance which steadily decreases as the applied forward voltage is increased.

The same is not true of silicon diodes such as the 1N914 and 1N4148. Using silicon diodes for D1 and D2 will give a "hard clipping" effect.

Using a "footswitch" for S2 enables the output socket to be switched between the output of the distortion unit and the direct signal from the guitar. This gives a simple but effective form of in/out switching.

Using a guitar fitted with low output pick-ups will provide an output level from the distortion unit which is substantially higher than the direct signal from the guitar. This can be corrected by backing off output level control VR1 to equalize the two signal levels.

The gain of the unit is likely to be excessive if it is used with high output guitar pick-ups. Results with high output pick-ups are likely to be better if the value of resistor R4 is raised to around 10 kilohms.

The current consumption of the circuit is only about one to two milliamps. Each PP3 size battery should therefore give over 100 hours of operation.

CONSTRUCTION

The complete unit can be built on a piece of 0·1in. matrix stripboard and details of the topside component layout

COMPONENTS

Resistors
R1 100k
R2 100k
R3 33k
R4 1k
All 0.25W 5% carbon film

See SHOP TALK Page

Potentiometer
VR1 10k min. preset, horizontal

Capacitors
C1 0µ47 radial elect., 63V
C2 22µ radial elect., 16V
C3 10µ radial elect., 25V

Semiconductors
D1, D2 OA90 or OA91 germanium diodes (2 off)
IC1 LF351N or TIL071CP bifet op.amp

Miscellaneous
S1 s.p.s.t. min.toggle switch
S2 s.p.d.t. heavy-duty pushbutton switch
JK1, JK2 Standard jack socket (2 off)
B1 9V (PP3 size) battery, with clips
Stripboard, 0·1in. matrix, size 23 holes by 17 strips; metal case, about 102mm x 72mm x 38mm; 8-pin d.i.l. i.c. holder; wire; solder, etc.

Approx cost guidance only **£11.50**

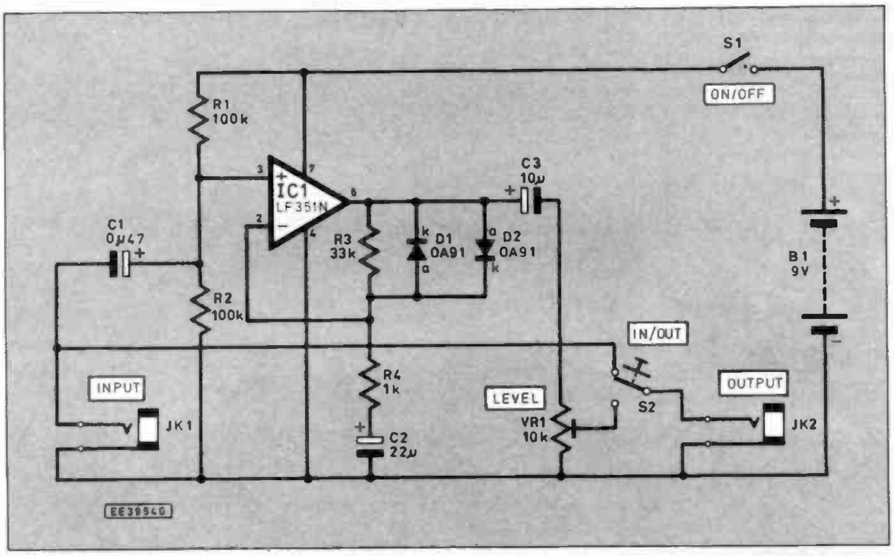
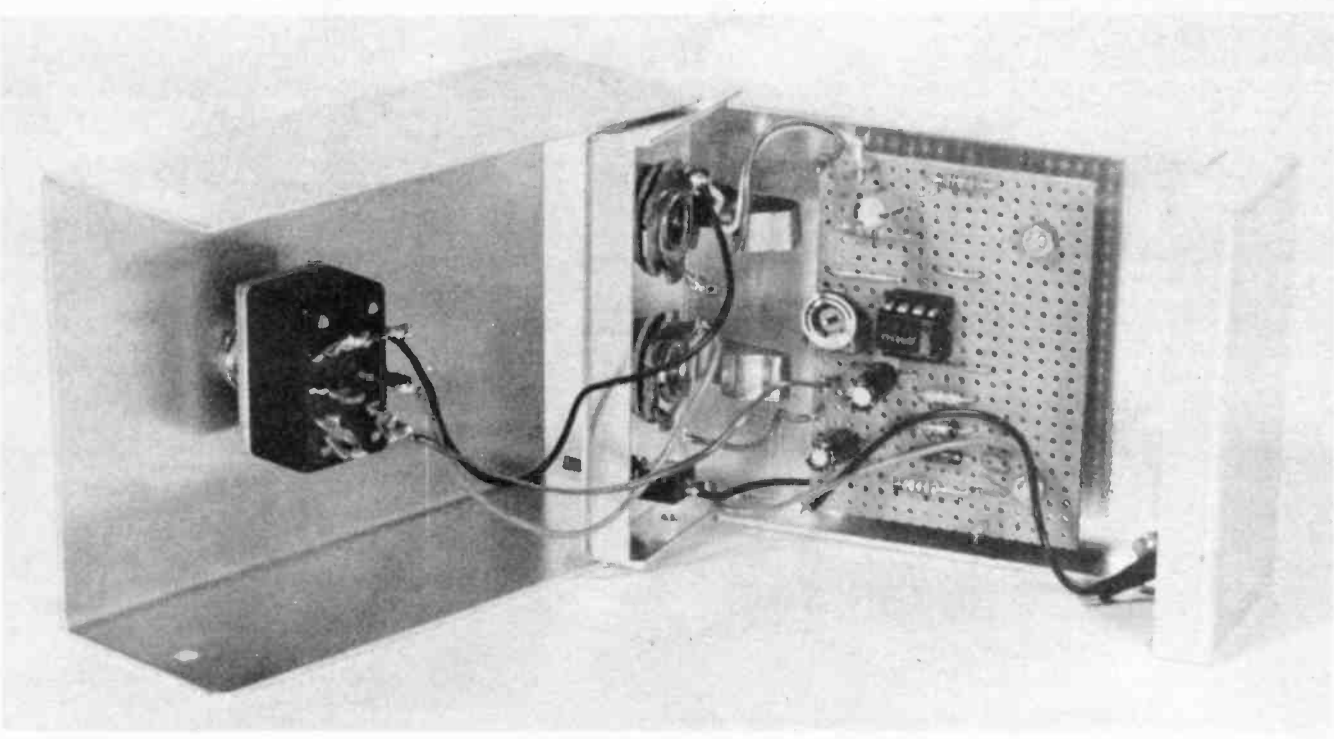
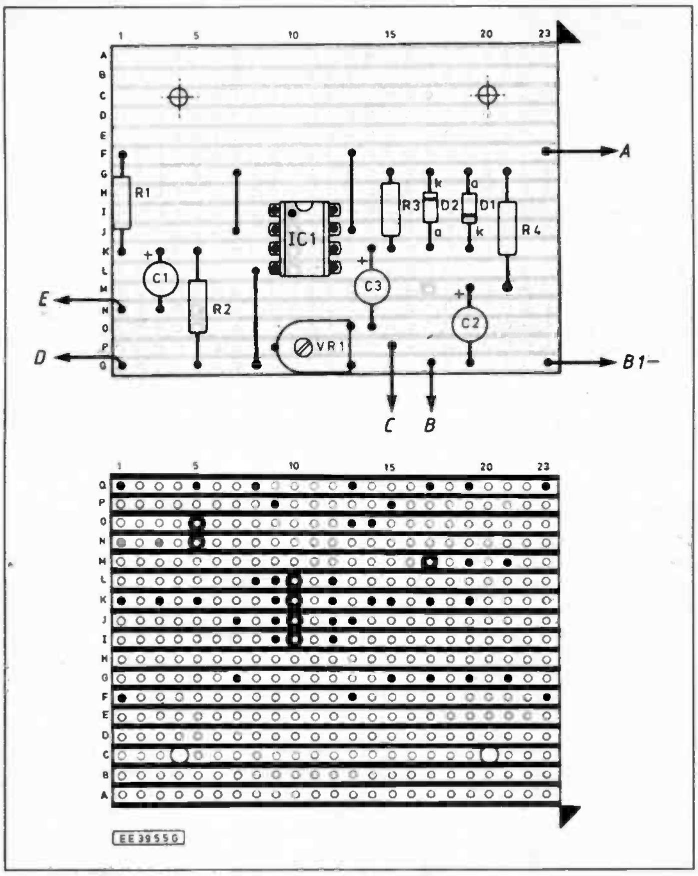
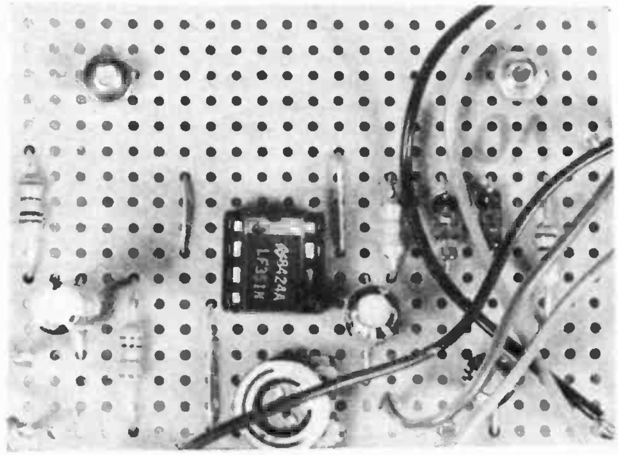


Fig. 2. Full circuit diagram of the Soft Distortion Effects Unit. It is basically just a conventional clipping amplifier. (below) The completed unit with the case opened to reveal position of the footswitch and circuit board.






The completed board showing the three link wires.

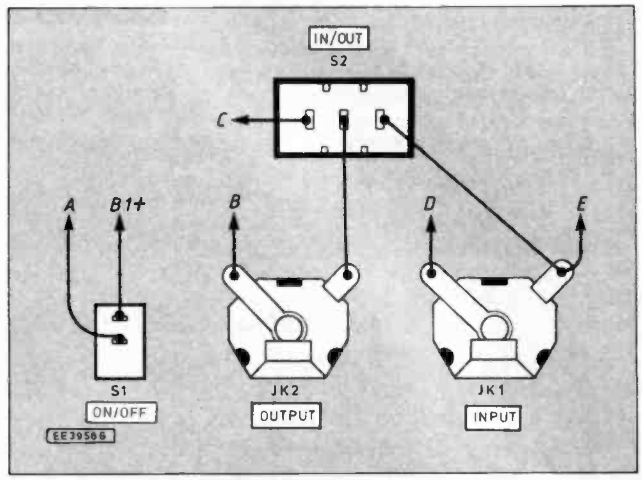


Fig.3 (above). Stripboard component layout and details of breaks required in the underside copper tracks.

Fig. 4. Interwiring between off-board components and leads to board. Use in conjunction with Fig. 3.

and breaks required in the underside copper tracks are shown in Fig. 3. The board has 23 holes by 17 copper strips.

Cut out a board of this size using a hacksaw, smooth any rough edges using a small flat file, and then drill the two 3·3mm diameter mounting holes. There are six breaks in the copper strips which can be made using either the special tool or a twist drill bit of about 5mm in diameter.

Construction of the board is mainly straightforward, but do not overlook the three link wires. These can be made from 24s.w.g. tinned copper wire, or off-cut trimmings from the resistor leadouts will probably suffice.

Diodes D1 and D2 are germanium types, and as such they are more vulnerable to heat damage than are the more familiar silicon devices. It should not be necessary to use a heatshunt on each leadout when it is soldered to the board, but the joints should be completed fairly rapidly when fitting these components.

The low noise op.amp IC1 is not a static sensitive device, but it is still recommended that an i.c. holder be fitted. Also, fit single-sided solder pins at the points where connections to off-board components will be made, and tin the pins with a generous amount of solder.

CASE

The unit could be built into a tough plastic case, but a *metal* case is preferable for an audio project such as this. A metal case provides screening against stray pick up of mains "hum" and other electrical noise.

A diecast aluminium box is ideal for this type of project. A case of this type has excellent screening properties and is extremely tough. Unfortunately, diecast aluminium boxes are also relatively expensive. The prototype is housed in a small box of folded aluminium construction, and this proved to be adequate in all respects.

Jack sockets JK1, JK2, and switch S1 are mounted on one end panel of the case, which effectively becomes the front panel. The component board is mounted on the middle section of the base panel, leaving sufficient space for the battery towards the rear of the unit. The board is mounted using 6BA or metric M3 screws, plus spacers about 6mm long so that the connections on the underside of the board are held well clear of the metal casing.

A heavy-duty pushbutton switch (S2) is mounted on the top panel of the case. This enables it to be operated by foot, so that the effect can be switched in and out in standard guitar effects unit fashion.

Switches of this type are normally of the successive operation variety. In other words, one operation of the switch switches the effect out, a second operation switches the effect back in again, a third switches out the effect again, and so on. It might be difficult to obtain a single-pole switch of this type. The simplest solution is to use a double-pole type and ignore one set of three tags.

The point-to-point wiring is shown in Fig.4, which should be used in conjunction with Fig.3. This wiring is very straightforward, but try to keep the wiring to JK1 and JK2 reasonably short and well separated. This will ensure that there are no instability problems due to stray feedback in this wiring.

The completed model showing the footswitch and input sockets

IN USE

The guitar is connected to JK1, and JK2 is connected to the guitar amplifier. Ordinary screened jack leads are needed to make both these interconnections. Preset VR1 is simply adjusted to give no subjective change in volume when the effect is switched in and out. A little trial and error is called for here.

With very high output pick-ups it is possible that the output level from the distortion unit will be slightly less than the direct output from the guitar. If this should be the case, set VR1 for maximum output (set fully clockwise) and back-off the volume control of the guitar slightly to equalize the two signal levels.

When using any unit of this type it is as well to bear in mind that it is adding extra gain into the overall setup. This means that a little extra care has to be taken in order to avoid problems with stray pickup, "hum" loops, and feedback. □

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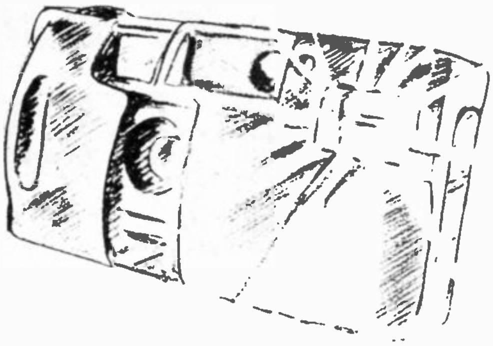


FLASH SLAVE UNIT

ROBERT PENFOLD

Highlight your sets with this low-cost, fast-acting slave. Multiple flash set-ups without multiple leads.

TRADITIONALLY a flash slave unit is used in order to reduce the amount of cabling in a multi-flash set-up. The secondary flashgun is triggered by the pulse of light from the main gun, via the slave unit which is merely a fast acting light activated switch.

If more than one secondary flashgun is required, it is merely necessary to have a separate slave unit to control each of the secondary guns. This avoids having long cables trailing from the camera to the secondary flashgun or guns. It also reduces the risk of expensive accidents caused by someone tripping over the connecting leads.

Multiple flash can be difficult with some modern cameras, including many of the more sophisticated ones, due to the lack of standard flash contacts. There is usually a way around this predicament in the form of a "hot shoe" adaptor or something similar, but a flash slave unit offers what is often a more simple and convenient solution to the problem.

CIRCUIT OPERATION

The circuit diagram for the Flash Slave Unit is shown in Fig. 1. Many slave flash designs have been published in the past, and all seem to feature a triac or a thyristor as the electronic switch. This was a good choice in the days when flashguns had quite high voltages but small currents in the trigger circuit, but it is a less wise choice these days.

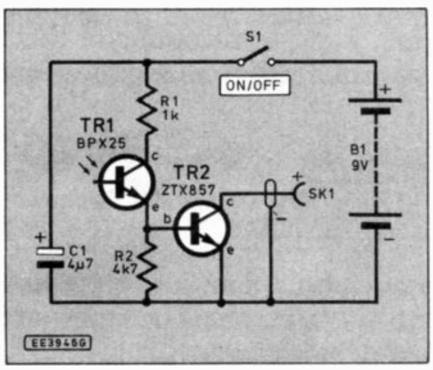


Fig. 1. The Flash Slave circuit diagram. Base terminal of TR1 is left unconnected.

Modern flashguns have quite low voltages in the trigger circuit, but use higher currents. For example, the measured voltage across the flash lead of my modern "Metz" flash unit is around 22 volts. This compares with a figure of around 175 volts for my old "Sunpak" flashguns. While this might seem to be of nothing more than academic importance, it can lead to problems if a thyristor or triac is used to control some modern flash units.

It has to be borne in mind that once a triac or thyristor has been triggered, it will remain switched on until the current flowing through the device has fallen to a very low level. There is no problem when a high trigger voltage unit is being controlled, as the current flow in the trigger circuit falls to a very low level once the flash of light has ended.

With some flash units that have low voltage trigger circuits there seems to be a significant current flow after the light pulse has been completed, which results in the triac or thyristor being held in the "on" state. The practical result of this is that the slave flash is triggered correctly the first time in each session, but it fails to trigger the flash subsequently.

To avoid this problem the current design uses a transistor (TR2) as the switching element. This is a high voltage and high current device which will function properly with high and low voltage trigger circuits. Note that TR2 can only function properly if it is connected to the flash lead with the correct polarity (*the positive lead MUST connect to TR2's collector (c)*).

FAST RESPONSE

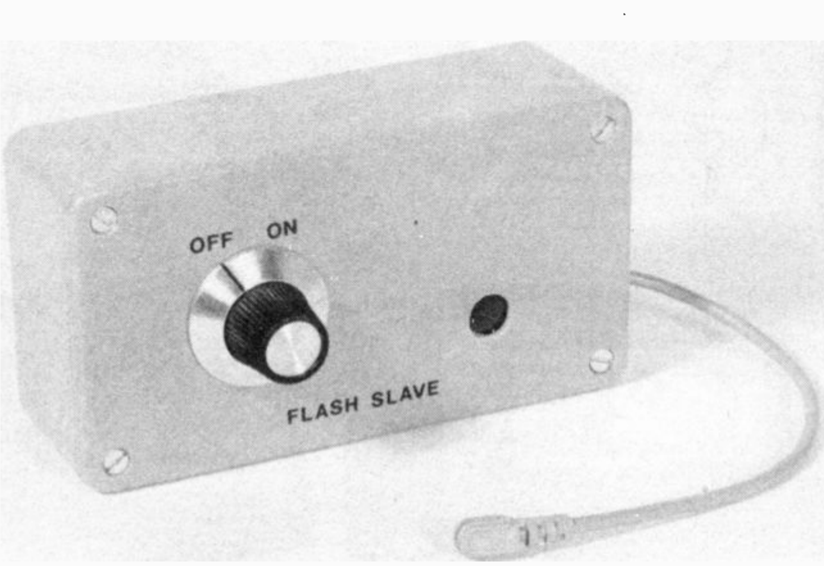
A flash slave unit must operate very rapidly, since a delay of even a few milliseconds could result in it firing after the camera's shutter has started to close. Photo-diodes and photo-transistors are both suitable for this application.

In this model, a photo-transistor (TR1) has been used as this gives better sensitivity. A BPX25 is used in the prototype, but similar devices such as the TIL81 and BPY62 were found to work just as well in this circuit.

Under ambient lighting TR1 passes small currents of only around 100 microamps. This gives a voltage across load resistor R2 which is too small to bias TR2 into conduction. When a pulse of light from the main flashgun reaches TR1, the current flow through TR1 rises substantially, TR2 is biased hard into conduction, and the slave flash is triggered.

The current flow through TR1 falls back to its original level once the pulse of light from the main gun has ceased, and TR2 then switches off. The circuit is then ready to respond to the next pulse of light from the main flashgun.

A supply decoupling capacitor C1 and a protection resistor R1 prevents the phototransistor TR1 from passing an excessive current. S1 is the on/off switch,



but as the current consumption is only around 100μA, the PP3 size battery will only run down very slowly if the unit should be inadvertently left switched on.

CONSTRUCTION

The stripboard topside component layout and wiring details are shown in Fig. 2. The underside of the board does not require any breaks in the copper strips to be made. The piece of stripboard has 15 holes by 14 copper strips.

Cut out a board of the appropriate size using a hacksaw, and then drill the two mounting holes. These can be 3·3mm in diameter, and they will then take 6BA or metric M3 mounting bolts.

If you are going to mount the board on stand-offs, the size of the mounting holes must be chosen to suit the particular stand-offs used. For stripboard, mounting nuts and bolts are recommended, as these generally provide a more secure mounting.

The components are well spaced out on the circuit board, but you should still take care to avoid accidental short circuits between strips due to excess solder. The transistor TR2 has an unusual encapsulation known as an "E-Line" case. One side is flat, while the other has slightly rounded corners and carries the type number. Make sure that rounded surface faces towards capacitor C1, and the flat side is towards resistor R2. Fit solder pins at the points where connections to S1, B1, and SK1 will be made.

The prototype is housed in a small plastic case which measures about 120mm by 65mm by 39mm, but this is actually somewhat larger than is really necessary. The component panel is mounted on the base panel, well towards one end of the case so as to leave space for the battery at the other end. The on/off switch is mounted on the lid of the case, adjacent to the battery.

A "window" for the photo-cell to "look" through must be made at the appropriate position in the lid of the case. The unit will look neater if some transparent plastic is glued in place behind the "window". However, it is not essential to do this.

Miniature coaxial plugs to match the sockets used on flash leads can be very difficult to obtain. These might be obtainable from a large photographic store, but there is a simple alternative in the form of a flash extension lead.

Cut the plug off the extension lead, together with about 150mm to 200mm of lead. Next drill a four millimetre diameter entrance hole for the cable at a suitable point on the case. Thread the cut end of the cable through the hole, prepare the end of the cable, and then connect it to the component panel.

Ideally you should use a multimeter to check the polarity of the signal from the flashgun so that the lead can be connected with the polarity shown in Fig. 2. In the absence of suitable test equipment you can resort to trial and error. It is highly unlikely that getting the flash lead connected the wrong way round will damage anything – the unit will simply not work until the lead is connected the right way round.

To complete the unit add the battery connector and the lead from the component panel to S1. The unit is then ready for testing.

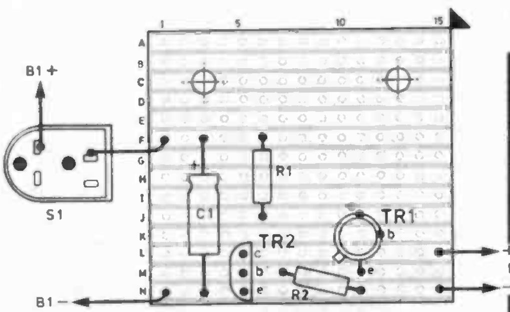
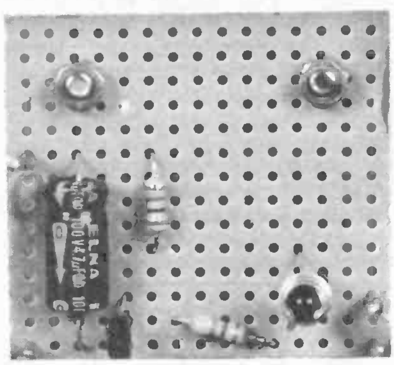
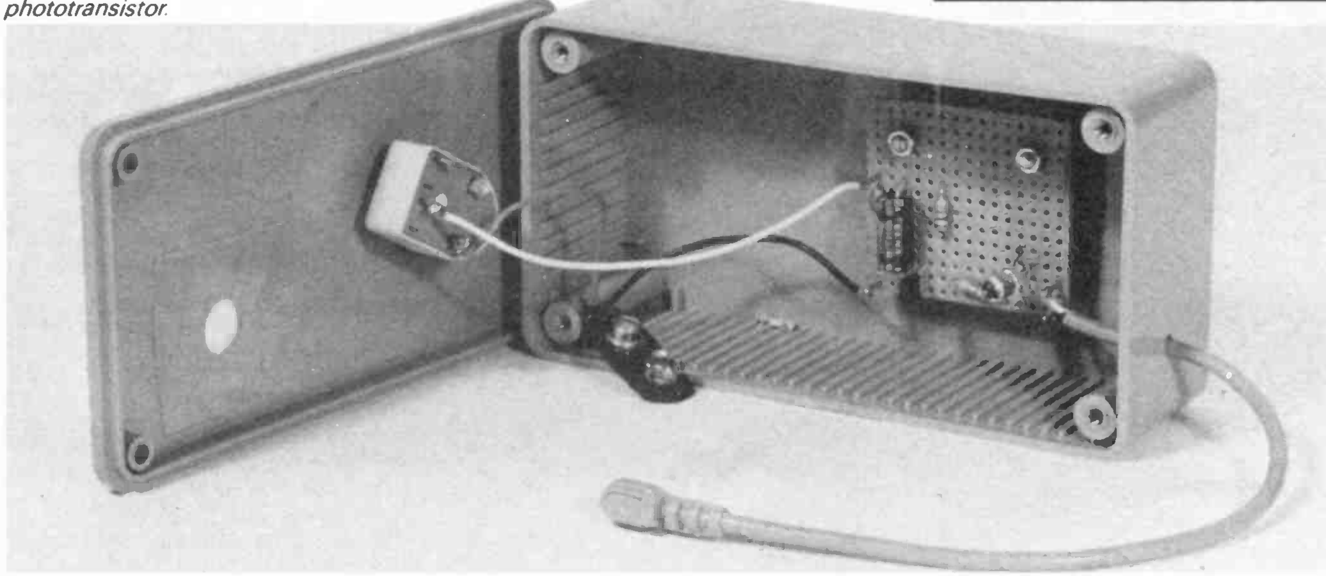


Fig. 2. Stripboard component layout and wiring. There are no breaks in the underside copper tracks.



(Right) Completed circuit board showing the phototransistor.

(Below) Layout of components inside the case. Note the hole in the lid for the phototransistor.



IN USE

When using the unit it must be kept in mind that the photo-transistor is equipped with a lens which makes it quite directional. When used indoors you will probably find that it does not make much difference which way the unit is aimed. This is simply because the light from the primary flashgun will be reflected around the walls, ceiling, etc., and the flash unit will pick up the light pulses via indirect routes if there is insufficient direct pickup.

When the unit is used out-of-doors, or in a very large building, it will probably be necessary to aim it at the primary flashgun with reasonable accuracy. A large blob of Blue-Tac can be used to fix the slave unit to a tripod, light stand, or whatever, with the appropriate orientation. With the unit picking up the direct light from the primary flashgun it will probably be possible to achieve a range of 20 metres of more.

A point to bear in mind when using any unit of this type is that high light levels on the photocell can block correct operation of the unit. Always avoid aiming towards any bright light, especially direct sunlight. □

COMPONENTS

Resistors

R1 1k
R2 4k7
All 0.25W 5% carbon film.

See SHOP TALK Page

Capacitor

C1 4μ7 axial elect., 63V

Semiconductors

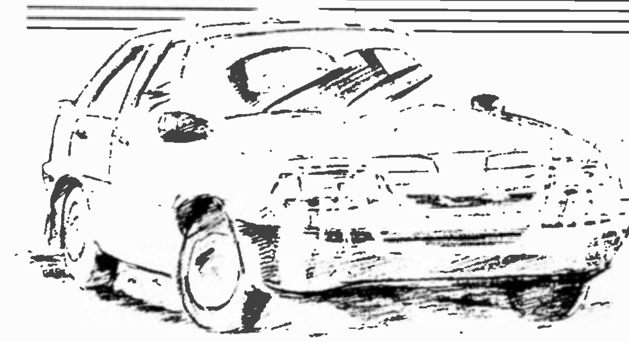
TR1 BPX25, BPY62, TIL81, or similar *npn* silicon phototransistor
TR2 ZTX857 high voltage *npn* silicon

Miscellaneous

B1 9V (PP3 size) battery, with connector clips
S1 Rotary on/off switch
SK1 Flash lead (see text)
Small plastic case, approx 120mm x 65mm x 39mm; 0·1in. matrix stripboard, size 15 holes by 14 strips; control knob; connecting wire; solder pins; solder, etc.

Approx cost guidance only **£10** *excl. flash lead.*

Easy-Build Budget Project



CAR ICE ALARM

ROBERT PENFOLD

Take no risks! Drive carefully when the warning light comes on. Tells the driver when the outside temperatures drop below zero.

IT IS argued in some quarters that car electronics projects are less popular now than they were ten or twenty years ago. This is due, they say, to the marked increase in the amount of electronics included as standard (or supplied as popular option extras) with most modern cars.

Car manufacturers seemed rather slow at introducing electronics into their products, and it is probably fair to say that many of the electronic gadgets found in modern cars appeared as "do-it-yourself" projects before they became standard production line items.

Despite the recent growth of built-in car electronics, unless you have a car with all the optional extras it is still possible to build some simple but useful car projects. The project featured here is an ice warning indicator which alerts the driver if there is a danger of ice patches on the road. The unit switches on a warning light if temperatures close to freezing point are detected by a small sensor.

CIRCUIT DESCRIPTION

The circuit diagram for the Car Ice Alarm project is shown in Fig. 1. This is based on an operational amplifier (IC1) which in this application functions as a voltage comparator. The output is high if the non-inverting input (pin 3) is at a higher voltage than the inverting input (pin 2).

The l.e.d. indicator D1 is switched off with the output in the high state. The output goes low if the non-inverting input is at a lower voltage than the inverting input. D1 is switched on with the output in the low state.

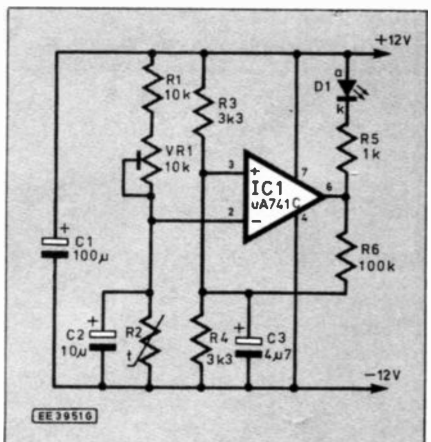


Fig. 1. Circuit diagram for the Car Ice Alarm.

The non-inverting input is fed with a reference voltage of roughly half the supply voltage. This is provided by the potential divider formed by resistors R3 and R4. Capacitor C1 decouples any noise spikes on the supply lines which could otherwise produce spurious operations of the circuit.

Another potential divider network across the supply lines provides an input voltage for IC1's non-inverting input. One element of this divider is formed by R2, which is a negative temperature coefficient thermistor. This simply means that rises in temperature result in a decrease in the resistance of R2. Its nominal resistance is 4k7 at 25°C, 318·4 ohms at 100°C, and 15k28 at 0°C.

The other arm of this potential divider is formed by the series resistance of preset VR1 and R1. VR1 is adjusted to give a resistance of 15k28 in this section of the potential divider.

This means that at temperatures above 0°C the inverting input will be at a lower voltage than the non-inverting input. This results in the output of IC1 assuming the high state, and l.e.d. D1 being switched off.

At temperatures below 0°C the voltage at the inverting input will be higher than the reference potential at the non-inverting input. This takes IC1's output low and switches on D1.

This gives the desired circuit action, but there is a slight problem in that IC1's output can go to in-between voltages with the thermistor R2 very close to the threshold temperature. IC1 can also become unstable with the circuit close to the switch-over point.

Both of these factors can result in erratic operation from the unit. Resistor R6 is included to provide a small amount of positive feedback so that stable operation is obtained, with the circuit triggering cleanly from one state to the other.

The current consumption of the circuit is about 5mA under standby conditions, rising to about 15mA when the unit is activated. In both cases this is insignificant when compared to the high capacity of a car battery.

CONSTRUCTION

The component panel is a piece of 0·1 inch pitch stripboard which has 22 holes by 17 copper strips. Details of the component layout and breaks in the underside copper tracks are shown in Fig. 2.

Diode D1 is shown as being mounted on the board in the normal way, but the easiest way of dealing with this component is to use a front panel mounted l.e.d. and hard wire it to the board. The alternative is to mount l.e.d. D1 directly on the component panel and leave it with long leadout wires. It can then fit into a hole drilled at the appropriate position in the front panel. With this second method it is essential to get everything very accurate, or it will not be possible to manoeuvre the l.e.d. into its mounting hole.

Most l.e.d.s have their polarity indicated by a "flat" on one side of the body. It is usually the cathode ("k") leadout that is the one next to the "flat". Also, this leadout is usually shorter than the anode leadout wire. If in doubt you can always adopt trial and error. If you get the polarity of D1 wrong the unit will not function properly, but there is no risk of damaging anything.

The thermistor R2 is also shown in Fig. 2 as being on the circuit board, but in reality this is wired to the main unit via a length of twin cable. Some sleeving or insulation tape should be used to prevent any accidental short circuits at the points where this lead connects to the thermistor.

It is also essential to protect R2 and these connections from what is likely to be a pretty hostile environment. Placing a piece of large diameter p.v.c. sleeving over the lower half of R2's body, its leadout wires, and the soldered connections should give adequate protection. A covering of epoxy adhesive should also do the job quite well.

Virtually any small plastic box will accommodate this project. A hole for the lead to the thermistor is drilled at one end of the case, and another hole for the two power leads is drilled at the opposite end. The circuit is powered from the car's 12V supply, but it should be powered via the ignition switch, *not* direct from the battery.

ADJUSTMENT AND USE

Before the unit can be properly installed in the car, the preset potentiometer VR1 must be given the correct setting. The easiest way to do this is to place the thermistor in some iced water, being careful not to get the leadout wires into the water. Wait a minute or so for the thermistor to adjust to the temperature of the water.

Start with VR1 set for maximum resistance (adjusted fully clockwise). The l.e.d. D1 should not be switched on at this stage. Slowly back-off VR1 until D1 lights up. Taking the thermistor out of the iced water should result in D1 switching off – placing the thermistor back in the iced water should result in it switching on again.

In both cases there will be a small delay while the thermistor adjusts to the changes in temperature. The unit is then ready for installation.

Some careful thought should be given to the positioning of the sensor. It should obviously be placed where it will not pick up significant heat from the engine, exhaust, etc. On the other hand, it should not be exposed to the airstream as the car moves, or to rain and spray from the road.

Mounting the thermistor in an open-ended tube will provide it with some protection, and give a more realistic prospect of finding somewhere suitable to mount it. Behind the front bumper guard is probably the best choice.

COMPONENTS

SHOPTALK Page

Resistors

R1	10k
R2	4k7 bead thermistor (at 25°C)
R3, R4	3k3 (2 off)
R5	1k
R6	100k

All 0.25W 5% carbon film

Potentiometer

VR1	10k min. preset, horizontal

Capacitors

C1	100μ radial elect., 16V
C2	10μ radial elect., 25V
C3	4μ7 radial elect., 63V

Semiconductors

D1	Panel mounting l.e.d. red
IC1	μA741C op.amp

Miscellaneous

Stripboard, 0·1in. matrix, size 22 holes by 17 strips, small plastic case; 8-pin d.i.l. i.c. holder; solder pins; connecting wire; solder; etc.

Approx cost guidance only **£6**

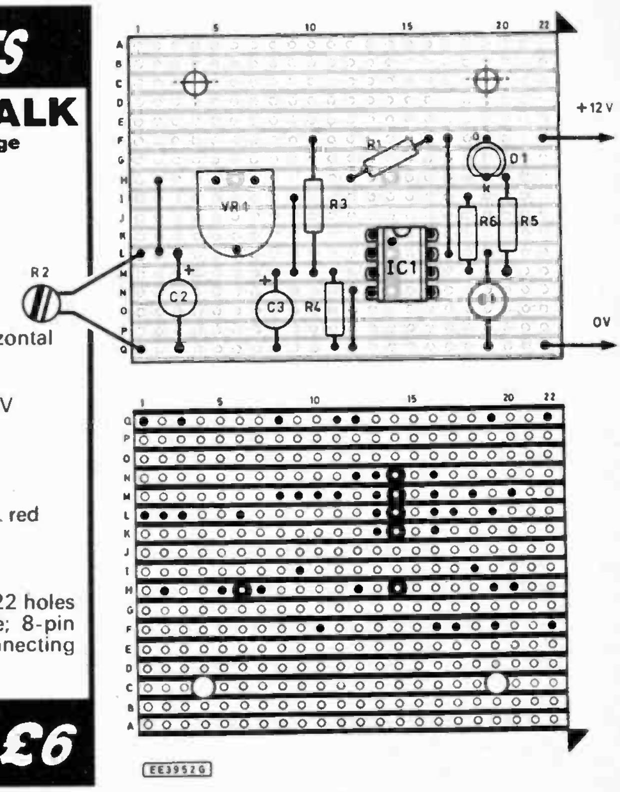
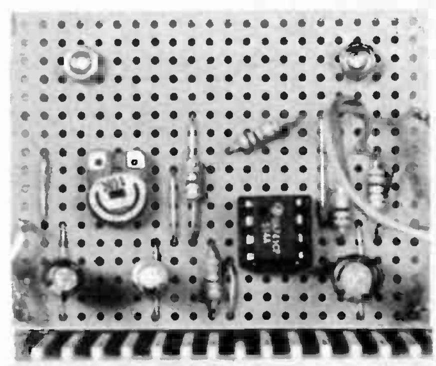
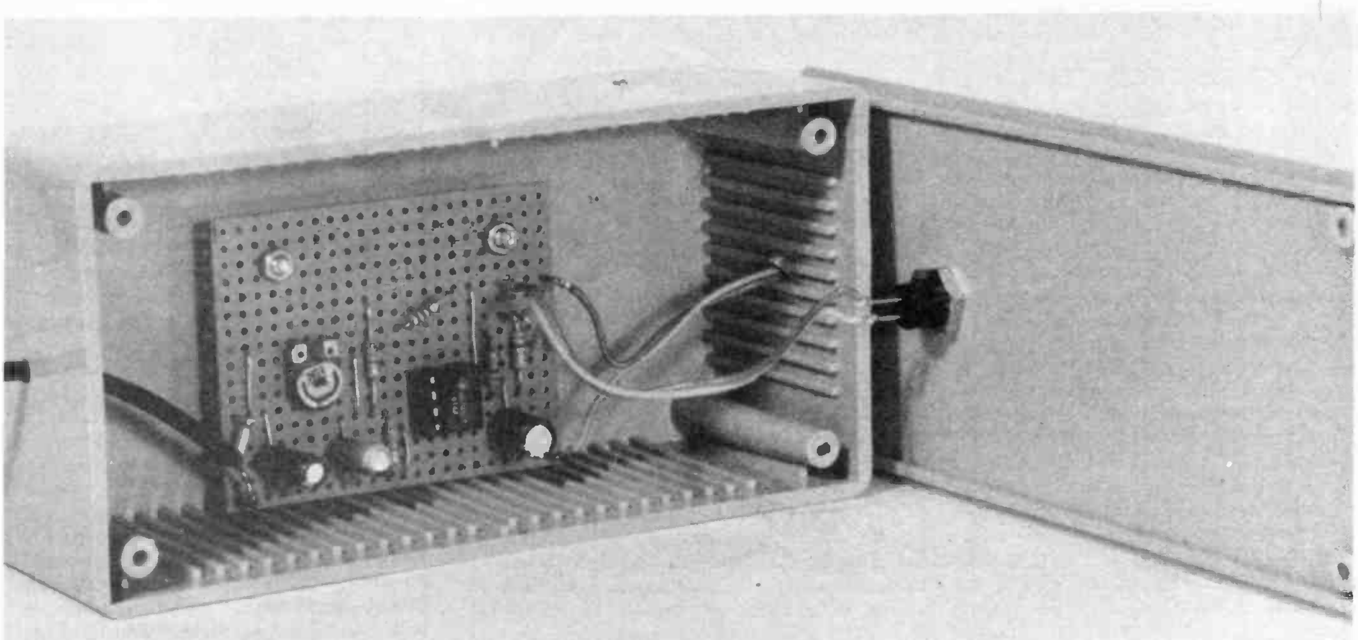


Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks.

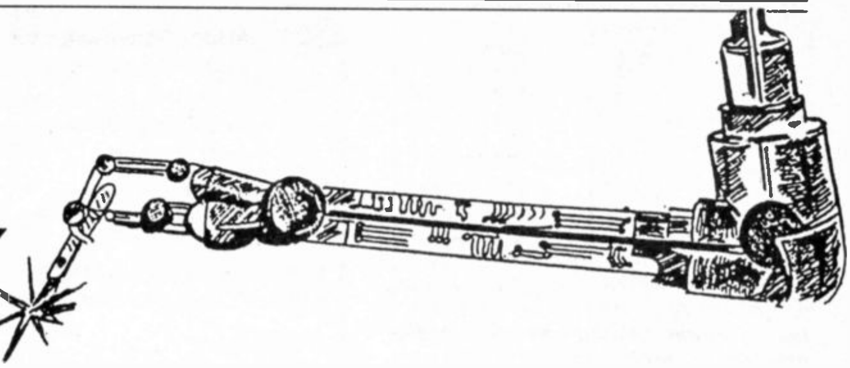


Layout of components on the completed circuit board.



Regular Clinic

CIRCUIT SURGERY



MIKE TOOLEY B.A.

Once again, welcome to Circuit Surgery, our regular clinic for readers' problems. In this month's Surgery we shall be describing a range extender which can be used to permit low-level audio measurements with a simple d.c. meter. We briefly revisit the low-battery warning indicator and SCART connector described in previous instalments of Circuit Surgery before concluding with a few more hints and tips sent in by readers.

A.C. voltage range extender

Most inexpensive multimeters, whether they be analogue or digital, provide somewhat inferior performance on the a.c. ranges. In the case of analogue meters this problem is rather more to do with relatively low input resistance which results in excessive loading of the circuitry.

In either case, resolution and sensitivity are both generally extremely poor. These drawbacks prevent such instruments from being used to make meaningful measurements of low-level audio signals in medium and high impedance circuits.

An electronic a.c. millivoltmeter (such as Maplin's excellent XM31J) is an excellent investment for anyone involved in audio work. Such instruments are, however, relatively expensive and often well outside the budget of the enthusiast working from home.

Mindful of this problem, I set about designing a range extender for my own fairly basic analogue multimeter. This instrument offers a fairly typical sensitivity of 20 kilohm/V on the d.c. ranges but only 8 kilohm/V on a.c. The most sensitive range on d.c. is 100mV full-scale but on a.c. it is 10V full-scale (i.e. 100 times worse!).

The complete circuit of the range extender is shown in Fig. 1. The field effect transistor (f.e.t.) TR1 provides a unity gain high impedance stage, which offers an input impedance of 10 megohm. This stage virtually eliminates the loading effect of the instrument on almost any conventional audio circuitry.

The two following stages, TR2 and TR3 provide a high-gain direct coupled amplifier, the voltage gain of which is made variable by means of preset VR1. Capacitor C3 is added to limit the upper frequency response of the instrument whilst R3 provides both d.c. and a.c. feedback to stabilise the amplifier.

Dodes D1 and D2 provide signal rectification and a second feedback path (via C5 and C6) ensures linearity. The meter (M1) is simply the analogue multimeter switched to the most sensitive d.c. current range (50µA in the case of the Maplin M-2020).

The circuit of Fig. 1 offers a sensitivity (which can be adjusted by means of VR1) of 50mV, 100mV or 500mV full-scale. In many cases, constructors will wish to have switched ranges and Fig. 2 shows how this can be achieved.

The range switch (S2) provides four a.c. ranges (0·1V, 0·5V, 1V, and 5V full-scale) and the loading effect of the input resistance is equivalent to one megohm (compared with 10 megohm for the circuit of Fig. 1). Further ranges (e.g. 10V full-scale) can easily be added by simply extending the potential divider chain with further decade values.

Calibration

A simple arrangement for calibrating the instrument is shown in Fig. 3. This circuit provides 1V r.m.s. at 50Hz from a nominal 12V transformer (it is worth checking the output voltage of the transformer using an

Fig. 1. Circuit diagram for the A.C. Voltage Range Extender. See Fig. 2 for range switching.

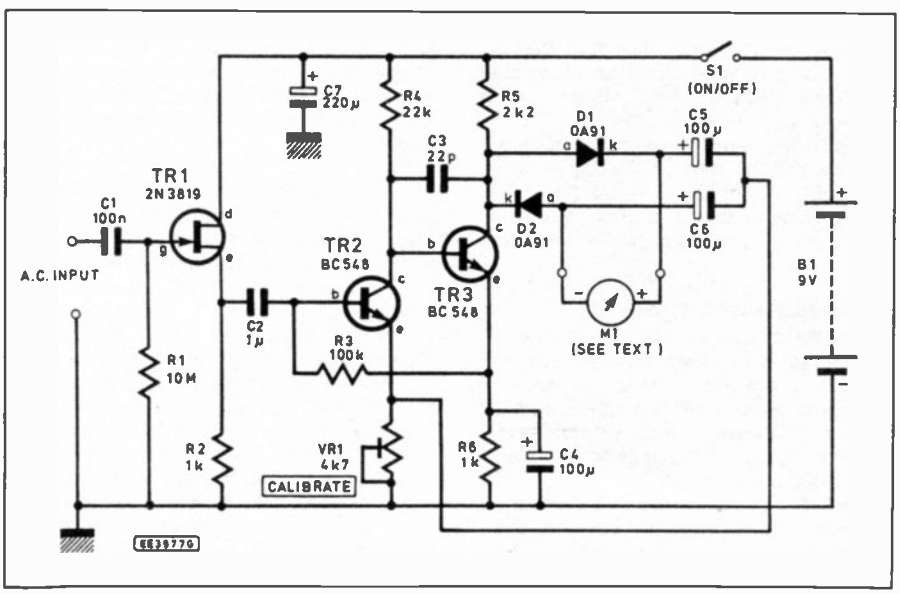
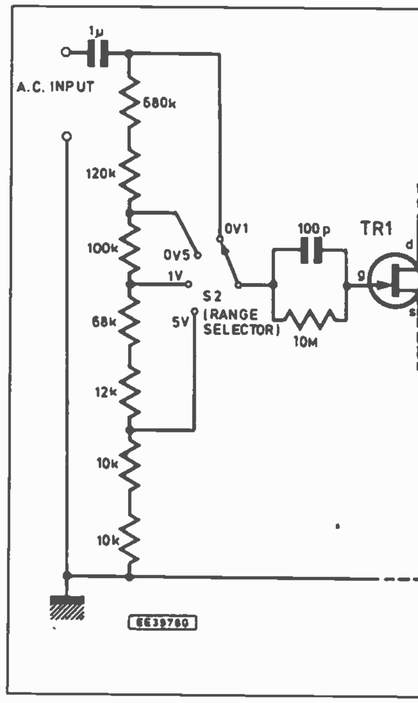


Fig. 2. Adding a range switching facility to the A.C. Voltage Range Extender.



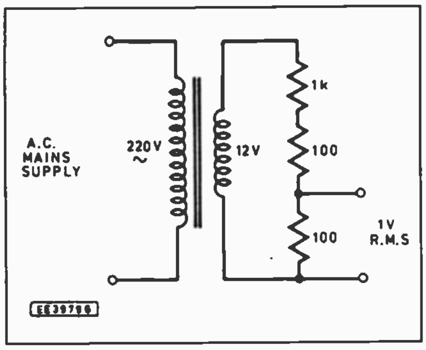


Fig. 3. Simple calibrating set up for the extender circuit Fig. 1/2.

existing multimeter connected to the 25V or 50V a.c. range *before* relying on this arrangement).

In order to calibrate the instrument, the extender's range switch is set to the 1V full-scale position and preset VR1 is simply adjusted for a full-scale reading on the multimeter. Readings may then be taken directly from the scale marked 0 to 10 (i.e. dividing each marked indication by 10). More accurate calibration will require the services of a calibrated audio signal generator, however an accuracy of five per cent (or better) can usually be achieved by this means.

SCART connector revisited

Several readers have queried the SCART pin connections given in *Circuit Surgery*, September 1992. In particular, there appears to be some confusion concerning the signal present at pin-20.

Our table shows pin-20 as having a dual role, either Composite Video (75 ohm, 0·1V pk-pk) or Synchronising Output (75 ohm, 0·3V pk-pk). The pin is normally used for Composite Video *Input* (the word "input" has been missed from the table). Furthermore, when used for synchronising (rather than video) the signal is an *input* not an "output" as shown.

When two items of video equipment are linked together with SCART connectors, the signals on pins 19 and 20 are crossed over. Hence, the Composite Video Output (pin-19) from one machine feeds the Composite Video Input (pin-20) on the other.

To put matters right, Fig. 4 and Fig. 5 show the wiring of 10-way and 21-way SCART interconnecting cables. The 10-way cable provides a means of interconnecting stereo audio and composite video signals whilst the 21-way cable adds RGB video, blanking and data communication signals.

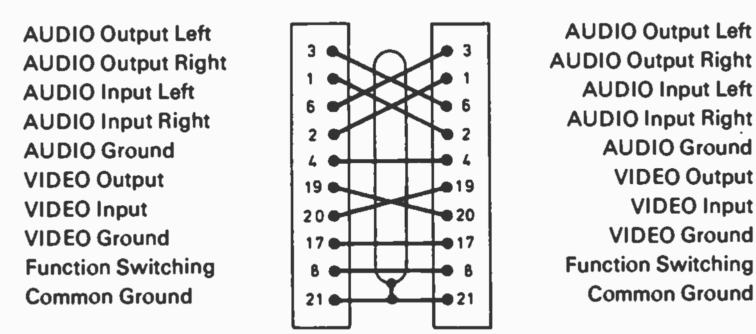


Fig. 4. 10-way SCART connecting cable

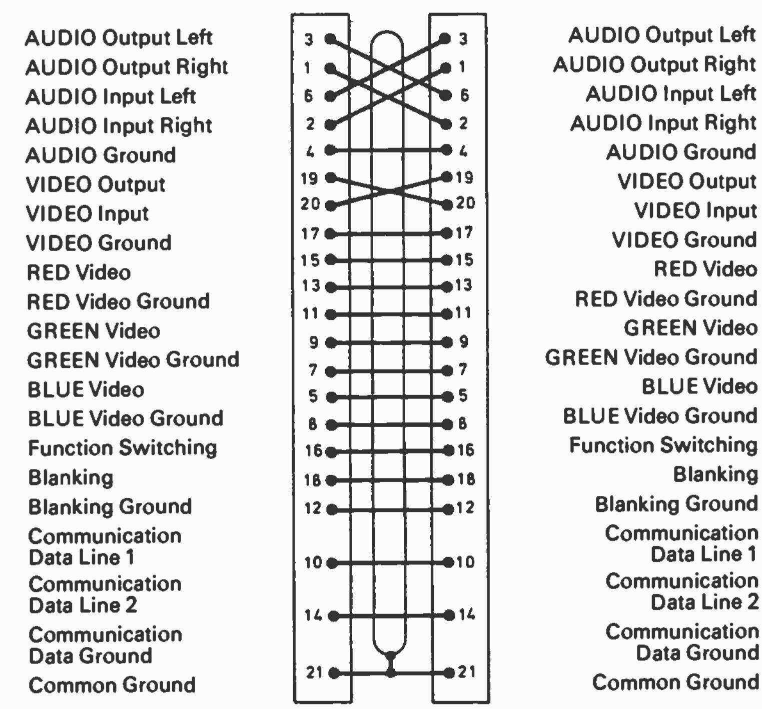


Fig. 5. 21-way SCART connecting cable

The 741 is dead, long live the 741

George Tworkowsky from New Tredegar has made an important point concerning the improved low battery warning indicator (*Circuit Surgery*, August 1992). George writes:

"It may be O.K. for a car battery but if you use a PP3 then 2mA quiescent current is too much to pay for monitoring the state of a battery. Why not leave the 741 in its place, a history museum (where it now belongs) and use something like an LF442 or TCL27L2?"

George is quite correct; the 741 is somewhat outdated. However, I suspect that many readers have a supply of these chips waiting for something to do (I certainly have).

Low-power J-FET input operational amplifiers offer much improved performance when compared with their bipolar predecessors. The LF441CN (*not* LF442) is a directly pin-compatible replacement for the 741C which only requires a quiescent supply current of around 150μA. Constructors of the improved low battery warning indicator may thus find that an LF441CN proves to be more acceptable when the circuit is used in conjunction with a low-capacity battery (e.g. PP3).

Finally, it is worth noting that Maplin's price for a 741C (QL22Y) is 28p as compared with 86p for an LF441CN (QY29G). On the basis of this, I suspect that many readers will still be using the 741 for some time!

More hints and tips

Steve Reed recommends wiring low-value fixed resistors in series with the dial and indicator lamps on older mains-operated equipment. Steve says that this can be instrumental in greatly extending their working lives, "avoiding the need to fit replacement bulbs at a later date".

Mark Brown has acquired a number of ex-equipment rechargeable batteries from *Greenweld* at a "bargain price". These batteries are designed for use with hand-held equipment but can be easily dismantled allowing the individual AA-size nickel cadmium batteries to be recovered. After several charge/discharge cycles, these batteries are usually "as good as new".

G. Preston has found a great many uses for flashing l.e.d.s. These are now available at reasonable cost from many suppliers and are ideal for model making projects (avoiding the need for 555 timers and series resistors).

Next month: We shall be describing an L.E.D. Bargraph Indicator which can be used to measure the current supplied to a car battery. We also offer some advice concerning the selection and use of batteries.

In the meantime, if you have any comments or suggestions for inclusion in *Circuit Surgery*, please drop me a line at: Faculty of Technology, Brooklands College, Heath Road, Weybridge, Surrey, KT13 8TT. Please note that I *cannot* undertake to reply to individual queries from readers however I will do my best to answer all questions from readers through the medium of this column.

Home Base

Jottings of an electronics hobbyist – Terry Pinnell

SHOCKING AFFAIR

When something goes wrong with a mains appliance in this house, my usual reaction is to 'phone for a service engineer, despite the inevitable hefty charge that I'd much rather avoid.

This goes without saying for some things of course. You definitely won't catch me poking about in the back of our colour TV set for instance, with its complex electronics and coil voltages around 15kV. I don't expect the high tension circuits were at quite that level in those earlier days, but I still vividly remember my dad being flung the length of the room while constructing our first set.

It had a six inch green ex-radar screen, uprated to a whopping nine inch by fitting an oil-filled plastic lens in front. Dad survived the shock and a few other similar shocks in the course of his hobby, I'm pleased to say, but that particular levitation stuck in my memory and probably helped me to develop a healthy respect for mains circuitry.

But I even baulk at taking the covers off more mundane items like our ageing dishwasher, which hardly contains state-of-the-art circuitry. I suppose my wariness stems from a combination of factors. For a start, without a good service manual it is often tricky working on these things. Knuckle-grazing experiences with assemblies that won't go back the right way have tempered my enthusiasm. Once you are inside, there's then the difficulty of deciding what is actually wrong. Chances are, the problem will have a commonplace cause, well known to the engineer who has seen it before.

But I guess the main reason for reaching for a phone rather than a screwdriver is that I can be pretty sure the repair will inevitably need some part or other that I won't have. On hearing those dreaded words "Needs a new pump," or "The motor's burned out," I know I'm not going to unearth anything useful in my junk box.

However, moving down to the really primitive level, I didn't think a simple fault in a pop-up toaster would get the better of me.

FOUR SLICE SAGA

Everything is OK when toasting just two slices. But when set to four, on ejecting the finished toast there is a spectacular blue flash, a loud bang, and the 13A fuse in the plug blows.

It has become even worse since the recent installation of our new trip meter. The still unrepaired toaster, blowing more regularly than a basking blue whale, now brings the entire house electricity supply to its knees, instead of just incinerating its own fuse. That means the chore of resetting the time on a couple of radios, a tea-making machine and (if left too long) resetting time and date on the video recorder. It also plays havoc with my remote-controlled lounge lighting system and unceremoniously zaps any work I might be doing on my PC.

Dismantling the toaster revealed nothing obviously amiss, although I have to admit I didn't really know what I was looking for. With the toast holder depressed, as it would be when in actual use, the resistance across the Live and Neutral terminals at the disconnected mains plug was about 40 ohms in the four-slice setting position. But surprisingly this was not momentarily shorted out when the carrier was released, as I would have expected from the symptoms.

Despite all sorts of rattling and fiddling I couldn't provoke a short, either across Live and Neutral or from either of those to Earth. I was therefore optimistic that I'd inadvertently fixed it, perhaps by the cleaning I'd done – but another explosion a few days later unhappily proved otherwise.

So, until I can think of some new approach, we are constrained to two slices at a time. Or, living dangerously, we can set it to four and try switching back to two just before it blows!

A TRIP TOO MANY

The new trip meter I mentioned is one of these residual current types. Some fault had developed with the twenty year old voltage-operated version and after predictably diagnosing it as unrepairable the SEEBOARD engineer told me those were now obsolete. So I forked out £123 for this modern replacement, consoling myself with the fact that it was a small price to pay for minimising the risk of inadvertent electrocution. But experience with it so far has left me with mixed feelings. Where do you draw the line between safety and convenience in this context?

The voltage-operated version used to cut the supply if mains voltage appeared anywhere on an earth wire, a potentially lethal situation that clearly warranted an immediate disconnection. The residual current type's claim to greater safety stems from the fact that it cuts the power in much less extreme but still dangerous circumstances. For my new unit this is when there is more than 100mA of mains current flowing to earth.

The reason for its name is that it actually monitors the difference (or "residue") between the currents in the Live and Neutral cables entering the house, which logically must be due to leakage somewhere. Simplistically visualising it another way, if at some instant 3.1 amps is going into the house in total via the Live cable, then exactly 3.1 amps should be coming out via the Neutral line. Any difference must be leakage, possibly via a mains Earth conductor or maybe via some other less obvious route to real earth – but definitely not one passing through anybody.

The trouble is, this new device seems to be tripping much more frequently than its predecessor, presumably because of the quite low 100mA trigger point. Whereas a faulty appliance or my carelessness while working on a project might previously have just blown a fuse or two, now the whole house goes down. How many of these occasions are genuinely life-threatening is difficult to say, and clearly one should err on the side of safety. But I can't help feeling there ought to be some more effective way, short of fitting individual trip meters to every socket.

I'm just glad I didn't opt for the alternative 40mA device, which probably trips every time you change TV channels.

Teach-In '93

with Alan Winstanley
and Keith Dye B.Eng(Tech)AMIEE

Part 3

Teach-In '93 continues a tradition of offering an interesting and thorough tutorial series aimed specifically at the novice or complete beginner in electronics. The series is designed to support those undertaking either GCSE Electronics or GCE Advanced Levels, and starts with fundamental principles to give the student a solid foundation before proceeding onto further topics.

WE INTRODUCED in Part Two the idea of a sine wave. The domestic mains a.c. supply looks something like that in Fig. 3.1. Recall the theory of "peak" values and the fact that the peak value of the 240V a.c. (r.m.s.) supply is in fact 339V. When we talk about sine wave voltages, we nearly always mean the root-mean-square (r.m.s.) value, not the peak.

The 240V a.c. mains supply which comes out of a standard 13 amp wall supply is far too high to operate most electronic equipment. Kettles and cookers run directly from the 240V mains, however something like a radio or indeed the Mini Lab, require a much lower voltage to operate. Many digital "logic" circuits which we consider in Part Six actually require a precise 5V d.c. supply – nothing more, nothing less.

POWER SUPPLIES

In electronics it's generally necessary to convert the potentially lethal high voltage mains into a low d.c. voltage which is safe to use and easier to work with. Inside equipment you will often find a *power supply*, which is a circuit that reduces the 240V a.c. to a safe d.c. level such as 9V or 12V d.c. – just like the electrical energy which is present in a small battery.

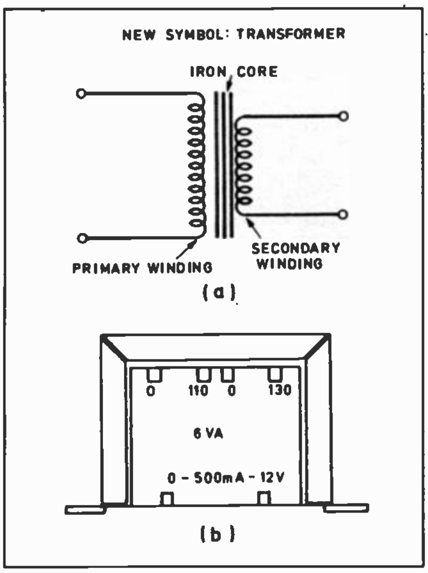


Fig. 3.2(a). Symbol for a step-down transformer.

Fig. 3.2(b). Appearance of a typical mains transformer. This is a 6VA type (12V 500mA secondary) with split primaries: connect them in series for 240V use.

TRANSFORMERS

A transformer is an electrical component which is capable of reducing a.c. voltages to a lower, safer value suitable for use with electronic circuits. They can only work on alternating currents, not direct currents. The symbol for and appearance of a typical transformer is shown in Fig. 3.2 – they consist of *two windings* of insulated copper wire, wound around a core of iron.

The primary winding is connected to the

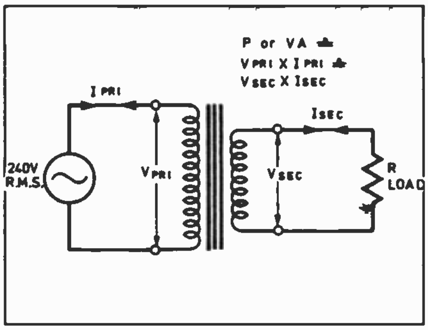


Fig. 3.3. The VA or Power rating of a transformer. It is possible for the current in the secondary (I_{SEC}) to be greater than the current in the primary circuit: however the power dissipation (voltage × current) in both windings will be roughly the same in an ideal transformer.

Fig. 3.1. Waveform of the domestic a.c. mains. Frequency is 50Hz (50 cycles per second)

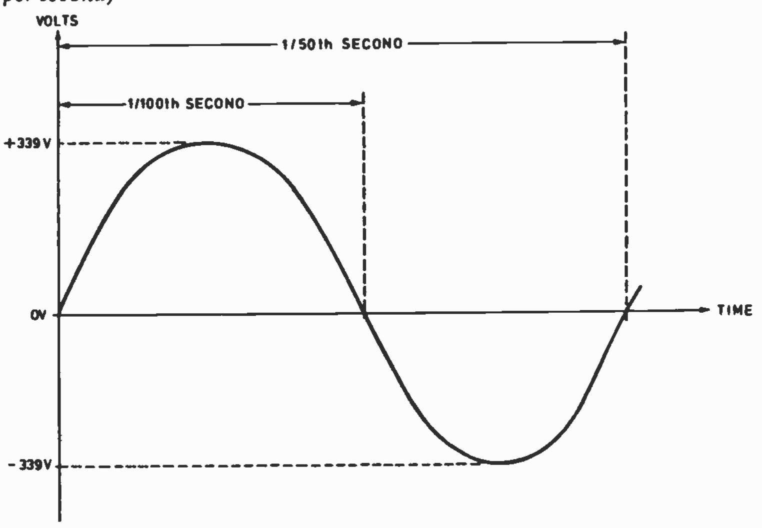
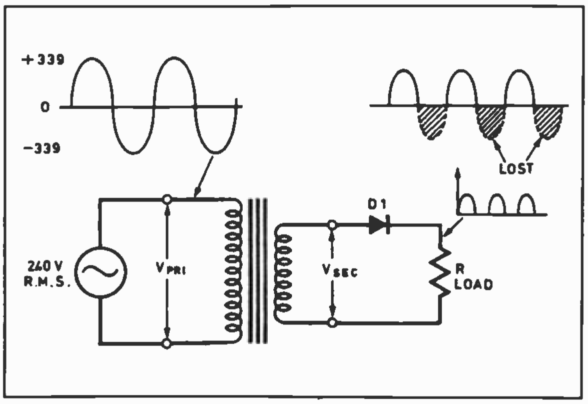


Fig. 3.4. A rectifier D1 is added to the secondary circuit. This cannot conduct for one half of the sine wave, reslting in a series of "bumps" or half-cycles across the load resistor.



240V a.c. mains and has a greater number of "turns" of wire than the **secondary** winding, across which a lower a.c. voltage is **induced**. (Hence an **inductor** is the general name given to any sort of coil.)

The value of the lower voltage which appears across the secondary depends on what type of transformer you select: it could be anything from 3V to 50V a.c. or more. A *step-down* transformer has a smaller voltage across the secondary than the primary: it "steps down" the mains voltage to a useable level. Other types of transformers are available which are used for audio signals, for instance, and are not intended to be connected to the mains. An electricity sub-station is actually a giant oil-cooled transformer.

The other main parameter of interest is the current available from the secondary. There is a limit to the current which you can draw from a transformer, because each winding has a certain resistance which causes the transformer to warm up (I^2R effect) when current passes through the windings.

The **VA rating** of a transformer is a guide to how much power the transformer can safely dissipate without being damaged. For "VA" you could think of "Watts". We always have to specify the secondary a.c. voltage and current in a transformer circuit. We know that $P = IV$, and so if a transformer is rated at 12V a.c. 25VA for example, then the secondary is capable of supplying up to 2 amps or so: 25VA roughly equals 12V × 2A. Again, all voltages and currents are r.m.s. values.

Fig. 3.3 shows a hypothetical arrangement where a 240V step-down transformer has a resistor connected as a load across the secondary winding. Another important rule of transformer action is that the power ($P = IV$ again) dissipated in the secondary circuit is roughly the same as that in the primary. Hence, because the primary is at a much higher voltage (240V), the *current* in the primary circuit will be considerably smaller than the current in the secondary circuit:

$$V_{PRI} \times I_{PRI} = V_{SEC} \times I_{SEC} \text{ VA (or Watts.)}$$

Thus current can flow in the secondary circuit which is *higher* than the current drawn from the mains by the primary circuit.

RECTIFICATION

Even though in Fig. 3.3 we have reduced our 240V r.m.s. a.c. waveform to a lower, more manageable value, it's still not possible to use this to power an electronic circuit because it is still an alternating (a.c.), not direct (d.c.), current. It's necessary to **rectify** this a.c. waveform in order to produce a d.c. current – one which flows one way only, like that obtained from the Mini Lab 6V battery pack.

In Fig. 3.4 the 240V mains a.c. sinewave is stepped down by a transformer T1 to produce a lower voltage V_{SEC} across the secondary. By adding the rectifier D1, one half of the cycle is now blocked, and the current in the secondary circuit can then only flow one way. This has an effect as shown in the diagram where the voltage across the load resistor R_{LOAD} is now a series of "humps" representing one half of the sine waves.

This type of circuit is known as a **half-wave rectifier** because it utilises only one half of the sine wave – the other half of the cycle is chopped by the rectifier. Losing one half of the sine wave like this is not the most efficient way of using a transformer.

However the d.c. voltage which is now produced is still unsuitable for use as a source of power, because it still bears little resemblance to the "straight line" of a d.c. battery supply. Those half cycles of the rectified sine wave need to be ironed out!

SMOOTHING

Smoothing of these "humps" is easily achieved by adding a large electrolytic **smoothing capacitor** (typically between 1000µF to 4,700µF or more) after the rectifier. As you may recall, these devices are *polarised* so they must **always be connected the right way round. It is extremely dangerous to reverse-connect an electrolytic capacitor.**

Referring to Fig. 3.5, the rectified a.c. voltage is now more or less smoothed out because the capacitor will charge up from the rising side of the half-cycle, and when the cycle swings back towards 0V, the capacitor releases its charge into the load before being recharged by the next cycle. This helps to maintain a roughly constant voltage across the load when there would otherwise be a gap between the humps.

The output waveform is thus a series of charging/discharging ramp-like voltages and Fig 3.5 shows the output voltage from the circuit in relation to the rectified sine wave voltage. The output is still not perfectly smooth because of the charging and discharging action of the capacitor – a "ripple voltage" is present as shown in the graph. Note that the peak value of the d.c. voltage is now the same as that of the a.c. peak voltage, because the smoothing capacitor charges up to the peak a.c. value before discharging into the load.

Therefore, the capacitor must have a voltage rating which copes with the **peak value of the voltage. The rectifier must be able to withstand a reverse voltage of** *twice* the peak value: C1 maintains a positive (peak) voltage on D1 cathode (k), so when the sine wave becomes negative, in effect the *peak to peak voltage* appears across the reverse-biased rectifier. Fiendish!

The main difficulty with this circuit is the poor "transformer utilisation" caused by the rectifier not conducting for one half of the a.c. sine wave. Additionally the d.c. waveform which appears across the load still has a high "ripple" content which is not satisfactory for many circuits. Finally, if the load draws more current, the output voltage across the smoothing capacitor will start to drop, because it is *unstabilised* – see later. In short, it's not much use!

BRIDGE RECTIFIER

An arrangement which is very common in mains-operated designs is shown in Fig. 3.6(a). It uses four rectifiers D1 to D4 as a "full wave bridge rectifier" configuration. The secondary a.c. voltage from transformer T1 is applied to the bridge which "steers" the sine wave such that even the negative half of the cycle is re-polarised and directed to the positive side of the smoothing capacitor C1.

Fig. 3.6(b) shows how current flows through the rectifiers D2 and D4 on the positive-going half of the sine wave cycle – the remaining two rectifiers cannot conduct because they are reverse-biased. When the sine wave cycle is reversed as in Fig. 3.6(c), the other two rectifiers then conduct and steer the current towards the smoothing capacitor, correctly polarised. This means that both halves of the sine wave are used to power the load.

A ripple waveform, frequency 100Hz, is still present as shown in Fig. 3.6(a), but the

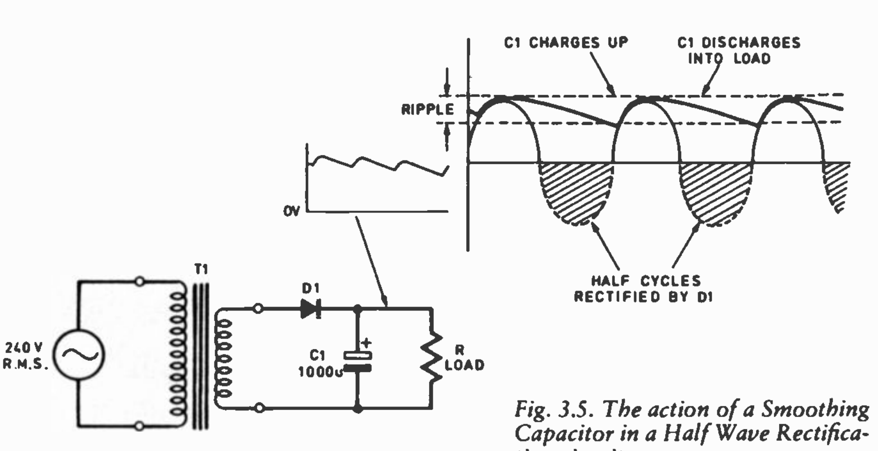


Fig. 3.5. The action of a Smoothing Capacitor in a Half Wave Rectification circuit.

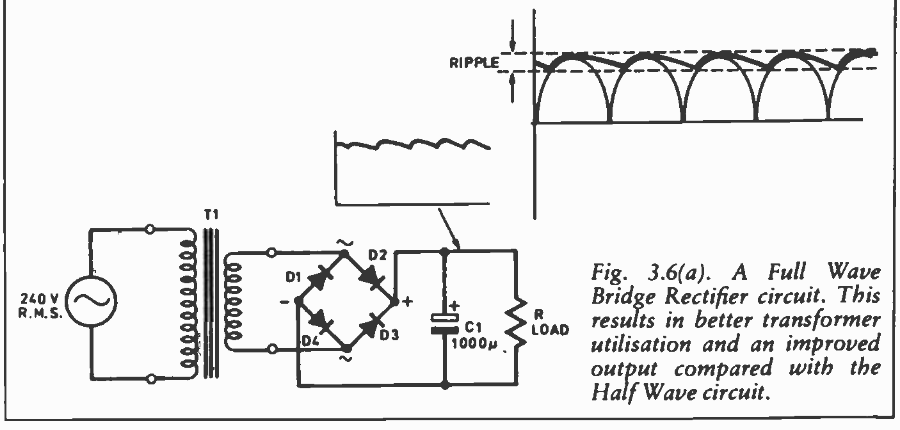


Fig. 3.6(a). A Full Wave Bridge Rectifier circuit. This results in better transformer utilisation and an improved output compared with the Half Wave circuit.

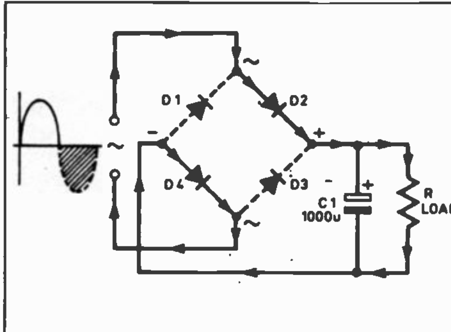


Fig. 3.6(b). Bridge Rectifier action: on the positive half of the a.c. sine wave, the current is steered by D2 and D4. D1 and D3 cannot conduct. C1 charges up as shown.

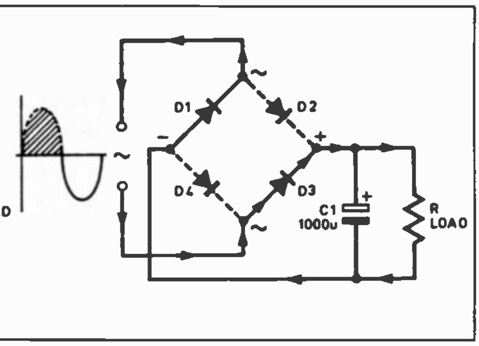


Fig. 3.6(c). On the negative half of the sine wave, D1 and D3 conduct to steer current towards C1, correctly polarised. D2 and D4 cannot conduct, being reverse biased.

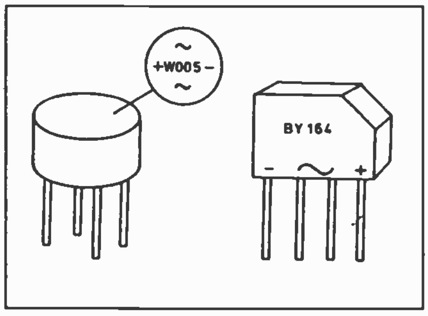


Fig. 3.7. Typical bridge rectifier packages. These contain four rectifiers, wired to form a full-wave bridge rectifier. Care must always be taken to connect them correctly.

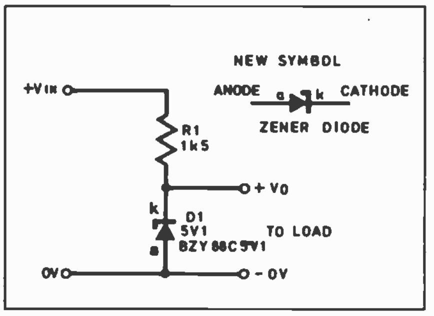


Fig. 3.8(a). Showing a 5V1 (=5·1 volts) Zener Diode with a series limiting resistor.

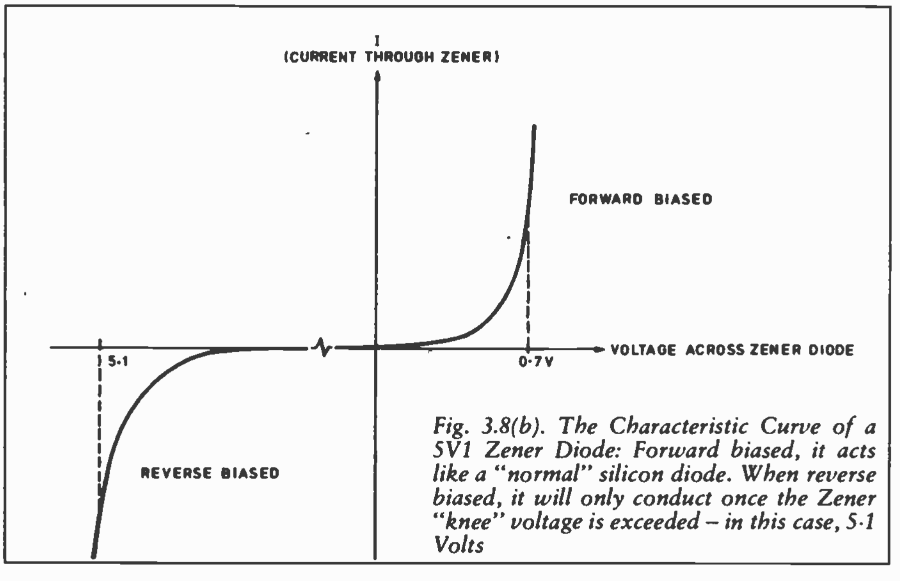


Fig. 3.8(b). The Characteristic Curve of a 5V1 Zener Diode: Forward biased, it acts like a "normal" silicon diode. When reverse biased, it will only conduct once the Zener "knee" voltage is exceeded – in this case, 5·1 Volts

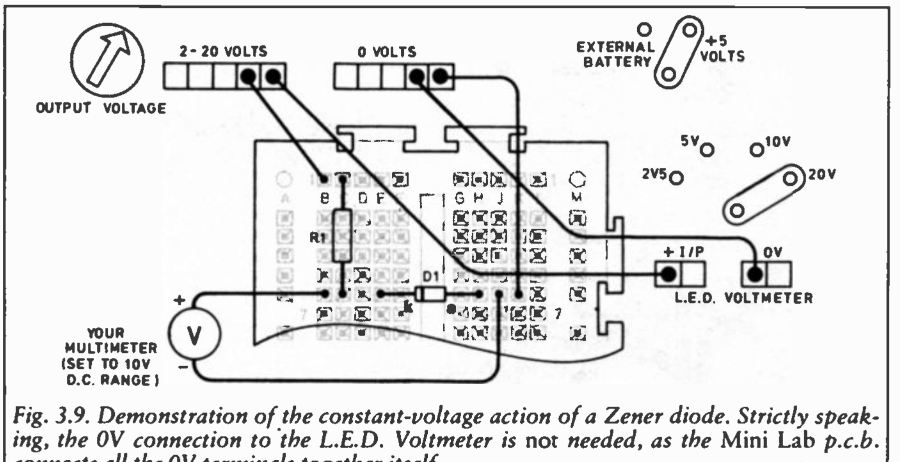


Fig. 3.9. Demonstration of the constant-voltage action of a Zener diode. Strictly speaking, the 0V connection to the L.E.D. Voltmeter is not needed, as the Mini Lab *p.c.b. connects all the 0V terminals together itself.*

d.c. output is of a better quality than the half wave circuit we discussed earlier because the smoothing capacitor is topped up twice as often by the bridge rectifier network. Again, note that C1 must be rated to cope with the peak voltage which appears across it. For example, a transformer with a 12V (r.m.s.) secondary voltage would charge the smoothing capacitor up to 17V peak value, so C1 should be rated at say 25V or more.

Using a bridge rectifier, there's no danger of the electrolytic being reverse-polarised, and the full cycle of the sine wave is utilised instead of half being blocked by a half wave rectifier. In spite of the ripple voltage, a reasonably smooth d.c. voltage is produced which is capable of driving many electronic circuits: it's the basis of many simple mains adaptors.

RATINGS

The four rectifiers used here can either be purchased separately provided they have both adequate Peak Inverse Voltage (PIV) ratings (remember they must cope with the **peak**, not r.m.s. voltage of the sine wave) and also the current requirements of the power supply. A more convenient method uses a "bridge rectifier" which contains four rectifiers ready-wired in bridge formation. Their terminals are always clearly marked like those in Fig. 3.7. Remember, it's **highly dangerous** to connect them incorrectly in case the electrolytic becomes reverse-polarised.

In the circuit configurations just examined, we often say that the output voltage is "unstabilised" or "unregulated" because it has a tendency to drop somewhat when we draw more current. This type of circuit may form the cheapest of mains adaptors, but generally speaking, unstabilised adaptors are completely unsuitable for sensitive equipment like portable lap-top computers, mobile phones or pocket T.V.'s because the voltage across the load will vary with the output current, and the off-load voltage may be excessive.

ZENER DIODES

This section requires the Mini Lab *Mains Power Supply which is described elsewhere in this issue.*

It's very easy to construct a power supply which is *stabilised* or regulated (same thing) to give a fixed voltage. Fig. 3.8(a) introduces the **Zener diode** which is a special version of a normal diode designed to provide a stable output voltage. This very useful component is included in some (e.g. NEA and LEAG) syllabuses but omitted from others (e.g. MEG), but it's certainly useful to familiarise oneself with its mode of operation.

In this circuit, V_{in} could be a varying or unstabilised voltage, perhaps from a full-wave bridge rectifier circuit like that of Fig. 3.6. D1 is a 5.1V Zener diode which you will see is *reverse-biased.* A normal diode would not conduct under these circumstances, but interestingly a Zener diode can indeed conduct current, and in so doing provides a *constant voltage* across its terminals. The value of the constant voltage V_o depends on which value Zener diode you select: a large range of voltages is available, typically from 2.4V up to 75V.

The Zener characteristic curve is shown in Fig. 3.8(b) which shows the sharp conduction "knee" which occurs at the Zener voltage, at which point current can then flow through the Zener but the voltage across the diode remains roughly stable.

Some operating precautions are required if the Zener is to work reliably. Firstly, you will see that a series limiting resistor R1 is needed to prevent excessive current destroying the diode. Secondly, the input voltage V_{in} must always be somewhat *greater* than the Zener voltage, or the Zener cannot conduct: for instance, you can't use a 5.1V Zener with an input voltage of only 3V say. Finally, we must always bear in mind the power dissipation rating (generally in milliwatts) of the Zener to prevent the device from being damaged.

Your new *Mini Lab* Mains Power Supply includes two modern integrated-circuit (i.c.) regulators (see later) to provide fixed +5V and +12V supplies as well as a complete *variable power supply section* which will offer you anything from two to nearly 20 volts d.c. by rotating a control. It has everything you need to demonstrate circuit principles and develop your own circuits too. From now on, it's no longer necessary to use the external 6V battery pack to operate your *Mini Lab.*

For the following demonstration you need a 5.1V 400mW Zener diode together with a 1k5 0·25W ± 5% resistor – extremely easy to obtain from most suppliers. For this and all other experiments from now on, your *Mini Lab* needs to be prepared as follows:-

i) Select "+5V" instead of the "EXT BATT" option using the on-board selector shorting plug in the power supply section; this connects the mains-operated 5V power supply to the *Mini Lab* instead of the 6V battery pack. (Note, the 5V rail also powers the L.E.D. Voltmeter and a few other modules on the *Mini Lab* board as well.)

ii) Use the built-in on-off switches of the power supplies just like you did before, in order to disconnect the supplies from your experiments before making any modifications. Now, a constant-current l.e.d. lights (once the output exceeds about two volts) when the variable voltage supply of your *Mini Lab* is switched on. The fixed 5V and 12V rails also have individual on-off switches with l.e.d. warning indicators.

iii) Ensure that the ***Variable Voltage Control*** *is fully anti-clockwise so that the output voltage is near zero* before switching it on.

Now plug the *Mini Lab* Transformer Unit into the mains and connect to the *Mini Lab* board through its a.c. inlet socket, then refer to Fig. 3.9 which shows the 5V1 Zener diode and the 1k5 series limiting resistor on the Veroblock, connected to the *variable* power supply. The L.E.D. Voltmeter is set to 20V f.s.d. and is used to monitor the variable voltage. Connect your multimeter (set to 10V d.c. f.s.d.) across the Zener diode as shown.

Switch on the 5V supply (for the L.E.D. Voltmeter) and also the variable power supply and gradually increase the voltage control from minimum (about 1.2V) to maximum (18V or more) and back again. Compare the voltage readings of the L.E.D. Voltmeter against the Zener voltage monitored on your multimeter. What happens? Repeat the experiment as necessary.

Eventually the Zener diode starts to conduct and then the voltage across the Zener stabilises, no matter what the variable supply is set at – providing it's at least 5V or more. We measured a Zener voltage of 5.11V using our digital multimeter: Zeners have a typical tolerance of ±5 per cent, so the actual Zener voltage could be between 4.8 to 5.3V or so. Reverse the Zener diode (keep R1 in place) and see what happens: now, the Zener acts just like a normal forward-biased diode.

SAFETY AND FIRST AID

In the GCSE Electronics workshop or classroom, it is **forbidden** to work alone when working on equipment, especially if it utilises the mains supply. In the event of an accident, should you receive an electric shock or burns then *there will be no-one nearby who can help you.*

Of course, this magazine has always carefully selected safe and sensible designs which the amateur constructor can confidently build at home, and the absorbing nature of *hobby* electronics implies that the hobbyist might indeed find him- or herself alone at home beavering away on a new project!

As far as GCSE/GCE Electronics is concerned, it is necessary to be able to demonstrate an understanding of the fundamental safety aspects of electronics. However, the section which follows on First Aid applies not just to GCSE candidates, but to everyone!

DANGERS OF ELECTRICITY TO HUMAN BEINGS

The *Mini Lab* operates from a 15V a.c. supply which is completely harmless. However, higher voltages such as the domestic a.c. mains or even higher H.T. (High Tension) or E.H.T. (Extra High Tension) voltages give rise to particular hazards.

The human heart is simply a muscle, and happens to be most susceptible to stimulation at an applied frequency of about 50Hz (which perversely also happens to be the a.c. mains frequency). The effects of electric shock are a combination of the voltage level applied and also the *current which flows through the body,* not to mention the time period of the shock itself. Assuming that an unfortunate person picks up a "live" electric device, typical effects on the hapless victim are as follows:–

CURRENT	EFFECT ON HUMAN BEINGS
1mA	Tingling.
9mA	Probably able to release the device.
16mA	Borderline on ability to drop the faulty device.
25mA	Probably unable to release the device to escape further electric shock.
16 to 50mA	Pain. Possible unconsciousness. Heart and respiration functions probably continue.
>100mA	Ventricular fibrillation (heart tremor). Respiratory paralysis (asphyxia, suffocation). **Severe shock and burns. POSSIBLE DEATH.**

It is crucial that you understand fully that an electric current passing through the body can affect muscles, causing contractions and paralysis – which accounts for the inability to "let go" or breathe. In the case of H.T. shocks, uncontrollable muscle spasms may additionally cause the victim to be thrown some distance, causing further injuries.

Burns are caused by the current passing through skin tissue, and the level of current is partly related to the *electrical resistance of the skin,* (Ohm's Law) which in turn depends on how dry or moist the skin is. Dry skin has a higher resistance, so less current will flow. **Severe burns** may result from contact with high voltage sources like overhead power lines.

FIRST AID

In the event of a person receiving a (suspected) electric shock *from the domestic mains supply,* you must act quickly and calmly to help the victim.

AVOID TOUCHING THE VICTIM IF HE MAY STILL BE IN CONTACT WITH THE ELECTRICAL SUPPLY, OR YOU MAY RECEIVE A SHOCK YOURSELF.

ISOLATE THE SOURCE OF ELECTRIC CURRENT: SWITCH OFF AND/OR UNPLUG, OR USE AN *INSULATING* WOODEN POLE OR OTHER NON-CONDUCTING MATERIAL TO REACH OVER OR TO PUSH THE VICTIM CLEAR OF THE SUPPLY.

IF THE VICTIM HAS STOPPED BREATHING, APPLY ARTIFICIAL RESPIRATION (KISS OF LIFE) IMMEDIATELY.

TREAT BURNS. ELECTRICAL CONTACT BURNS ARE OFTEN *DEEPER THAN THEIR SIZE SUGGESTS.*

FIRSTLY RELIEVE PAIN AND REDUCE TISSUE DAMAGE AND SWELLING BY COOLING THE AFFECTED AREA WITH CLEAN COLD WATER, ICE CUBES, FROZEN PRODUCE etc.

THEN REMOVE ANY ITEMS OF A CONSTRICTIVE NATURE (RINGS, WATCHSTRAPS, BRACELETS, BELTS, BOOTS etc) BEFORE SWELLING STARTS.

APPLY A STERILE DRESSING FOR PROTECTION FROM INFECTION. DO NOT APPLY LOTIONS, OINTMENTS etc. OR PRICK BLISTERS.

SEEK MEDICAL ATTENTION IF REQUIRED.

The section on Burns Treatment is also applicable to localised dry heat burns received from a hot soldering iron.

RESISTOR CALCULATION

The calculation for the series resistor has to take into account the fact that the load placed across the Zener will draw a current. The Zener always requires a nominal current (say a few milliamps) to flow through it, too. In Fig. 3.10, a load is placed across the Zener diode which has a series resistor R1. A current I_{IN} flows into the resistor before dividing into two paths: I_Z is the current through the Zener and I_L is the *maximum current* which the load is likely to draw. Hence, $I_{IN} = I_Z + I_L$.

If we know the input voltage (V_{IN}) to the circuit, this voltage will be divided across the resistor R1 and the Zener diode. Therefore, $V_{IN} = V_R + V_Z$. This leads us to consider the calculation for the series limiting resistor:

$$R = \frac{(V_{IN} - V_Z)}{(I_L + I_Z)}$$

In other words, using Ohm's Law, the value of the resistor (as always) is equal to the voltage dropped across it divided by the current flowing through it. The voltage drop is the difference between the input voltage and the Zener voltage ($V_{IN}-V_Z$); the current through the resistor must be the sum of currents flowing through the Zener and the load ($I_L + I_Z$).

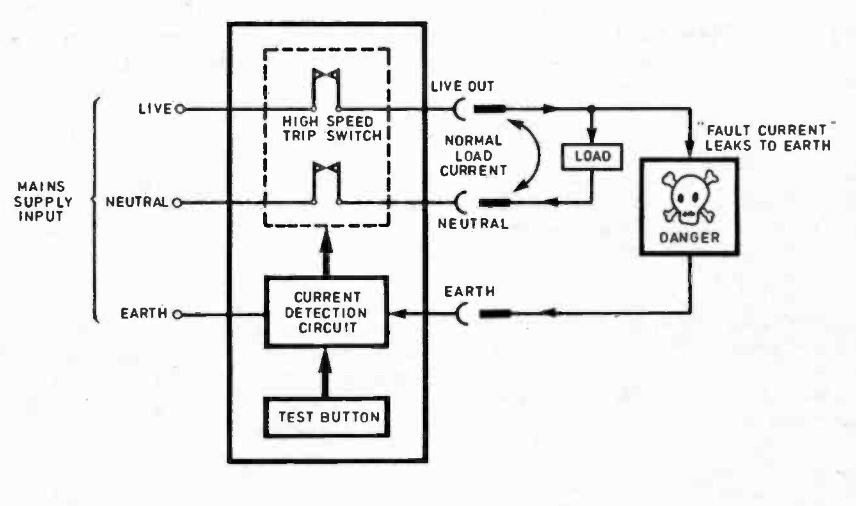
In our calculation above, we took into account the *maximum* load current. What happens if the load then draws *less current* than this? The resistor will still limit the current to the same value because the voltage drop across it doesn't change, but now the Zener will draw *more current*. Take a look at the example of Fig. 3.11(a) where a 5.1V Zener is in series with a 68 ohm resistor, across a 10V d.c. supply. A load draws 25mA. The current through the Zener can be calculated quite easily, as follows:–

PROTECTION FROM ELECTRIC SHOCK – THE E.L.C.B.

The best way of all of protecting yourself from electric shock is to utilise a *Residual Current Device (R.C.D.)* or *Earth Leakage Circuit Breaker (E.L.C.B.)*. The two names are synonymous. These are available in the form of plug-in adaptors or wall-mounting sockets, and a simplified version is shown in below. An E.L.C.B. incorporates a sensitive circuit which detects any *earth leakage current* passing through to the Earth terminal. It monitors the load current flowing between Live and Neutral, and if an imbalance or difference arises then the E.L.C.B. assumes that some of the output current is leaking to Earth instead of returning to Neutral.

The E.L.C.B. will then "trip", immediately disconnecting the electrical supply. Typically, they operate within 20-30mS (0.03 seconds) – well before any serious harm can result, and far quicker and with greater sensitivity than a fuse. So even if you are unfortunate enough to touch a "live" wire then although current may start to flow through your body to earth, the E.L.C.B. will detect this and immediately trip, thereby saving your life!

They generally have a test switch to help you confirm that the unit is functioning correctly. Typically they cost £15 to £30 and are widely available from DIY stores. **Don't confuse them with an "M.C.B.." (Miniature Circuit Breaker) which is nothing more than a resettable fuse, like the thermal cut-out FS2 in the Transformer Unit. They do *not* offer the sensitivity or protection of an Earth Leakage Circuit Breaker.**



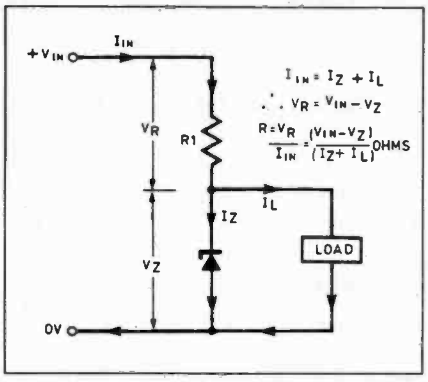


Fig. 3.10. Calculation for the series resistor: it's a lot easier than it looks!

Calculate the current through the resistor. The voltage across the resistor will be 10V – 5.1V (Zener voltage) = 4.9V, so the current through the resistor (using I = V/R) is about 72mA.

The Zener current accounts for the difference between the current through the resistor and the current drawn by the load. $I_Z = 47mA$.

If the load now decreases to say 5mA, as in Fig. 3.11(b), the current through the resistor remains unchanged at 72mA because the voltage across it is still 4.9V due to Zener action. We know from Part One of *Teach-In* that the total current into a junction equals the sum of the currents going out – so if 5mA goes out into the load, the rest of the current (67mA) "sinks" into the Zener.

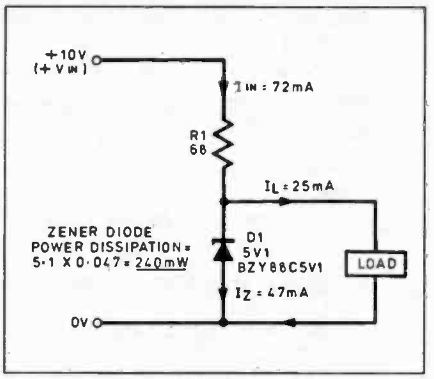


Fig. 11(a). Zener power dissipation with a load current (I_L) of 25mA.

POWER DISSIPATION

Hence, if the load current decreases, the Zener current increases accordingly. We therefore have to ensure that the Zener has an adequate power dissipation rating to take account of "worst case conditions" when the current through the Zener is at its peak. A standard rating for a small Zener diode is 400mW to 500mW and the power dissipation of the Zener diode in Fig 3.11(a) will be about 240mW (P = IV) – no problem. However, in Fig. 3.11(b) the Zener will dissipate about 340mW which is getting near to the maximum rating of many smaller types of Zener. Phew!

The other consideration is the power dissipation of the resistor. Use any of the power formulae to work out the values for R1 in

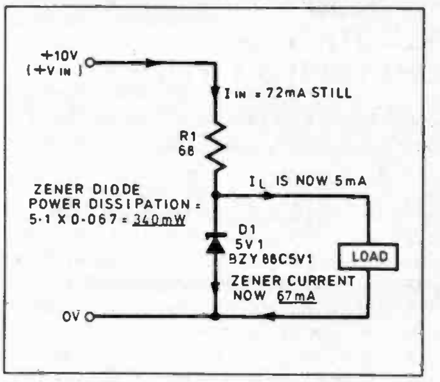


Fig. 3.11(b). When the load current reduces, the Zener diode current will increase accordingly, resulting in increased power dissipation in the Zener diode, which must be rated for "worst case" conditions.

Fig. 3.11 – 350mW in both cases – so a 0·5W type is called for.

Zener diodes are typically used to provide a fixed supply voltage to circuits where a stable supply is essential. A reasonable low-power stabilised mains adaptor could be constructed using the principles we have just examined. Unlike the simple half wave and full wave circuits described earlier, the stabilised output voltages remain more or less the same regardless of the current drawn by the load. We'll be taking a look at some interesting *integrated circuit* (i.c.) regulators later on – your *Mini Lab* has three of them, and they're really easy to use!

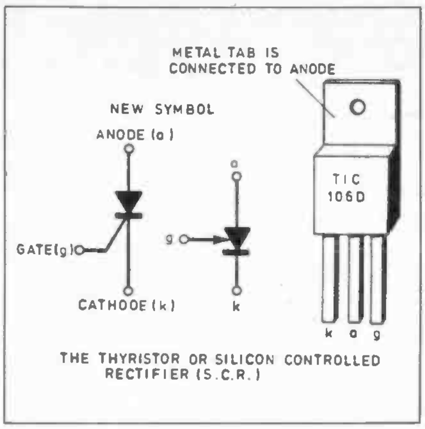


Fig. 3.12 (left). Symbol for the Thyristor (S.C.R.). Either symbol could be used, but check which one is preferred by your Examination Board.

Fig. 3.13 (right). Pin connections for the TIC106D thyristor.

THE THYRISTOR

Another interesting variation on the theme of diodes is a device called a "silicon controlled rectifier" (SCR) or "thyristor". This component is interesting and fun to use, though whilst featured in at least the LEAG and NEA Syllabuses, is omitted from at least two others (MEG and SEG). Thyristors have a third terminal called a "gate" and their symbol is shown in Fig. 3.12. The gate has an important influence on the operation of the thyristor, because current won't flow though the thyristor from anode to cathode until a suitable signal is present at the gate terminal.

A major feature however is that *once the thyristor has been triggered into conduction by the gate, current can continue to flow even if the gate signal is removed.* The only way to turn off the thyristor is to remove the power, e.g. by switching off the supply or by shorting the anode to the cathode.

THYRISTOR SPECIFICATION

For our next experiment, you will require a thyristor type TIC106D which is readily available from many suppliers. This was chosen because it is easy to handle and not so easy to damage. The specification for our TIC106D thyristor reads as follows:

V_{gt}	1.0V
I_{gt}	0.2mA
V_{rrm}	400V
I_t	5A average

"V_{gt}" is the *maximum gate trigger voltage* (generally 0.8V is the minimum) and "I_{gt}" is the *maximum permissible gate trigger current*, whilst "V_{rrm}" is equivalent to the PIV rating of the rectifier. "I_t" is the average forward current through the thyristor (from anode to cathode) when it is conducting.

Fig. 3.13 shows the pin connections for the TIC106D device. It has a metal tab which was designed to be bolted to a heat-dissipating radiator (a "heatsink"), but we don't need to do this in our safe, low-power experiments. The tab is connected to the anode and as such is "live" (albeit at a safe, low voltage in our circuits).

THYRISTOR EXPERIMENT

A circuit diagram to demonstrate the "latching" action of a thyristor is shown in Fig. 3.14(a). A 6V d.c. supply is provided by the *Mini Lab* Variable Power Supply switched via S1, a *normally-closed* push

TEACH-IN GCSE QUESTIONS

Since we feel that the sbject of Safety is of paramount importance in electronics, this month we reproduce two brief questions from past GCSE papers. Firstly, by kind permission of the Northern Examining Association, a safety-orientated question which appeared in their Summer 1991 Examination, Paper 2 on GCSE Electronics (2052), Question A1

A1 A mains-operated power supply is mounted in a metal case. An earth wire is connected to the case from a three-pin plug which has its own fuse.

(a) State the colour(s) of the insulation of the wire which should be connected to the earth pin of the plug.

(b) If the case does become live, how do the earth connection and the fuse act to prevent the user from receiving an electric shock?

(c) The earth wire on this power pack became disconnected from the case. A person touched the power pack, which was switched on, and received a violent electric shock. As a result this person collapsed over the power pack.

What would you do to give immediate help to the person?

(d) **(i)** What do the letters "e.l.c.b." stand for?

(ii) State **one** advantage of this device over a normal fuse.

The second question is reproduced by kind permission of the Welsh Joint Education Committee, which quizzed candidates about a low-voltage soldering iron in the Summer 1990 Examination, Paper 2, Question 1.

As always, suggested answers are given. The answers are the work of the authors not the Examining Boards, and may not represent the only possible solutions.

1 *(a)* Some soldering irons are connected to the mains by a special power supply. This power supply uses a transformer to isolate the iron and allow it to operate on 24 volts.

Describe a danger which is prevented by **each** of the following safety features of this soldering system:

(i) a 'power is on' indicator;

(ii) an earth connection to the metal casing of the special power supply;

(iii) a fuse;

(iv) a heat resistant power cable;

(v) the use of the transformer to allow the iron and its cable to operate at 24 volts instead of 240 volts.

(b) The soldering iron takes 2 amps at 24 volts.

(i) Calculate the power of the iron (in watts).

(ii) The following fuses are available.

0.1A, 1A, 5A, and 13A.

Which fuse would you fit to the output of the power supply?

(c) Mains-powered 9V dc supplies can often be used with radios instead of batteries.

(i) Give **one** function of a capacitor in this type of power supply.

(ii) Why might it be dangerous to connect an electrolytic capacitor the wrong way around in this power supply?

(iii) How can a large capacitor in a mains powered circuit cause a danger, even when the power is disconnected?

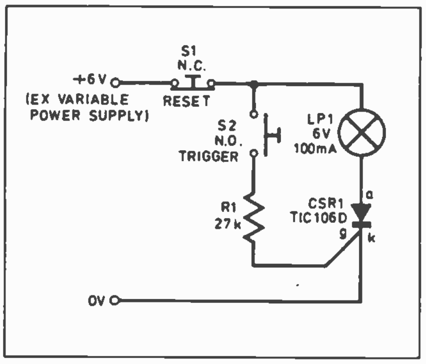


Fig. 3.14(a). The thyristor in a simple application circuit. Press S2 to trigger the device, and S1 to reset it.

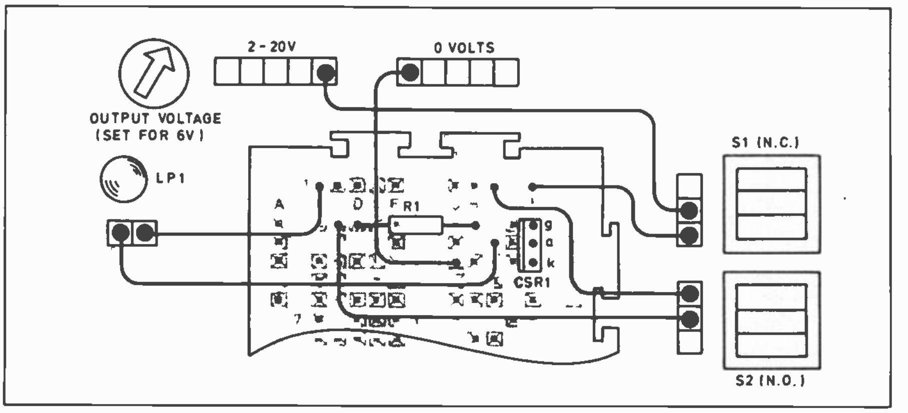


Fig. 3.14(b). Mini Lab interwiring diagram for the Thyristor demonstration. Adjust the Variable Power Supply Control to give an output of 6V.

switch. The thyristor is connected across the 6V supply and the anode/ cathode is effectively in series with a bulb LP1.

Switch S2 is a *normally open* push switch which when closed, will supply +6V via resistor R1 to the gate terminal of the thyristor. R1 is needed as a series limiting resistor because the maximum voltage we can connect to the gate terminal is 1.0V with respect to 0V. Also, the maximum current we can permit to flow into the gate terminal is 0.2mA (as per the data), so the minimum value of R1 is calculated using Ohm's Law:

$R = V / I = (6.0-1.0) / 0.2mA$

$= 25k$ minimum.

Resistors of 25k aren't made so we chose a near preferred value of 27k ±5% for reliable triggering.

This circuit can be assembled on the *Mini Lab* as illustrated in Fig. 3.14(b). Set the Variable P.S.U. to 6V by using either your multimeter or the L.E.D. Voltmeter to check the output voltage beforehand. (Remember to switch on the 5V d.c. supply to operate the L.E.D. Voltmeter.)

The thyristor will slot straight into the Veroblock using the orientation of the metal tab as a guide. Connect appropriate jumper wires to the adjacent switches and the filament bulb as shown then check your wiring before finally switching on the d.c. supply on the *Mini Lab*. Nothing should happen!

Press down S2 in order to "trigger" the thyristor at its gate terminal, and the lamp should illuminate. (If not, check you have wired the thyristor correctly, the bulb is firmly in its holder and the wires are firmly in their respective sockets.)

Release S2 – the bulb remains illuminated! Once the SCR has been triggered, it remains in this conductive state until it is reset. One way of doing this is to interrupt the power, so press S1 to disconnect the supply and extinguish the bulb. Press S2 again to re-trigger the thyristor.

In the non-conductive state (bulb extinguished), only a tiny "leakage" current flows through the thyristor. Using a sensitive ammeter we measured it at 0.1 microamps. In the conductive state, the current through the thyristor is limited only by the load, which in this case is a bulb. The S.C.R. can handle up to 5A (or 5A r.m.s. in a.c. circuits, when it will rectify the a.c. supply).

SIMPLE ALARM CIRCUIT

This "latching" action could be utilised in a simple alarm circuit such as that of Fig. 3.15 which is a variation of the circuit we just discussed. The "trigger" switch has been omitted altogether and a constant signal is therefore applied to the gate. However the current flowing through R1 is shorted to 0V by a continuous length of wire which forms a "closed circuit protection loop". The result is that normally, the thyristor cannot trigger because of the 0V present at its gate.

Physically cutting the wire removes the short-circuit between the gate and 0V; the gate terminal can therefore rise to the 1V it requires to trigger the thyristor which will now conduct. Replacing the short to 0V will not affect the conducting thyristor: you reset it by pressing S1. See if you can work out how to build this circuit yourself, using a length of wire to ground the gate terminal to 0V as shown. We have also replaced the lamp with an l.e.d. and 390 ohms series limiting resistor.

You could also add the *Mini Lab*'s buzzer in parallel with the bulb or R2 and D1 to generate a warning tone when the protection loop is broken. Try it: simply observe the correct positive and negative polarity of the buzzer and link it with jumper wires over to the Veroblock.

Finally have a look at the circuit diagram of Fig. 3.16 which is a thyristor incorporating a resistor and 100µF capacitor network on the gate terminal. See if you can build this circuit yourself – just connect it up and wait! Try different values of the capacitor if you have any available.

GCSE QUESTION (see previous page)

QUESTION ONE: ANSWERS

This was a straightforward question which commendably tested the candidates' fundamental knowledge of First Aid.

(a) Green/Yellow. If you didn't know that, go and stand in the corner!

(b) The Earth, being connected to the metal case, provides a route of very low resistance for the mains supply. It is easier for the current to take this route rather than flowing through a human body to Earth, so when the case becomes "live", a large current will flow to Earth which soon causes the fuse to melt and disconnect the supply.

(c) Do not touch the victim until you have switched off and unplugged the power supply – do this straight away. Check for breathing, employing artificial resuscitation techniques *immediately* if required. (An experienced First Aider will further apply external heart compression if no heartbeat is found.) Treat any burns and then call for help.

(d) (i) Earth Leakage Circuit Breaker, of course! All *Teach-In* readers know that!

(ii) High sensitivity – tripping at typically 30mA current flow to Earth. You could alternatively mention the high speed of operation – typically under 30mS. The Examiners commented that few candidates seemed aware of these advantages over an ordinary fuse.

QUESTION TWO: ANSWERS

(a) (i) By warning that the iron is switched on, and therefore hot, it helps prevent accidental burns.

(ii) Earth prevents electrocution should the mains supply come into contact with the case.

(iii) The fuse prevents a fire hazard should a fault develop within the unit which causes an excessive current to flow.

(iv) The heat resistant cable prevents exposure of live wires should the iron tip accidentally come into contact with it.

(v) It further reduces the risk of accidental electrocution by operating the iron at a safe, low voltage.

(b) (i) $P = IV$, answer: 48 watts.

(ii) A 5A fuse would be sufficient. 0·1A and 1A are inadequate to supply the 2A needed; 13A is far too large to provide safe protection.

(c) (i) Smoothing the ripple content of the rectified supply.

(ii) This produces a potentially dangerous chemical reaction leading to explosion, which could injure the eyesight of a nearby person.

(iii) A high voltage charge could reside on the capacitor which could cause an electric shock or spark hazard, even though the power has been disconnected.

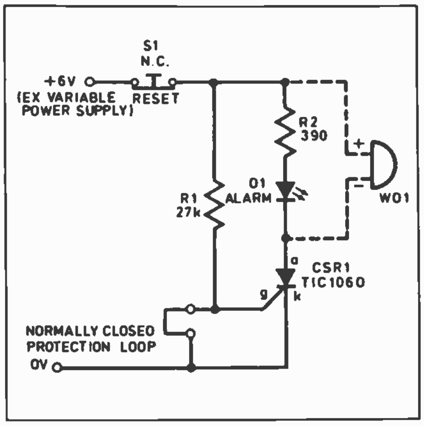


Fig. 3.15. A simple tamperproof Burglar Alarm. Cutting the protection loop triggers the Thyristor and illuminates D1 until reset. Add the Mini Lab *buzzer WD1 as shown, to give an audio alarm also.*

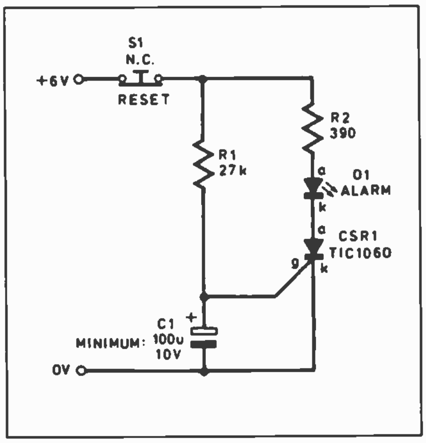


Fig. 3.16. A suggested Time Delay Indicator. Try changing the values of C1.

SAFETY

GCSE Examining Boards place a welcome emphasis on the area of safety in electronics. We have already described one dangerous situation to be avoided – that of connecting an electrolytic capacitor the wrong way round: the chemical reaction could cause an explosion. *(**Only a qualified Tutor can demonstrate this effect under controlled conditions taking suitable safety precautions.**)* Additionally, these components are capable of storing their charge for some considerable time, and if the equipment operates at a high voltage (such as a TV set, which may run at several tens of thousands of volts inside), *a charged capacitor can be a source of an extremely unpleasant electric shock, even after the power is disconnected.*

When working on certain types of equipment, you must be wary of capacitors which might have retained a high voltage charge. Look at the printing on their cans: if you see a voltage rating of, say, 400V, this gives you a clue as to their possible "contents". Discharge it slowly through a resistor – say 10k or more – *and do not touch the terminals at any cost.*

MINI LAB VOLTAGE

When it comes to dealing with the 240V (339V peak) domestic mains supply, it is vital that certain sensible precautions are taken to prevent injury. The low a.c. and d.c. voltages on the *Mini Lab* board are completely safe to handle as the task of stepping down the lethal mains voltage to a safe and manageable level is performed by a mains transformer.

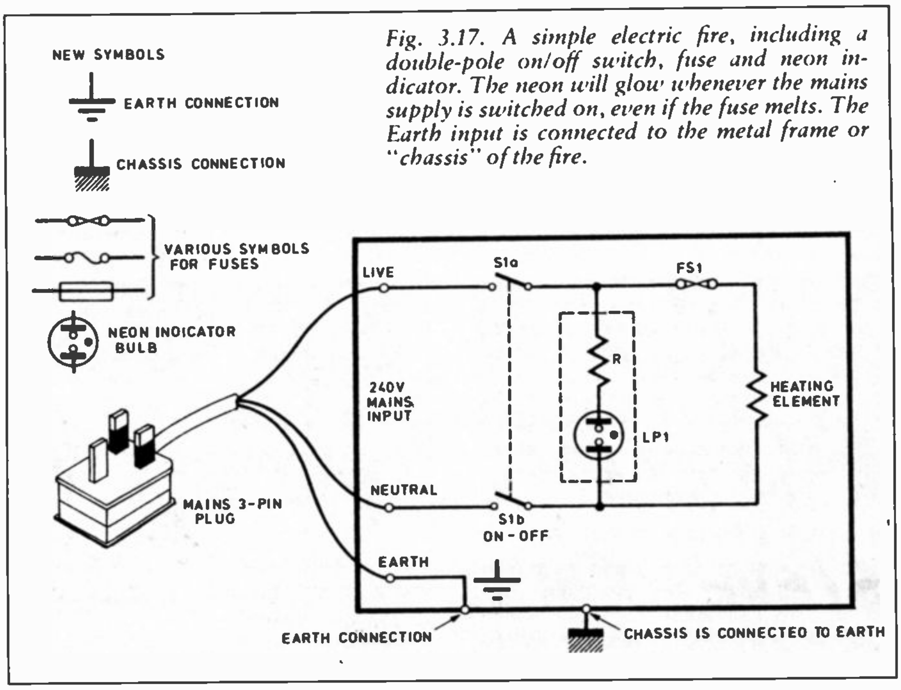


Fig. 3.17. A simple electric fire, including a double-pole on/off switch, fuse and neon indicator. The neon will glow whenever the mains supply is switched on, even if the fuse melts. The Earth input is connected to the metal frame or "chassis" of the fire.

In fact the Transformer Unit incorporates protection in two key areas. Firstly, a mains fuse is in series with the primary winding and this will melt if an excessive current is drawn on the mains side – perhaps if the transformer has an internal fault. Secondly, a thermal cut-out (a type of resettable fuse) is included on the secondary circuit and this will trip if you draw an excessive current from the secondary.

However, a more subtle safety precaution is also built into your *Mini Lab* Transformer Unit. You may have noticed that we require the Earth wire, which comes in with the Mains Live (also sometimes called "Line") and Mains Neutral supplies, to be connected to the mounting frame of the transformer. What effect does this have?

EARTHING

You are probably aware that a typical modern 240V mains cable contains three cores, which in the UK are coloured Brown (Live), Blue (Neutral) and Green/Yellow (Earth). As you now know, the mains a.c. supply takes the form of a sine wave. During one half of the sine wave cycle, the Live feed is positive with respect to Neutral, and during the second half it becomes negative – so the sine wave present on the Live alternates between +339V and –339V peak with respect to the Neutral connection. No current should normally flow to Earth, which should be at the same zero potential as Neutral.

The Earth is actually an essential *safety precaution* which is necessary when the mains supply is connected to any equipment which has either a metal cabinet or metal fittings (such as transformer mounting screws). Fig. 3.17 is the circuit diagram for a simple electric fire which has a single bar heating element represented by a resistor. It is connected to the domestic Live and Neutral mains supply and is switched on and off with a double-pole switch. A *fuse* is also shown in the Live feed. You will see these in 3-pin mains plugs or additionally within electronic equipment itself.

The metal frame or "chassis" of the electric fire is electrically connected to the Earth core, and this protects you if one of the wires inside the fire should come adrift and perhaps touch the case. A very large current suddenly flows to Earth which offers a path of very low electrical resistance to the current, which soon causes the fuse to melt and disconnect the supply to the fire.

Without the Earth connection, the errant wire would cause the metal case to become "live" – with the result that if you touch the cabinet you will receive a **potentially fatal electric shock** because current will flow from the case and through your body to Earth – possibly killing you in the process. Equipment which is described as "Double Insulated" (the symbol for which is two concentric squares) *does not require earthing*, and such equipment only has a twin-core mains cable with no Earth core. Refer to the maker's instructions as necessary for advice.

FUSE RATING

If the heating element dissipates 1kW (1,000 watts), it draws a current of about 4 amps (use the P = IV formula) at 240V r.m.s. The most common values of domestic cartridge fuse (of the type seen in mains plugs) are 1, 3, 5 and 13 Amps. There's no point in using too *low a fuse rating* because the current drawn by the element will simply melt the fuse even though no fault exists. A 5A fuse would provide proper protection in this circuit.

Too *high* a fuse rating is undesirable and dangerous, because firstly they take longer to blow than a lower value fuse, and also if a fault arises, other parts of the circuit (such as the mains cable) might overheat and catch fire before the fuse can melt (if at all). This gives rise to a serious fire hazard – so choose fuse values carefully.

Also, if you accidentally sever the cable and short out the cores, an excessively large current will flow and the fuse in the plug will melt to disconnect the supply. Hence, the fuse's most important job is actually to oversee the *mains cable*, not the apparatus. What fuse rating would you choose for a twin-bar (2kW) fire? Or a 25 watt soldering iron? (Answer: 13A and 1A respectively.)

INDICATORS AND SWITCHES

Also incorporated in our simple circuit is a *mains neon indicator*, which in this example is fitted such that it will always glow to remind you that the mains supply is switched on. Neon bulbs ionise at roughly 70-80V and require a series limiting resistor for 240V mains operation, which are generally already built in to any 240V panel-mounting neons. However, some mains switches are available which incorporate a neon indicator: we used such a part on the Transformer Unit to good effect.

Another safety feature in our simple electric fire is the switch itself; notice how both the Live and Neutral feeds are switched simultaneously to completely *isolate* the fire from the mains when not in use. A single-pole switch may be utilised, in which case this must be placed in the Live feed. It is *unsafe* to switch just the Neutral on and off whilst permitting the Live to remain constantly connected. This is because, in ignorance, the user might switch off the (Neutral) supply prior to changing say a faulty electric element or a light bulb, but the circuit will actually remain **live** and create a possible **electric shock hazard.**

MAINS PLUG

One item which every item of mains-operated equipment needs is a mains plug, see Fig. 3.18. Examiners are rightly keen to ensure that you understand the implications of wiring such a plug incorrectly. You *must always* check the following crucial factors in order to ensure that a mains plug connection is both reliable *and* completely safe for *all* users, not just yourself: lives depend on it!

- Check the correct value, size and type of fuse; otherwise a fire hazard may result. Check the cable for any damage, and replace if it shows sign of wear and tear.
- Strip back just enough *inner* core insulation to ensure that sufficient copper core comes into contact with the plug's terminals. Ensure the screw terminal grips the copper wire properly.
- Check you connect the **right** colour core to the **right terminal**; it is *very dangerous* to confuse the colour-coding and mistakes could result in a **fatal electric shock being delivered.**
- Always ensure that the *cord-grip system* grips the *outer insulation* and prevents the cable from being jerked out of the plug. It **must** grip the outer insulation, not just the inner cores (which is worse than useless). A cable restraint of some kind is also necessary at the equipment-end of the cable: if the cable is pulled out from here, the "live" cable ends may cause a lethal shock.
- Finally, inspect the plug to ensure it is not cracked or damaged in any way: we've seen some real horrors which in industrial/ commercial use would be quite illegal. A modern plug with shrouded pins is best.

ENVIRONMENTAL ASPECTS

There are a few less obvious factors which may contribute to increasing the hazards surrounding the applications of electronics. If your classroom or workbench has poor lighting, for instance, you may fail to recognise a potentially dangerous situation – such as bare mains connections perilously close to a nearby metal screwdriver, or you may mis-read a 40V capacitor as being suitable for your 400V circuit!

Extension leads are often orange or yellow coloured so that you can't miss them – especially outdoors. Also look for warning symbols and signs on equipment which warn of high voltages. Work in surroundings which promote a safety-first approach.

Water is the biggest enemy of electrical equipment: it conducts electric current and will short out any mains or high voltage circuitry and could even become live itself. **You must keep all mains and high voltage equipment well away from water.** It is incidentally **extremely dangerous** to take any mains-operated and/ or high voltage equipment into a bathroom: if you have wet hands you could easily be killed if you touch any live circuitry. The only electrical sockets you will ever find in any bathroom are special safety-type outlets for razors only, which include an *isolating transformer* so that they are never directly connected to the mains.

By far the best way to protect yourself from electric shock is to utilise an *Earth Leakage Circuit Breaker (E.L.C.B.)*, also known as a *Residual Current Device (R.C.D.)* – see the separate panel which outlines their operation. The *Teach-In* workshop is fitted with E.L.C.B.'s as a precaution: we certainly don't take risks.

GCSE Examining Boards commendably require a fundamental knowledge of First Aid action to be taken in the event of an electric shock: we detail this separately. Further advice may be sought from a First Aid Manual (e.g. as published by St. John's Ambulance).

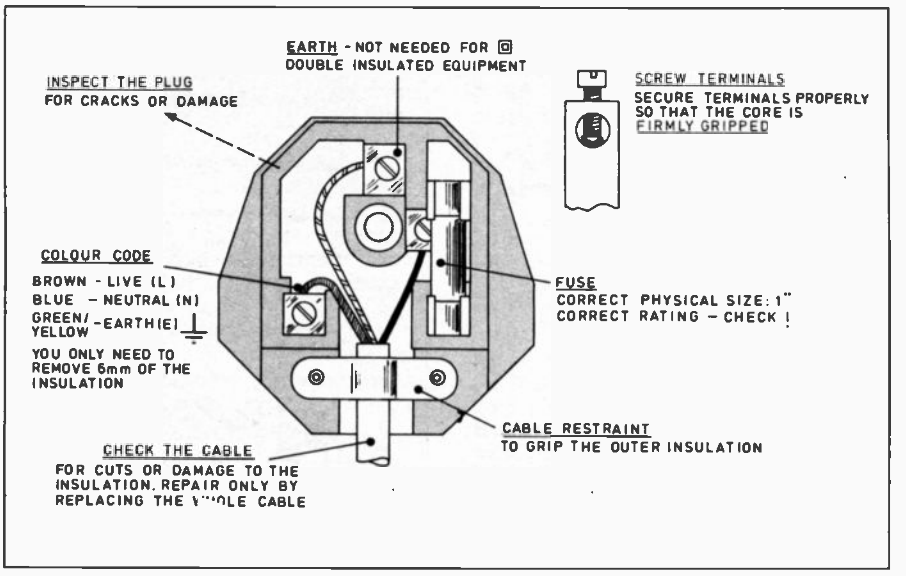


Fig. 3.18. It is dangerous to incorrectly wire a mains 3-pin plug. Use this Check List and do the job properly!

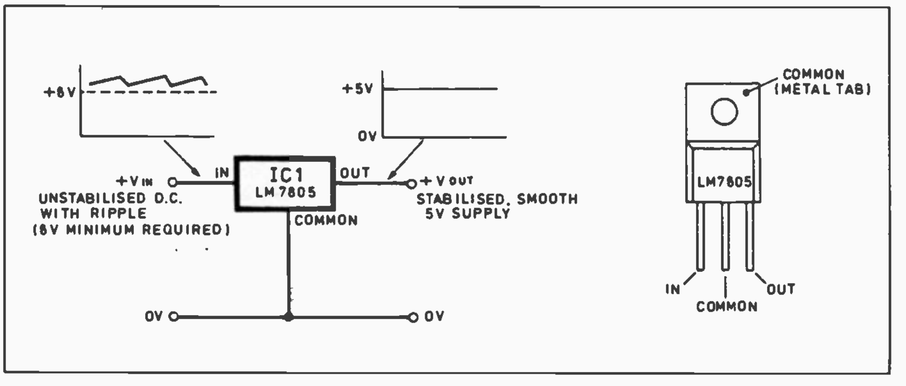


Fig. 3.19(a). A Positive (5 Volt) Fixed Voltage Regulator Integrated Circuit. The +5V output is smooth, noise-free with no ripple. The i.c. is overheat-proof and short-circuit proof. Typically, 3V appears across the i.c. so a minimum input of 8V is needed for correct operation.

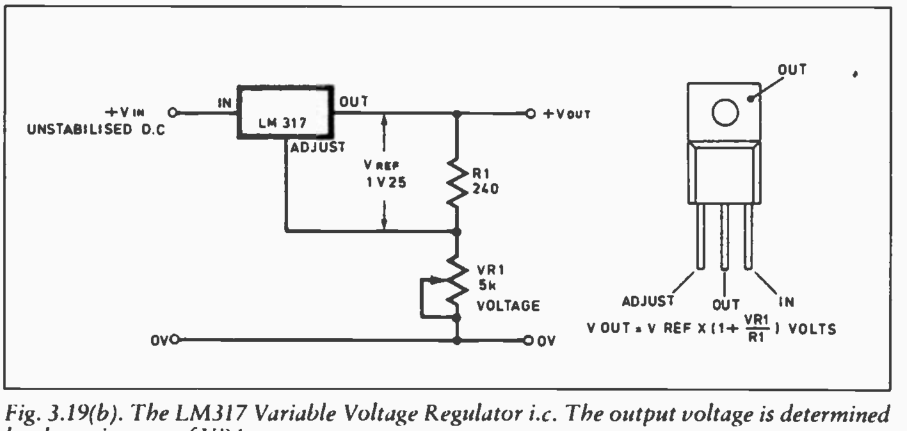


Fig. 3.19(b). The LM317 Variable Voltage Regulator i.c. The output voltage is determined by the resistance of VR1.

REGULATOR I.C.s

We described earlier in this part the voltage-stabilising action of a Zener diode. These semiconductor devices are very cheap and are suitable for low power applications such as basic mains adaptors. For more demanding applications, *integrated circuit regulators* are very commonly utilised: the *Mini Lab* uses three. For now, all you need to know is that an integrated circuit (commonly nicknamed a "silicon chip") is a member of the class of semiconductor components: we describe in future parts of *Teach-In* a variety of integrated circuits which are capable of performing a whole host of functions, depending on their type.

Fig. 3.19(a) shows a *fixed positive voltage regulator*. The output voltage is stabilised at a certain value, such as +5V or +12V (depending on what value of regulator you choose) and this will be maintained as long as the input voltage is higher than the output by about three or four volts (the "dropout" voltage). Additionally the devices are short-circuit proof and are also protected against overheating – they simply shut down if they are asked to dissipate too much power.

Regulator i.c.s mostly look very similar to the thyristor we introduced earlier – but you must *always* connect them the right way round or they will be damaged. Connection diagrams like the one in Fig. 3.19 are generally shown in supplier's catalogues, noting that they differ between family types.

Fig. 3.19(b) is a *variable positive voltage regulator* type LM317, a very popular integrated circuit device which is very simple to use. The *Mini Lab* utilises one at the heart of the Variable Power Supply, and only an external resistor and potentiometer are required to determine the output voltage. A highly accurate 1.25V reference voltage is present across R1, and the output voltage V_{OUT} is roughly determined by the formula:

$$V_{OUT} = V_{REF} \times (1 + V_{R1} / R1) \text{ volts}$$

where V_{REF} is 1.25V and the values of the resistors are measured in ohms. Customarily R1 is set at 240ohms but 220ohms is fine. For a typical application, have a look once again at our design for the *Mini Lab* Power Supply shown elsewhere in this issue. Note also the use of a "heat sink" which is an aluminium extrusion to which the regulator is bolted to assist with the dissipation of excess heat. The design offers you a complete power supply providing from roughly 2V to 18V, and which is short-circuit proof, thermal overload proof and offers a very high performance at a very modest price.

Next month, we introduce probably the most useful electronic component of all: the transistor. Using these amazingly versatile devices, we will demonstrate some interesting functions which could not be achieved with the basic parts we have discussed so far. Your *Mini Lab* also acquires a versatile Signal Generator capable of providing sine, square and triangle waveforms at a wide range of frequencies. There will be plenty of practical work to perform on the *Mini Lab* – join us next month!

TEACH-IN CORRECTIONS

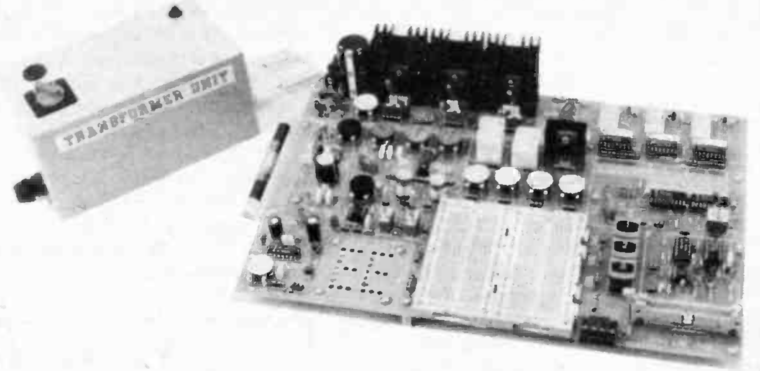
One or two corrections from the first two parts have been pointed out by readers – thanks for your feedback.

In **Part 1 page 732** centre column, the third paragraph starts "Our 470R and 100R resistors could thus . . ." It should read "Our 470R and **220R** resistors could thus . . ."

In the *Mini Lab* **Part 2, Fig. 2** a link wire is missing from between IC1 and IC2 this is shown on the p.c.b. and should be inserted. Also in **Part 2** GCSE Answers (f) states "we know from (e) that 14mA will flow" it should say "we know from **(d)** that **6mA** will flow". In the "Advanced Level" box (again **Part 2**) our friendly computer threw out the last two lines and I'm afraid we did not notice, they should read "frequency or range of frequencies. This application is discussed in future parts." We apologise for these mistakes.–*Ed.*

VEROBLOCKS

Unfortunately we have discovered that supplies of Veroblocks for the *Mini Lab* have dried up (BICC Vero have stopped manufacture). We are selecting an alternative which can be stuck to the *Mini Lab* p.c.b. using foam sticky pads. This will not affect the experiments.



MINI LAB

Alan Winstanley & Keith Dye B.Eng(Tech)AMIEE

The Everyday with Practical Electronics Mini Lab ***has been created to accompany Teach-In '93, and enables the reader to assemble demonstration circuits by following the clear instructions and diagrams contained in the main text, with every chance of it working first time. The Mini Lab is an exciting learning aid which brings electronics to life in an enjoyable and interesting way: you will both see, and hear, the electron in action.***

DURING the early stages of *Teach-In*, the *Mini Lab* utilises a safe low-voltage battery pack as its power source. As we progress through the tutorial, it expands to include a selection of appealing and useful circuits and soon the fixed 6V battery pack restricts the versatility of the *Mini Lab* system. Additionally, many circuits which we introduce in the coming months require precise stabilised voltages, so the external battery eventually has to become redundant.

The Power Supply section to be described is a versatile design which is very satisfying to construct on the Mini Lab printed circuit board (p.c.b.). It incorporates three integrated circuit (i.c.) regulators, and offers *fixed voltage* stabilised outputs of both +5V and +12V, and also a *variable voltage* d.c. supply of roughly 2V to 18V which will be useful for experimentation purposes.

TRANSFORMER UNIT

The Power Supply is constructed in two sections: the regulators are assembled onto the p.c.b., and secondly a Transformer Unit is built in a separate plastic box. This latter item contains a simple mains voltage section and is totally enclosed for safety. Fig. 1 shows the circuit diagram of the simple Transformer Unit.

Mains a.c. supply is switched through a double-pole switch S1 which completely isolates the Live and Neutral supply from the unit. S1 includes a 240V neon and so the switch illuminates when the power is switched on. The primary circuit is fused by FS1 which will melt if a fault causes an excessive current to be drawn.

A 20VA mains transformer (T1) is used which actually had two primary windings (0-110V and 0-130V) on the prototype; these are connected *in series* to enable it to operate on 240V a.c. Your own version might already have a 240V primary which is then simply connected straight to FS1/ S1b. The *secondary* has twin windings, rated 15V a.c. 0.66A each. By connecting the winding in *parallel*, a rating of 15V a.c. 1·32A can be obtained, which gives a *total power rating* of 20VA.

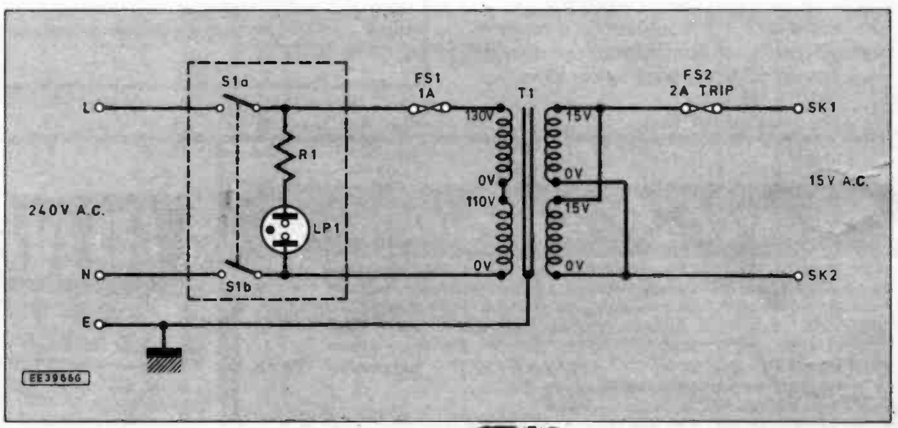
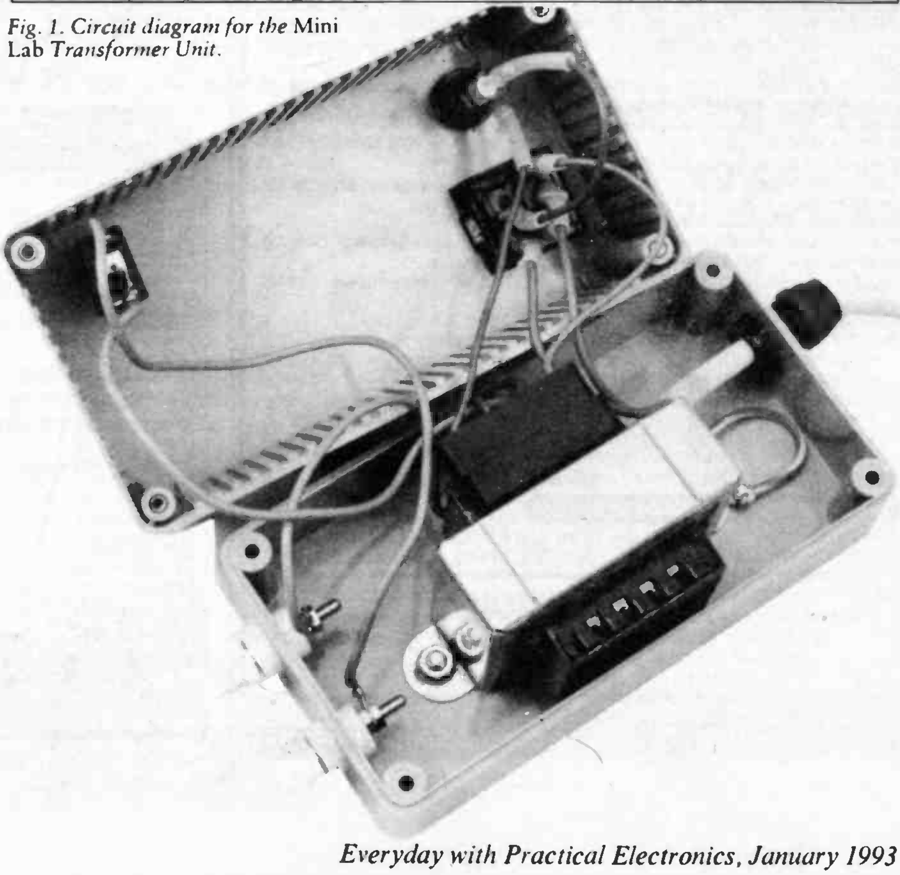


Fig. 1. Circuit diagram for the Mini Lab *Transformer Unit.*



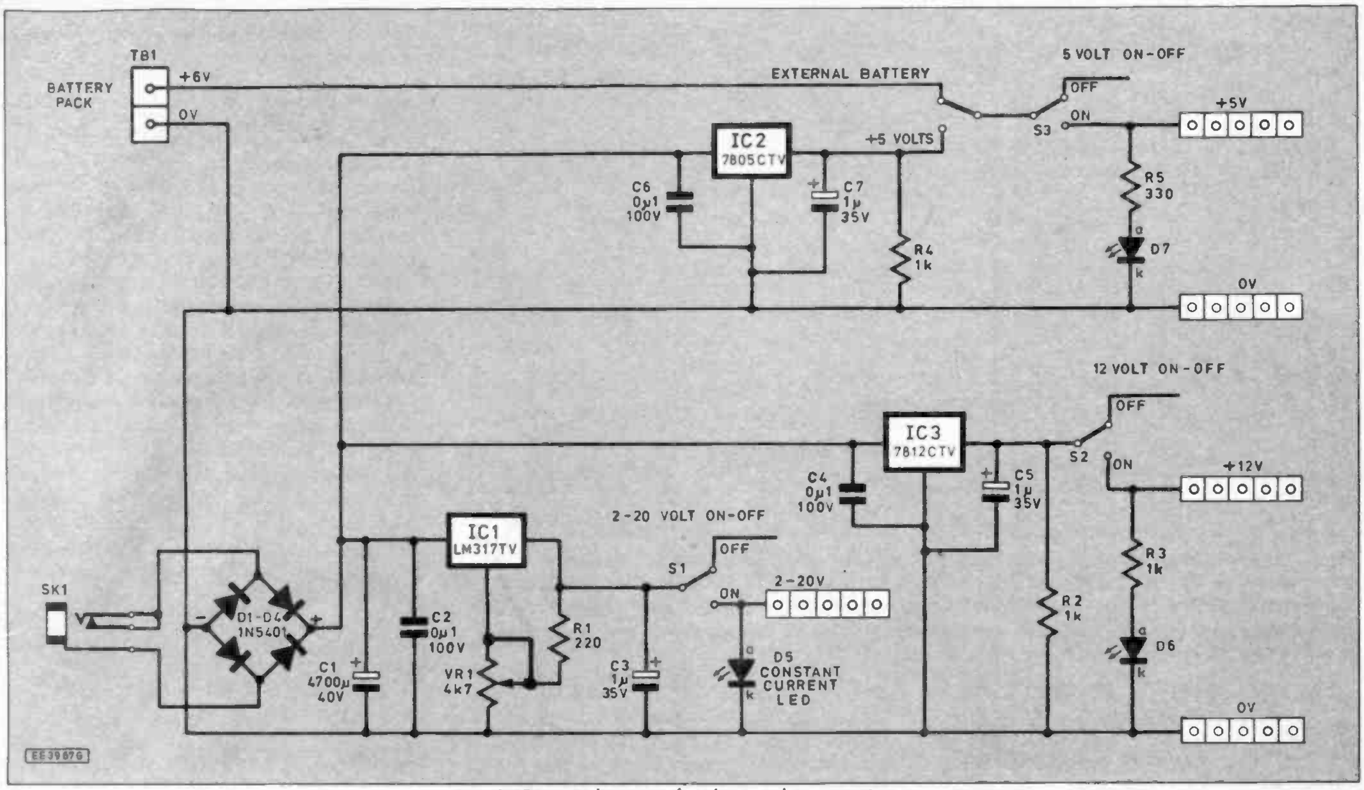


Fig. 2. Circuit diagram for the regulator section.

It is *crucial* that the secondaries are connected properly: 0V to 0V and 15V to 15V as shown. **It is dangerous to wire them incorrectly.** The resultant 15V a.c. (with 1·32A available) is connected via FS2, a 2A thermal resettable trip, to SK1 and SK2 which are two 4mm output terminals. FS2 will interrupt the low voltage supply in the event of an over-current fault. A twin-core lead connects the 15V a.c. to the power inlet on the *Mini Lab*.

The Earth input is to be connected to the mounting frame of T1, so that if for any reason the mains winding should short to the transformer core (perhaps the insulation fails) then a large current will flow to Earth and melt FS1, thereby disconnecting the mains supply. It also prevents the transformer mounting bolts from becoming "live".

REGULATOR SECTION

The circuit diagram of the Power Supply section to be assembled on the *Mini Lab* board is shown in Fig. 2. The 15V a.c. from the Transformer Unit connects via SK1 to four heavy-duty rectifiers D1 to D4 which together form a bridge rectifier. These rectify the 15V a.c. and C1 is a large electrolytic smoothing capacitor, which smoothes out the bridge rectifier output to give about 21V d.c. off load, as measured.

IC1 is an LM317 variable voltage regulator, the output voltage of which is determined by VR1. S1 switches the variable output on or off, and D5 is a **constant current l.e.d.** which illuminates when the supply is more than about +2V. Note D5 does **not** need a series limiting resistor.

IC2 is a +5V regulator i.c., the output from which is switched on or off by S3, D7 illuminating accordingly. Likewise IC3 is a +12V regulator whose output is switched by S2 and D6 lights when the +12V rail is switched on. An on-board selector shorting plug – already fitted in Part One – is employed to choose whether "EXTERNAL BATTERY" or "+5 VOLTS" is to appear at the +5V/+6V distribution socket strip: this precaution prevents both the 6V battery and 5V supply from ever being connected together.

Note that all three regulators are short-circuit proof and include thermal shutdown, and will automatically limit the current to a safe value (about 1A) in the event of an excessive load being applied. Ultimately, FS2 will trip out if an excessive total current is demanded from the secondary of the transformer. The extra capacitors distributed around the circuit may seem to have no function, but in fact they help to eliminate any spikes and "noise" which improves overall performance.

MINI LAB – COMPONENTS

Note, a small number of components are shown on the Power Supply *circuit diagram* which were actually fitted to the p.c.b. in Part One – so to avoid duplication, they are **not** repeated in this Parts List which details the part required for Part Three only.

See SHOP TALK Page

Resistors

R1	220
R2 to R4	1k (3 off)
R5	330

All ¼W 5% carbon film

Potentiometer

VR1 4k7 0·25W horizontal preset and thumbwheel.

Capacitors

C1	4700µ p.c.b. electrolytic 35V (Panasonic TSU series) 10mm pitch snap in terminals.
C2, C4, C6	0µ1 (100n) polyester 5mm pitch (3 off)
C3, C5, C7	1µ tantalum 35V (3 off)

Semiconductors

D1 to D4	1N5401 rectifier (4 off)
D5	**Constant current** l.e.d.
D6, D7	0·2inch l.e.d. (2 off)
IC1	LM317T regulator TO-220
IC2	L7805CV +5V 1·5A fixed regulator TO-220
IC3	L7812CV +12V 1·5A fixed regulator TO-220

Miscellaneous

S1, S2	S.P.D.T. sub-miniature toggle (2 off)
SK1	2·5mm p.c.b. mounting power inlet

Heatsink, 5·8 deg C/Watt TO-220, p.c.b. solder-in type (3 off); TO-220 fixing and insulating kit (3 off); s.i.l. turned pin sockets (15 off) (+5V and 0V already installed in Part One).

TRANSFORMER UNIT

Miscellaneous

T1	Chassis mounting 20VA mains transformer, 240V primary, 0V-15V 0·6A and 0V-15V 0·6A twin secondaries
S1	Mains d.p.s.t. plastic rotary or rocker switch with built-in neon
FS1	1A 20mm fuse with panel-mounting safety fuseholder
FS2	2A panel-mounting thermal resettable trip
SK1, SK2	4mm yellow terminals (2 off)

All-plastic box 150mm x 80mm x 76mm. A sturdy type is required in view of the mass of the transformer; 4mm yellow plug (2 off); 2·5mm d.c. power plug; one metre 6A 3-core mains cable; one metre twin-core figure-8 cable; cable gland; nuts; bolts; feet etc.

Price **£34** Approx

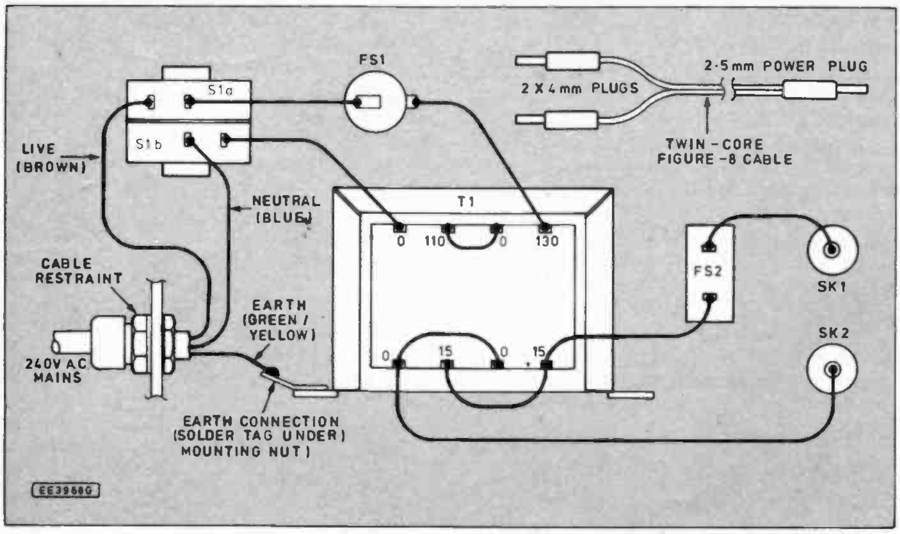


Fig. 3. Transformer Unit wiring diagram. The transformer is to be earthed as shown and no other metal fittings are permitted. If the specified switch S1 is used, then the terminals are numbered as shown. All wiring is completed with 6A cable.

CONSTRUCTION

The Transformer Unit assembly is shown in Fig. 3, and is to be constructed in an **all-plastic** box *only*. The size depends on the dimensions of your own transformer, but we recommend a box which measures 150 × 80 × 76mm and should accommodate most 20VA transformers.

Commence by preparing the box to accept the switch and fuses. Drill holes of the appropriate diameter, carefully filing them out to shape if necessary. The recommended "all-plastic" mains rotary switch incorporates a neon and requires a square cut-out about 26 × 26mm – other types can be used but the cut-out needs to be shaped accordingly. A separate double-pole switch and neon could be utilised also, if desired.

Prepare the case to accommodate the mains cable inlet and the two 4mm terminals. You **MUST** ensure that when the box is assembled, no parts mounted on the box will touch or interfere with the transformer inside, and that everything fits together neatly – so choose the positioning of the parts with care. For safety reasons, no metal fittings (e.g. a metal toggle switch for S1) are permitted at all on the plastic box, apart from the transformer mounting bolts which are to be earthed.

Continue construction by following the interwiring diagram of Fig. 3. Use one metre of 6A, 3-core mains cable along with a cable restraint device (e.g. a "gland" or a p-clip with rubber grommet) to prevent the cable from being pulled out. The internal mains interwiring can be completed with further 6A cable, noting that the Earth input is soldered to a solder tag underneath one of the transformer mounting bolts. **If you have any worries or queries, refer to an experienced Tutor or competent electronics constructor for advice.**

TRANSFORMER CONNECTIONS

Close attention must be paid to the transformer connections so that the primary is wired for 240V operation, and that the secondary 15V windings are wired in parallel correctly – 15V to 15V, and 0V to 0V **only**. These connect to the 4mm output terminals with solder tags; alternatively, ordinary 4mm sockets can be used. It is also good practice to insulate all mains joints with either heat-shrink sleeving or p.v.c. sleeving if available.

Complete the Transformer Unit by fitting a three-pin plug, fused at 3A, to the mains cable, then fabricate the *Mini Lab* connecting lead using twin-core wire terminated with 4mm plugs at one end and the d.c. power plug at the other. Finish off by adding four non-scratch adhesive feet to the underside of the plastic box. Check out all interwiring most carefully, then test the unit by plugging into the mains and switching on – the neon indicator will illuminate. Measure the output voltage with your multimeter set to **A.C. Volts** which should read about 15V to 16V a.c.

MINI LAB ASSEMBLY

If the specified components are used, these will fit the *Mini Lab* p.c.b. directly with no problems whatsoever. Many of the components are polarity-conscious and it is **crucial** that they are connected the right way round or damage will result – especially the rectifiers (the stout leads of which must be gently bent with pliers to align with the board), the smoothing capacitor, which will snap into place, and the tantalum bead capacitors. The silk-screen printing on the board clearly shows the orientation of all devices. Follow it closely (see Fig. 4).

It is best to fit the smaller components to the board first, following on with the

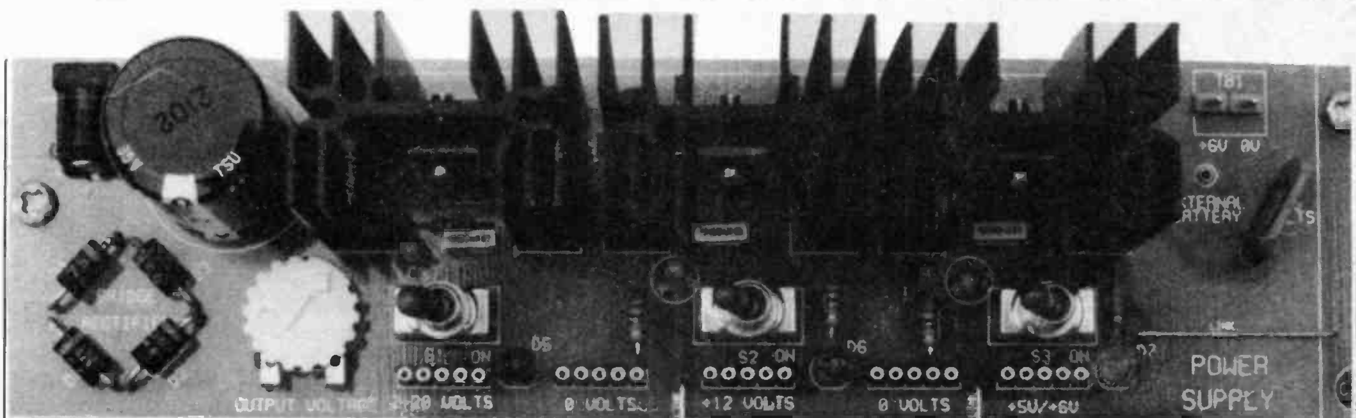
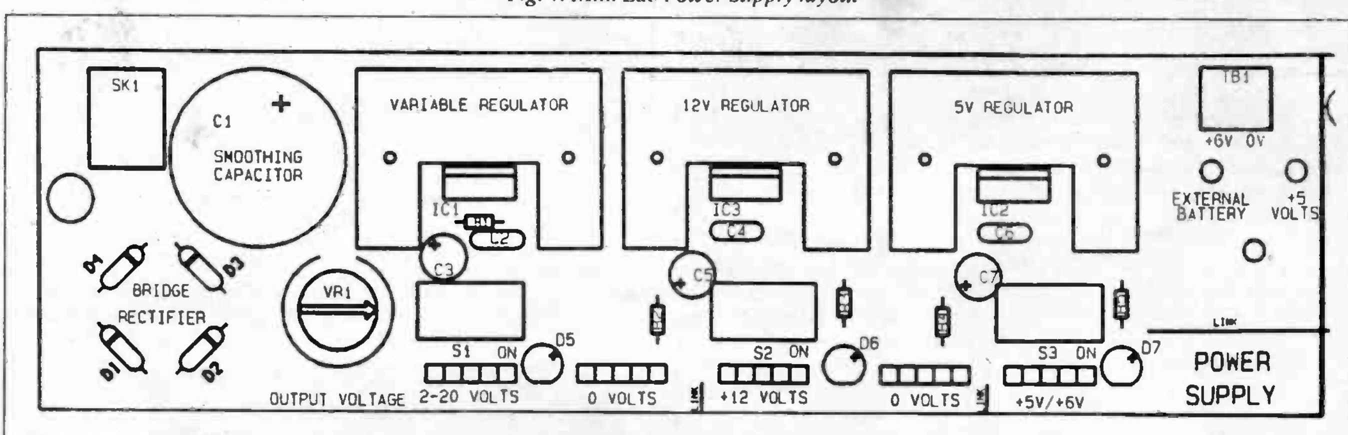


Fig. 4. Mini Lab Power Supply layout



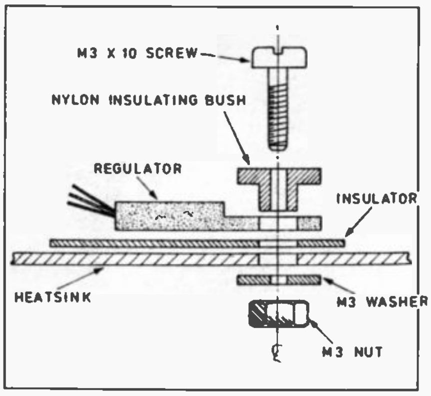


Fig. 5. Regulator mounting and insulating kit details. A standard "TO-220" fixing kit is used.

switches, heatsinks and lastly the smoothing capacitor. The three regulators are to be bolted to their heatsinks using an M3 fastener and TO220-type mounting kit which insulates the metal tabs of the devices from the heatsink (see Fig. 5). Mount the devices onto their respective heatsinks *first* before fitting the assemblies to the board. The *only* way you will manage to solder the recommended heatsinks to the p.c.b. is with a large tip iron, rated at say 25 watts. A fine-tip iron will not be adequate, and the heatsinks *must* be completely flush against the board prior to finally being soldered into place.

Readers should actually have little difficulty with assembly providing that care is exercised so that neither the board nor the components are damaged through excess heat. With assembly completed, check that all components are correctly orientated, and inspect the soldering carefully, looking for dry or incomplete joints and shorts between adjacent solder pads.

TESTING

Now connect the Transformer Unit to the Mini Lab a.c. inlet socket and switch on the mains: check that the +5V and +12V outputs function by measuring their outputs with your multimeter – the l.e.d. indicators should illuminate when the appropriate toggle switch is closed. Test the output of the variable regulator the same way, by rotating the voltage control – the output should be from 1·25V minimum to approximately 18V d.c. Finally, don't forget to set the selector plug to "+5V" to disconnect the battery pack. The *Mini Lab* L.E.D. Voltmeter actually operates from the +5V supply – try using it to measure the output voltages from your new Power Supply section which is now ready for use.

As your *Mini Lab* continues to grow, it becomes important that you handle it in a way which avoids physically damaging the components. The best way is to hold the unit by the breadboard(s), thumb on top and fingers underneath where there are no solder joints. Finally, you should expect the +5V regulator heatsink to often become warm or hot in operation: this is normal and there is no need to worry. The other regulators may also occasionally warm up in use.

Next Month: Signal Generator.

READOUT

THE CATS WHISKERS!

Dear Ed.,

I am writing to say how much I enjoy your magazine, which I have been reading for a goodly number of years.

I first became interested in radio as an 11-year-old lad before the war. I graduated from crystal sets to one valve reflex circuits, and thence to short wave radios, and all sorts of other noise producing devices!

Pending joining the RAF I worked in the local radio shop in the early part of the war. I served my apprenticeship charging accumulators and eventually repairing domestic radios.

I took a Monthly Radio Servicing correspondence course, which enabled me to understand the theory, the practical aspects were nicely covered by the many and varied faults on radios bought in for repair!

The early war years with the shortage of components (and skilled technicians), gave me the opportunity to learn a great deal about fault finding, improvisation, and repair of the domestic radio, and record player (radiogram in those days). It was a marvellous grounding, and the diagnostic skills learnt have stood me in good stead.

I joined the RAF in 1943 and again good fortune came my way in the shape of a basic radio/electronics course, and then four months airborne radar training. War or no war I enjoyed servicing airborne radar, and was associated with IFF, ASV, H2S, radio altimeter, etc., names which are now consigned to the history books, but though the technology is now solid state, the principles in many instances remain the same.

After the war I had the opportunity to go back to civvy radio (as it was called), but this seemed a retrograde step and I looked for something different, but of course still in radio or electronics.

Once again I was blessed with good fortune and I found a job with the Government in communications, (back to my first love, the superhet!), this was like doing your hobby, and being paid for it!

Now in retirement I have my *Everday Electronics* – what more could a man want?

It is interesting to note that those who have spent a life time with analogue equipment, find digital circuitry rather uninteresting. I suppose because it either works or it doesn't.

Alas the march of time – the analogue men like old soldiers will slowly fade away until the aerial socket and the loud speaker are the only analogue devices left! But not yet, so please don't give up on the analogue projects!

One final aside, whilst visiting Portugal in October I was looking for an English newspaper at a small newsagents shop, and I noticed a familiar cover, yes, the October issue of *Everyday Electronics*, what's more a week later they had the November issue.

Keep up the good work, the cats whisker brigade is still with you (just)!

Mr. P. W. Warwick
Cheltenham

WELCOME BACK

Dear Ed.,

Having taken Practical Electronics from the first issue in 1964, I was on the verge of finally cancelling when you brought out *Everyday with Practical Electronics*.

Welcome back to the original and worthwhile style of interesting hobby electronics in place of simply being a Computer/TV/Hi-Fi catalogue.

I appreciate the change to what seems like the original format and now look forward to reading it regularly again.

Stephen H Alsop
Managing Director
S&S Systems Ltd., Sheffield

THAT MNEMONIC

Dear Ed.,

The letter published in *Readout* of the December issue from Councillor Des Loughney about the resistor mnemonic. I would agree with the editors comments, I do not know how many similar complaints there have been but as someone at the sharp end of education and not on a committee, I can assure the councillor and his constituent that there are far worse mnemonics out there in the public domain and most if not all compiled by students.

My alternative which is non-sexist, non-racist, non-political and which gives my age away is:– Bye Bye Ruth On You Go (to) Birmingham Via Great Western

J. Stubbs (Lecturer)
Coventry

Thanks, this one (or similar versions) seems to be very popular, please keep other versions coming.

INTERFACE

Robert Penfold

PROBABLY everyone involved in computing occasionally has problems interconnecting two pieces of equipment via RS232C serial interfaces. It is a subject which seems to bring in a steady trickle of letters from readers in difficulty, and is certainly something that has caused me a few headaches over the years.

There are standard methods of connection which will give the desired result in most cases. It is certainly a good idea to try one of these before buying an RS232C breakout box and testing every possible combination of interconnections in an attempt to find one that works!

Pin Assignments

In an ideal world there would be no problems with serial interconnections, and a single type of lead would successfully wire together any two RS232C equipped units. In reality this is not possible since various types of connector are currently used for RS232C ports. There is in fact a standard RS232C plug/socket, which is the 25-way D-type. However, in practice there are plenty of computers, etc. which do not use this type connector, or which use the right type of connector with a non-standard method of connection.

This is not the main problem though. The connections required between two units depends on what the two units actually happen to be. A method of interconnection which works fine for a computer and a modem is unlikely to give the desired result if it is applied to a computer and a printer. You therefore have to select the right method of interconnection for the two types of equipment you are dealing with.

The pin assignments for a standard RS232C port are shown in Fig. 1. From time to time I am asked whether this type of diagram shows an outside view, or the port as seen looking from within the computer (or whatever). The convention is for ports to be shown as outside views, not "computer's eye" views. This would seem to be the logical method, since this shows the port the way you normally see it. A few manufacturers (including Sinclair) have not stuck to this convention though.

Pin Numbers

If in doubt, remember that virtually all multi-way computer and audio connectors are marked with pin numbers, and that referring to these will make it clear which pin is which. However, unless you have exceptionally keen eyesight you will need a magnifier in order to read the pin numbers. Without the aid of a magnifier you might not even be able to see that the numbers are there!

With a 25-way connector having only two pins unused, there are obviously some 23 different pin functions on a full RS232C port. In reality most of these are simply not implemented on most RS232C ports. At least five lines are needed for two way communications with handshaking, and many ports have about eight or nine lines actually implemented.

The most important lines are the ones carried by pins two to eight, and by pin 20. Most of the others are secondary lines (presumably to act as back-ups in the event of a damaged cable), and lines that are only needed for synchronous serial links. In a computer context you are only likely to encounter asynchronous links, where there are no lines devoted to carrying clock or other timing signals.

Serial Ports

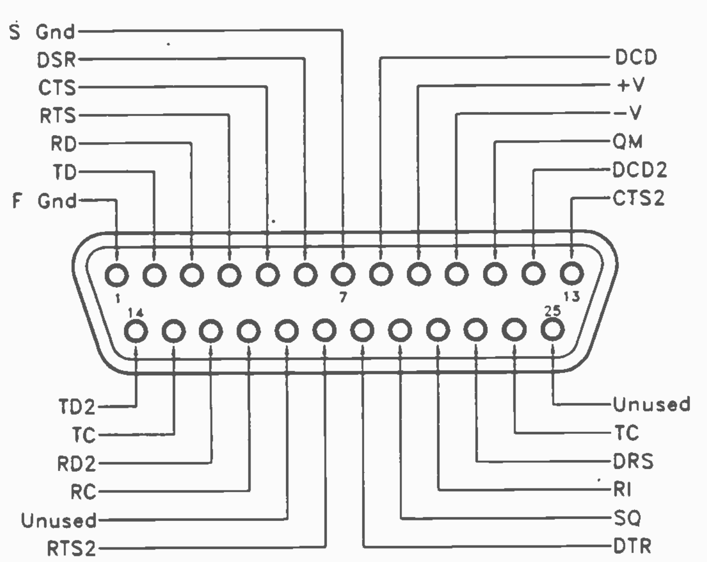
The serial ports of most modern computers, printers, etc. use a 25-way D-connector with the standard pin assignments. A wide variety of connectors are used for the serial ports of older computers. Where a different type of connector is utilized the equipment is (or was) often supplied with an adaptor so that standard RS232C leads can be used with the equipment.

For example, many PCs have nine pin D-connectors for their serial ports, but are supplied complete with nine to 25 pin "pigtail" adaptor leads. The popularity of the PC is such that the adaptors are not always needed. RS232C leads having nine pin D-connectors (or both 25 pin and nine pin D-connectors) are readily available. Fig.2 shows the pin assignments for the nine pin PC serial port.

Where a PC has a 25-way connector for its serial port, it is unlikely that anything more than these nine functions will be implemented. In fact no computer RS232C port is likely to have anything beyond these nine functions.

Missing Link

It is worth pointing out that a serial link can only work properly if the units at both ends of the system are set to operate



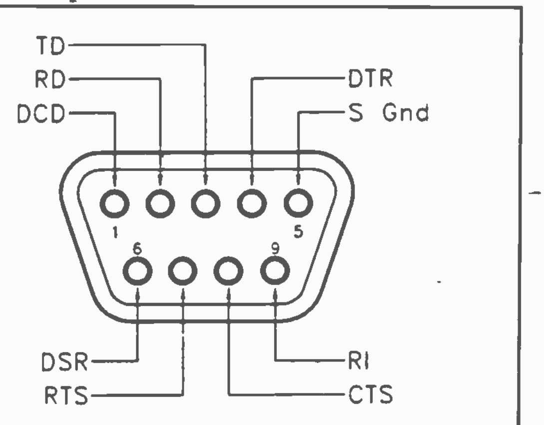


Fig. 2 (above). Pin assignments for the PC AT 9-pin RS232C D-connector.

Fig. 1 (left). Standard RS232C pin assignments. Most practical RS232C ports only implement about five to nine of these functions.

using the same baud rate and word format. Getting either of these wrong is likely to produce scrambled data, or the receiving device might detect that the data is being decoded incorrectly and simply refuse to do anything. At the computer end of the system the baud rate and word format are set using operating system commands. For instance, the MS/DOS Mode command for a PC, or *FX commands for a BBC computer.

Remember that most applications software has a setup program or a facility within the program which enables the baud rate and word format to be controlled. The applications program will override any serial interface parameters setup using the operating system.

With printers, plotters, etc. there are the rows of d.i.p. switches to contend with, or possibly a liquid crystal display and a number of push-buttons. Either way you will probably need to read the manual very carefully in order to get everything set up correctly.

The most basic type of two-way link requires three connecting wires (Fig.3). This system has just a ground connection, plus cross-coupling of the RD (receive data) and TD (transmit data) terminals. This setup is sometimes used for computer to computer communications, and can occasionally be used to connect a computer to a peripheral device such as a printer.

There is clearly no hardware handshaking, but some systems rely on implementing the handshaking using codes sent via the RD-TD links. In other cases there is no need for handshaking because the receiving device can easily keep up with a continuous flow of data. If you try this method and the result is large chunks of missing data, then the problem is almost certainly due to missing links between the pins which carry the handshake signals.

Handshaking

For computer to computer communications with hardware handshaking the method of interconnection shown in Fig.4 will usually give good results. Two handshake lines are needed; one to control the flow of data in each direction. Matters are complicated by the fact that there are two sets of handshake lines on an RS232C port. Hence this setup has the RD and TD lines cross coupled, plus two sets of handshake lines which are also cross coupled.

In my experience it is DTR (data terminal ready) and DSR (data set ready) that are of importance in a computer context. However, it is advisable to play safe and also link the RTS (request to send) and CTS (clear to send) pins.

For a link between a computer and a printer or plotter the method of connection shown in Fig.5 is usually successful. The data link from the printer back to computer may seem to be superfluous, but it might be needed for software handshaking. Also, some printers and plotters have the ability to send data of some sort back to the computer (although this facility seems to be little used in practice).

The hardware handshaking is something less than straightforward, with some odd cross coupling and the DCD (data carrier detect) terminals being brought into action. Just why this should be necessary I am not entirely sure.

The DCD pins are inputs, but this function does not seem to be implemented on many modern printers. Even where it is implemented, the manual for the printer or plotter often seems to indicate that this input is largely ignored, and its precise function is not given. Does anyone know the purpose of the DCD line in a printer interfacing context?

Anyway, the interconnections shown in Fig.5 usually provide the desired result. If not, then the straightforward method of Fig. 4 should give correct operation. If your computer has a very basic serial port with only one handshake output, connecting this to either CTS or DSR on the printer should give a properly controlled flow of data.

Straight Leads

The types of lead described so far are forms of null modem cable. This is where the cable has to provide cross coupling so that inputs connect to outputs, and outputs connect to inputs. RS232C interconnections are complicated by the fact that there are two types of equipment. These are data terminal equipment (DTE) and data communications equipment (DCE).

With the former the outputs are outputs, and the inputs are inputs. Data communications equipment on the other hand, outputs information from its notional inputs, and receives information on its notional outputs.

The basic idea is to have a DCE unit at one end of the system, and a DTE device at the other. The interconnections can then be provided a simple "straight" or "pin-to-pin" cable which provides the interconnections shown in Fig.6. Of course, the cross coupling is still present, but it is within the DCE interface and does not have to be provided by the connecting cable.

Few items of computer gear are of the DCE variety. The only common DCE units are modems, which almost invariably need a straight lead to connect them to the computer.

It is worth pointing out that some RS232C ports will not work properly if a handshake input is left unconnected. This is simply because the input will "float" to the hold-off state if it is left unconnected. Fortunately, most serial ports are designed so that data can flow uninterrupted if the handshake inputs are left "floating". In a few cases though, the handshake lines may need to be cross coupled even though they are not needed to regulate the flow of data.

One final point is that the outputs of RS232C interfaces should all include current limiting. Consequently, there should be no risk of damage occurring if you experiment with various interconnections, even if two outputs should be accidentally wired together.

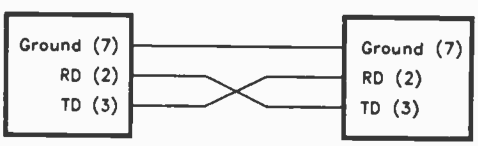


Fig. 3. Basic three wire link with no hardware handshaking.

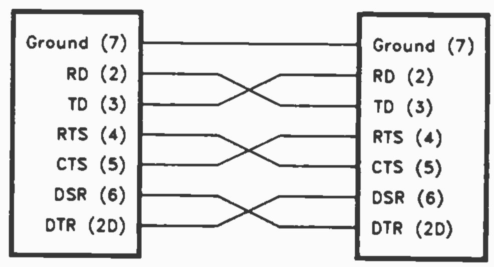


Fig. 4. Computer to computer link with handshaking.

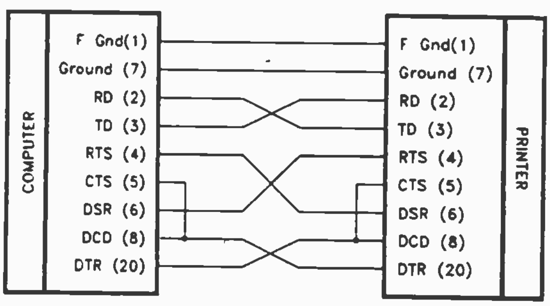


Fig. 5. The usual connections for a computer to printer link.

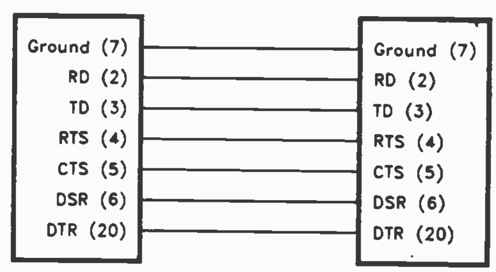


Fig. 6. A "straight" lead is needed to connect a DCE interface to a DTE type.

DOWN TO EARTH

George Hylton

DODGES WITH DIODES

Rosie bought an old valve radio because she'd fallen in love with its fifties-style plastic cabinet. It didn't work. "Can you fix it for me? I only ever listen to Radio 4, long wave." The solution to the problem involved using diodes in various ways. That's what this article is really all about.

The whole radio was dead. A quick look inside showed that some dabbler had been cutting cables and altering wiring.

A write-off! However, I had to hand an old car radio, whose only fault was a broken tuning dial. By clearing out some of the valve radio's components I could fit it inside the cabinet, tuned permanently to Radio Four. The only controls needed would be volume and on/off, and I could use the existing mounting holes for these, giving a fifties appearance but nineties reliabilty.

POWER SUPPLY

The old radio had a typical valve-type mains transformer (Fig. 1) with a high-voltage secondary for the high tension (HT) supply (about 300V) and a low-voltage, high-current winding delivering 6.3V a.c. for valve heaters and dial lamps. The transformer was well-built and still working. I wanted to retain it for the dial lamps, at least. Could it also be used to obtain 12V d.c. for the car radio?

A check showed that the car radio drew about 100mA, rising to about 500mA during loud passages of music. The four valve heaters in the old radio must have consumed at least an ampere between them. With no drain on the h.t. winding the transformer would hardly be overworked. Worth a try.

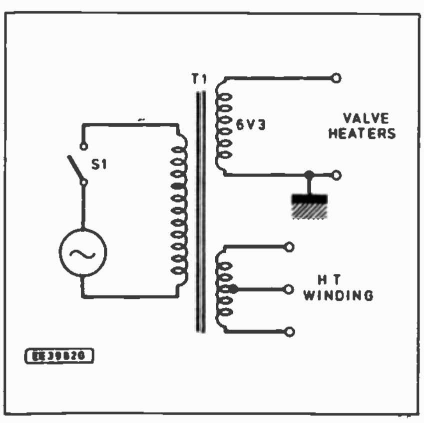


Fig. 1. Winding arrangement for a typical mains transformer for a valve radio. Some transformers have an extra low-voltage winding for the rectifier valve heater.

VOLTAGE DOUBLER

One side of the 6·3V a.c. winding was "earthed" to the metal chassis. To use the existing wiring of the dial lamps it had to remain earthed. This ruled out the use of a conventional voltage-doubling rectifier for making 12V d.c. from 6V a.c. However, the less usual "half wave" form (Fig. 2) would do, since it has a common ("earth") connection for both a.c. input and d.c. output.

In operation, first D1 charges C1 to the peak value of the a.c. input, minus the drop in D1. Since the peak is about 1·4 times the nominal (r.m.s.) voltage and the drop in D1 about 1V (for a single silicon diode) this gives about 8V d.c. Next, when the a.c. has the polarity shown in Fig. 2, D2 conducts. The available voltage is the a.c. input plus the d.c. stored in C1. Again, there is a voltage drop of about 1V in D2. The upshot is that C2 eventually charges to twice the peak a.c. voltage less 2V.

Since current is drawn from the a.c. source on every half cycle there is no d.c. through the transformer winding. With 6·3V a.c. input the d.c. output should be about 16V. In fact, it was 14V when driving a small car bulb which took about 0.5A, and about 17V when there was no load. Too much for the car radio, but enough to permit the use of a 12V stabilizer (7812). Satisfactory.

DIAL LAMPS

The old, burnt-out dial lamp bulbs were marked "6·5V". This was rather surprising. Designers normally use a higher-than-needed voltage (such as 8V), because there is still enough light output but a greatly extended life. Maybe the dabbler had inserted them. Unfortunately, I couldn't buy any 8V lamps where I was. The only bulbs available that fitted were rated at 6V, 1.8W., When tried, they shone with a bright whitish light – an indication that their life expectancy would be short.

The obvious safety precaution was to connect a dropping resistance in series with each bulb, to reduce the 6·3V to, say, 4V. The nominal current for a 6V, 1·8W lamp is 0·3A. To drop 2·3V at this current needs 78 ohms, and the resistor must dissipate 0·69W. At 4V the lamp current will be reduced, but not much, so a likely standard value is 82 ohms and for safety its rating should be above 0·69W, indicating 1W as the stock power rating. I didn't have any suitable resistors.

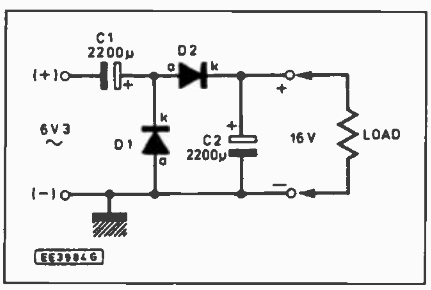


Fig. 2. Voltage doubling rectifier with common input and output line.

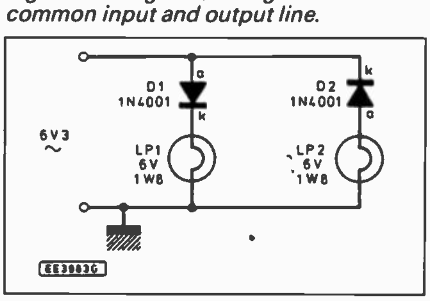


Fig. 3. Using diodes for sharing current between two lamps.

What to do? I could wire the bulbs in series, so that each received half the voltage. Experience told me that this is not a good idea. If one lamp drops more voltage than the other is glows brighter. It might match the lamps initially, but if one failed and was replaced by something slightly different the variation in brightness would appear.

Why not connect a diode in series with each lamp? This would conduct on alternate half-cycles, roughly halving the current. There would also be the diode drop of around 1V, so the voltage would be reduced too. I had plenty of small rectifier diodes so this solution was adopted (Fig. 3).

To avoid passing d.c. through the 6·3V winding the diodes were connected with opposite polarities. So D1 conducts on one half cycle and D2 on the next, with current in the reverse direction. There is no net d.c. through the winding, only a jerky sort of a.c.

MAGIC EYE

The old radio had a "magic eye" tuning indicator. This was in effect a miniature cathode-ray tube. A segment of its screen lit up. By applying the receiver's a.g.c. voltage to a deflector plate the area of the illuminated segment varied with signal strength. This enabled you to tune properly.

Removing the magic eye left a gaping hole in the front panel. It had to be filled with something, preferably decorative. I decided on a cluster of four red l.e.d.s. They wouldn't do anything, but at least they look nice. They could have been driven from the 12V supply via a dropping resistance.

However, l.e.d.s are rectifiers so can generate their own d.c. from an a.c. input. They won't stand much reverse voltage, so the thing to do is connect them in parallel-reverse-polarity (Fig 4). The reverse voltage of one pair is then limited to the forward voltage of the other.

A common dropping resistance limits the a.c. Each pair of l.e.d.s receives on average half the current, and R1 can be chosen to limit this to what the l.e.d.s can stand. Note that the peak current is quite high. My l.e.d.s dropped about 1·6V, so that each series pair dropped 3·2V.

The available peak voltage, after deducting this drop, is 5·7V and with 150 ohms the peak current is 38mA. The average current for either series pair is less than half this. To be on the safe side, assume it is half and choose R1 accordingly. Most l.e.d.s will stand 10mA, many 20mA and some even more. When in doubt use a low value for the current.

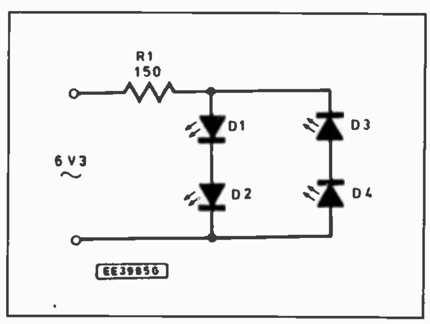


Fig. 4. Working l.e.d.s from an a.c. supply. Single l.e.d.s may be used instead of series pairs.

BARGAINS – Many New Ones This Month

THIS MONTH'S SNIP is a 250 Watt Toroidal Transformer which has tapped mains input and 3 secondaries: 230V 1 amp 20V and 6V but if these voltages are not quite what you want it is very easy to add an extra winding, 4 turns adds or subtracts 1 volt. You can also use this as a 250 watt isolation. Price only **£10** but it's heavy so please add **£2** carriage if not collecting. Order Ref. 10P97.

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20W 4 OHM TWEETER also made by Goodmans for Ford, mounted on a baffle but easily unscrewed from this. Yours for **£1.50**, Order Ref. 1.5P9.

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WHERE YOU UNLUCKY during any of the cold spells? Did any of the pipes in your loft freeze and then burst? Some friends of ours were away at the time and had ceilings come down. It could be just as cold this winter but you can avoid pipes freezing by winding our waterproof heating wire around them. Operating cost, even without thermostat, is only a few pence per week. 15m length consumes about 25 watts. This is the length we recommend for the normal house and the cost is **£5.00**, Order Ref. 5P109. Or, if you want specified length, send **35p** per metre.

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AMSTRAD KEYBOARD MODEL KB5. This is a most comprehensive keyboard, having over 100 keys including, or course full numerical and qwerty. Brand new, still in maker's packing, **£5**, Order Ref. 5P202.

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INSULATION TESTER WITH MULTIMETER internally generates voltages which enables 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. These instruments are ex British Telecom but in very good condition, tested and guaranteed OK, probably cost at least £50 each, yours for only **£7.50**, with leads, carrying case **£2** extra, Order Ref. 7.5P/4.

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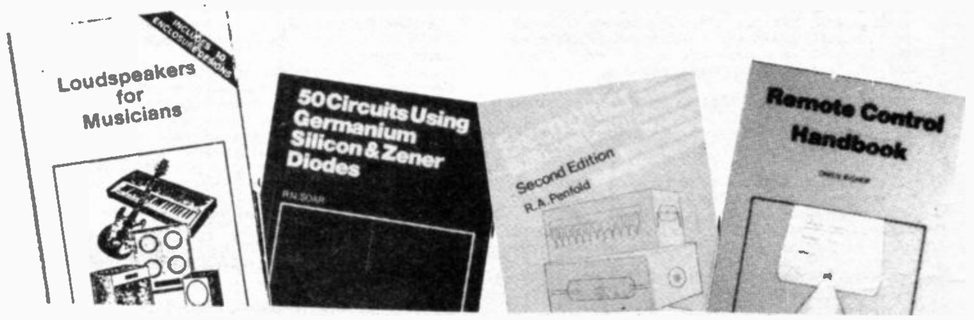

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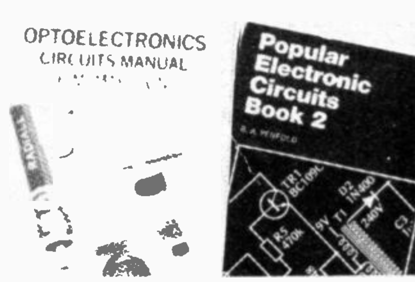

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Superhet Broadcast Receiver/Tuner/Amp		679/680	£4.22

PCB SERVICE

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Digital Experimenter's Unit – Pulse Generator	682	£4.46
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Weather Stn: Rainfall/Sunlight Display	685	£4.27
Rainfall Sen and Sunlight Sen	686/687	£4.16
Amstrad Speech Synthesiser — MAY '90	689	£4.68
80 Metre Direct Conversion Radio — JUN '90	691	£4.95
Mains Appliance Remote Control — JUL '90		
Encoder Board A	694	£6.61
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The Tester	696	£4.15
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Mains ON/OFF Decoder	697	£4.55
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Simple Metronome	698	£3.94
Hand Tally: Main Bd and Display Bd — SEP '90	699, 700	£10.95
Alarm Bell Time-Out	701	£4.10
Mains Appliance Remote Control		
Temperature Controller (p.c.b. only)	702	£5.20
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LM723 Module	713	£4.21
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Teach-In '91 Part 8 – Light Sensitive Switch	761	£4.74
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BALLOON RADIO

There seems to have been quite a stir in Victoria, Australia, last May when the Shepparton & District Amateur Radio Club launched a weather balloon with a radio transmitter and computer aboard which broadcast on the 2 metre band, by voice, every minute.

The transmissions gave the time since launch; outside and inside temperatures; altitude; and rate of climb. Amateurs over a wide area monitored and recorded the transmissions and over a hundred reports were received by the club, with the best over a distance of more than 1,200km.

Gil Griffith, VK3CQ, was about 180km from the launch and has sent me a print-out of his observations from the time he first picked up the transmissions 53 minutes after launch, when the balloon was at 23,000ft.

His observations record that it reached 66,000ft after 2hrs 18min before bursting and descending by parachute. His last full entry is at 2hrs 50min when the parachute was at 32,660ft and signal strength was down to S1 and fading. It landed at about 3hrs 20min and after three days was found by a search party in a tree in New South Wales with the radio package intact and in good condition.

Gil's print-out is quite fascinating. Apart from recording the vagaries of the flight, particularly in the last half-hour as the balloon struggled to reach maximum height, it shows some interesting variations in signal strength as the flight progressed. This gradually increased to S9 at 29,330ft dropping to S2 at 32,660ft. By 45,000ft it had worked up to S9 again, remaining almost constant at this level up to 65,000ft apart from a drop to S5 between 55-58,000ft, going down to S5 again at maximum height.

Gil's set-up for receiving the signals was quite straightforward. He used a hand-held transceiver with a quarter wave ground plane antenna, switching to a 10 element horizontal beam to obtain compass bearings for his report.

It must have been quite exciting following the progress of the balloon and recording all this information. This is the sort of experimental activity many radio amateurs love to get involved in, and of course short-wave listeners can do the same thing without a transmitter.

ESPERANTO STATION

The latest newsletter of ILERA, the International League of Esperantist Radio Amateurs (or, to give its proper name, the Internacia Ligo de Esperantistaj Radio Amatoroj), reports that a Special Event amateur station, OE1XEW, was operated from the 1992 Esperanto Congress in Vienna which was attended by over 3,300 people from 69 countries.

The station was operated by Esperanto speaking amateurs from Germany, Austria, Italy, France and England, and made about 200 contacts of which about a quarter were in Esperanto.

ILERA aims to encourage the use of amateur radio by existing Esperantists and to encourage existing radio amateurs to learn and use the language. If you want to hear what Esperanto sounds like, look out for the ILERA nets on Tuesdays at 1430hrs on 7066kHz; Wednesdays at 0830 on 3764-3770; and Sundays at 0745, also on 3764-3770 (clearest frequency). All times are UK local.

For more information about ILERA, write to Barry Foreman G0EXS, 10 Wilmington Close, Brighton BN1 8JE. For information about Esperanto itself, contact The Esperanto Centre, 140 Holland Park Avenue, London W11 4UF. Tel: 071-727 7821.

MONITORING AT BALDOCK

The annual report of the Radiocommunications Agency (RA), referred to in my November column, mentions the work of the Agency's Radio Monitoring Station at Baldock in Hertfordshire.

This station's main purpose is to investigate and clear interference to international radio services, especially those concerned with safety of life, and to monitor the use of the spectrum.

It covers all frequencies from 9kHz to 18Ghz and undertakes direction finding, frequency measurement and signal analysis, and measurement of field strength and spectrum occupancy. For direction finding it obtains cross bearings from suitably located stations run by other national administrations which, like Baldock, are members of the International Monitoring Service.

Of particular concern to amateurs is the importance attached to identification of allocated frequencies which are under-used, to improve spectrum usage planning. There has long been a saying in the amateur world, "If you don't use it, lose it!", and this is an increasing possibility in the face of today's intense demand for more spectrum by all services.

The station is in three parts. A terrestrial monitoring station, principally concerned with frequencies up to 30MHz, which is continuously manned, and during 1991/92 had a success rate of 97 per cent for clearance of complaints of persistent interference.

A second part comprises mobile teams which systematically monitor usage of the PMR (Private Mobile Radio) bands on a national basis, interference to terrestrial services and satellite earth stations, continental interference, and carry out other tasks such as data/speech comparison and propagation studies.

The third part is the satellite monitoring station which was built to monitor communications satellites but nowadays also monitors the broadcast satellites.

RIS

Another interesting aspect of the work of the RA, covered in its Annual Report, is the Radio Investigation Service, the objective of which is to ensure that authorised radio users within the UK can operate without undue interference. This is achieved by ensuring that licensed users, including radio amateurs, adhere to the conditions of their licences, and by taking action, where necessary, against those who disregard the rules.

In 1991/92, the RIS inspection programme included aeronautical and marine radio, fixed services, broadcasting, paging and hobby radio. In the space available here, this bare outline cannot do justice to the surprisingly wide range of radio services and users covered by the RIS, and the importance of their work in protecting the radiocommunications of the emergency services.

VIDEOS AVAILABLE

Two videos from the RA, however, vividly bring to life the work of both the Monitoring Station and the RIS, and are well worth seeing. These are *The Listening Ear - A look at Baldock Monitoring Station*, and *In Touch - A look at the R.I.S.*, each around 10-12 minutes.

Although short, they show the impressive highly sophisticated equipment used by both services and provide interesting examples of the work involved, packing a great deal of information in the time they have. I found them both fascinating and illuminating.

These videos can be borrowed for short periods free of charge by amateur radio clubs, or other bona fide interested groups. Written requests should be sent to the Radiocommunications Agency Librarian, Room 605, Waterloo Bridge House, Waterloo Road, London SE1 8UA. Tel: 071-215 2352 for enquiries or further information.

AMATEURS HELP SHUTTLE

On September 18, a small battery-powered amateur radio transceiver successfully linked astronauts with NASA Mission Control after computers handling official communications at White Sands in New Mexico failed briefly, plunging the shuttle into a temporary communications blackout.

The onboard 2-metre transceiver was part of the Shuttle Amateur Radio Experiment (SAREX) used by astronauts to talk to school children and licensed amateurs on earth. Mission Control in Houston asked amateur operators in the nearby SAREX control room to transmit a message to Astronaut Jay Apt, N5QWL. This was relayed via an Australian amateur who was standing by for a scheduled shuttle contact at Queensland University of Technology. *(W5YI Report)*.

PRACTICAL ELECTRONICS INDEX – 1992

Volume 28 January 1992 to October 1992

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