MAY 1991

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

£1.50

SPECIAL

SAFETY AT HOME PROJECTS

SMOKE ALARM REPEATER

PASSIVE INFRA-RED REPEATER

PERSONAL STEREO POWER INDICATOR

NEW SERIES MODULAR DISCO LIGHTS PROJECT

ISSN 0262-3617

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The No.1 Magazine for Electronics & Computer Projects

HIGH POWER AMPLIFIER For your car, it has 150 watts output. Frequency response 20HZ to 20 KHZ and a signal to noise ratio better than 60db. Has builtin short circuit protection and adjustable input level to suit youe existing car stereo, so needs no pre-amp. Works into speakers ref 30P7 described below. A real bargain at only £57.00 Order ref 57P1.

HIGH POWER CAR SPEAKERS. Stereo pair output 100w each. 4ohm impedance and consisting of 6 1/2" woofer 2" mid range and 1" tweeter. Ideal to work with the amplifier described above. Price per pair £30.00 Order ref 30P7.

PERSONAL STEREOS Customer returns but complete with a pair of stereo headphones very good value at £3.00 ref 3P83.

2KV 500 WATT TRANSFORMERS. Suitable for high voltage experiments or as a spare for a microwave oven etc. 250v AC input. £10.00 ref 10P93

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. £6.00 ref 6P18

FIBRE OPTIC CABLE. Stranded optical fibres sheathed in black PVC. Five metre length £7.00 ref 7P29

12V SOLAR CELL. 200mA output ideal for trickle charging etc. 300 mm square. Our price £15.00 ref 15P42

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 wall brackets, bulb holders etc. Brand new and guaranteed. £25.00 ref 25P24.

Pack of two PAR38 bulbs for above unit £12.00 ref 12P43

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 15P39 Suitable mains adaptor £5.00 ref 5P191

FM TRANSMITTER housed in a standard working 13A adapter (bug is mains driven). £26.00 ref 26P2

MINATURE RADIO TRANSCEIVERS. A pair of walkie talkies with a range of up to 2 kilometres. Units measure 22x52x155mm. Complete with cases. £30.00 ref 30P12

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 15P42A

10 BAND COMMUNICATIONS RECEIVER. 7 short bands, FM, AM and LW DX/local switch, tuning 'eye' mains or battery. Complete with shoulder strap and mains lead. £34.00 ref 34P1

WHISPER 2000 LISTENING AID. Enables you to hear sounds that would otherwise be inaudible! Complete with headphones. Cased. £5.00 ref 5P179.

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. £25.00 ref 25P21.

LOW COST WALKIE TALKIES. Pair of battery operated units with a range of about 150'. Our price £8.00 a pair ref 8P50

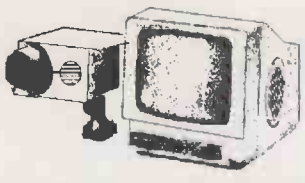
7 CHANNEL GRAPHIC EQUALIZER plus a 60 watt power amp! 20-21KHZ 4-8R 12-14v DC negative earth. Cased. £25 ref 25P14.

NICAD BATTERIES. Brand new top quality. 4 x AA's £4.00 ref 4P44. 2 x C's £4.00 ref 4P73, 4 x D's £9.00 ref 9P12, 1 x PP3 £6.00 ref 6P35

TOWERS INTERNATIONAL TRANSISTOR SELECTOR GUIDE. The ultimate equivalents book. Latest edition £20.00 ref 20P32.

CABLE TIES. 142mm x 3.2mm white nylon pack of 100 £3.00 ref 3P104. Bumper pack of 1,000 ties £14.00

VIDEO AND AUDIO MONITORING SYSTEM



Brand new units consisting of a camera, 14cm monitor, 70 metres of cable, AC adapter, mounting bracket and owners manual. 240v AC or 12v DC operation complete with built in 2 way intercom. £119.00 ref 119P1.

1991 CATALOGUE AVAILABLE NOW IF YOU DO NOT HAVE A COPY PLEASE REQUEST ONE WHEN ORDERING OR SEND US A 6"X9" SAE FOR A FREE COPY.

GEIGER COUNTER KIT. Complete with tube, PCB and all components to build a battery operated geiger counter. £39.00 ref 39P1

FM BUG KIT. New design with PCB embedded coil. Transmits to any FM radio, 9v battery req'd. £5.00 ref 5P158

FM BUG Built and tested superior 9v operation £14.00 ref 14P3

COMPOSITE VIDEO KITS. These convert composite video into separate H sync, V sync and video. 12v DC. £8.00 ref 8P39.

SINCLAIR C5 MOTORS. 12v 29A (full load) 3300 rpm 6"x4" 1/4" O/P shaft. New. £20.00 ref 20P22.

As above but with fitted 4 to 1 inline reduction box (800rpm) and toothed nylon belt drive cog £40.00 ref 40P8.

SINCLAIR C5 WHEELS 13" or 16" dia including treaded tyre and inner tube. Wheels are black, spoked one piece poly carbonate. 13" wheel £6.00 ref 6P20, 16" wheel £6.00 ref 6P21.

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 17P3.

SOLAR POWERED NICAD CHARGER. Charges 4 AA nicads in 8 hours. Brand new and cased £6.00 ref 6P3.

MOSFETS FOR POWER AMPLIFIERS ETC. 100 watt mosfet pair 2SJ99 and 2SK343 £4.00 a pair with pin out info ref 4P51. Also avaliable is a 2SK413 and a 2SJ118 at £4.00 ref 4P42.

10 MEMORY PUSH BUTTON TELEPHONES. These are 'customer returns' so they may need slight attention. BT approved. £6.00 each ref 6P16 or 2 for £10.00 ref 10P77.

12 VOLT BRUSHLESS FAN 4 1/2" square brand new ideal for boat, car, caravan etc. £5.00 ref 5P206.

acorn data recorder ALF503. Made for BBC computer but suitable for others. Includes mains adapter, leads and book. £15.00 ref 15P43

VIDEO TAPES. Three hour superior quality tapes made under licence from the famous JVC company. Pack of 10 tapes £20.00 ref 20P20.

ELECTRONIC SPACESHIP. Sound and impact controlled, responds to claps and shouts and reverses when it hits anything. Kit with complete assembly instructions £10.00 ref 10P81.

PHILIPS LASER. 2MW HELIUM NEON LASER TUBE. BRAND NEW FULL SPEC £40.00 REF 40P10. MAINS POWER SUPPLY KIT £20.00 REF 20P33 READY BUILT AND TESTED LASER IN ONE CASE £75.00 REF 75P4.

SWITCHED MODE POWER SUPPLY (Boshert) +5 at 15A, +12 at 3A, -12 at 2A, +24 at 2A. 220 or 110v input. Brand new £20.00 ref 20P30.

SOLDER 22SWG resin cored solder on a 1/2kg reel. Top quality. £4.00 a reel ref 4P70.

600 WATT HEATERS. Ideal for air or liquid, will not corrode, lasts for years. coil type construction 3"x2" mounted on a 4" dia metal plate for easy fixing. £3.00 ea ref 3P78 or 4 for £10.00 ref 10P76.

TIME AND TEMPERATURE MODULE. A clock, digital thermometer (Celcius and Farenheit (0-160 deg F) programmable too hot and too cold alarms. Runs for at least a year on one AA battery. £9.00 ref 9P5.

Remote temperature probe for above unit £3.00 ref 3P60.

GEARBOX KITS. Ideal for modeis etc. Contains 18 gears (2 of each size) 4x50mm axles and a powerful 9-12v motor. All the gears etc are push fit. £3.00 for complete kit ref 3P93.

ELECTRONIC TICKET MACHINES. These units contain a magnetic card reader, two matrix printers, motors, sensors and loads of electronic components etc. (12"x12"x7") Good value at £12.00 ref 12P28.

JOYSTICKS. Brand new with 2 fire buttons and suction feet these units can be modified for most computers by changing the connector etc. Price is 2 for £5.00 ref 5P174.

QUALITY PANEL METERS. 50uA movement with 3 different scales that can be brought into view with a lever! £3.00 each ref 3P81.

CAR IONIZER KIT. Improve the air in your car! clears smoke and helps to reduce fatigue. Case required. £12.00 ref 12P8.

METAL DETECTOR. Fun light weight device for buried treasure! 33" long with tune and fine tune controls. £10.00 ref 10P101.

6V 10AH LEAD ACID sealed battery by yuasha ex equipment but in excellent condition now only 2 for £10.00 ref 10P95.

12 TO 220V INVERTER KIT. As supplied it will handle up to about 15 w at 220v but with a larger transformer it will handle 80 watts. Basic kit £12.00 ref 12P17. Larger transformer £12.00 ref 12P41.

VERO EASI WIRE PROTOTYPING SYSTEM. Ideal for designing projects on etc. Complete with tools, wire and reusable board. Our price £6.00 ref 6P33.

MICROWAVE TURNTABLE MOTORS. Ideal for window displays etc. £5.00 ref 5P165.

STC SWITCHED MODE POWER SUPPLY. 220v or 110v input giving 5v at 2A, +24v at 0.25A, +12v at 0.15A and +90v at 0.4A £12.00 ref 12P27.

TELEPHONE AUTODIALLERS. These units, when triggered will automatically dial any telephone number. Originally made for alarm panels, BT approved. £12.00 ref 12P23 (please state telephone no req'd).

25 WATT STEREO AMPLIFIER ic STK043. With the addition of a handful of components you can build a 25 watt amplifier. £4.00 ref 4P69 (Circuit dia included).

LINEAR POWER SUPPLY. Brand new 220v input +5 at 3A, +12 at 1A, -12 at 1A. Short circuit protected. £12.00 ref 12P21.

MAINS FANS. Small type construction. Approx 4"x5" mounted on a metal plate for easy fixing. New £5.00 5P166.

POWERFUL IONIZER KIT. Generates 10 times more ions than commercial units! Complete kit including case £18.00 ref 18P2.

MINI RADIO MODULE. Only 2" square with ferrite aerial and tuner. Superhet. Req's PP3 battery. £1.00 ref BD716.

HIGH RESOLUTION MONITOR. 9" black and white Phillips tube in chassis made for OPD computer but may be suitable for others. £20.00 ref 20P26.

SURFACE MOUNT KIT. Makes a high gain snooping amplifier on a PCB less than an inch square! £7.00 ref 7P15.

SURFACE MOUNT SOLDER. In easy to use tube. Ideal for above project £12.00 ref 12P18.

CB CONVERTORS. Converts a car radio into an AM CB receiver. Cased with circuit diagram. £4.00 ref 4P48.

FLOPPY DISCS. Pack of 15 31/2" DSDD £10.00 ref 10P88. Pack of 10 51/4" DSDD £5.00 ref 5P168.

SONIC CONTROLLED MOTOR. One click to start, two click to reverse direction, 3 click to stop! £3.00 each ref 3P137.

FRESNEL MAGNIFYING LENS. 83 x 52mm £1.00 ref BD827.

LCD DISPLAY. 4 1/2 digits supplied with connection data £3.00 ref 3P77 or 5 for £10.00 ref 10P78.

ALARM TRANSMITTERS. No data avaliable but nicely made complex transmitters 9v operation. £4.00 each ref 4P81.

100M REEL OF WHITE BELL WIRE figure 8 pattern ideal for intercoms, door bells etc £3.00 a reel ref 3P107.

ULTRASONIC LIGHT. This battery operated unit is ideal for the shed etc as it detects movement and turns a light on for a preset time. (light included). Could be used as a sensor in an alarm system. £14.00 each ref 14P8.

CLAP LIGHT. This device turns on a lamp at a finger 'snap' etc. nicely cased with built in battery operated light. Ideal bedside light etc £4.00 each ref 4P82.

ELECTRONIC DIPSTICK KIT. Contains all you need to build an electronic device to give a 10 level liquid indicator. £5.00 (ex case) ref 5P194.

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 6P36.

ONE THOUSAND CABLE TIES! 75mm x 2.4mm white nylon cable ties only £5.00 ref 5P181.

PC MODEMS 1200/75 baud modems designed to plug into a PC complete with manual but no software £18.00 ref 18P12

ASTEC SWITCHED MODE POWER SUPPLY. 80mm x 165mm (PCB size) gives +5 at 3.75A, +12 at 1.5A, -12 at 0.4A. Brand new £12.00 ref 12P39.

VENTILATED CASE FOR ABOVE PSU with IEC filtered socket and power switch. £5.00 ref 5P190.

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 5P167.

CUSTOMER RETURNED switched mode power supplies. Mixed type, good for spares or repair. £2.00 each ref 2P292.

DRILL OPERATED PUMP. Fits any drill and is self priming. £3.00 ref 3P140.

PERSONAL ATTACK ALARM. Complete with built in torch and vanity mirror. Pocket sized, req's 3 AA batteries. £3.00 ref 3P135

POWERFUL SOLAR CELL 1AMP .45 VOLT! only £5.00 ref 5P192 (other sizes avaliable in catalogue).

SOLAR PROJECT KIT. Consists of a solar cell, special DC motor, plastic fan and turntables etc plus a 20 page book on solar energy! Price is £8.00 ref 8P51.

RESISTOR PACK. 10 x 50 values (500 resistors) all 1/4 watt 2% metal film. £5.00 ref 5P170.

CAPACITOR PACK 1. 100 assorted non electrolytic capacitors £2.00 ref 2P286.

CAPACITOR PACK 2. 40 assorted electrolytic capacitors £2.00 ref 2P287.

QUICK CUPPA? 12v immersion heater with lead and cigar lighter plug £3.00 ref 3P92.

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

FERRARI TESTAROSSA. A true 2 channel radio controlled car with forward, reverse, 2 gears plus turbo. Working headlights. £22.00 ref 22P6.

ULTRASONIC WIRELESS ALARM SYSTEM. Two units, one a sensor which plugs into a 13A socket in the area you wish to protect. The other, a central alarm unit plugs into any other socket elsewere in the building. When the sensor is triggered (by body movement etc) the alarm sounds. Adjustable sensitivity. Price per pair £20.00 ref 20P34. Additional sensors (max 5 per alarm unit) £11.00 ref 11P6.

TOP QUALITY MICROPHONE. Unidirectional electret condenser mic 600 ohm sensitivity 16-18khz built in chime complete with magnetic microphone stand and mic clip. £12.00 ref 12P42.

WASHING MACHINE PUMP. Mains operated new pump. Not self priming £5.00 ref 5P18.

IBM PRINTER LEAD. (D25 to centronics plug) 2 metre parallel. £5.00 ref 5P186.

COPPER CLAD STRIP BOARD 17" x 4" of .1" pitch "vero" board. £4.00 a sheet ref 4P62 or 2 sheets for £7.00 ref 7P22.

STRIP BOARD CUTTING TOOL. £2.00 ref 2P352.

3 1/2" disc drive. 720K capacity made by NEC £60.00 ref 60P2

TV LOUDSPEAKERS. 5 watt magnetically screened 4 ohm 55 x 125mm. £3.00 a pair ref 3P109.

TV LOUDSPEAKERS. 3 watt 8 ohm magnetically screened 70 x 50mm. £3.00 a pair ref 3P108.

BBC TRACKBALLS Once again in stock only £4.00 ref 4P86

CROSS OVER NETWORKS 8 ohm 3 way Japanese made units Excellent units avaliable at only £2.00 for a pair! ref 2P363

SPEAKER GRILLS set of 3 matching grills of different diameters. 2 packs for £2.00 (6 grills) ref 2P364

50 METRES OF MAINS CABLE £3.00 2 core black precut in convenient 2 m lengths. Ideal for repairs and projects. ref 3P91

4 CORE SCREENED AUDIO CABLE 24 METRES £2.00 Precut into convenient 1.2 m lengths. Ref 2P365

TWEETERS 2 1/4" DIA 8 ohm mounted on a smart metal plate for easy fixing £2.00 ref 2P366

COMPUTER MICE Originally made for Future PC's but can be adapted for other machines. Swiss made £8.00 ref 8P57. Atari ST conversion kit £2.00 ref 2P362.

6 1/2" 20 WATT SPEAKER Built in tweeter 4 ohm £5.00 ref 5P205

5" X 3" 16 OHM SPEAKER 3 for £1.00!! ref CD213

ADJUSTABLE SPEAKER BRACKETS Ideal for mounting speakers on internal or external corners, uneven surfaces etc. 2 for £5.00 ref 5P207

PIR LIGHT SWITCH Replaces a standard light switch in seconds light operates when anybody comes within detection range (4m) and stays on for an adjustable time (15 secs to 15 mins). Complete with daylight sensor. Unit also functions as a dimmer switch! 200 watt max. Not suitable for flourescents. £14.00 ref 14P10

2 MEG DISC DRIVES 3 1/2" disc drives made by Sony housed in a 5 1/4" frame 1.2 meg formatted. £66.00 ref 66P1.

360K 3 1/2" DISC DRIVES 1/2 height £25.00 ref 25P26

40 CHANNEL TRANSCEIVER 4 WATT OUTPUT, HANDHELD SQUELCH CONTROL ETC £70.00 EACH REF 70P1

OR AVALIABLE AS A PAIR WITH NICAD BATTERY PACKS FOR £150.00 REF 150P1

Illuminated channel display, 10 section aerial, Hi-Low power switch, external aerial socket, DC charger socket, 12v DC power socket, carrying strap and owners manual.

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ABC

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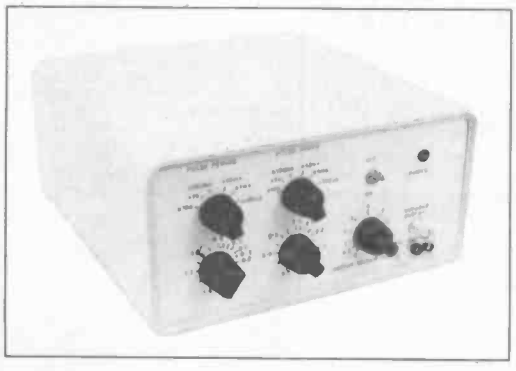
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .

V.A.T.

ALL UK READERS PLEASE NOTE

The prices in this issue were set before the change in VAT rate. If prices shown in advertisement are VAT inclusive please add 2% to your total order to compensate for the 2.5% increase in VAT. Where VAT must be added please make sure the new 17.5% VAT rate is used.



Projects

Series

Features

Our June '91 Issue will be published on Friday, 3 May 1991. See page 283 for details.

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OPTO & DISPLAYS

Z4372 Epson LCD module EA-Y40040AT. 40 × 4 character format. Viewing area 156 × 34mm. Full alphanumeric 96 character set contained in the module's own memory. 5V supply. With comprehensive data. List price over £200.
Our special price **£40.00**
Z4335 Dot graphics LCD module. Hitachi type LM200. 40 × 64 dot, display area 132 × 39mm. Overall size 180 × 75mm. These can be driven by the HD6183 controller which has a built in character generator etc. Supplied with data. Farnell's price, £100.00.
Our Price **£30.00**
HD61830 chip. Supplied at our cost price **£8.00**
Z1814 Intelligent display by Densitron. LCD 16 character (5 × 7dots) 3.07 × 5.73mm + Hitachi HD44780A00 microprocessor on PCB 80 × 36mm. 15 way connector on edge of board. Same as Farnell's LM020L; their price £21.00. Supplied with full data.
Price **£8.00**
Z4115 8 digit 12.7mm high LCD and holder. These are 14 segment devices allowing alphanumeric display. Normally costing over £15.00 we are offering these for just **£4.50**
Z1637 LCD Display - Direct drive 3½ digit similar to RS588-572 except 'LO-BATT' instead of arrow symbol. 12.7mm high digits. Op voltage 4-12 RMS @ 32Hz typ. Consumes only 25µA with all segments on. RS price £7.97 each. Supplied with data.
Prices **£2.00**
10+ 1.52; 25+ 1.30; 100+ 0.85

LCD Clock/ Temp Module

LP971 Versatile unit 68mm × 35mm with 13mm high display. Range - 19.9 to 69.8°C. Uses a single AA cell. 12hr clock with 0.5 s/day accuracy. High & low temp alarms, °C or °F, serial data output. With comprehensive data.
Price **£9.95**
LP972 External probe **£2.95**

COMPONENT PACKS

LOTS MORE IN OUR CATALOGUE!

K531 Precision Resistor Pack - High quality, close tolerance R's with an extremely varied selection of values mostly ¼W and ½W; tolerances from 0.1% to 2% - ideal for meters, test gear etc.
Price ..... **250/£3.00**; 1,000/£10.00
K539 LED Pack. Not only round but many shaped LEDs in this pack in red, yellow, green, orange and clear. Fantastic mix of new full spec devices.
Price ..... **100/£5.95**; 250/£11.75
K575 Plastic Power Pack. Mainly TO126 and TO220 transistors, SCRs, Triacs etc. All new full spec marked devices offering fantastic value. Lots of TIP and BD types.
Price ..... **50/£7.50**
K582 Polystyrene Caps. An amazing range of values from a few pF to 0.01. Tolerances 1-20%. Voltages to 500V. Pack of 200.
Price **£4.00**
K580 Metal Oxide resistors, TR4 0.25W by Electrosil. Wide range of values, mostly 5%, few closer tolerances. Super value pack of 200.
Price **£2.00**
K801 Seven seg LED pack. Big variety of sizes in this pack. May include Red and Green. Also overflow/polarity displays, single/double digit, also 7/8/9 digit magnified displays. Sizes from 0.11" to 0.8". 20 pieces for just **£3.95**
K572 Resistor Networks. Both SIL and DIL in here, from 6 to 16 pin. Plenty of popular values like 1k, 4k7 and 10k, and a good sprinkling of many other values.
Pack of 100 ..... **£4.50**
K803 PCB headers pack with/without ears, straight and right angle from 10-64 way.
Pack of 20 ..... **£5.50**
K802 DIN41612 connectors. These popular PCB connectors come as 32/64/96 way. Both plugs and sockets, some with pins missing. Normally costing £1-£3 each.
Pack of 25 ..... **£8.00**

MOTOR + GEAR PACK

K579. This pack contains 10 assorted battery powered motors (mostly 3V) + 90 gears etc; 16-60mm dia + worms and shafts. Amazing value.
Price ..... **Only £7.95**

INDICATOR PACK

K700 Big variety of neons in this pack! Round, square and oblong, clip and screw fix. Red, Green, Amber and Clear. Tag & wire-ended. All are 110V, but suitable resistors for use on mains are included. Really great value for money!
Price ..... **20/£2.50**

1991 CATALOGUE + SPRING SUPPLEMENT

YOU GET A GREAT DEAL MORE WHEN YOU DEAL WITH GREENWELD!!

The 1991 Greenweld Catalogue is out NOW!

★ Many substantial reductions
★ Quantity pricing for bulk buyers
★ 132 pages of value-packed goods + a further 48 pages in 2 supplements
★ Next 6 updates plus lists included in price
★ Easy to use order form
★ 1st class reply paid envelope
★ Our famous Bargain List

Price to include Catalogue, current bargain list and next 6 lists. All supplied with reply paid envelope £2.50 (UK & BFPO) £5.00 Overseas.

SWITCH MODE POWER SUPPLIES

Over the years, we've had many different switch mode power supplies, but this latest unit is without doubt one of the finest we've ever seen! Made by Astec, it is a totally enclosed steel cased unit measuring 175 × 136 × 65mm, which has incorporated in it a switched and fused IEC mains inlet. Inside, the PCB is 160 × 80mm with output pins fitted on one end. A connector to these pins to extend the outputs to the exterior of the case is provided.
Specification:

Model Number:	**BM41012**
Input:	115/230V, 50/60Hz
Outputs:	+ 5V 3.75A
	+ 12V 1.5A
	- 12V 0.4A
Total Wattage:	65W

Prices ..... **£14.95**; 100+ 11.21

We've also discovered a small quantity of an Astec model offered previously. Regrettably we've had to increase the price, but they still represent outstanding value for money. Enclosed in a steel case 203 × 112 × 60mm is a PCB 197 × 106mm. Input and Outputs are via pins on the PCB.
Specification:

Model Number	**AC9231**
Input	115/230V, 50/60Hz
Outputs	+ 12V 2.5A
	+ 5V 6A
	12V 0.5A (+ or -)
	5V 0.5A (+ or -)
Total Wattage	50W

Prices ..... **£17.95**; 100+ 13.46

We still have good supplies of yet another Astec model. This one is partially cased, the overall size being 160 × 104 × 45mm. The PCB measures 160 × 100mm. Input and Outputs are on flying leads, all colour coded. There is also an additional IEC socket to extend mains to another unit.
Specification:

Model Number	**AA12531**
Input	115/230V, 50/60Hz
Outputs	+ 5V 5A
	+ 12V 0.15A
Total Wattage	50W

Price ..... **£6.95**; 100+ 5.21

Have you purchased the above AA12531 PSU?
We now supply a conversion kit to change the outputs to + 5V 2.5A; + 12V 2A; -12V 0.1A and -5V 0.55A.
K625 Complete kit and instructions.
Price **£3.50**
K626 Instructions only.
Price **£1.00**
Z8887 Made by STC, this 160 × 100mm PCB is attached to an aluminium chassis 165 × 102 × 65mm and has a single 5V 6A output. Supplied with connection details, we can offer these at fraction of their normal cost!
Prices ..... **£5.95**; 10+ 4.95; 100+ 3.95
Z8888 As above but 5V 10A output.
Prices ..... **£8.95**; 10+ 6.50; 100+ 5.20
Z8890 DC-DC Converter board Panel 220 × 195 require 50V I/P for 5V 19.5A O/P.
Prices ..... **£7.95**; 25+ 5.20; 100+ 3.89

VISTEL II VISUAL TELEPHONE

Total communication for deaf people - this brilliant piece of equipment has a full QWERTY keyboard and 40 character screen. Text editor. 9,500 character memory. Auto answer. Auto dial. Calculator. Printer interface. RS232 (V24/28) serial interface. Modem support V21/23/25. These are new and boxed but because the makers are bankrupt, there's no guarantee. Originally sold for over £500. A comprehensive 143 page instruction manual is provided. (Manual only - send £12, £10 refunded on return).
Our special price **£150.00**

HARDWARE PACKS

K805M2 screws. Good mix, this. Cheesehead, c/s, pan, mostly pozi, few slot. Lengths to 12mm. All steel with various plating
Pack of 100 ..... **£1.80**
K806 M2.5 screws. Various heads - mostly pan and c/s pozi. All plated steel. Lengths to 10mm.
Pack of 100 ..... **£1.50**
K807 M3 screws. Good selection of sizes including a few brass. Most heads. Lengths to 35mm.
Pack of 100 ..... **£1.50**
K808 M4 screws. Huge variety! Pan, c/s, cheese, set, slot, pozi. From 4-50mm long. All steel, plated, black/hi-tensile.
Pack of 100 ..... **£1.60**
K809 M5 screws. As above.
Pack of 100 ..... **£2.00**

BREADBOARDS

FREE, if requested, with every order for breadboards this month! K574 wire link pack with about 250 links for use with breadboard or PCB's!
G708 Protobloc 1 - 400 tiepoints, size 80 × 60mm. Takes up to 3 16 pin chips.
Price **£2.50**
G711 Protobloc 2 has a total 840 tie points. Will accommodate up to 7 16 pin devices. Size 172 × 64mm **£3.95**
G712 As above, but mounted onto a rigid base plate complete with 3 4mm terminals for power connections. A mounting bracket which clips into the base is also provided to accept a variety of components including switches and pontentiometers, etc **£6.95**
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Z8885 Telephone answering machine believed to have been used as an alarm system. Steel chassis 245 × 220 × 35mm contains PCB 228 × 145mm and an 8-track cassette unit. The output from the tape head is fed into an MC3301 quad op-amp. The PCB also has 10 CMOS gates, 3 relays, isolator transformer, several transistors, R's, C's, etc. 12-way connector for BT line, 12V supply etc also plug and socket arrangement for Auto/Manual and Bell delay.
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Z4307 8-track cassette mechanism. Sturdy steel chassis 132 × 126 × 50mm. Contains 12V motor, solenoid, tape head and mechanical bits to change track.
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M	TC511000Z-12	349	£5.00	3.00
M	TMS4256-12	508	£2.50	1.50
M	MSL27128K	142	£2.50	1.50
M	MB81256-20	296	£5.00	3.00
M	TMM2063P-10	92	£3.00	2.00
M	MB81C68-35	624	£2.00	1.30
M	TMS4161-15NL	3102	£1.00	0.60
M	TMS2516JL	184	£1.20	0.70
M	TMS2114L-45	141	£0.60	0.40
M	MC68A50P	77	£1.00	0.60
M	HN482764-4	98	£2.00	1.30
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132	5AB8088-P	300	£4.00	2.00
OSL	27C64-2	40	£2.00	1.30
OSL	AM2952DC	96	£1.00	0.60
OSL	MM58274BN	100	£2.50	1.50
132	AM2966DC	780	£1.00	0.60
132	MC10131L	600	£1.00	0.60
132	MC8T95	188	£1.00	0.60
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132	MSL2732K	112	£1.50	1.00
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261B	D4364-12	27	£2.00	1.00
261B	HM3-2064U-5	14	£2.50	1.50
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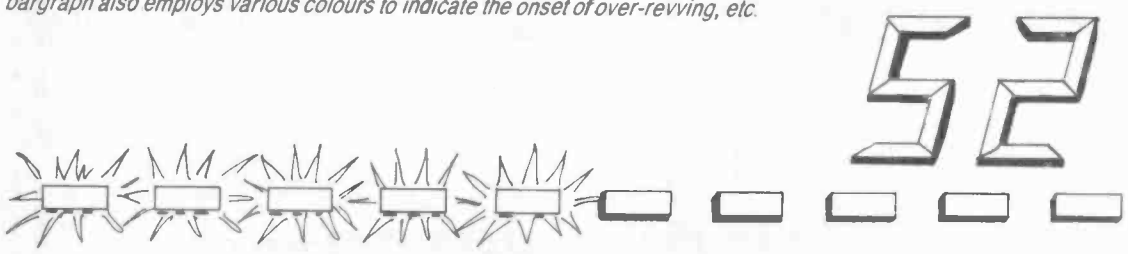

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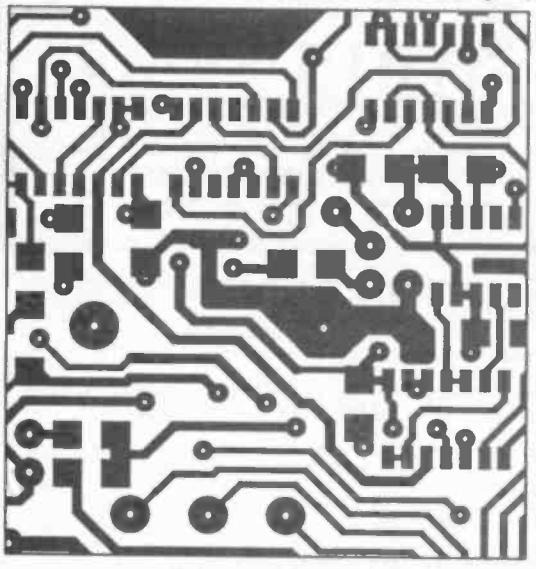

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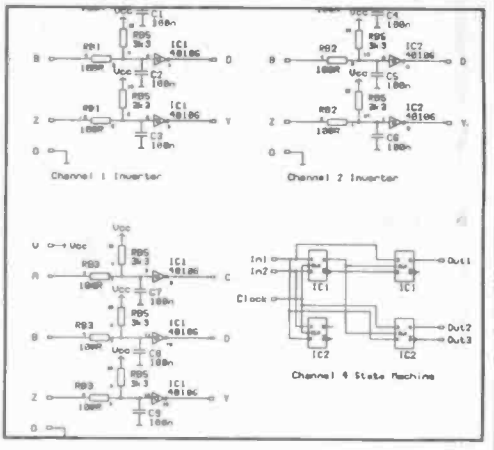

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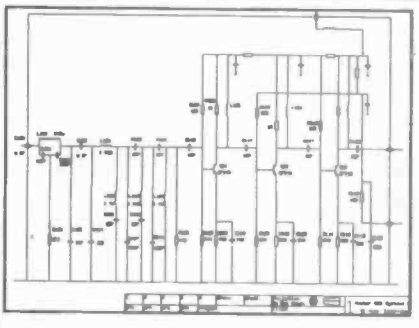

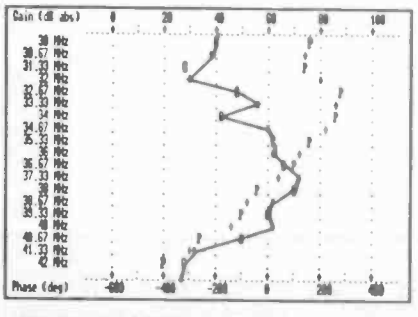

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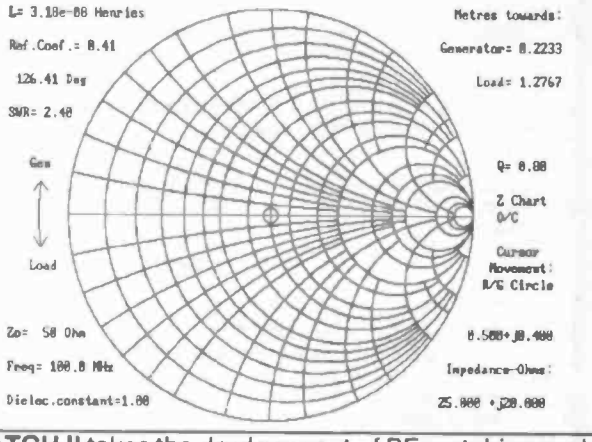

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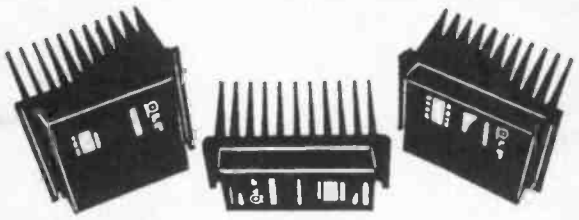

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HY128P	60W Bipolar amp (8 ohm)	£15.80	MOS128P	60W Mosfet amp	£38.85
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Note: These modules require additional heatsinks

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PSU30 Pre-amplifier	£11.55	PSU542 HY248	£29.30
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PSU432 MOS128	£26.55	PSU732 HY364	£34.75
PSU512 HY244, HY128(2)	£28.20	PSU742 HY368	£37.00
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These encapsulated modules are now supplied with 0.1" pin connectors for direct mounting into pcb/veroboard

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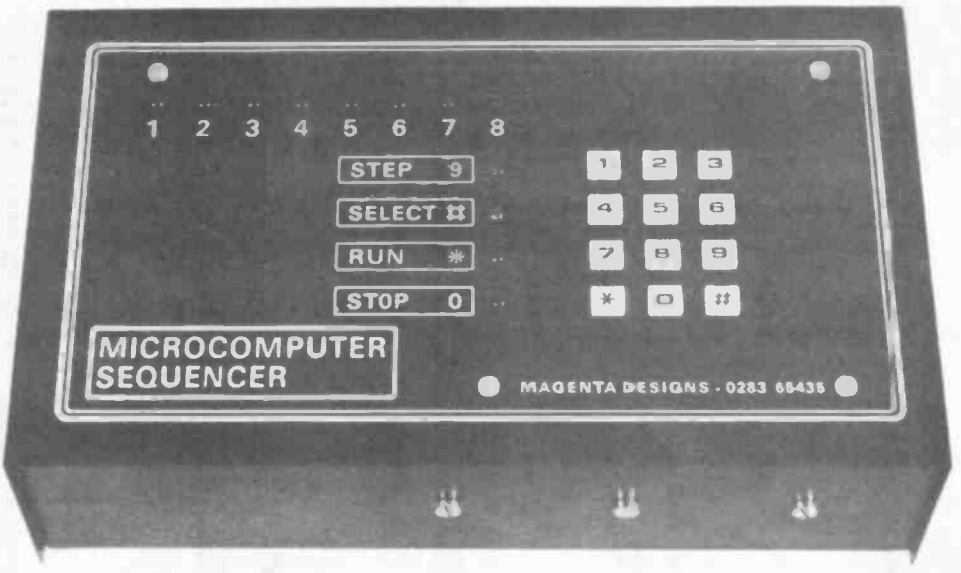

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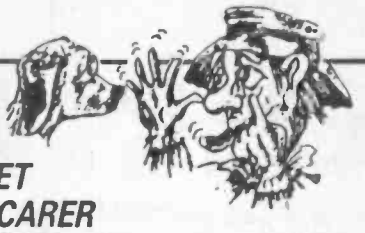

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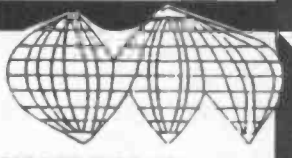

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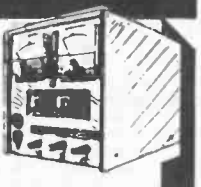

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A superb design giving 0.25V and 0-2.5A. Twin panel meters indicate Voltage and Current. Voltage is variable from zero to 25V. A Toroidal transformer MOSFET power output device, and Quad op-amp IC design give excellent performance.

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4 CHANNEL LIGHT CHASER

EE Jan '90

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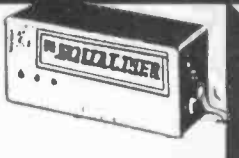

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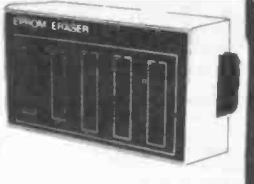
KIT REF 838 **£55.95**

EPROM ERASER



EE OCT '88

Safe low-cost unit capable of erasing up to four EPROM's simultaneously in less than twenty minutes. Operates from a 12V supply. Safety interlock. Convenient and simple to build and use.

KIT REF 790 **£27.90**

LIGHT RIDERS

EE OCT '86

Three projects under one title – all simulations of the Knight Rider lights from the TV series. The three are a lapel badge using six LEDs, a larger LED unit with 16 LEDs and a mains version capable of driving six main lamps totalling over 500 watts.

KIT REF 559 CHASER LIGHT	£15.25
KIT REF 560 DISCO LIGHTS	£21.93
KIT REF 561 LAPEL BADGE	£11.40

EE TREASURE HUNTER

EE AUG '89

A sensitive pulse induction Metal Detector. Picks up coins and rings etc., up to 20cms deep. Low "ground effect". Can be used with search-head underwater. Easy to use and build, kit includes search-head, handle, case, PCB and all parts as shown.

KIT REF 815 **£41.95**

Headphones **£1.99**

SUPERHET BROADCAST RECEIVER

EE MAR '90

At last, an easy to build **SUPERHET** A.M. radio kit . Covers Long and medium Wave bands. built in loudspeaker with 1 watt output. Excellent sensitivity and selectivity provided by ceramic I.F. filter. Simple alignment and tuning without special equipment. Kit available less case, or with pre-cut and drilled transparent plastic panels and dial for a striking see-through effect.

KIT REF 835 **£16.79**

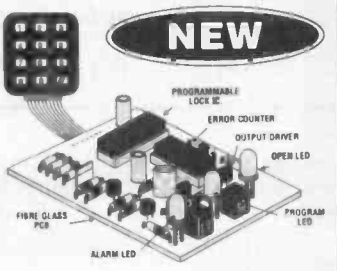
TK FOR KITS

SINGLE CHANNEL REMOTE CONTROL KIT

Designed for maximum flexibility this sensitive IR receiver can operate from 240V ac or 9 to 15V dc allowing it to be used in many applications where a single channel control is required such as lights, garage doors, car alarms etc. The 3 Amp relay output switches mains or low voltage circuits on and off alternately when the transmitter is operated and is virtually immune to spurious switching. Range with XK135 transmitter approx 20ft. Size: 60 x 42 x 24mm

XK134 IR Receiver £10.95
XK135 Transmitter £5.95

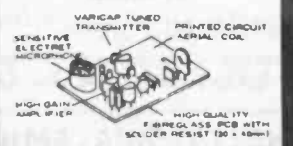
PROGRAMMABLE ELECTRONIC LOCK KIT



Keys could be a thing of the past with this new high security lock. Secure doors to sheds, garages, even your home or prevent the unauthorised use of computers, burglar alarms or cars. One 4–digit sequence will operate the lock while incorrect entries will sound an alarm. The number of incorrect entries allowed before the alarm is triggered is selected by you. Further entries will be ignored for a time also set by you. Only the correct sequence will open the lock and switch off the alarm. The sequence may easily be changed by entering a special number and code on the supplied keyboard. Kit includes; keyboard, alarm buzzer, high quality PCB and all electronic components. Supply 5–15V DC. Will drive our Latch Mechanism (701 150 @ £18.98) or relay directly.

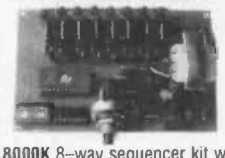
XK131 £21.95

SUPER–SENSITIVE MICROBUG



Only 45x25x15mm, including built–in mic. 88–100MHz (standard FM radio). Range approx. 300m depending on terrain. Powered by 9V PP3 (7mA). Ideal for surveillance, baby alarm etc. **XK128** £6.95

DISCO LIGHTING KITS



DL8000K 8–way sequencer kit with built–in opto–isolated sound to light input. Only requires a box and control knob to complete £45.95

DL3000K 3–channel sound to light kit, zero voltage switching, automatic level control and built–in mic. 1kW per channel £21.50

XK139 Uni-directional chaser. Zero switching and built-in audio input.....£13.95

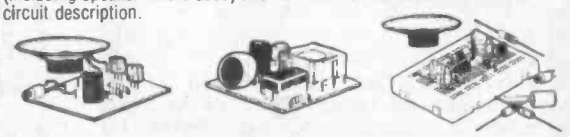
POWER STROBE KIT

Produces an intense light pulse at a variable frequency of 1 to 15Hz. Includes high quality PCB, components, connectors, 5Ws strobe tube and assembly instructions. Supply: 240V ac. Size: 80x50x45.

XK124 STROBOSCOPE KIT. £17.25

SIMPLE KITS FOR BEGINNERS

Especially aimed at the beginner. Have fun with your project even after you have built it and also learn a little from building it. These kits include high quality solder resist printed circuit boards, all electronic components (including speaker where used) and full construction instructions with circuit description.



SK1 DOOR CHIME plays a tune when activated by a pushbutton £4.95

SK2 WHISTLE SWITCH switches a relay on and off in response to whistle command £4.95

SK3 SOUND GENERATOR produces FOUR different sounds, including police/ambulance/fire–engine siren and machine gun £4.95

XK118 TEN EXCITING PROJECTS FOR BEGINNERS this kit contains a solderless breadboard, components and a booklet with instructions to enable the absolute novice to build ten fascinating projects including a light operated switch, intercom, burglar alarm and electronic lock. Each project includes a circuit diagram, description of operation and an easy to follow layout diagram. A section component identification and function is included, enabling the beginner to build the circuits with confidence £18.95

NEW

REMOTE CONTROL DIMMER KIT

Imagine controlling the brightness of your lights or switching them on or off from the comfort of your armchair! This kit contains all the components from front panel to the last screw to enable you to do just that and fit the shallowest wall boxes. Max power 300W (not fluorescents).

XK132.....£19.95

IR TRANSMITTER KIT

Designed for use with the XK132 and comes complete with a pre-drilled box. A PP3 9 volt battery is required.

MK 6.....£4.95

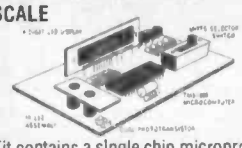
XK136 TOUCH DIMMER KIT.....£12.95

VERSATILE REMOTE CONTROL SYSTEM

These kits can switch up to 16 pieces of equipment on and off or control 16 functions depending on the keyboard selected for the MK18 transmitter. MK12 receiver has 16 logic outputs and operates from 12 to 24V d.c. or 240V a.c. via the transformer supplied. The MK18 requires a 9V battery and keyboard. Great for controlling lights, TVs, garage doors etc.

MK12 IR Receiver.....£21.50
MK18 Transmitter.....£9.50
MK 9 4-way Keyboard.....£3.30
MK10 16-way Keyboard.....£9.50
601 133 Box for transmitter.....£2.95

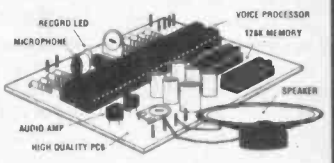
ELECTRONIC WEIGHING SCALE



Kit contains a single chip microprocessor. PCB, displays and all electronics to produce a digital LED readout of weight in Kgs or Sts/Lbs. A PCB link selects the scale-bathroom/two types of kitchen scales. A low cost digital ruler could also be made.

ES1 £8.25

VOICE RECORD/ PLAYBACK KIT

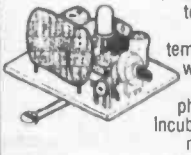


This simple to construct and even simpler to operate kit will record and playback short messages or tunes. It has many uses – seatbelt or light reminder in the car, welcome messages to visitors at home or at work, warning messages in factories and public places. In fact anywhere where a spoken message is announced and which needs to be changed from time to time. Also suitable for toys – why not convert your daugher's £8 doll to an £80 talking doll!!

Size ..... 76 x 60 x 15mm
Message time ..... 1–5 secs normal speed, 2–10 secs slow speed

XK129 £25.95

PROPORTIONAL TEMPERATURE CONTROLLER KIT



Uses "burst fire" technique to maintain temperature to within 0.5°C. Ideal for photography, incubators, wine making, etc. Maximum load 3kW (240V AC). Temperature range up to 60°C. Size 50x40x25mm. **XK140**.....£9.85

TK ELECTRONICS

TK ELECTRONICS

13 Boston Road
London W7 3SJ
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EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

The No.1 Magazine for Electronic & Computer Projects

VOL. 20 No. 5 MAY '91

Editorial Offices:
EVERYDAY ELECTRONICS EDITORIAL,
6 CHURCH STREET, WIMBORNE,
DORSET BH21 1JH
Phone: Wimborne (0202) 881749
Fax: (0202) 841692. DX: Wimborne 45314.

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Advertisement Offices:
EVERYDAY ELECTRONICS ADVERTISEMENTS,
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GREAT HOLLAND, ESSEX CO13 0JS.
Phone (0255) 850596

THE EDITORIAL SMILE

A number of little incidents give us the odd smile in the Editorial offices. Our readers constantly keep our spirits up with notes of praise or thanks when writing in for subscriptions or with technical queries, but there is also a trickle of "odd" letters or events that give us a laugh.

A subscription renewal reminder addressed to a prisoner in H.M. Prison, Lancaster, that came back marked "Gone Away – Not Known At No . . . " was intriguing; the letter from the Irish Training and Employment Authority signed by an instructor who's Christian name was Brian but who's name was typed (presumably by his secretary) as Brain is another example.

Sometimes it's the odd use of English from overseas readers that brings a smile, for example "would you please send me one to get me familiar with you" or "if you can give me some orientation please, I fall in love with the magazine . . . for ever", from readers in Finland and Venezuela. Who am I to smile, I can't speak or write in anything but English (some say I can't even write in English but we won't go into that) so, please overseas readers, don't get upset, we love to hear from you and we generally understand your letters.

INSULTING

While mentioning upsetting readers, another incident that made us smile recently was the reader who was "insulted" when I told him winding a transformer was "quite a simple task". The comment was intended to prevent him being put off by coil winding, which many readers are not sure about (see the *Wind Your Own Transformers* article in this issue), but he wrote back saying he was quite insulted – "With my qualifications, City & Guilds Intermediate Telecommunications Certificate (1, 1 grade); Ten years service as a Technical Officer with B.T. and I am at present reading for an Honours degree in Design and Technology. So I do realise that to wind wire round a transformer bobbin is 'quite a simple task'. Thanks for the insult."

Of course I had no way of knowing if he was a beginner or if he was an experienced constructor when he first wrote in – it takes all sorts! Thankfully most of our readers are not quite so touchy – if I've insulted any of you it was *probably* not because I intended to! We deal with a very wide range of reader abilities and try to please everyone as much as possible.

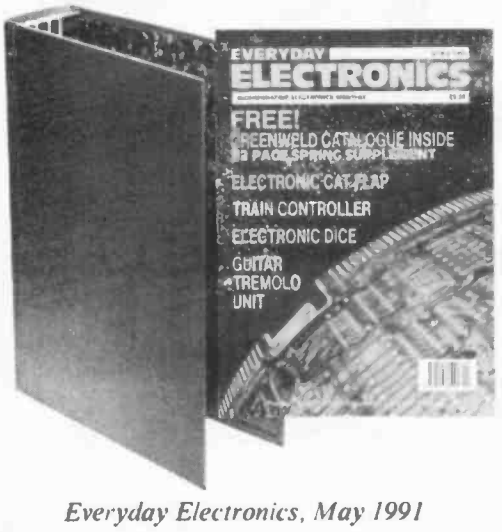
INSOLUBLE PROBLEMS

Some incidents are caused by circumstances which we have not foreseen. The *Humidity Tester* in our April issue required the use of saltpetre (potassium nitrate), we received a 'phone call from someone in Northern Ireland saying that, for obvious reasons (it is used to make gunpowder) it was not available in that part of the UK – unfortunately not a problem that we can solve.

Mike Kenward

SUBSCRIPTIONS

Annual subscriptions for delivery direct to any address in the UK: £17.00. Overseas: £21.00 (£39 airmail). Cheques or bank drafts **(in £ sterling only)** payable to Everyday Electronics and sent to EE Subscriptions Dept., 6 Church Street, Wimborne, Dorset BH21 1JH. **Subscriptions can only start with the next available issue.** We can also accept Access or Visa payments for subscriptions. For back numbers see below.



BACK ISSUES

Certain back issues of EVERYDAY ELECTRONICS are available price £1.70 (£2.20 overseas surface mail) – **£ sterling only please** – inclusive of postage and packing per copy. Enquiries with remittance, made payable to Everyday Electronics, should be sent to Post Sales Department, Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH. 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 Feb, April, Aug, Sept, Nov. & Dec. 87, March, April, June, Oct, & Dec. 88, March 89 & March 90.**

BINDERS

Binders to hold one volume (12 issues) are available from the above address for £4.95 (£6.95 to European countries and £9.00 to other countries, surface mail) inclusive of post and packing. *Normally sent within seven days but please allow 28 days for delivery.*

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Editor: MIKE KENWARD

Secretary: PAMELA BROWN

Deputy Editor: DAVID BARRINGTON

Business Manager: DAVID J. LEAVER

Editorial: WIMBORNE (0202) 881749

Advertisement Manager:
PETER J. MEW, Frinton (0255) 850596

Classified Advertisements:
Wimborne (0202) 881749

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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TRANSMITTERS/BUGS/TELEPHONE EQUIPMENT

We would like to advise readers that certain items of radio transmitting and telephone equipment which may be advertised in our pages cannot be legally used in the U.K. Readers should check the law before using any transmitting or telephone equipment as a fine, confiscation of equipment and/or imprisonment can result from illegal use. The laws vary from country to country; overseas readers should check local laws.

Constructional Project

DIGITAL LCD THERMOSTAT

MARK STUART

Cut domestic heating costs. Control the greenhouse environment. Photographic chemical temperature control.

THIS electronic thermostat uses a thermistor probe sensing from −10 to +110 degrees Celsius. A four digit 0.5 inch l.c.d. display indicates the current temperature within 0.1 degrees and the circuit continuously records Maximum and Minimum temperatures which can be displayed by pressing the appropriate buttons.

Two independently adjustable set points can be programmed as upper and lower thermostat switch points so that a "dead band" can be incorporated to prevent unnecessary heater cycling where tight temperature control is not required. Instant read-out of the set points is available at all times and the display can be switched to show degrees Fahrenheit.

A clock is also incorporated which can be selected by push button to give a 12 hour read out with AM – PM indication.

ALARM

For temperature monitoring applications an alarm is incorporated which sounds for one minute whenever the temperature passes outside the upper and lower set points. This is useful for Frost or Overheating detection. The alarm can be silenced and reset by a push button or can be disabled if required.

The probe can be immersed in liquids and can be extended without undue loss of accuracy to 50 metres or more, allowing soil or greenhouse temperatures to be monitored and recorded. The Minimum and Maximum readings are particularly useful for this and can be reset whenever required.

All of the above features are available without external power. A single AA cell provides over one years operation.

MORE POWER

For thermostatic temperature control additional power is required to allow the circuit to operate a relay or low power fan or heater. The output of the circuit is a Darlington transistor rated at 120V and 1A which can be set to turn on at high or low temperatures. The option of high temperature switching allows the circuit to operate a cooling fan or greenhouse ventilator. When used with external power the circuit draws its operating current from this supply instead of the battery which is needed only for memory retention in the event of power failure.

DOMESTIC HEATING

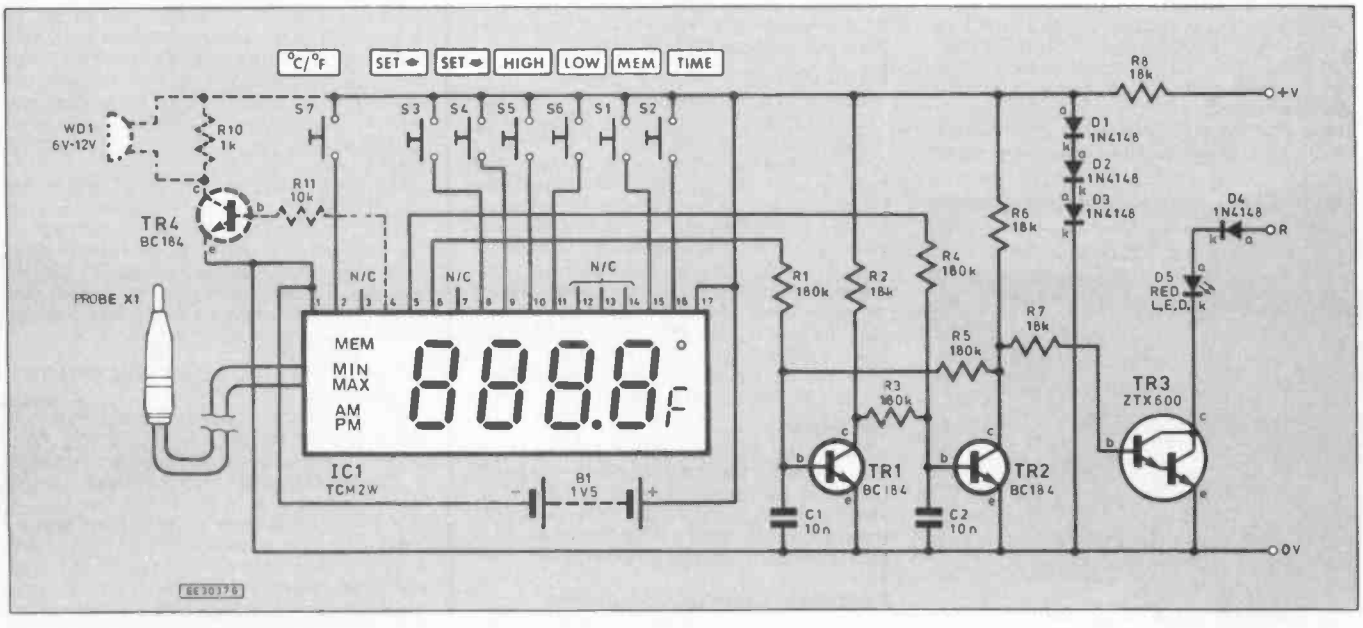
For control of mains power a separate relay and power board is described which provides 10A 250V a.c. changeover contacts, allowing the circuit to be used in a wide range of applications.

One notable application of the circuit is for the control of domestic hot water systems. By setting the high and low set points well apart it is possible to reduce boiler cycling substantially.

In summer the hot water system can be left on continuously and the thermostat will allow the boiler to operate only when the lower threshold has been reached. The boiler will then run continuously until the water is heated to the upper threshold before the thermostat switches it off and will not run again until a substantial amount of water has been used.

This is in contrast to normal operation where the boiler cycles all day long topping up the water temperature which has not fallen significantly, resulting in increased wear and tear to the boiler, pump and motorised valves as well as greater fuel consumption.

Fig. 1. Complete circuit diagram for the Digital LCD Thermostat. The temperature probe XI comes with the display module. The alarm feature is optional.



CIRCUIT DESCRIPTION

The full circuit diagram for the thermostat section of the Digital LCD Thermostat is shown in Fig. 1. The power/relay circuit is shown in Fig. 2.

Most of the work is done by the TCM2W l.c.d. thermometer module IC1 which has a total of 17 connections. The functions of these pins are as follows:

1) 1.5V Battery Negative
2) Display Degrees C / Degrees F
3) Sampling Rate – 10 Seconds or 1 Second between readings
4) Alarm Output
5) High Temperature Output
6) Low Temperature Output
7) Memory Reset – Clears all memories
8) Set Temperature (increase) / Hours
9) Set Temperature (decrease) / Hours
10) Display High Temperature
11) Display Low Temperature
12) Unused
13) Momentary High/Low Output
14) Master Reset
15) Memory Display (Max – Min)
16) Temperature / Clock
17) Battery Positive

A pin shown with two input functions is switched over by connecting it to battery positive. For more specialised functions it is sometimes necessary to press more than one button at a time – these are described later.

The alarm output from the module (pin 4) drives the base of TR4 via R11 which provides a higher output current and voltage swing to drive a small piezoelectric transducer. The output frequency is 4kHz which is not ideal for most transducers – usually 2.5kHz is preferred, but the output volume is plenty for most applications. Resistor R10 provides the necessary d.c. path around WD1.

THRESHOLD LEVELS

To give the correct operating function for a thermostat with adjustable upper and lower thresholds the latch circuit provided by transistors TR1 and TR2 is necessary. The latching action operates as follows:

Initially assume that the input temperature is below the lower set point. The module Low Temp output will be high (1.5V), and TR1 will be turned on via R1. The collector of TR1 will be at 0V as will the module High Temp output and so there will be no drive to TR2 which will be off.

The collector of TR2 will be held at almost 1.5V by R6 providing additional current to turn on TR1 via R5. The output Darlington transistor TR3 will be turned on via R7.

As the temperature rises above the lower set point both the module Low and High Temp outputs will be at 0V. TR1 will remain turned on via R5 and the circuit will stay in this state even if the temperature falls below the lower set point again.

When the temperature eventually rises above the upper set point the module High Temp output rises to 1.5V. This turns on TR2 via R4 so that its collector voltage falls to nearly 0V. This turns off TR1 via R5 and output transistor TR3 via R7. The collector of TR1 rises to 1.5V and so holds TR2 on via R3.

If the temperature now falls below the upper set point the circuit remains in the same state with TR2 on and TR1 and the output transistor off. This state is only changed when the temperature falls below the lower set point and the cycle returns to the starting point.

Capacitors C1 and C2 prevent the latch being affected by interference spikes.

The state of TR3 is indicated by l.e.d. D5 which lights when load current is drawn. In the event of currents above 40mA being required from TR3 it is necessary to add a resistor across D5 to shunt some of the current. Diode D4 protects TR3 from reverse voltages that could be applied by accident.

SUPPLY BACK-UP

Power from external supplies drives the module via series dropping resistor R8 and shunt regulating diodes D1, D2, D3. As the total current is under 20µA a high value resistor is used and supplies from 3V to 60V can be connected without component changes. Three diodes in series drop around 1.5V at low current levels and so give the required module voltage.

The battery B1 does not supply power when its voltage is below the regulated supply across the diodes and so is not normally used when external supplies are connected except when the alarm is sounding. When the external supply is removed the battery instantly takes over and runs the module and the latch, maintaining the memory and the latch condition.

It is not recommended to use a rechargeable battery as the slow trickle charge is more destructive than helpful. The best option is to fit a good quality Zinc Chloride cell.

It is not recommended to run the circuit without a battery unless the alarm is disabled by disconnecting R11. Just removing the sounder is not enough as current will still flow via R10 and R11.

POWER SUPPLY

Power to the Thermostat can be provided by any supply between 3V and 60V. The supply shown in Fig. 2 is a simple mains supply incorporating a mains rated 10A relay.

The transformer T1 output of 24V is half-wave rectified by diode D7 and smoothed by C3. Resistor R9 protects the circuit by limiting the potential output current under short circuit conditions.

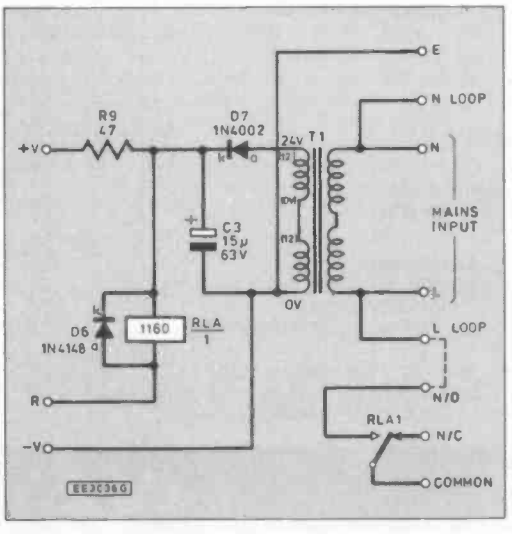
The relay coil resistance is rated at over 1kilohm and so the current required at 24V is only 20mA or so. D6 provides a path for the decaying relay coil current when TR3 turns off and so prevents damaging high voltage spikes.

The use of a very small transformer has several good safety points. The first is that such transformers can sustain continuous short circuits on their secondary windings, and the second is that the primary winding wire is so thin that it acts as its own protection fuse.

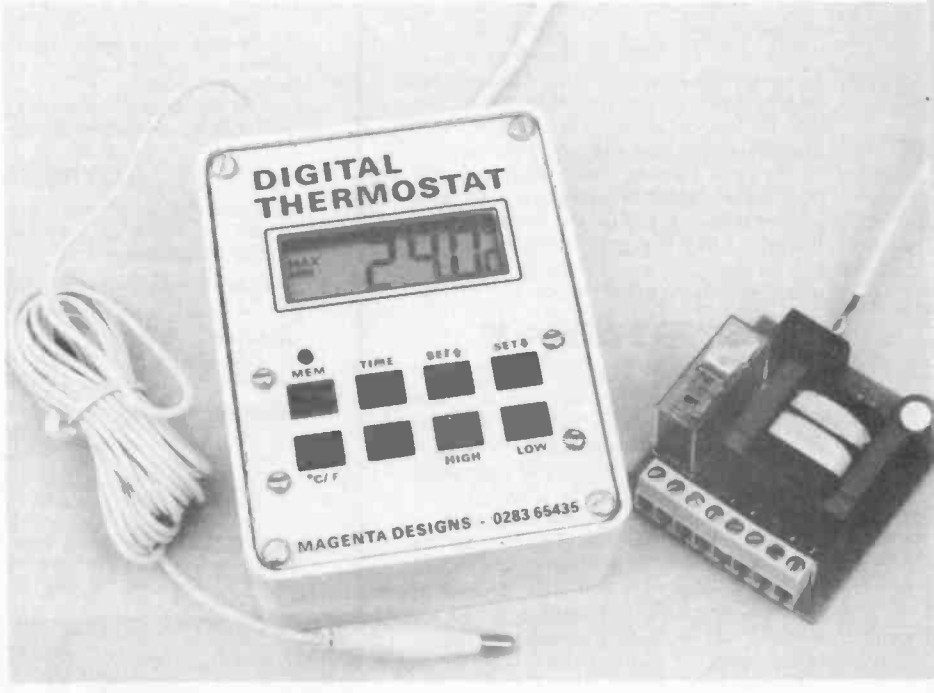
The only problem that can occur is high temperature if the primary develops shorted turns. To ensure that this is not a danger the supply can either be housed in an "Earthed" metal box, or, fitted with a thermal fuse rated at 90 degrees C fixed near to the primary winding in series with the incoming mains live lead and housed in a non flammable plastic box.

Extra terminals on the power supply board facilitate wiring by providing additional connection points.

Fig. 2. External power supply and relay circuit for the thermostat.



The completed thermostat system, including sensor probe and relay board.



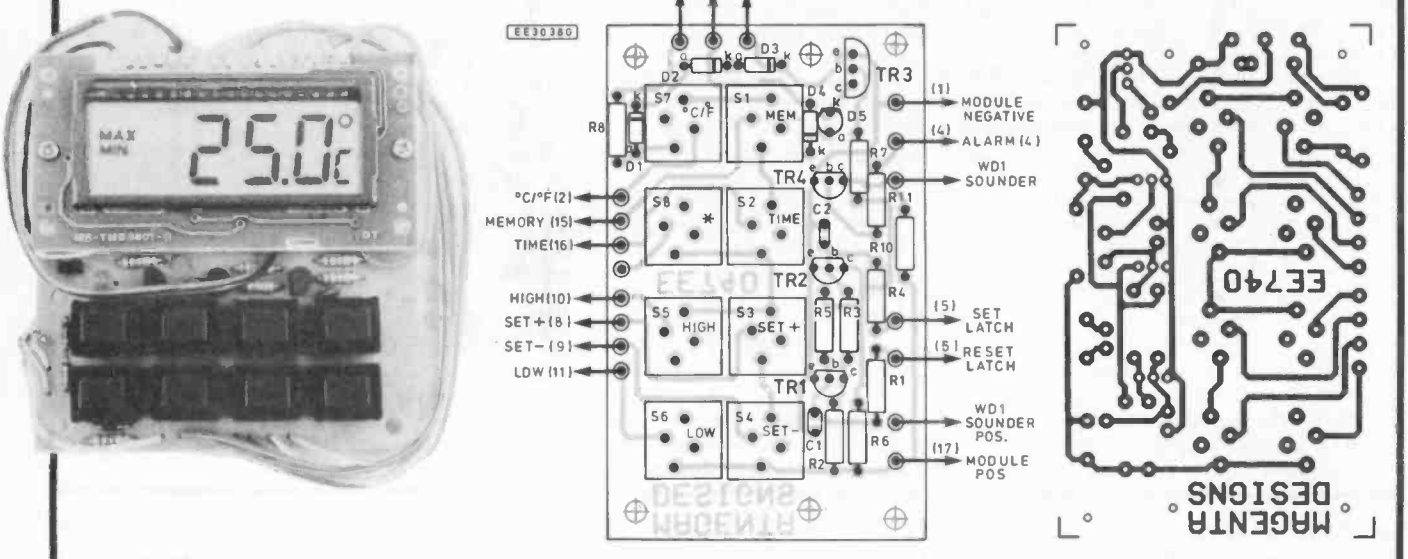


Fig. 3. Thermostat printed circuit board component layout, full size copper foil master patern and photograph of the display module. A spare pushbutton switch has been included and the pre-punched front panel allows for this switch. Note that one set of contacts on each switch are commoned together internally and complete the supply connections on the board.

The entire thermostat circuit is completely isolated from the mains but additional safety is provided by earthing the secondary side of the transformer, especially as the probe could be used in liquids. The tip of the probe is not in electrical contact with the sensor element inside.

CONSTRUCTION

The Digital LCD Thermostat is built on two small printed circuit boards (p.c.b.s). These boards are available from the *EE PCB Service*, codes EE740 and EE741

The component layout and full size copper foil master pattern for the Thermostat board is shown in Fig. 3. The assembly of the thermostat board is straightforward and as long as the components are identified correctly there should be no difficulty. The transistors and diodes must be fitted the right way round but all other components can go either way.

The diodes have a broad black or coloured band at the cathode (k) end which must be fitted as shown in Fig. 3. The transistors are easier to fit the correct way as they have one flat side. Make sure that BC184 transistors are used and NOT BC184L which have a different pin out.

The push buttons must align with the front panel cutout holes and so need to be pushed right down to the board before soldering. Any that are slightly misaligned can be corrected by re-melting the solder when the panel is finally fitted.

POWER/RELAY BOARD

The component layout and full size copper foil master pattern for the Power/Relay board is shown in Fig. 4. This board carries mains voltages so each stage of construction should be checked very carefully before moving onto the next.

There are only a few components on the Power Supply/Relay board. The diodes need to be fitted with their cathode ends as shown and capacitor C3 has its negative side marked with a black line and a series of minus signs.

Provided the correct relay is used it can

COMPONENTS

CONTROL BOARD

See SHOP TALK Page

Resistors

R1, R3, R4, R5	180k (4 off)
R2, R6, R7, R8	18k (4 off)
★R10	1k
★R11	10k

All 0.25W 5% carbon

Capacitors

C1, C2	10n ceramic 50V, 0.1in. pitch (2 off)

Semiconductors

D1-D4	1N4148 signal diode (4 off)
D5	Red l.e.d. (3mm)
TR1, TR2, ★TR4	BC184 *npn* silicon (3 off)
TR3	ZTX600 *npn* Darlington high gain
IC1	TCM2W 4½-digit l.c.d.temperature display module, with remote probe (Magenta)

Miscellaneous

★WD1	6V-12V piezoelectric transducer
B1	1.5V AA size battery
†S1-S8	Pushbutton non-locking switch (8 off)

Printed circuit board available from *EE PCB Service,* code EE740; case, size 78mm x 102mm x 37mm; connecting wire; solder pins, M3 fixing nuts and bolts; solder etc.

★ Optional components for audible warning circuit.

† One pushbutton switch is included as a spare.

PSU and RELAY BOARD

Resistors

R9	47

0.25W 5% carbon

Capacitors

C3	15µ radial elect. 63V

Diodes

D6	1N4148 signal diode
D7	1N4002 1A 100V rect.

Miscellaneous

T1	3VA Mains transformer; Primary 0V-120V, 0V-120V; or 240V Sec. 0V-12V, 0V-12V; or 24V
RLA	24V 1160 ohm coil, with 10A 240V changeover contacts

Printed circuit board available from *EE PCB Service,* code EE741; 8-way p.c.b. mounting screw terminal block; 3-way p.c.b. mounting screw terminal block; plastic case, 62mm x 80mm x 37mm; 3-core connecting wire.

Approx cost guidance only **£32**

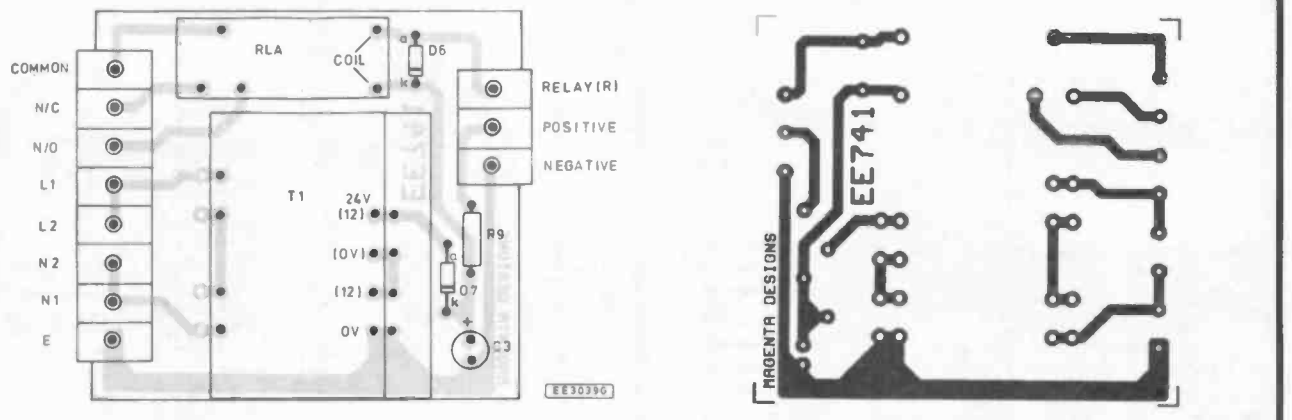


Fig. 4. Printed circuit board component layout and full size copper foil master pattern for the Power Supply/Relay board. Two sets of holes have been drilled in the board to cater for two sizes of transformer. As mains voltages are present, be extremely careful with this board and double-check all wiring before powering-up.

only be fitted one way round to match the board drillings. Note that it must be a 24V type with over 1k resistance.

The transformer must be treated with care as there are very fine wires between its windings and connecting tags, and these may easily be broken by rough handling. As with the relay, the transformer will only fit one way round provided the correct type is used.

Note that there are two sets of drillings in the board to allow a choice of transformer size to match either 1.2VA or 3VA, depending on availability. There is no benefit in using one type in particular.

The power board has been designed to fit into a standard small ABS plastic case, and should not require any mounting screws as it is a snug fit. If mounting nuts and bolts are used they *must* be nylon types for safety.

WIRING

Wiring between the Display module and the Thermostat board is done using thin solid core 1/0.5 mm wire. This allows the leads to be held in position by bending them into place unlike stranded wire which is relatively springy and hard to keep in position.

Begin by soldering 150mm lengths of wire to the eight points on the push button side of the board and to five of the seven points on the opposite side of the board (see Fig. 3). The alarm sounder (if used) has wire ends which should be soldered either way round straight onto the board positions marked Sounder and Sounder Pos.

Next remove the display module battery, position the thermostat board in the correct place next to the module and make the wire connections to the gold pads on one side or the other. It is not necessary to thread the wires through the module connectors' holes, simply lay them onto the pads and solder. This is easy to do if the pads and wire ends are tinned first and then held together and heated with the soldering iron.

The circuit is now ready for testing, before final assembly.

TESTING

Double check the wiring and when everything looks correct re-fit the battery to the display module. The temperature should be displayed after a short delay. If not remove and re-fit the battery several times to ensure that the module power-on reset function is given a chance to work.

Once a temperature reading is obtained, press the °C/°F button and check that the display changes over from Celsius to Fahrenheit with a C or F indication on the right. If not, check the button and its connection to the correct module pad.

The Time button should produce a clock display with AM or PM indicated on the left side. Whilst holding this button pressed, check that the two Set buttons alter the Hours and Minutes display.

Release the Time button and press the Low button. The display should be a row of dashes and the word MIN.

The module is waiting for the lower set point to be entered using the two Set buttons. Set the display to a few degrees below room temperature and press Low again to return to the normal temperature display.

Repeat the process for the High button but set the upper set point a few degrees above room temperature. The settings of these two values can be reviewed by pressing High or Low once. Press again to restore normal display.

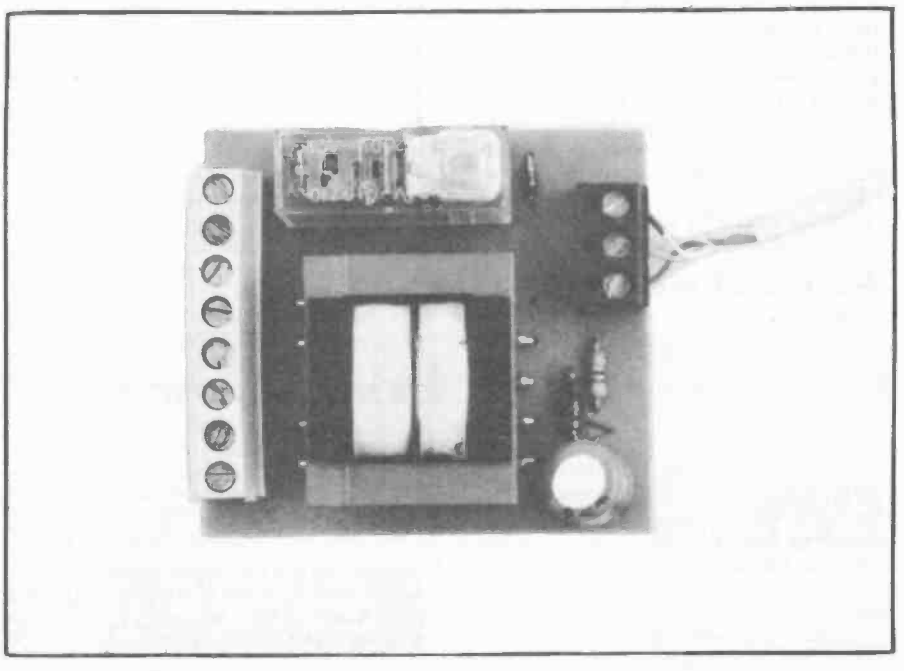
The correct operation of the latch can be checked by wiring a 9V battery with a series resistor (220ohms to 1kilohms) between the –V and Relay (R) points on the edge of the board (battery negative to board –V). This will enable the l.e.d. to light when the latch is set.

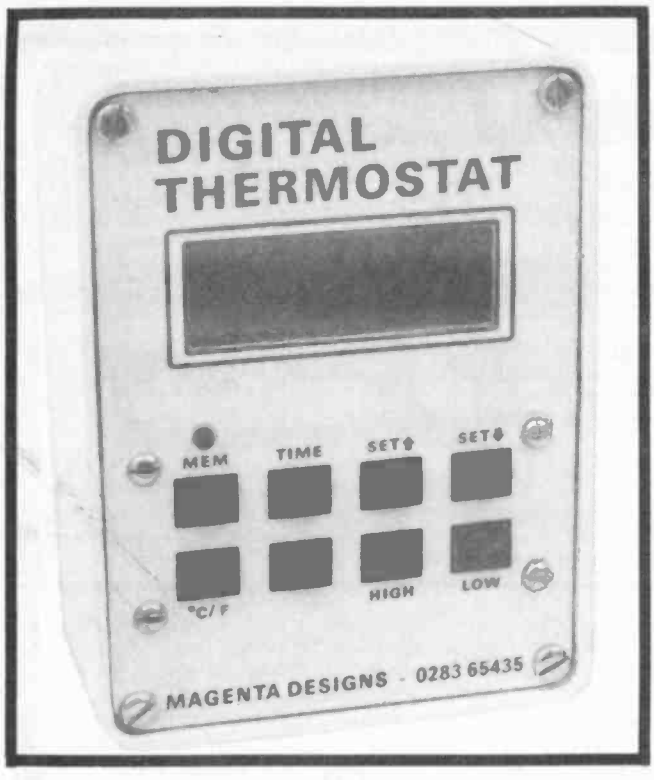
Hold the probe near to the soldering iron and as the temperature rises beyond the upper set point the l.e.d. should light and the word MAX flash on the display. The alarm should also sound and the display remain fixed for one minute. After this time the display should revert to normal, updating the temperature display at 10 second intervals.

Allow the temperature to fall below the upper set temperature and check that the l.e.d. remains on. Put the probe into some cool water and as the temperature falls below the lower set point the l.e.d. should go out and the alarm sound. After the one minute delay bring the temperature back within the limits and check that the l.e.d. remains off.

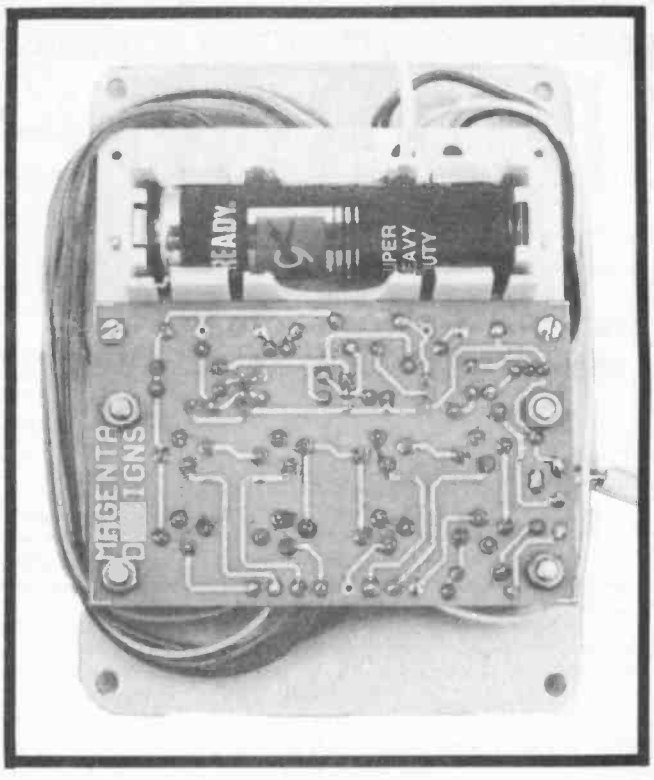
If all this is correct the latch is working correctly and the only remaining function to check is the Maximum and Minimum memory. Hold the Mem button in and press High to display the highest reading recorded. Press Mem and Low to display the lowest.

The finished Power/Relay board (full size). The 8-way connecting block was made up from four two-way p.c.b. screw terminal blocks.





Front panel of the Digital LCD Thermostat showing the lay-out of the "programming" buttons and display window.



The battery holder is part of the Display Module which is fastened to the p.c.b. behind the front panel cutout.

To clear the high memory press Mem and High and both Set buttons together. To clear the low memory press Mem and Low etc. The upper and lower set points can be cleared by pressing High and the two Set buttons or Low and the two Set buttons.

FAULTS

Faults are likely to be due to badly soldered joints or incorrect components and should easily be found by inspection. Crossed wires should be self-evident as the button functions will vary.

The operation of the latching circuit can be investigated further using a multimeter if necessary, and the inputs can be provided artificially by disconnecting the Set and Reset wires from the module and touching them onto the battery positive terminal.

The power supply and relay board can be tested by connecting the mains supply and measuring the output voltage. To be safe fit the board inside the case or fit leads to the three output terminals so that measurements can be made without coming into contact with the mains connections. A 1A mains fuse should be fitted into the mains plug.

Expect an output voltage of over 40V off load. The relay can be operated by shorting the Relay output to –V and should click solidly.

As a final check the boards can be interconnected and the correct operation of the l.e.d. and relay confirmed. It should be possible to remove the display module battery without any change to the operation of the circuit, provided the alarm components are not used. Check that the total voltage across D1-D3 is 1.5V.

FINAL ASSEMBLY

The temperature probe will need to be disconnected from the display module so that its lead can be threaded through a small hole drilled in the rear part of the thermostat case. The position of the hole is not critical and should be chosen to suit the application. The use of a plug and socket is NOT recommended for the probe connections as the long term accuracy and reliability could suffer unless very good quality connectors are used.

The Module is easily dismantled by removing the self tapping screws from the plastic battery housing. Always remove the battery first, and remember which pads take the probe connections. The probe can be connected either way round.

To extend the probe lead it is possible to use ordinary twin speaker cable. Twin screened cable will be preferable in areas prone to interference, with the screen connected to battery negative. The accuracy can be checked by measuring water temperature and comparing it with a known accurate thermometer.

The display module is attached to the thermostat board using M2 screws and 3mm spacers (or two nuts). This sets the height so that the display lies just behind the front panel cutout. The whole assembly is mounted on the case front panel using 6BA or M3 screws and 12mm metal or insulating spacers.

The Magenta kit comes with a pre-punched and printed panel to give a really professional look. If desired a plain panel can be drilled and cut to fit, but the square cut-outs are hard to make neatly without good tools.

APPLICATIONS

This is a versatile and effective temperature controller. The output can be used to control heating and cooling systems or to sound alarms to indicate over or under temperature conditions.

Its prime application is in domestic heating control where its use is virtually guaranteed to save money. Most hot water systems have few controls and there is rarely any form of temperature monitoring or display.

By controlling hot water temperature with a wide band between upper and lower set points and the probe taped onto the outside of the hot water cylinder major savings can be made. The temperatures can be monitored and adjusted by trial and error to obtain the most suitable settings, and the distance of the probe from the top of the cylinder varied to adjust the controlled volume.

Other applications include soil heating; greenhouse heating, cooling and ventilation; tropical aquarium temperature control; frost protection; photographic chemical temperature control, and a vast range of commercial and industrial applications. The relay can be arranged to close on falling or rising temperature by interchanging the Set and Reset connections to the module, and additional slave relays can be added if extra contacts are needed.

Low voltage applications do not need the mains transformer, and the output transistor can drive either low voltage relays or power transistors to control fans and heaters. There will be many applications where a low voltage isolated supply is available and so the power supply section is not necessary.

SAFETY

Note that although the thermostat is as reliable as any other piece of electronic equipment it should not be relied upon in situations where its failure could put life or property at risk. A sensible procedure would be to have a simple mechanical safety thermostat to limit over or under temperature, and to use the electronic thermostat for accurate control within these limits.

When used with domestic heating systems the boiler normally contains all of the necessary protection devices. The thermostat can be fitted into the external wiring without danger. ***Do not tamper with the wiring inside the boiler under any circumstances.*** □

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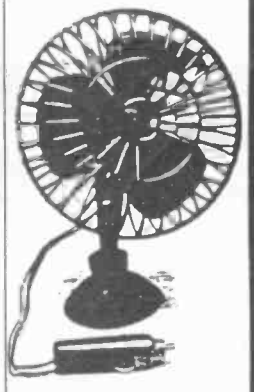

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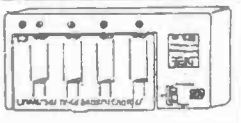

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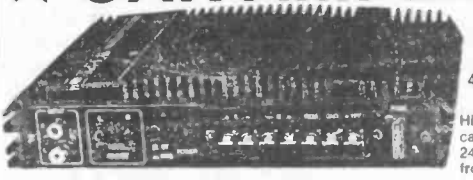

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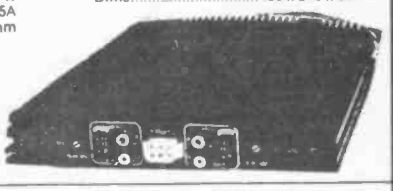

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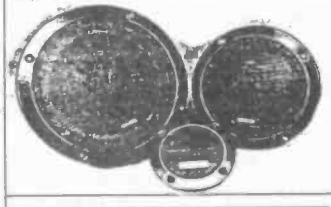

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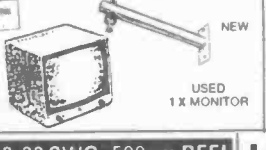

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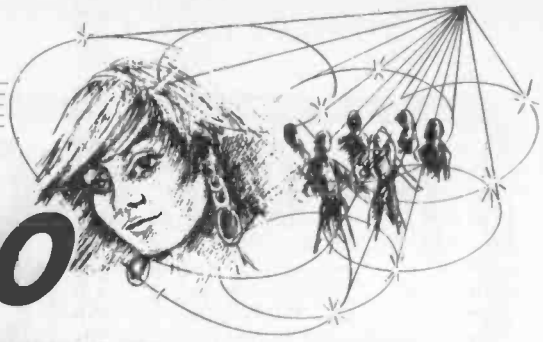


MODULAR DISCO LIGHTING SYSTEM

Part One: SWITCHED POWER OUTPUT MODULE

CHRIS BOWES

First of a series of modules that should make you a No. 1 hit for disco light shows—On-The-Road or for Home Parties

ALTHOUGH there are a number of disco lighting systems which are available, either as complete units for purchase, or as constructional circuits, they all seem to suffer from the common problem of inflexibility.

Most systems actually comprise two distinctly separate circuits. One part (which is invariably a low voltage, control circuit) is used to generate the control sequence which determines which of the (usually four) outputs is actually in operation.

This is linked to the second part, which is used to actually switch on and off the mains voltage outputs, which are connected to the mains voltage lamps, under the control of the low voltage circuit. This mains switching circuit, often employs triacs or solid state relays.

With conventional disco lighting systems, these two circuits are usually inextricably linked within the single unit so that if, after a time, the effect tires with familiarity, the complete unit has to be replaced. This may be in spite of the fact that the part of the unit which switches on and off the lights will be, in one form or another, repeated in the new unit purchased.

CASE FOR ISOLATION

Often the reason for the permanent linking of the two different circuits is the common practice of commoning the mains Neutral wire line with the 0V line of the low voltage circuit, in order to reduce the overall cost of the system. This practise has an unfortunate spin off, in that, if for any reason the Live and Neutral phases of the incoming mains voltage should become reversed, then the 0V (Earth) wire of the low voltage circuit could become connected to the "Live" of the mains wiring. If this unfortunate circumstance is compounded with an absence of an effective mains Earth for any reason, a unit constructed in this manner could become potentially lethal.

Great care has been taken in the design of the Modular Disco Lighting System to ensure that this problem will never occur. All of the low voltage circuitry is completely isolated from the mains connections via a transformer driven power supply and the output switching circuits, where mains voltages are present, are isolated from the control circuitry by means of optical isolators.

SYSTEM OUTLINE

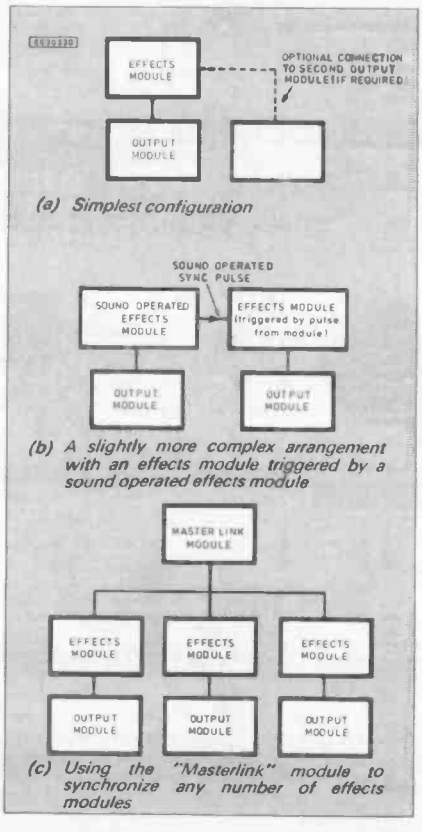
The Modular Disco Lighting System has been designed to take advantage of the fact that it is more convenient, more flexible and safer for the two parts of the circuitry to be organised as separate, optically coupled modules. Being linked together in such a way, means that the low voltage part of the circuit can be easily replaced with another, different, effects controller as required.

A modular system also lends itself to even more versatility if the demands of the overall system are taken into account during the initial design stage. For example, any units (such as the Sound-to-Light Module) in the system, which are connected to a sound source have been designed so that they will also provide a pulsed output, driven by the beat of the music. This output pulse can, if required, be selected to drive any of the pulse driven units and so synchronise any or all of the other effects in unison, in time with the beat of the music.

The Mains Output Controllers have been designed so that the input signals which drive them are also available (suitably buffered) at an output socket. This output can thus be fed in turn to the input of another controller. As the next controller in the chain will also provide it's input, again suitably buffered at an identical, output socket it becomes, theoretically, possible to link an infinite number of output units together.

The power which is required to drive the low voltage control units is provided by the mains driven output control units. The low voltage units can, however, control more than one output controller and so the low voltage power distribution network within the inter module connections has been designed so that, in a multiple module system, most of the units will continue to function even in the event of a failure in one part of the system.

Fig. 1. Examples of how various modules can be connected together.



(a) Simplest configuration

(b) A slightly more complex arrangement with an effects module triggered by a sound operated effects module

(c) Using the "Masterlink" module to synchronize any number of effects modules

MODULES

In addition to the two types of modules described above which can be categorised as *Effects Modules* and *Output Modules*, the Modular Disco Lighting System has also been designed to include a third type of *System Control Module*. These modules are used to interlink, control and route signals from the low voltage control modules.

One module (called *Masterlink*) has been designed in such a way that any or all of the functions available on the effects mod-

ules can be synchronised together. Some examples of how various modules can be connected together are shown in Fig. 1 but in effect, the number of possible arrangements are infinite, governed solely by the availability of space, power and cash.

The heart of the system lies with the Switched Power Output Module, described in this first article. One output module is required for each display of up to three amps loading. The power output module also provides power to drive the other modules in the system.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Switched Power Output Module is shown in Fig. 2. This module consists of three separate, fairly simple, circuit building blocks consisting of a power supply, a signal processing system, and the main switching system.

POWER SUPPLY

The power supply is a conventional transformer driven full wave rectifier circuit. Mains power is fed through fuse FS1 and switch S1 into the primary of the mains transformer (T1), the secondaries of which are combined to provide an a.c. current. This passes through the rectifier bridge (D1 to D4).

The rectified current is smoothed by capacitor C1 and fed via the output fuse FS2 to the control switches (S2 to S5) and by the diode D13 to the remainder of the modules connected to the system. The inclusion of D13 is perhaps unusual in power supplies but it is included to allow the "commoning" of the outputs of a number of power supplies, in similar modules, to power the rest of the system.

When a similar power supply (from another output module) is connected to the output chassis mounted plug PL1/7 to PL1/8 then the positive and common rails are connected together and the inclusion of output diodes prevents complications which might otherwise occur.

SIGNAL PROCESSING

Incoming signals from the input socket SK1/1 to SK1/4 are fed to a 4050 non-inverting buffer, IC1. The buffered signals are then fed both to the output chassis plug (pins PL1/1 to PL1/4) and through diodes D6, D8, D10 and D12 to the inputs of the respective optically isolated triacs IC2-IC5.

Within the complete system any Switched Output Module can be used to route the signals from an effects or control modules to an additional routing controller or output module. IC1 is therefore included to provide buffering and prevent false operation of outputs due to signal loss. Capacitor C2 is a standard decoupling capacitor which is included to smooth the power supply for the logic part of the system and to provide decoupling.

The switches S2 to S5 are included to allow manual operation of each of the opto isolators. When any of the push-to-make switches, S2 to S5 are operated, the positive supply (V_{SS}) is fed through the push switch and it's associated diode to the input of that circuit's opto isolator.

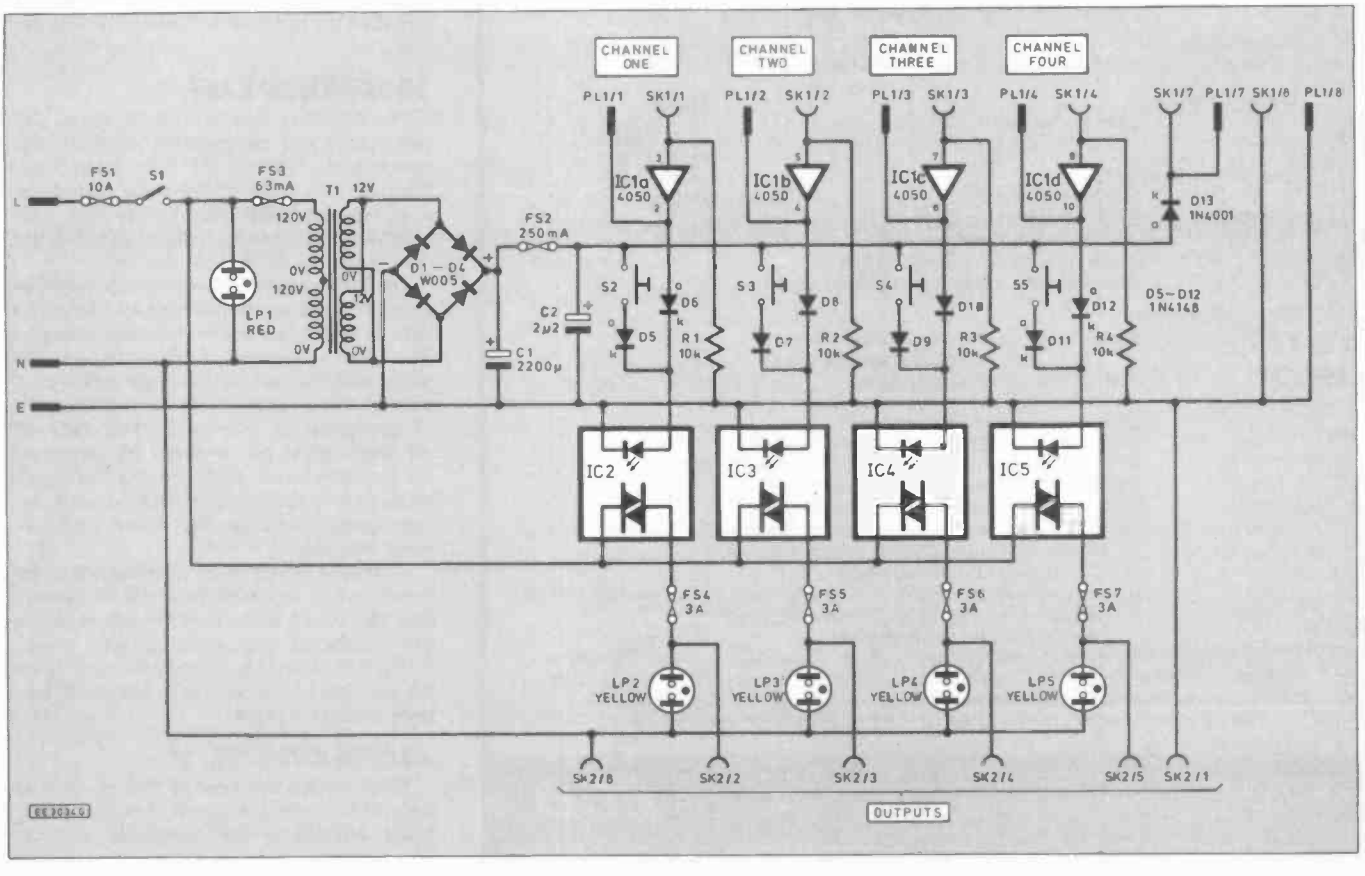
The two diodes connected to the input of each isolator serve to form a simple OR gate which allows either of the two inputs (in this case that from the push-to-make switches and the input from the external effects module) to be in the active state without this interfering with the other input.

MAINS SWITCHING

Each of the circuits is provided with an identical mains switching system which operates in the same way as the following description for channel one.

When a Logic 1 ("high") signal, generated either from an external source and

Fig. 2. Complete circuit diagram of the Switched Power Output Module for the Disco Lighting System. FS3 is a protection fuse for the transformer. LP1 to LP5 are mains neons which each incorporate a dropper resistor.



routed via pin 1 of SK1 or from the operation of S2, is available at the cathode (k) of either of the two diodes D5 or D6 then the l.e.d. section of the opto isolator (IC2) is energised and triggers the triac section. This causes a current to flow from the output of S1, through the triac to the output connection (pin 2) on socket SK2. Fuse FS4 is included in the circuit to protect IC2, which has a maximum rating of 3A.

The presence of an output mains voltage at SK2 pin 2 is signified by the illumination of neon LP2. Because of the circuitry inside the solid state relay (IC2), this neon also glows at half power, irrespective of whether it is energised or not, in the event of there being no load connected to the output pin. This has often proved to be a useful aid when fault finding.

CONSTRUCTION

The Switched Power Output Module is built on a single-sided printed circuit board (p.c.b.). The full size foil pattern and the component layout is shown in Fig. 3. This board is available from the *EE PCB Service*, code EE739.

The entire system has been designed so that all of the modules can be fitted into the same style of case so it is recommended that the case detailed in the components list, or one with similar dimensions, should be used for all modules.

Once a suitable board has been made or purchased, the components can be inserted into the board and soldered in place. Although this process can be carried out in any convenient order. You will find that it is easier to perform this task if the components are inserted in ascending order of size.

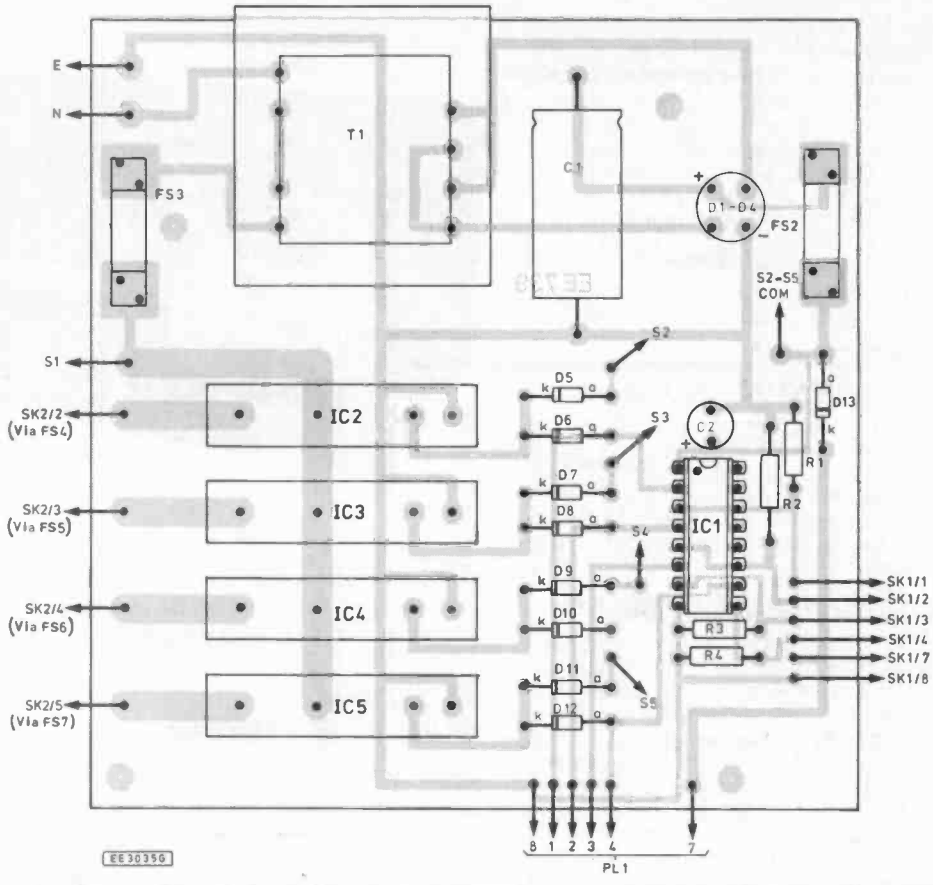


Fig. 3. (above) Printed circuit board component layout and (right) full size copper foil master pattern for the Switched Power Output Module.

All the components of a particular size should be soldered into position before going onto a larger size of component. Care should be taken to ensure that the polarity sensitive components (C1, C2, IC1 and all of the diodes) are connected with the correct polarity.

IC1 is best accommodated in a socket which is soldered in place along with the other components. The i.c. should be inserted as the last task before testing out the unit.

WIRING UP

The board is best not wired up to the panel mounted components until all the components, except for IC1, have been inserted and soldered in place. Similarly it is recommended that before any case mounted components are installed that the case should be drilled and lettered.

The connections between p.c.b. and the case mounted components should be made with flexible wires cut to the correct length. There are a number of connections to be made and the use of as many colours of wire as are available will reduce the risk of confusion at this stage. The ends of the leads must be prepared by stripping the insulation and solder tinning the bared wires before the cable is inserted into the appropriate holes on the board and soldered into place.

Alternatively, to make construction even easier, p.c.b. terminal pins can be driven into the board at each point where wires are connected and soldered into place. When this method is employed wiring up of the unit can be left until after the p.c.b. has been secured in place.

ASSEMBLY

Space within the case of this module is somewhat limited so care must be taken when assembling the completed project. The suggested order of operation is to first

COMPONENTS

SWITCHED OUTPUT MODULE

See SHOP TALK Page

Resistors

R1-R4	10k (4 off). All 0.25W 5% carbon

Capacitors

C1	2200μ axial elect. 25V
C2	2μ2 tantalum, 63V

Semiconductors

D1-D4	W005 bridge rectifier
D5-D12	1N4148 signal diode (8 off)
D13	1N4001 1A 50V rec. diode
IC1	4050 Hex, non-inverting buffer
IC2-IC5	3A solid state, opto-isolated relay (4 off)

Miscellaneous

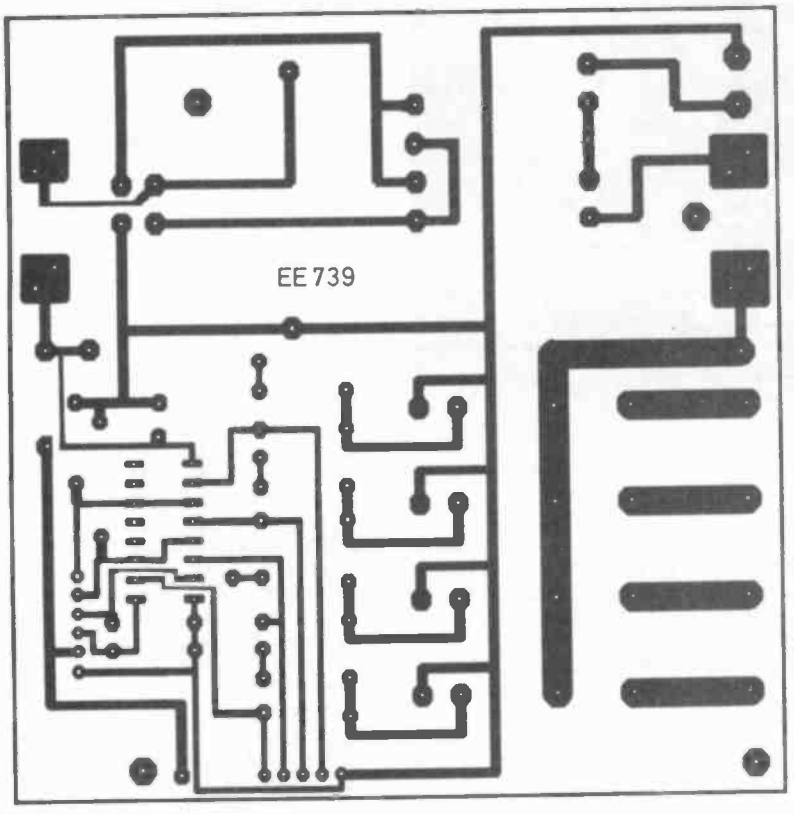
T1	Mains 6VA p.c.b. mounting transformer; 12V 0.25A, 12V 0.25A secondaries
S1	10A 240V s.p.s.t. toggle switch
S2-S5	S.P.S.T. min. push-to-make switch (4 off)
LP1	240V panel mounting neon, red
LP2-LP5	240V panel mounting neon, yellow (4 off)
FS1	10A 20mm fuse and panel mounting fuseholder
FS2	250mA 20mm fuse and p.c.b. fuse clips
FS3	63mA 20mm fuse and p.c.b. fuse clip
FS4-FS7	3A 20mm fuse and panel mounting fuseholder (4 off)
SK1	10-pin circular video chassis mounting socket (with matching cable plug)
SK2	8-pin non-reversible mains 6A chassis socket, Bulgin P552 (2 off)
PL1	10-pin circular video chassis mounting plug (with matching cable socket)

Aluminium instrument case (Maplin "Blue Case 233"), size 250mm x 150mm x 75mm; 16-pin d.i.l. socket; heavy-duty wire (see text); mains 3-core cable; connecting wire; p.c.b. stand-off pillars (4 off); solder tags; solder etc.

Printed circuit board available from the *EE PCB Service*, code EE739.

Approx cost guidance only

£60 *plus case*



loosely install the mains output sockets, the signal input and output sockets and mains switch S1 into the case.

The printed circuit board containing the main circuitry can then be offered to the case floor in the correct place and the position of the holes through which the stand-offs will fit should then be marked on the inside of the case floor. All of the components and the printed circuit board should then be removed and the holes drilled for the screws which secure the stand-offs, which can then be installed.

Installation of the printed circuit board should be left until later. All of the case mounted components with the exception of the five neon indicators and the mains input chassis mounted plug and the input and output signal connectors can then be installed in the case and secured in position.

These components may be wired together as appropriate, remembering that the current flowing between the input mains chassis mounted plug, switch S1, fuse FS1 and the main circuit board can at times ***exceed 10A and appropriate rated wires MUST be used for these connections.*** Similarly the wires joining the Neutral and Earth connections of the mains input plug to their common connections on the output sockets ***MUST*** also be made with similar size of wire.

A similar heavy-duty earth wire should be used to provide the Earth pin of the mains input plug with a good "earth" connection to the metalwork of the chassis (case). A convenient point for this connection is to one of the two bolts used to secure the mains input plug to the chassis.

Where connections are made between the chassis mounted components and the printed circuit board a suitable length of wire should be connected to the component ready for later termination on the circuit board.

NEONS

Installation of the neons is made much easier if the "live" connection to the neon is made by means of suitable heavy duty wire connected to the appropriate fuseholder and then passed through the neon mounting holes. This wire should be soldered onto the appropriate terminal of the neon whilst the neon is outside of the case.

The neon can then be pushed through its mounting hole and, when all five have been installed, a piece of bared wire can be soldered across each of the remaining tags. This wire is then connected to the Neutral terminal on the output socket.

Wiring of the signal input and output sockets is commenced by first soldering suitable lengths of colour-coded wire onto the terminals of the plug and socket before they are mounted on the case. The wires can then be passed through the appropriate hole in the case and the socket retaining nut screwed firmly in place.

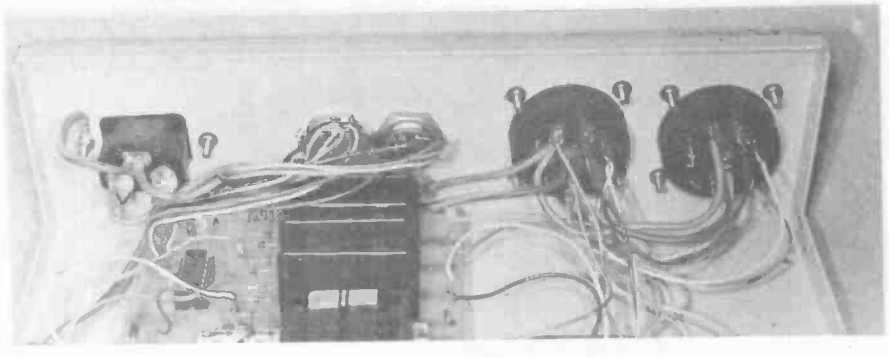
At this stage the printed circuit board can then be offered into place and secured on its stand-off retainers. The connections to the board can now be installed and this task will be made easier if terminal pins have been soldered to the board whilst the board has been made up.

The final task is to install the chassis mounted mains inlet plug and connect it to the wires which have been prepared for termination to it. Each connection should be checked with a test meter to ensure that the case is effectively connected to the Earth input of the mains input plug.

TESTING

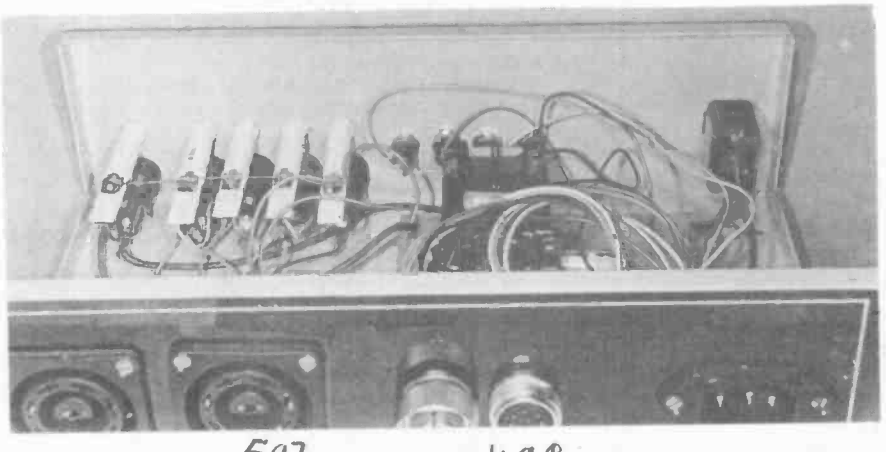
The usual checks to ensure that no incorrect connections have occurred should be made before the unit is connected to the mains supply and tested. It is important to remember, when testing this unit, that ***MAINS VOLTAGE is present on the PRINTED CIRCUIT BOARD so extreme care should be exercised when attempting to fault find*** on this unit.

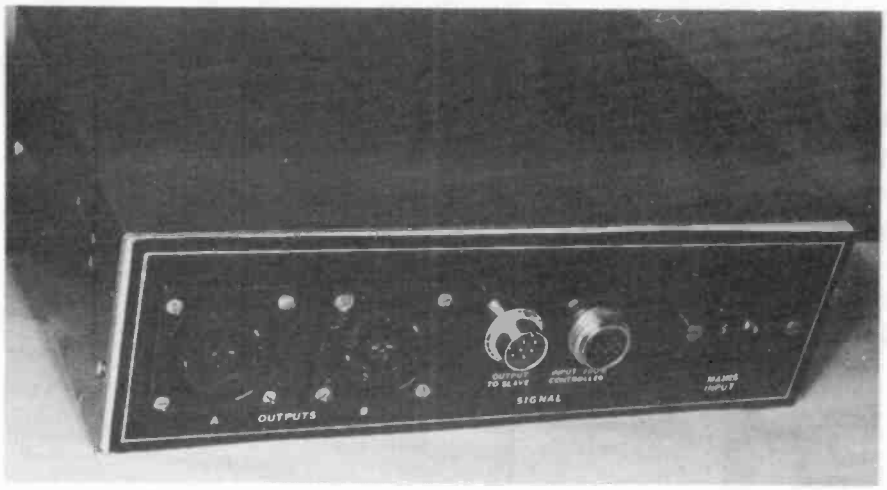
Once the unit has been connected to a source of mains power, and the mains switch S1 turned on, the red neon on the right hand side of the panel (LP1) should be seen to glow. If a load has been



Wiring and layout of components on the rear panel. Two Buglin output sockets, wired in parallel, have been used to allow lighting banks to be sited either side of the "stage".

Wiring to front panel components. The common connection wire across the neons can be seen. It might be safer to sleeve this lead.





Layout and lettering of the sockets on the rear of the case.

connected to the output socket then none of the neons LP2 to LP5 should be alight.

If no load is present then these neons may glow at about three quarters power. This is not unusual and is useful in so far that this effect helps in the diagnosis of faults in the output circuit.

When the press switches (S2 to S5) are operated the appropriate neon should come on to full brightness. If a load is connected to the output sockets this should also be switched on.

To test the input connections and the buffer amplifier (IC1) a nine volt battery may be used to simulate the input of a control signal from an "effects module" connected to the input. The negative connection of the battery is taken to a suitable Earth point and if the positive connection is temporarily touched onto pins 1, 2, 3, and 4 in turn of the input socket then the appropriate circuit should be switched on.

If you wish to check that this is also being transmitted to the output sockets a test meter or logic checker may be connected to the appropriate output pin and the effect of connecting the plus nine volts to the equivalent pin on the input socket should produce an output of about 16 volts (Logic 1) on the output socket.

IN USE

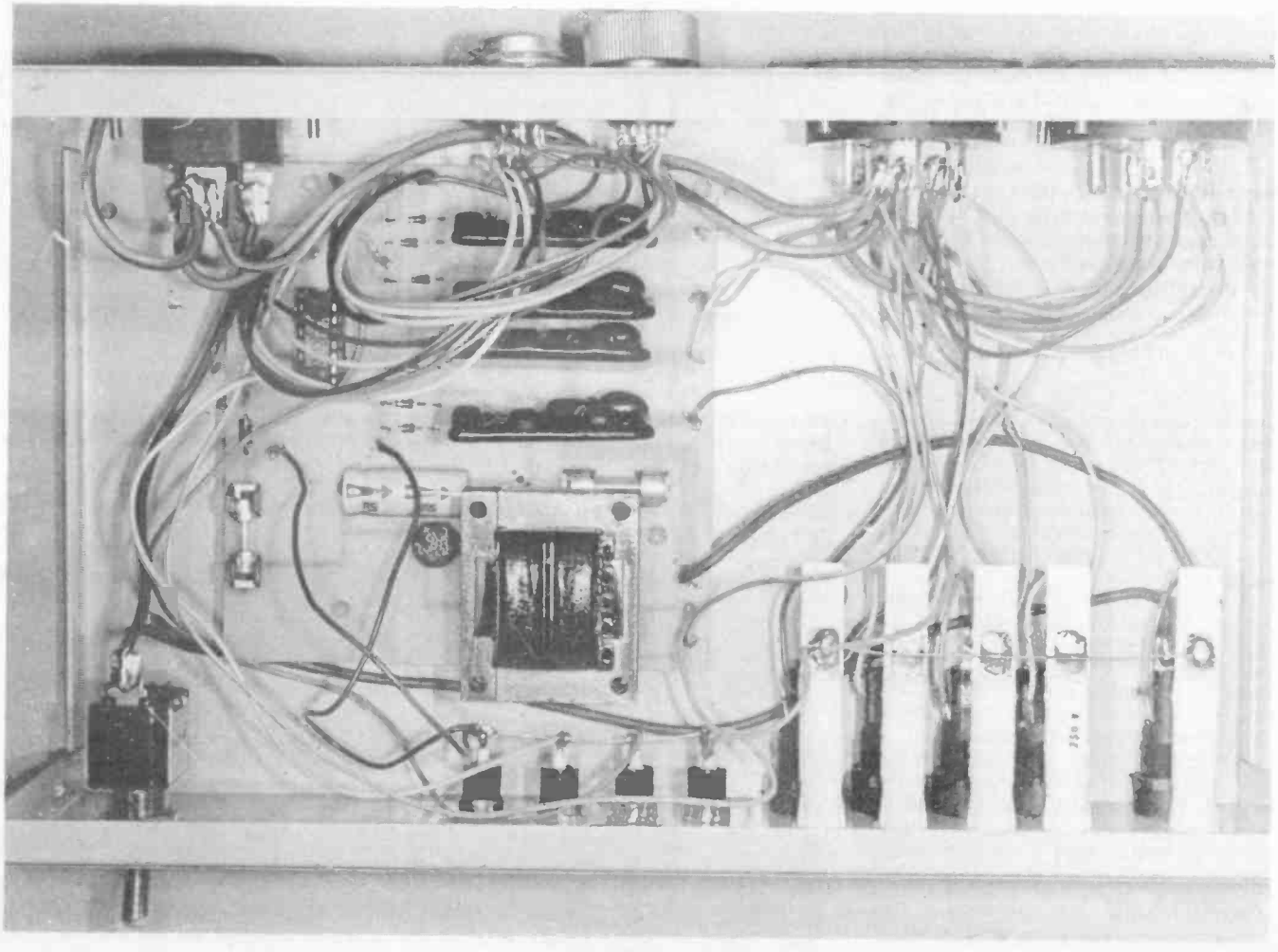
When using this unit the selected effects module is connected by means of a suitable cable to the input socket of the switched output module and a suitable light display is connected to the output "Bulgin" sockets. The effects module will then control the output module in the desired pattern, with the output circuits which are on being indicated on the yellow output neons (LP2-LP5).

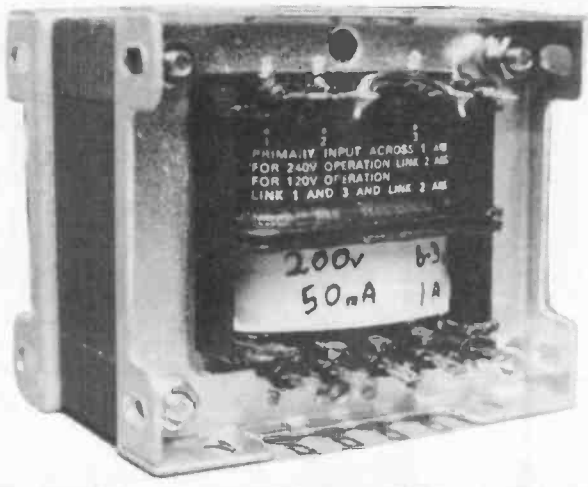
If desired, usually because of the need of a greater output than 3A (750W) to be driven from the output module, the signal input of a second output module can be connected to the signal output of the first Switched Output Module. In fact any number of additional output modules can be connected in a daisy chain formation in this way, since each signal output is buffered from the input signal.

The effects module connected to the output module(s) draws it's operating power from all of the output modules to which they are connected. In the event of more than one output module being driven by an effects module the effects module will continue to work even if all but one of the output modules suffers a loss of power or fails in any other way.

Next Month: A Simple Chaser and a Sweep Chaser will be described. This provides an introduction to how the system for generating effects works and enables you to get your system up and running.

Early prototype model showing positioning of components inside the case. Some of the components on the circuit board have been changed and repositioned on the final model but the case layout remains the same.





WIND YOUR OWN TRANSFORMERS

By Pete Roberts

MANY constructional projects are designed to use an off-the-shelf mains transformer. However specialised designs may well call for an equally specialised transformer which can only be obtained either by having one custom wound (expensive) or by winding your own.

Seen from the safety aspect, the mains transformer is the most critical component in any mains powered project and sloppy workmanship can lead to both shock and fire hazards. Transformer design is a "black art" where theory comes very much second to "suck-it-and-see" experimentation. Such parameters as core material and dimensions, turns per volt together with wire gauges needed for given currents have all been optimised over many years of design and manufacture. Happily, though, transformer kits are now available where all the hard work's been done for you *including* pre-winding of the critical mains primary.

Transformers constructed using these kits should, as long as the maker's instructions are strictly followed, result in a finished article which meets the BS415 standard for electrical safety. It must be emphasised, however, that a homebuilt transformer should NOT be used as a replacement in BS415 approved equipment. By law, the manufacturer's genuine spare part must be fitted.

VOLT AMPERES

Transformer kits are available in several different sizes, and the first task is to define your requirements exactly. First, let's look at this business of VA (Volt Amperes). Why are transformer ratings not specified in good old watts? The answer lies in the general cussedness of alternating current circuitry.

Where the load is purely resistive (i.e. low voltage soldering irons or valve heaters) the current flow in the load is exactly in step with the applied voltage. This means that calculating the real power-expressed in watts actually dissipated in the load is simply a matter of multiplying current and voltage together.

Loads other than purely resistive may contain inductance and/or capacitance as well as resistance and are termed complex or reactive loads. The current flow in a complex load will not be completely in step, meaning that some of the current flowing will be "wattless" and do no useful work in the load.

As this article is about the "nuts and bolts" of transformer construction I don't want to delve too deeply into a.c. theory so we can forget about power factors and whatnot for now. Suffice to say that as some of the current does no actual work, that portion of the voltage and current actually doing useful work in the load is termed as "Apparent Power", specified in volt-amperes.

The wattless, or reactive current doesn't just disappear unfortunately; it circulates in the transformer windings causing extra heating. This means that the transformer has to have a somewhat higher rating than would be expected. By far the most common transformer load in electronic projects is the rectifier/reservoir capacitor combination in the power supply. This arrangement has a capacitive (leading) characteristic where current flow leads the applied voltage. Anyone building a battery charger should bear in mind that storage batteries display a very similar characteristic and require the transformer to be similarly uprated. Table.1 gives the uprating factors for most applications and all currents are assumed to have r.m.s. values.

REGULATION

One other factor needs to be taken into account when calculating secondary voltage – regulation. Unfortunately in an imperfect world, transformers aren't perfectly efficient. Energy is lost both in the winding resistances (copper loss) and magnetic "resistance" in the core (iron loss). This means that as you increase the load on the transformer the secondary voltage(s) fall off; the regulation, expressed as a percentage, tells you by how much.

In practice, this means that the extra turns have to be added to the secondary winding(s) over and above the calculated amount; the actual increase being so many percent of the theoretical number of turns for so many VA loading. The actual figures vary according to transformer size and the relevant information is given in the instructions packed with the kit. The bigger the transformer the better the regulation so if your project demands a particularly stable output voltage use the 200VA kit whatever your actual requirements.

CALCULATIONS

Now, at last you can specify all necessary parameters. Assuming you've already decided on your output voltage the next step is to work out your required current. To do this simply multiply your theoretical value by the appropriate factor from Table 1. Next, multiply the voltage and current rating together to give you your VA rating. Now, from the turns-per-volt tables in the kit instructions, you will be able to work out the number of turns needed on your winding. To this figure is added the extra number of turns needed to compensate for losses.

Finally, the wire gauge needed for a given current is again specified in the kit instructions. Where your particular requirement would fall between two wire gauges use the next heaviest (*lower* s.w.g. or *higher* mm diameter).

Where your transformer has multiple secondary windings, calculate the parameters for each secondary completely separately, finally adding all the VA's together to arrive at the complete transformer's power rating.

Finally, you have to decide which size kit to buy. Most of you will, like myself, be winding by hand; meaning that you'll not get as many turns into the bobbin as an accurate (and very expensive!) coil-winding machine. Whilst in theory you should get 20VA's worth of secondary onto the bobbin of the 20VA transformer kit, in practice I would use the 50VA job. Likewise, anything above 45VA or so might point to using the 100VA kit rather than the 50VA.

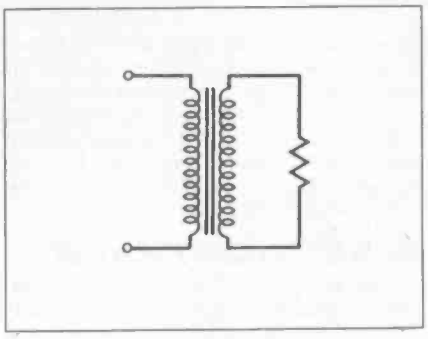
Saying that, the transformer to be described in this article is rated at 16VA and was successfully built on the 20VA kit. It can be done as long as you're careful and patient! I'll give you three design examples, based on RS Components kits, the last of which is the actual transformer whose construction is to be described. This transformer is to supply the power in a two-valve radio project which I hope to present at a later date.

EXAMPLES

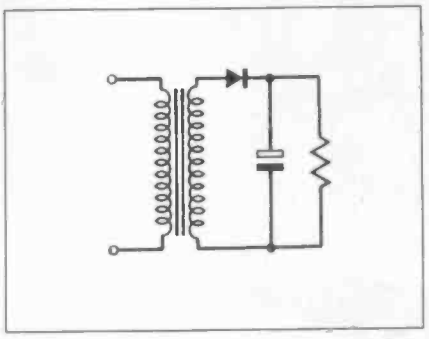
For our first example, it is required to run a 24V 40W soldering iron from 240V a.c. mains. As this is a resistive load no uprating of the secondary current is needed. Bear in mind that in all these kits the primary is wound in two halves. For 240V mains these are connected in series, for overseas readers with 110V mains the windings are connected in parallel (Fig. 1).

Power = 40W = 40VA
On-Load Voltage = 24V
Current = 40/24A = 1.67A
Use 50VA kit (4.9 turns per volt)
Theoretical turns = 24 × 4.9 = 117.6 (118)
Extra turns for regulation = 1% per 5VA load: 8% for 40VA
Extra turns = 9.4
Actual turns needed = 117.6 + 9.4 = 127
Wire gauge to carry 1.67A = 0.8mm (21 s.w.g.)

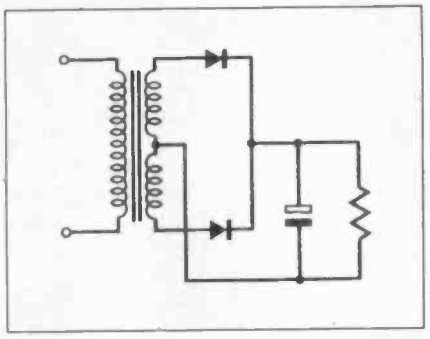
TABLE.1. COMMON PSU CONFIGURATIONS



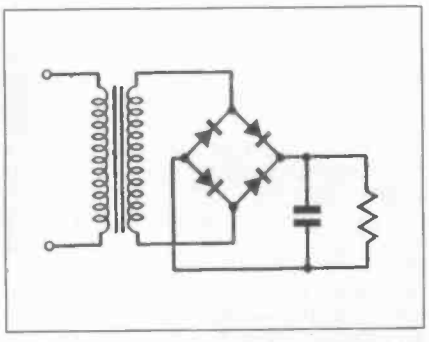
Resistive load $I_{SEC} = I_{LOAD}$



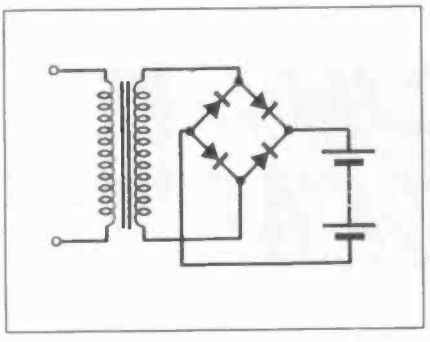
Half wave rectifier – capacitive filter $I_{SEC} = 3.6\ I_{LOAD}$



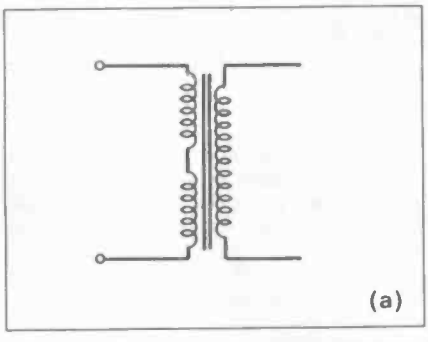
Full wave biphase rectifier – capacitive filter $I_{SEC} = I_{LOAD}$



Full wave bridge rectifier – capacitive filter $I_{SEC} = 1.6\ I_{LOAD}$



Full wave bridge rectifier – battery charger $I_{SEC} = 1.6\ I_{LOAD}$



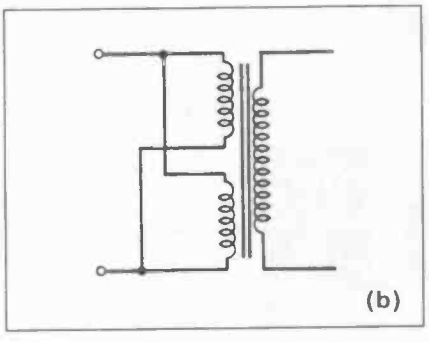


Fig. 1(a) Primary series connected for 240V mains. (b) Primary parallel connected for 120V mains

For our second example we'll consider a transformer that is to supply 20 volts in a regulated p.s.u. giving 13.8 volts at 3 amps. The p.s.u. incorporates a full-wave bridge rectifier and capacitor filter. As the designer has only specified p.s.u.output current the transformer rating will have to be uprated by the appropriate factor.

Factor for full wave bridge/capacitor combination = 1.6
Secondary current = 3 × 1.6 = 4.8A
On load voltage = 20V
Power = 20 × 4.8 = 96VA

As only a single winding of comparatively few turns is needed the 100VA kit should be adequate.

Turns per volt (100VA kit) = 3.7
Theoretical turns = 20 × 3.7 = 74
Extra turns for regulation = 1% per 10VA load: 9.6% for 96VA
Extra turns = 7
Actual turns needed = 74 + 7 = 81
Wire gauge to carry 4.8A = 1.25mm (18 s.w.g.).

For our final example a transformer is required to supply 200mA at 200V and 6.3V at 1A. The transformer ratings have been specified and take into account any uprating.

High voltage winding
On load volts = 200
Secondary current = 50mA
Power = 10VA

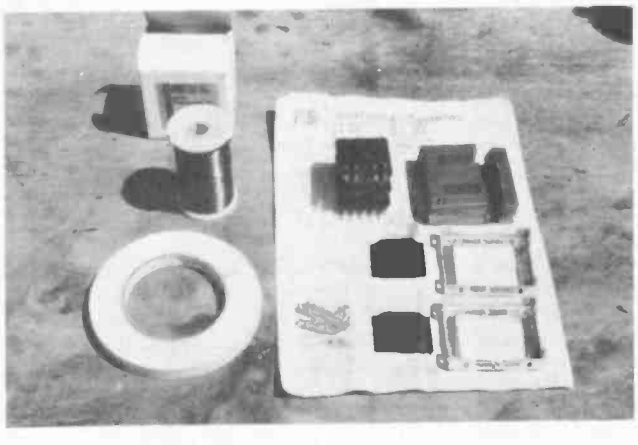
Low voltage winding
On load volts = 6.3
Secondary current = 1A
Power = 6.3VA

Total Power = 10 + 6.3 = 16.3VA
Use 20VA kit (6.4 turns per volt)
200V winding = 200 × 6.4 = 1280 turns
Extra turns for regulation = 1% per 2VA load 5% for 10VA
Extra turns = 64 giving a grand total of 1344
Wire gauge to carry 50mA = 0.15mm (38 s.w.g.)
6.3V winding = 6.3 × 6.4 = 40.3 turns
Extra turns for regulation = 1% per 2VA load: 3% for 6VA
Extra turns = 1.2 giving a total of 41.5 (i.e. 42 turns)
Wire gauge to carry 1A = 0.56mm (24 s.w.g.)

PUTTING IT TOGETHER

Now for the interesting bit, actually putting your transformer together. As they say, a picture is worth a thousand words so I'll let the following photo sequence do the talking as much as possible.

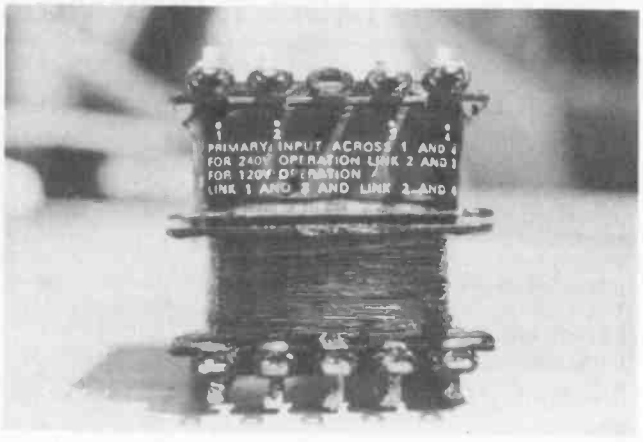
Firstly, get all your materials together. Unpack the kit (Picture 1) and check the contents against the instruction sheet. Next you'll need tools: soldering iron, side cut-



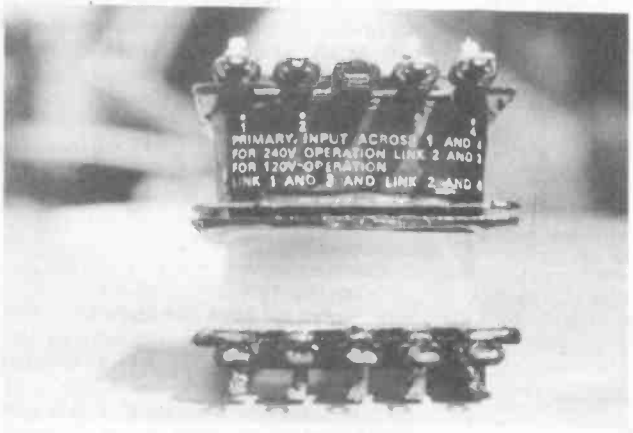
1 *The basic kit*

2 *Tools and winding materials*

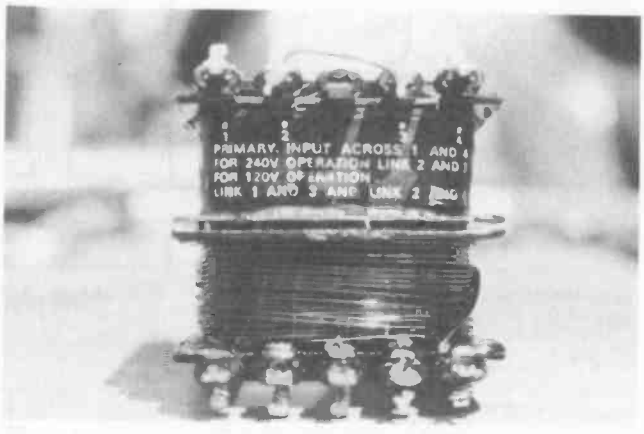
3 *Commencing winding*



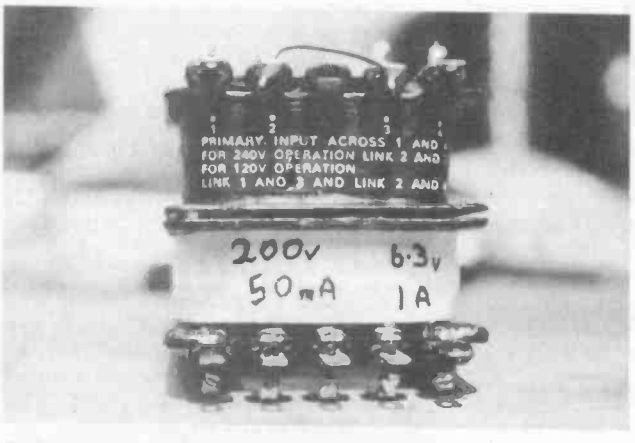
4 *The first secondary in place*



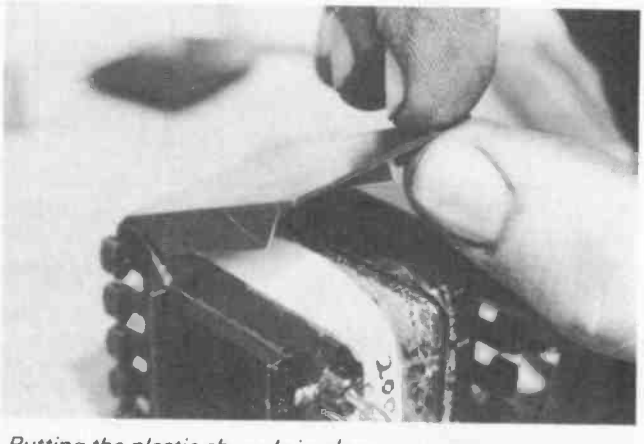
5 *Insulation between secondary windings*



6 *Both secondaries in place*



7 *Insulation and marking of secondaries*



8 *Putting the plastic shrouds in place*

ters, long nose pliers, screwdriver and scissors. You will also need insulating materials; suitable types will be suggested later but for all applications paper masking tape and varnish will be needed (Pic. 2).

As I do quite a lot of coil winding I use a special insulating varnish but for one-off jobs ordinary polyurethane varnish will do nicely. Optional items are PTFE thread tape (the type used for plumbing joints) and yellow polyester "transformer" tape.

Naturally you'll need a suitable amount of enamelled copper wire of the correct gauge for the job. **Under no circumstances use plain tinned wire** as to do so would result in one large shorted turn which could result in a fire when the transformer is powered up.

WIRE

Enamelled copper wire comes in three grades: self-fluxing PVA and polyurethane insulated, both of which are suitable for temperatures of up to about 110°C, and polyester HT2 enamelled which can withstand temperatures up to 180°C. Whichever you use is a matter of choice but the polyester enamel appears to be physically tougher than the other types and stands up better to the rough handling encountered during hand winding. It goes without saying that *you must use brand new wire* rather than any salvaged from old equipment.

To avoid twisting and snapping of the wire during winding the reel has to be able to rotate freely as wire is removed. I use a large screwdriver as a mandrel, with the reel slid onto the blade before clamping the blade to the bench with a "G" cramp or vice.

WINDING

Now you are ready to start winding. Firstly, tin the end of your wire for about 25mm from the end. With self-fluxing wire this is done in exactly the same way as plain copper wire. Other types will need the enamel removing with medium grade emery paper. During tinning, avoid breathing any fumes as small amounts of dangerously toxic isocyanates can be given off.

After tinning, the wire end should be wrapped round the plain, vertical part of the chosen bobbin terminal and neatly soldered. Avoid excess heat as it's easy to soften the plastic bobbin. Now start winding the coil (Pic. 3), taking care to wind the wire as neatly as possible.

Where multiple secondaries are to be wound the one using finer wire should be wound first. This is to reduce the possibility of damage to the enamel coating as fine wire follows the sharp corners in the centre of the bobbin without unduly straining or cracking the enamel.

Unless you've got incredibly good powers of concentration, you should make a note of the turns as you wind them on.

There's nothing worse than to get halfway through a winding of several hundred turns only to lose count and have to start all over again. I always have a pad and pen handy and make a mark for every so many turns counted. For small windings I usually count batches of ten, with batches of 50 or even 100 for larger windings.

While winding, generously coat the winding with varnish which will protect the wire from ingress of damp as well as preventing the winding buzzing in use. When the required number of turns has been wound, the end of the wire is then tinned and soldered to the appropriate terminal.

After terminating the winding, a generous coat of varnish should be applied and allowed to dry whereupon the result should look like Pic. 4. Finally, wind on a couple of layers of polyester "transformer" tape followed by a couple of layers of masking tape (Pic. 5).

Where another secondary is to be wound, this is done in exactly the same way as the first as in Pic. 6. Note that in our example this is the low voltage, heavy current winding. It is good practice to wind all your secondaries in the same direction as in many applications the phasing of the outputs is critical.

After all windings are on and the final layer of masking tape in place, mark the secondary details on the winding before you forget (Pic. 7). It's also a good idea to fit the primary link now as that's another easily overlooked detail. One other point; you will notice that in the example transformer the windings completely fill the bobbin. This ensures maximum efficiency.

The next task is to fit the plastic shrouds to the sides of the bobbin. These protect the windings from damage through contact with the core as well as affording extra electrical insulation, and they *must not* be left out. The shrouds are fitted as in Pic. 8.

ASSEMBLY

Now, the core has been assembled. Firstly, all the "E" sections are fitted alternately left to right (Pic. 9). Make sure that the sections are inserted in the correct order as it's very easy to get one trapped behind its predecessor. Continue filling the bobbin with sections until the final one really has to be forced in.

The core stack should be as tight as possible or else the finished transformer will be noisy as well as less efficient. Incidentally, you will have some sections left over. Don't worry over this; presumably extra sections are supplied to replace any damaged during assembly.

The assembly should now look as in Pic. 10, and it's easy to see where the "I" sections fit in. These are inserted as in Pic. 10. Finally, the entire stack is carefully tapped down with a light mallet or the back of a wooden brush. Finally, the end clamps are fitted as described in the instructions. The RS kits have fibre washers fitted behind the clamping bolts; these **must not** be left out.

TESTING

The end result should look something like Pic. 11, and it's now time for testing. Firstly, check for any continuity between the primary and core and primary to secondary(s). With your meter switched to its highest ohms range the reading must be infinity in all cases.

Next do a resistance check on all the windings (Pic. 12). Primary resistance will vary between tens to hundreds of ohms depending on the size of the transformer and whether the two windings are in series (240V) or parallel (120V). An open circuit would probably point to a bad joint on your primary link(s).

The secondary resistances will depend on wire gauge and how many turns. A simple continuity test is sufficient here. Now it's time for the acid test; those of a nervous disposition may now prefer to retire behind sandbags! Connect the transformer to the mains – preferably with a small fuse in the plug (3 amp or less).

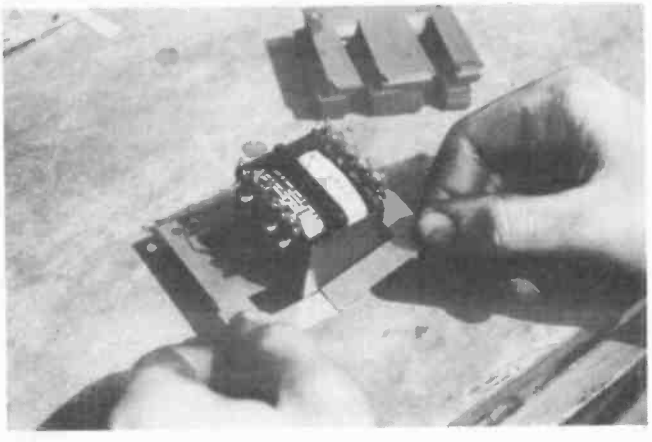
Check the temperature after a few minutes; any significant heating (or smoke!) would point to either shorted turns in the secondary or incorrect connection of the primary for the supply voltage. If all is OK the next task is to check the secondary voltages. These are measured using a shiftable a.c. voltage range on your meter.

CAUTION

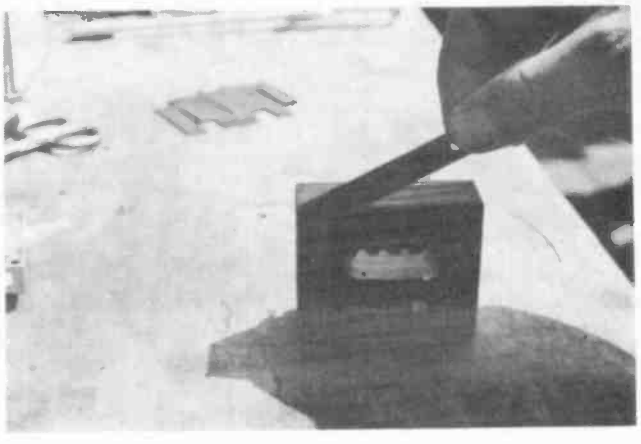
A word of caution: **take great care not to get yourself across the mains voltage on the primary terminals.** Remember also that if, like the example, your finished transformer has output voltages in excess of 50 volts that they can be just as lethal as the mains supply. When meter testing on high voltage circuits it is always best to stand on a rubber mat and try to keep one hand in your pocket or behind your back.

Remember that your output voltages have been calculated to be correct at a given load; the test readings will be a few percent higher. If the error is substantial then you've probably miscounted turns and the transformer will have to be stripped and wound again. If it passes all the above tests it's ready for use. To finish off, give both the core and windings a good coat of varnish (taking care not to get any varnish on the terminals) and allow to dry.

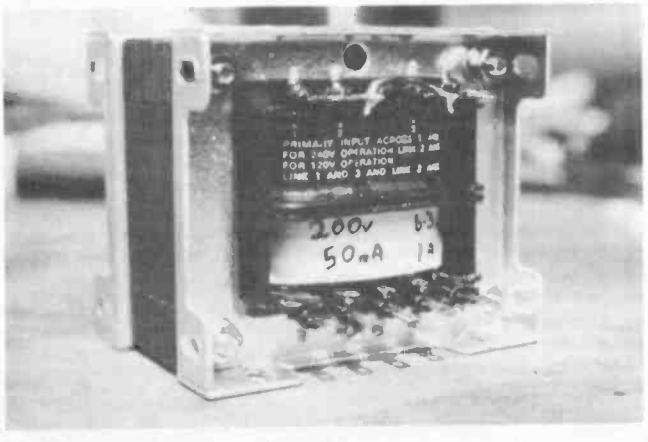
Before finishing off, a word of advice



9 *Fitting the "E" laminations*



10 *Fitting the "I" laminations*



11 *The completed transformer*

12 *Measuring winding resistance*

when winding high voltage secondaries. The enamel coating of the wire will only withstand a certain amount of voltage. When hand winding several hundred turns of fire wire it's very easy to have a turn or two slip down into the earlier part of the winding, posing a risk of insulation breakdowns.

A layer of insulation every 50 volt's worth of winding will prevent this happening. A few turns of PTFE thread tape will do the trick nicely without taking up much room. Make sure that the insulation is snug against the cheeks of the bobbin. If you've got polyester insulating tape then this is ideal. Ordinary PVC insulation tape is *not* suitable for transformer work as it softens too much when warm.

I think that we've covered all the relevant points now but please bear in mind that the advice in this article is based on the RS Components range of transformer kits. Other supplier's kit instructions may vary slightly and this article should be used in conjunction with the maker's instructions. Should there be any apparent discrepancy then the maker's instructions take precedence.

FINAL SAFETY POINTS

As safety is important, I'd just like to go over a few points again:

1. All secondaries must be wound from *new* enamelled copper wire of an adequate gauge for the current it is expected to carry.
2. Where the transformer is wound with a 1:1 ratio for isolation purposes, ensure that the prewound primary is the winding connected to the mains.
3. Don't attempt to modify the primary winding or wind any turns on top of it.
4. Don't under any circumstances use uninsulated wire for winding.

Winding very high voltage secondaries (over 240 volts) is a job fraught with danger. Even the slightest defect in the insulation can result in arcing and flashover with the attendant risk of fire. It's best to leave the winding of such transformers to a specialist firm who will have the expertise and the materials needed for the job.

Bear in mind also that the information in this article applies only to power transformers operating at 50/60Hz. audio output transformers and some inverter transformers use different core materials and winding parameters and usually have to be custom designed for a specific job.

As long as you're patient and careful, making your own transformer is not difficult. It is also what hobby electronics should be all about; learning by doing. You should also be able to save a bit of money as a transformer kit is usually cheaper than the ready made item. Most of all, you can tackle unusual projects – for instance, equipment using valves – where a ready made transformer may not be readily available.

Finally, I have made up several of these transformers as replacements in industrial electronic equipment and have not had a single failure to date (touch wood!) so I can recommend them with confidence. Happy winding! □

SHOPPING LIST

Transformers Kits – Available in various sizes from:

Maplin Electronics	0702 552911 (customer services)
Electromail (RS kit)	0536 204555
Enamelled Copper Wire	available from either of the above companies, from many other advertisers, or from the Scientific Wire Co, 811 Forest Rd, London E17 081 521 1568
Polyester Tape	Electromail (12mm or 19mm widths)
Masking Tape	any d.i.y. shop (see text) or Electromail (500ml)
PTFE Thread Tape	any d.i.y. shop or Electromail

FOR YOUR ENTERTAINMENT

by Barry Fox

Interactive CD

I promised to report on Commodore's plans for CDTV, the multimedia CD system which rivals Philips' CD-I (CD-Interactive) and Intel's DVI (Digital Video Interactive).

CDTV (which actually stands for Commodore Total Dynamic Vision!) was, as expected, unveiled and demonstrated at the Winter Consumer Electronics Show held in Las Vegas in January. The system will go on sale this Spring in the USA and UK, before other countries.

The word from the software companies, who are getting fed up with the delay on CD-I, is that they welcome CDTV. It may not be as good as CD-I, but, in the words of one "it is here and it works – if Philips holds back the domestic launch of CD-I in Europe until June 1992, when the chips for replaying Full Motion Video are ready, they are dead. It will be too late".

DVI is out of the domestic market frame. You need to spend around £2000 on a plug-in circuit board and add-on CD-ROM drive for a 386 desk top PC. DVI is fine for professionals (e.g. the system is used for passenger information guides at the de Gaulle airport in Paris) but it is not a consumer product.

The clear impression from Las Vegas was that Commodore recognise the crucial value of a market lead over CD-I. It is also clear that CDTV, which is based on the Amiga computer with its well-respected graphics capability, has plenty of technical potential. But Commodore is pushing CDTV onto the market before there is programme material available that comes anywhere near to exploiting that potential. This could backfire. If CDTV gets an early bad name, it could turn the public off the whole idea of multi-media CD, whatever the system.

The CDTV player combines an Amiga chip set with a CD player in a black casing which looks like a video recorder but takes compact discs instead of video cassettes. There is no keyboard, just an infra red remote control with arrow keys to move a cursor across the screen and "accept" keys, like those on a computer mouse, to trigger a function selected by the cursor.

Like CDI, CDTV is a "buy and play" system. The user plugs the player into a TV set and hifi, loads a disc and switches on. There is none of the complicated setting up needed for CD ROM systems. The CDTV player will be boxed with a disc which behaves as an interactive multi media instruction manual. Although the player will also play conventional CD audio discs, all discs must be put into a protective caddy before loading into the machine.

Interestingly, Commodore's CDTV players are being made in Japan by Matsushita Kotobuki, a subsidiary of the company which is backing Philips on CD-I. The quoted price for the UK is £699, with program discs costing £25-£30.

US and UK Launches

The US and UK product launches will be handled quite differently. Whereas Commodore hopes to take the US market by storm by a heavy push with adverts like "Honey turn on the TV I'm trying to think", Commodore's UK division is moving far more cautiously.

Commodore UK will put out 1500 machines on a six week trial to consumers, journalists, businesses and educational establishments. Triallists will be given software to try and asked to fill in questionnaires. Then, in the Spring, CDTV will go on sale through Dixons and other multiples. Players will not be sold by computer dealers; and Dixons have been asked to stack CDTV players with video recorders and CD players, not computers.

Even before the trial had begun, Commodore UK was getting feedback that £700 is far too much. The Amiga computer sells for under £300 and a standalone CD player costs well under £200. Commodore people in the UK are already looking for lower prices on CDTV. They realise it would be fatal to launch at £699 and then cut prices too soon after.

There are 30 CDTV software titles now ready, with 50 promised for launch and 100 by the end of the year. This, says Commodore, does not include "shovelware", the company's dismissive term for software which has been written for existing computer game machines and routinely converted into the new disc format.

But it has to be said that only a few of the 30 program discs running on 20 CDTV machines at the Las Vegas show came close to exploiting the potential for CDTV which Commodore promises. One of the titles demonstrated at the press launch, "Defender of the Crown", has pitifully poor animation and is already available as a CD ROM game in the UK. When I reviewed it in CD-ROM format last year I reckoned I would rather spend time at the dentist than playing the game.

There is no accounting for taste, though. Commodore tell me Defender is a popular game. But will the kids who already play it on a cheap computer, now spend at least £700 (or even £500) on a CDTV player just for the bonus of the stilted dialogue and snatches of music that are stored on the Defender CD along with the game?

Embarrassed, Old Boy?

The Ministry of Defence got its stolen laptop computer back, just before war broke out in the Gulf. The MOD's blunder must not be swept under a carpet of old boy net forgive and forgetfullness. The MOD lost its laptop when it was stolen from from an unguarded car on 17 December.

What really matters is that the whole sorry saga, and the government's attempt to limit embarrassment damage with a D notice, leaves little doubt that the MOD had failed to encrypt the data stored on the discs or non-volatile memory. And this is wholly inexcusable.

Inexpensive encryption programs for desktop and laptop PCs are readily available and easy to use. I know this first hand because I was reviewing the latest version (Ver 5.0) of Norton Utilities just as the MOD's men were losing their laptop.

Norton Ver 5.0 costs £139 pounds and contains all the programs which will be familiar to existing Norton users (facilities to recover files inadvertently erased, repair corrupted data and wilfully wipe files so that they can never, ever be recovered). Norton 5.0 also includes a program called Diskreet which protects confidential files by coding them with the data encryption standard, DES, developed by IBM and the US government.

The user simply choses a gobbledegook password which no one else can possibly guess. Thereafter all text stored in the computer can be read out only after the password has been re-entered. The encrypted text does not even show up on the computer's normal file listing. The only hope of cracking the code, other than to spend 2000 years on random guesswork, is to use the banks of supercomputers built by the National Security Agency at Fort Meade near Washington and the British Government's Communications Headquarters at Cheltenham.

Footnote: If you buy Norton Ver 5.0, be warned that you may well not find the Diskreet encryption program included. It was there on the first batch of packages exported to Europe, but then the National Security Agency in the US clamped down, objecting to the export of DES software on the grounds of national security. So although US versions of Norton 5.0 do include Diskreet, versions sold in Europe do not.

The NSA and GCHQ must be confident they can crack anything before it is sold. They want to be sure there is never any data in circulation which the authorities cannot read!

None of this, of course, alters the basic point, namely that low cost, easy to use hard encryption systems were available off-the-shelf to the general public (at least in the USA) before the MOD lost its lap-top.

SAFETY AT HOME

SMOKE ALARM REPEATER

T. R. de VAUX-BALBIRNIE

A selection of inexpensive, easy to build, audio/visual "monitors" that will enhance personal safety in and around the home

● *Smoke Alarm Repeater* ● *Personal Stereo Power Indicator* ● *Passive Infra-Red Repeater* ●

This add-on unit will "repeat" an audible warning when the master alarm is triggered but is sited too far away to be heard directly. Will also benefit those who are partially deaf.

SMOKE DETECTORS are now commonplace with many people seeing the good sense of fitting them strategically around the house. The Smoke Alarm Repeater project is a battery-powered add-on unit which gives an audible warning when the alarm is too far away to be heard directly. This could be the case if it is sited in some distant part of the house or in an outbuilding. This system will also benefit those who are partially deaf. The Smoke Alarm Repeater has been designed for use with the common type of ionisation detector powered by a PP3 battery inside the unit.

A spin-off from using this system is that the smoke detector will operate from a battery pack inside the new unit rather than from the small one in the detector itself. Replacement is therefore made at a much more comfortable level and avoids standing on a chair or ladder. This would be of particular help to the elderly in avoiding accidents.

Also, since the battery is much more substantial than the one it replaces, it will have a very long life. Note that no on-off switch has been provided – this prevents the system being switched off by accident.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Smoke Alarm Repeater is shown in Fig. 1. A 9V battery pack B1 supplies current for the new circuit and also for the existing smoke detector through resistor R1.

With the alarm on standby, the current requirement of a typical smoke alarm is 10μA or less. With the value of resistor R1 specified (56Ω), Ohm's Law ($V = I \times R$) predicts that 0.56mV approximately will appear across it. This is negligible and has no effect.

When smoke is detected and the alarm sounds, the current increases to some 5mA and the voltage across resistor R1 rises to 280mV approximately. This voltage is "lost" as far as the smoke detector is concerned – the nominal voltage appearing across it will now be 9V – 0.28V = 8.72V. This is close enough to the nominal 9V operating voltage to permit correct operation.

The potential divider consisting of equal value resistors, R2 and R3 divide this voltage into two equal parts so IC1 pin 2 has a voltage of 4.36V (half of 8.72V) applied to it with the alarm sounding and 4.5V (half of 9V) while silent. It is the sensing of this difference of 140mV which operates the new circuit.

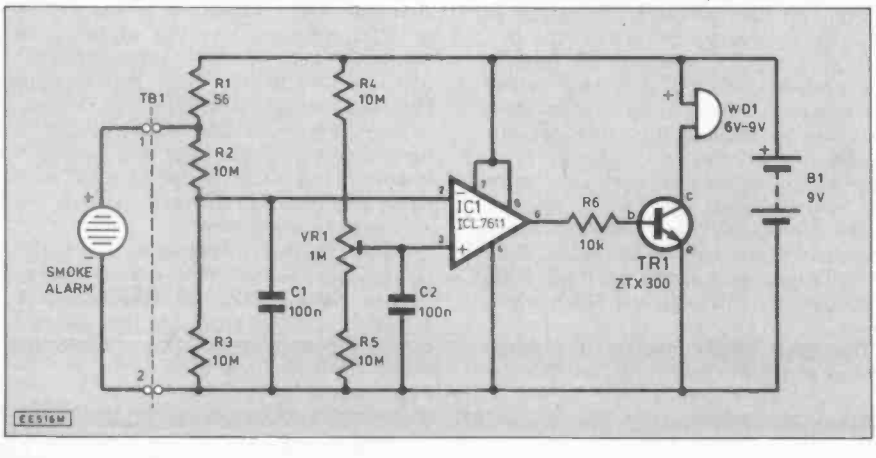
An operational amplifier IC1 is used as a voltage comparator. This operates in the following way. When the voltage applied to the non-inverting input, pin 3, exceeds that at the inverting one, pin 2, the device is on with the output, pin 6, high (positive supply voltage). Under other conditions it is off.

A preset potentiometer VR1 together with fixed resistors R4 and R5 form a potential divider connected across the supply. With the sliding contact of VR1 at minimum rotation, the voltage applied to IC1 pin 3 will be 4.3V and at maximum rotation 4.7V approximately.

At the end of construction, it will be adjusted to provide 4.4V approximately to pin 3. Thus, with the alarm on standby, the inverting input voltage exceeds the non-inverting one and the op-amp is off.

When smoke is detected, the conditions are reversed and the non-inverting input voltage will exceed the inverting one. The op-amp then switches on with pin 6 going high. Current then flows into transistor TR1 base through current-limiting resistor, R6 and the audible warning device, WD1, in the collector (c) circuit sounds.

Fig. 1. Complete circuit diagram for the Smoke Alarm Repeater.



SMOOTH OPERATION

Capacitors C1 and C2 serve two purposes. The first is to bypass any a.c. mains pick-up which may occur in the connecting leads. This could cause switching of the op-amp and consequent false operation.

The second purpose is to hold the inverting and non-inverting input voltages fairly steady in the case of rapid fluctuations. In use, these capacitors charge up to the peak voltage levels occurring at pin 2 and pin 3 and any rapid changes will be smoothed out.

Some smoke detectors have a flashing l.e.d. which operates once per minute approximately to confirm that the unit is receiving power. There will therefore be a rapid pulse of current flowing through resistor R1 each time this happens. The smoothing effect of capacitor C1 will prevent this

from operating the buzzer in the new unit since there will be insufficient time for the voltage at pin 2 to fall below that at pin 3.

Capacitor C1 will also prevent the individual bleeps of the existing buzzer from causing repeated switching of the op-amp. This has been shown to give more stable operation. Readers wishing the new audible warning device to have a bleeping sound will therefore need to use a pulse-tone buzzer.

As the batteries age, the available voltage falls. However, since the voltage applied to both inverting and non-inverting op-amp inputs fall in like manner, the op-amp switches at the same point. Operation continues unaffected until the voltage is too low to operate the smoke detector.

The CMOS input op-amp, IC1, specified has been chosen for its extremely low standby current requirement (10μA or less) and the total current needed by the new circuit is 12μA approximately. With the smoke detector itself drawing 10μA, the total current supplied by the battery under standby conditions is some 22μA – the prototype required only 14μA. With this very modest drain, the 9V battery pack inside the unit should last almost as long as its shelf-life, providing the alarm has not been required to sound very often or for long periods.

The audible warning device should be chosen for its loudness – small, cheap buzzers will give disappointing results. A piezoelectric device operating at a frequency of 3kHz and having an impedance of 1kΩ or thereabouts will be found most effective. Do not use a buzzer which requires external drive circuitry – this would not work in the present circuit.

COMPONENTS

See SHOP TALK Page

Resistors

R1	56
R2, R3, R4, R5	10M (4 off)
R6	10k

All 0.25W 5% carbon

Potentiometer

VR1	1M sub-min. enclosed carbon preset, lin.

Capacitors

C1, C2	100n ceramic (2 off)

Semiconductors

IC1	ICL7611 low-power CMOS op-amp.
TR1	ZTX300 *npn* silicon

Miscellaneous

WD1	Piezoelectric audible warning device 6V-9V operation. Frequency 3kHz. with internal drive (or pulse tone buzzer – see text.)
B1	AA size alkaline cells (6 off) and holder.
TB1	2-way 3A screw terminal block.

Stripboard, 0.1in matrix 10 strips x 20 holes; plastic case, size 125mm x 70mm x 49mm; PP3 battery connector (2 off); strain relief bush; light-duty two-core wire (e.g. loudspeaker wire); single strand connecting wire; solder, etc.

Approx cost guidance only **£10** *excl. Batts*

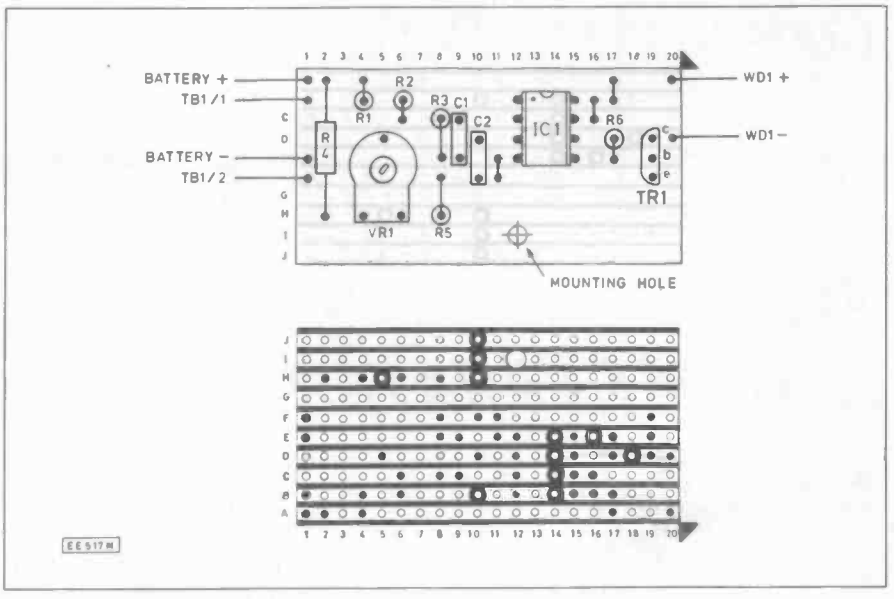


Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks.

The 9V battery pack used in the prototype unit consisted of six "AA" size alkaline cells in a holder having a PP3-type connector. For heavy-duty use "C" size cells could be used.

CONSTRUCTION

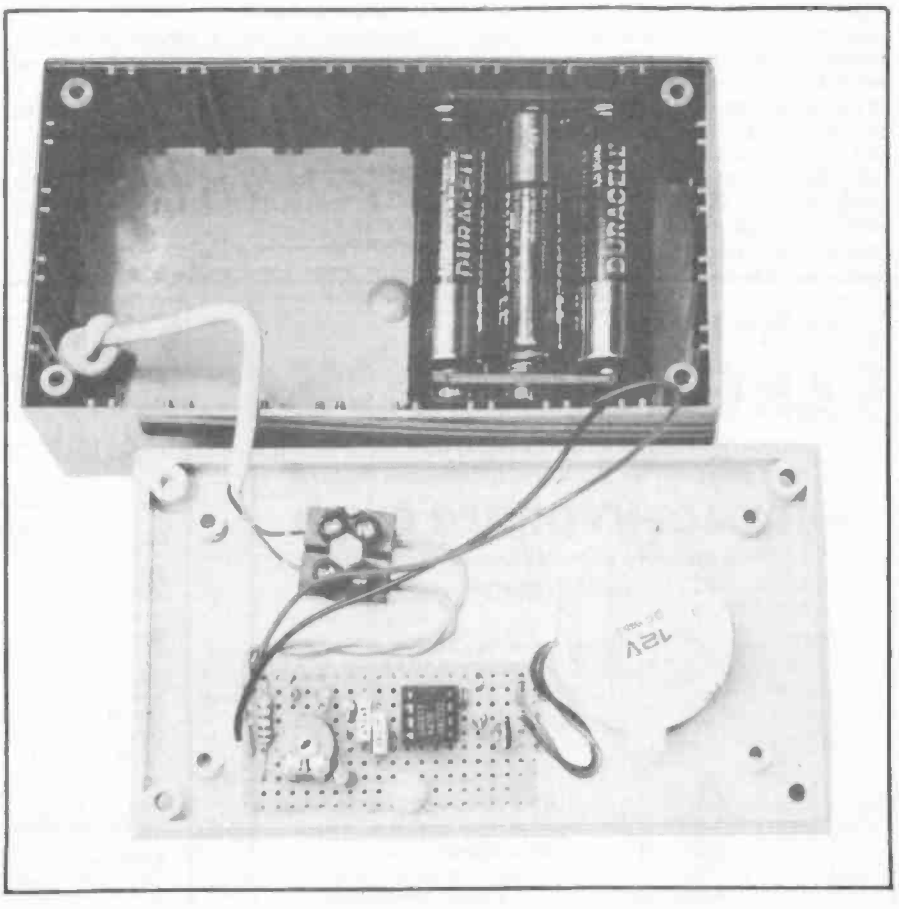
Construction of the Smoke Alarm Repeater is based on a circuit panel made from a piece of 0.1in. matrix stripboard, size 10 strips × 20 holes. The component layout and details of breaks required in the underside copper tracks are shown in Fig. 2.

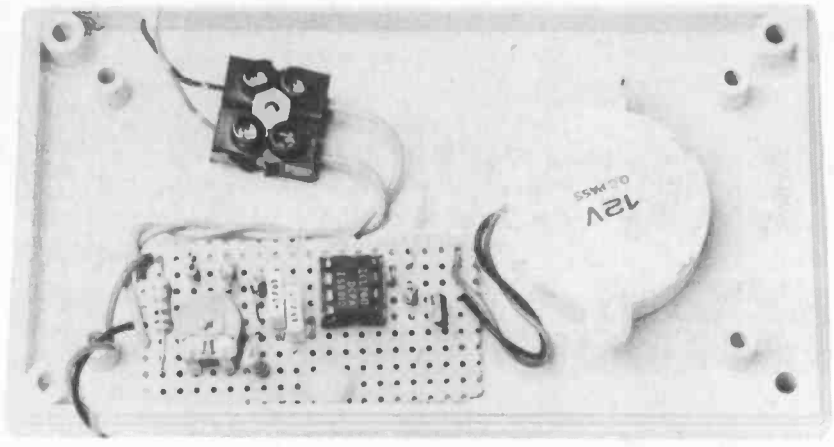
Begin construction by cutting the stripboard to size, drilling the mounting hole and making the track breaks and inter-strip links as indicated. Follow by soldering all the on-board components in position.

After making a careful check for errors, solder 8cm pieces of light-duty stranded connecting wire to copper strips B and F on the left-hand side of the circuit panel as indicated. Solder the positive wire of the battery connector to strip A and the negative one to strip E.

Solder the positive and negative connections of the audible warning device to strips A and D respectively on the right-hand side. Adjust VR1 sliding contact fully anticlockwise.

The completed repeater showing components mounted on the lid of the case. The battery pack also powers the existing Smoke Detector.





The circuit board, terminal block and warning siren are bolted in position using nylon nuts and bolts.

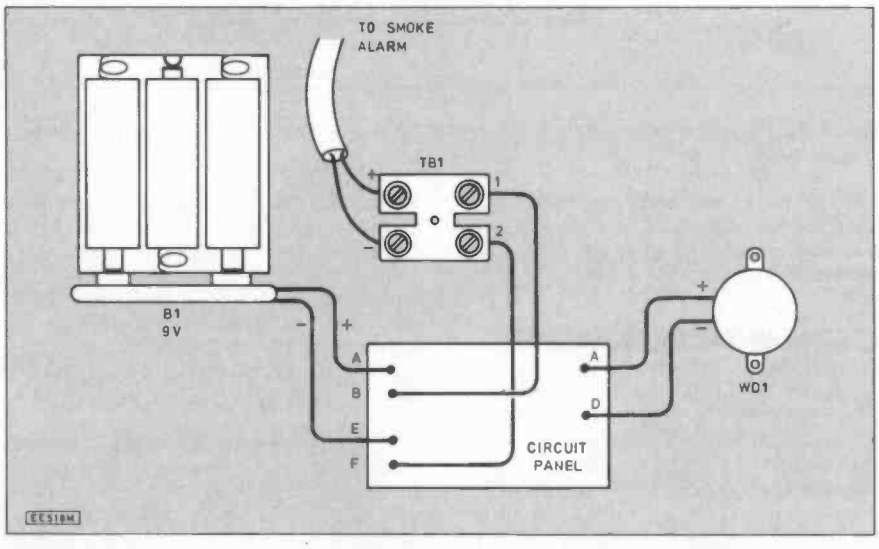


Fig. 3. Interwiring from the circuit board to the off-board components.

CASE

Drill holes in the back of the case for wall mounting if required. Note that all components, apart from the battery pack, were mounted on the lid in the prototype unit (see photograph).

Drill holes for the screw terminal block, TB1, circuit panel and warning siren WD1 mounting. A large hole, 18mm in diameter, should be made in between the two small mounting holes for the sound to pass through when WD1 is in position. Drill a hole in the side of the case large enough for the interconnecting wires to pass through to the smoke detector.

Referring to Fig. 3, mount all remaining components and complete the internal wiring. Attach the circuit panel using a small fixing through the hole drilled for the purpose. If necessary, use two adhesive fixing pads on the underside to provide some padding. Nylon fixings were used throughout in the prototype unit since these give a neater appearance to the front panel of the finished unit.

Insert the batteries into their holder and connect them up. Use of the specified box is advised since the battery pack will be held firmly with the PP3 connector on the one hand and WD1 fixings on the other when the lid is in position.

Adjust preset VR1 sliding contact clockwise to the position where the buzzer just sounds and then back-track anti-clockwise until it is just silent again. You will need to do this slowly due to the effect of capactior C1 described earlier.

INSTALLATION AND TESTING

Decide on a position for the new unit and route a piece of light-duty two-core wire between here and the Smoke Alarm. Fit the distant end with a PP3 battery connector. *Take care – it is easy to confuse the polarity and it is essential that this is correct.* Use of loudspeaker wire would be a good idea since this is marked with the polarity.

Note that the colours of the battery connector wires – if it is of the type having flying leads – (normally red for positive and black for negative) will be reversed, i.e. the *black* one being the positive. This is because the connector is being used in the opposite sense in supplying current to the Smoke Alarm rather than taking current from a battery. If the connector is of the type which needs wires soldering to it, connect the positive one to the plain terminal and the negative to the castle-like one.

Remove the existing Smoke Alarm battery and snap the PP3 connector into position in its place. Pass the other end of the wire through a "strain relief bush" and the hole drilled in the side of the case. Once the lead has been fed through the hole the bush should be tightened up to provide strain relief.

Connect the free ends of the lead to terminal block TB1/1 (positive) and TB1/2 (negative). Trigger the smoke alarm, this should operate normally and the buzzer in the new unit should begin sounding after one second approximately.

Working slowly, make any adjustments to VR1 as necessary. A small range of VR1 rotation should be found where correct and reliable operation is provided. Set VR1 sliding contact to the centre of this range. Finally, fit the lid of the case checking for trapped wires. The Smoke Alarm Repeater may now be put into permanent service. □

Constructional Project

PERSONAL STEREO POWER INDICATOR

T. R. de VAUX-BALBIRNIE

Don't damage your ears - keep an eye on the power output

PERSONAL stereos of the "Walkman" variety – that is, those using headphones, have been popular for a number of years. People use them because, in theory at least, they do not disturb others and are capable of providing high-quality reproduction combined with a loud sound output. It is the latter point which is the subject of this article.

Because of the good quality sound, users often listen at high volume to increase their listening pleasure. Here lies the problem, for such practice is known to cause permanent damage to the hearing. The user may thus be storing up trouble for the future.

At the time of writing, there is some discussion in the media about new personal stereo units being produced with a limited power output. However, even if this were to be done, there would be many of the old type still in use for a long time.

In fact, the power delivered by the headphones is very small but since it is mostly directed at the eardrum, the sound is perceived as loud. Those readers who come into contact with teenagers regularly, will know that their hearing is often below standard. This all adds up to the wisdom of keeping a check on the power output of personal stereos and radios.

EXCESSIVE LOUDNESS

But what is excessive loudness? A good criterion seems to be that the sound is too loud if the words of the song can be heard by someone sitting next to the wearer of the headphones. Playing music at this level over a period of time will almost certainly damage the hearing.

Another test is for the tape to be listened to by someone who does not like the music. He or she will turn it down naturally to a more reasonable level. The trouble is that the wearer of the headphones is usually quite unaware of the very real danger which exists.

The Personal Stereo Power Indicator project is a battery-powered device built in a small plastic case. A flying lead plugs into the earphone socket on the tape player and the headphones, in turn, are plugged into a socket on the side of the new unit.

When switched on, an l.e.d. bargraph displays the relative power output level. An indication may be obtained for either the right-hand or left-hand channel according to the position of a miniature slide switch.

The unit need not be switched on continuously – the headphones will operate whether it is on or not. It is only necessary to monitor the sound level when listening to a change of music or when the volume control is adjusted. This is why the prototype was fitted with a push-to-test button switch.

In occasional use, the internal battery will give many months of service. Of course, there must be goodwill on the part of the user. There is no point in using the device if the reading is simply ignored.

The unit was intended for use with personal stereo systems. However, it would be equally useful for those using headphones to listen to music from other sources.

Many people use headphones plugged into their main audio system, either because their choice of music offends others or so that other members of the family can hear the television. When such power amplifiers are used it is even more likely that the volume will be turned up too far.

CIRCUIT DESCRIPTION

The full circuit diagram for the Personal Stereo Power Indicator is shown in Fig. 1. This works by measuring the instantaneous voltage appearing across the headphones.

Since the resistance of the headphones is reasonably constant, this voltage provides a fair measure of the power delivered and hence of the sound output. There is no point in actually calibrating the display in terms of watts – relative levels are sufficient for the present purpose.

The circuit centres on IC1, a dedicated integrated circuit bargraph driver. This device contains a set of voltage comparators. When it senses a voltage applied to its input pin 5, its ten outputs (pin 1 then pins 18 to 10) go low one by one, according to the level of this voltage.

IC2 is the actual l.e.d. display. This contains ten l.e.d. bars which are lit up one by one by current flowing from the positive supply line through the l.e.d. bar to the appropriate IC1 output as it goes low. Since previous bars remain lit as successive ones come on, this provides a "thermometer" type display.

The voltage applied to IC1 pin 5 needs to lie in the range 0.25V to 1.25V. Below 0.25V all bars are off and above 1.25V they are all on. With the chosen bargraph driver, the change in voltage needed to light successive bars is non-linear and follows a "logarithmic" relationship.

Thus, the first bars light up with relatively small increases in voltage but the later ones need increasing voltages to switch on. This may be likened to a person climbing a ladder where successive rungs become further apart. This suits the physiological response of the ear which is itself logarithmic.

On test, it was found that the peak voltage applied to headphones in normal listening is less than one volt but varies according to the efficiency of headphones being used – some sound louder for the same input. Some form of adjustment is therefore needed to allow the

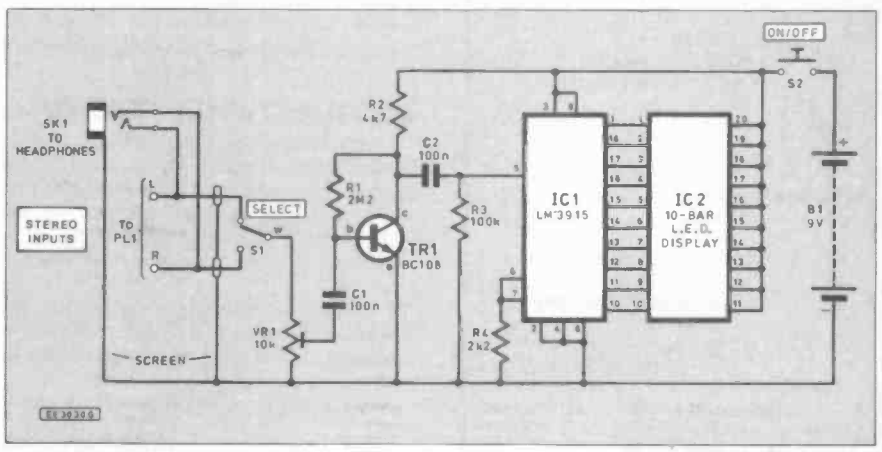


Fig. 1. Complete circuit diagram for the Personal Stereo Power Indicator.

device to operate correctly with any headphone/stereo unit combination. With some headphones, a boost in signal output is needed to operate IC1, with others a decrease.

With push-to-test switch S2 on, current flows from battery B1 to the rest of the circuit. Transistor, TR1 and associated components form a simple amplifier circuit.

The headphone input voltage is selected from either the right-hand or left-hand channel according to the position of two-way switch, S1. This is then applied to the track connections of preset potentiometer, VR1. A fraction of this voltage is tapped off between the sliding contact and supply negative and applied to transistor TR1 base through capacitor, C1.

Consider the situation when VR1 sliding contact is near the bottom of its travel. Very little signal voltage is applied to transistor TR1 base (b) so even though TR1 amplifies this voltage, the signal at the collector (c) is still at a smaller level than the headphones provided originally.

COMPONENTS

Resistors

R1	2M2
R2	4k7
R3	100k
R4	2k2

All 0.25W 5% carbon

See SHOP TALK Page

Potentiometer

VR1	10k sub-min. vertical preset

Capacitors

C1, C2	100n ceramic (2 off)

Semiconductors

TR1	BC108 *npn* silicon
IC1	LM3915 log. bargraph driver
IC2	Red 10-bar l.e.d. display

Miscellaneous

S1	Miniature SPDT slide switch
S2	Miniature push-to-make switch
B1	9V alkaline PP3 battery and connector
PL1/SK1	3.5mm stereo chassis socket and matching line plug

Stripboard, 0.1in matrix 11 strips x 29 holes; plastic case, 110mm x 56mm x 20mm; 18-pin d.i.l. socket; 20-pin d.i.l. socket; miniature twin-screened stereo wire; stranded connecting wire; self-adhesive plastic feet (4 off); small fixings; solder etc.

Approx cost guidance only **£14** *excl. Batt*

As the sliding contact is raised, a greater fraction of the headphone voltage is applied to TR1 base. The signal at the collector is now at a greater voltage than the headphones provided originally. The voltage at TR1 collector is applied to IC1 pin 5 through capacitor C2 which operates IC1 in the manner already described.

Preset VR1 will be adjusted at the end of construction to provide correct operation. Note that once VR1 has been adjusted for a pair of headphones, it will not necessarily be correct for another pair and VR1 may need re-adjusting.

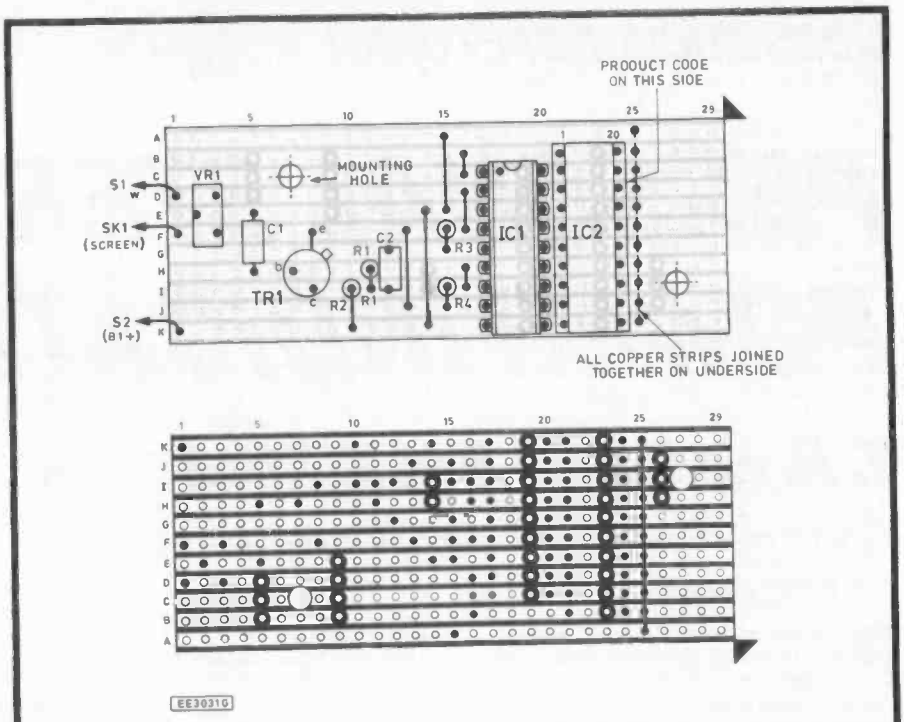


Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks. Note the method of determining the orientation of the display IC2 and link wire across the holes at position 25.

Resistors R1 and R2 are TR1 bias and load resistors respectively. The prototype unit was tested with several different personal stereos and headphone combinations and with suitable adjustment to VR1 it worked well in all cases.

Resistor, R4, sets the l.e.d. bar operating current to the correct value. Since this is done automatically by IC1, there is no need for separate current-limiting resistors as would normally be the case.

CONSTRUCTION

Construction of the Personal Stereo Power Indicator uses a circuit panel made from a piece of 0.1in. matrix stripboard, size 11 strips × 29 holes. The component layout and details of breaks required in underside copper tracks are shown in Fig. 2.

Commence construction by cutting the stripboard to size, drilling the two mounting holes and making the track breaks as indicated. Next solder the two i.c. sockets in position.

Using a piece of single-strand connecting wire, make the common anode (positive) connection for all ten l.e.d's contained in IC2 by interconnecting strips *A-K* on the copper strip side of the circuit panel. Follow with the inter-strip links and the on-board components.

After making a careful check for errors, solder 5cm pieces of light-duty stranded connecting wire to copper strips *D*, *F* and *K*. Adjust VR1 sliding contact fully clockwise (as viewed from the left-hand edge of the circuit panel).

CASE

Prepare the box to receive the circuit panel by firstly measuring the position of the bargraph IC2 carefully and cutting a hole in the lid just large enough for this component to be pushed through. Drill holes in the base to align with the mounting

The completed unit showing the "power output" monitor bargraph display.

holes already drilled in the circuit panel. Make holes in the side for S1 and S2 also for SK1 and for the input wire to pass through.

Hold the circuit panel in place temporarily and mark preset VR1 position. Drill a small hole in the side of the box so that this component can be adjusted using a small screwdriver. Referring to Fig. 3, mount remaining components and complete the interwiring using light-duty stranded connecting wire.

Measure a short piece of light-duty twin screened wire and remove 20mm of the outer insulation from one end. Twist the screening together and remove a few millimetres of insulation from each of the inner signal conductors. Pass the wire through the hole in the box and secure it on the inside to prevent it from pulling free. Connect it to S1 on the inside shortening any wires as necessary.

Fit a stereo jack plug to the other end of the twin screened lead. Note that the outer (sleeve connection) is connected to supply negative (earth) while the other two connections (the tip and middle connections are connected to Left and Right stereo channels respectively.

Insert the i.c.s into their respective sockets the correct way round. Note that IC2 has a product code on its right-hand side and this identifies the orientation – it will not work if connected in the wrong sense.

Mount the circuit panel on the base of the box using small fixings. Place plastic spacers on the bolt shanks of such a thickness that when the lid of the box is in position, IC2 is level with the top face.

Connect the battery and attach it to the base of the box using an adhesive fixing pad. Fit the base with self-adhesive plastic feet if necessary to prevent any protruding bolt heads on the underside from scratching work surfaces.

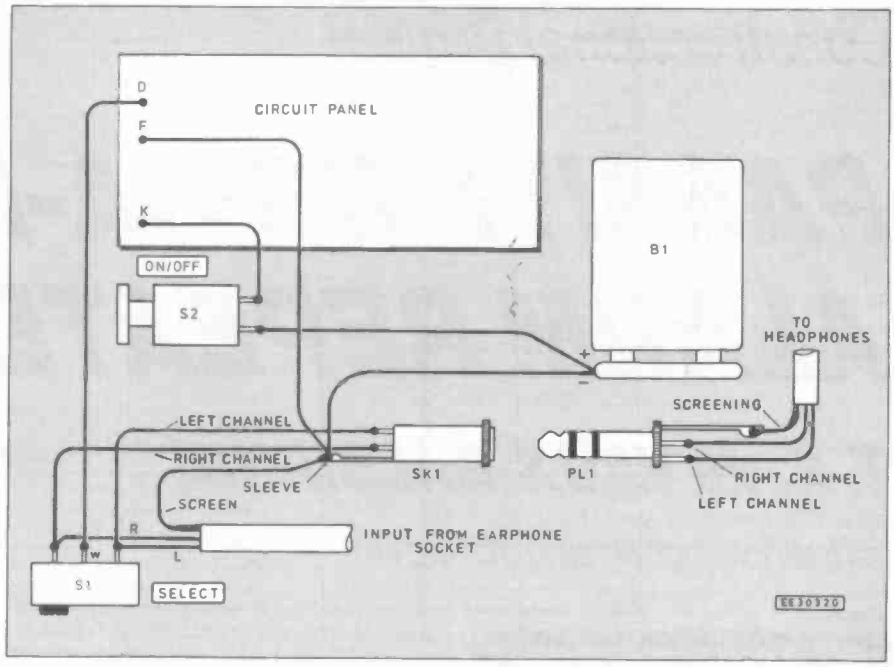


Fig. 3. Interwiring to all off-board components. The screened lead from the select switch S1 should also be terminated with a suitable jack plug for the player/radio.

TESTING

Plug the headphones into the socket on the unit and insert the jack plug on the end of the flying lead into the tape player. Play a tape in the usual way. The sound should be heard through the headphones normally.

Press switch S2 and rotate VR1 sliding contact anti-clockwise using a small screwdriver through the hole drilled in the side of the case. IC2 bars should begin flashing.

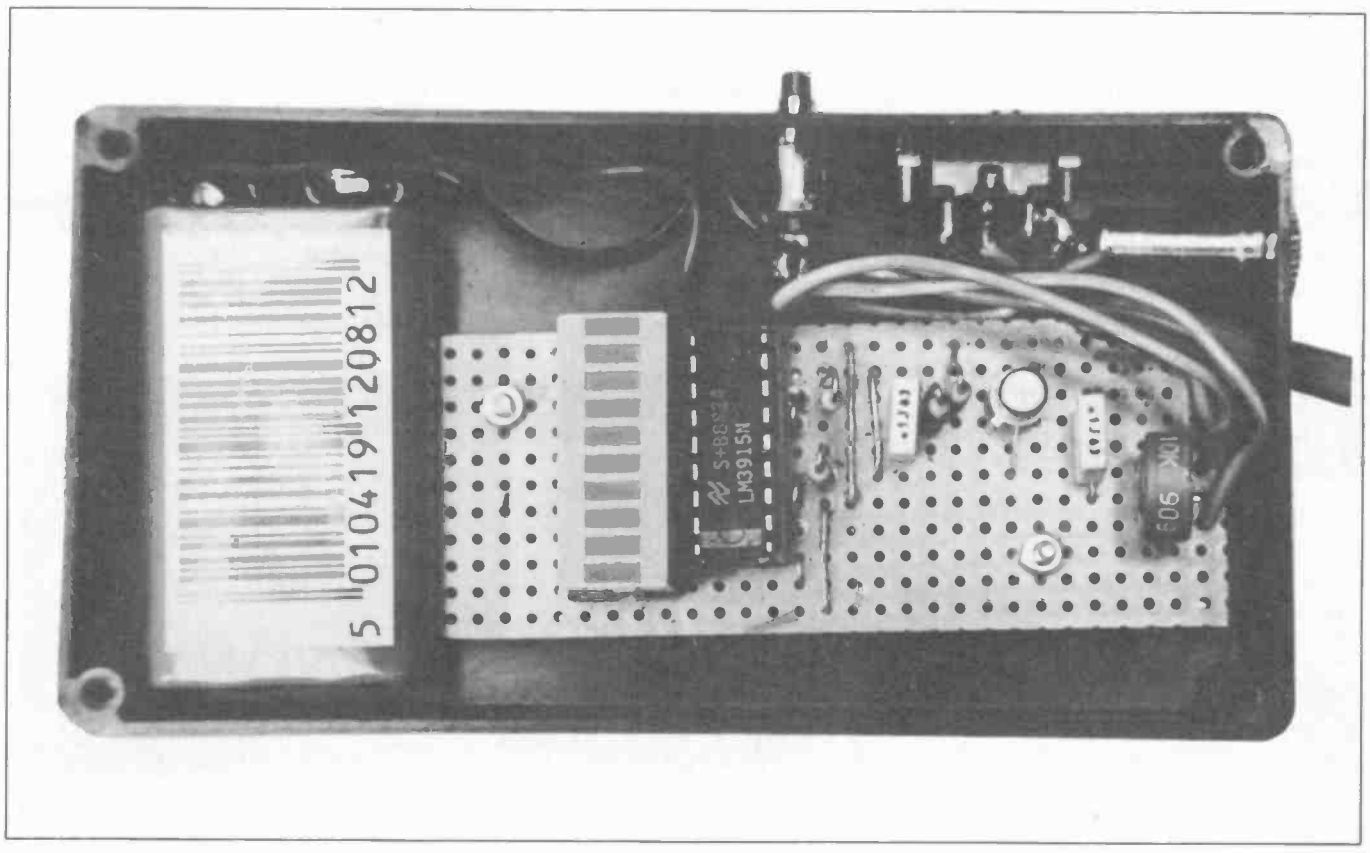
Increase the volume and observe the effect. Successive bars should now light according to the volume of the music.

SETTING-UP

If all is well, the unit may be set up by adjusting VR1 for correct operation. This should be done so that the eighth or ninth bar is just beginning to flash when the music is too loud. The setting-up will naturally be subjective but a little common sense should soon get the adjustment right.

Do not rely on your own judgement – use a helper. Remember the rule of thumb – if someone else can hear the music – it is too loud! If in doubt, always err on the safe (quiet) side. Hearing loss is a serious matter – take no risks! Use the Personal Stereo Power Indicator regularly! □

Layout of components inside the case. Use screened leads to connect the jack socket/plug to the select switch and "earphone socket" lead.



Constructional Project

PASSIVE INFRA-RED ALARM REPEATER

T. R. de VAUX-BALBIRNIE

Is it a friend or an intruder?

Construction of the PIR Repeater involves making mains connections. It is therefore essential for any reader wishing to construct this project to be satisfied that he or she can make a safe job. If not, *a qualified electrician must be consulted.* There are a number of safety points which are explained elsewhere and it is *essential* to follow these carefully.

PASSIVE infra-red (PIR) detectors are useful devices and are becoming increasingly popular with householders. There are two types. The first is the indoor variety and is designed to trigger an alarm when an intruder is detected. The other is mounted outdoors and switches on mains lighting either for security purposes or simply to light the way along a dark pathway.

PIR sensors work by detecting the body heat (infra-red radiation) emitted by a person walking in front of the detector window. The target only operates the device if it is moving and this makes the PIR principle attractive because it is reliable and has a high immunity to false triggering.

BASIC ARRANGEMENT

This project is concerned with the *external* type of PIR sensor operating mains lighting. If the light cannot be seen from the house, the occupier has no way of knowing that the PIR unit has triggered.

Such information could be useful since it could signal the presence of an intruder and may be worth investigating. The Repeater unit described is an add-on circuit which signals the user with a high-pitched tone when the PIR detector triggers – an l.e.d. on the front of the Repeater also lights.

The audible warning device sounds for a preset time independent of the time of operation of the mains lighting. With the component values stated, the time period is five seconds approximately, but is easily changed if required. Using a short time of operation, the device could even be used as a form of executive doorbell!

A switch on the unit may be used to set an alternative mode of operation whereby the buzzer is silent but the l.e.d. remains on indefinitely until the circuit is reset using a push-button switch. This facility could be useful to signal the user that the unit had triggered in his or her absence.

The circuit requires a standby current of 70μA approximately. While sounding it requires 18mA and with the l.e.d. only operating, 10mA approximately. The internal alkaline PP3 battery should last for several months in normal service and – for safety reasons – may be replaced without removing the lid of the box. For heavy-duty use, it is suggested that a re-chargeable PP3 battery or an external battery is used.

SAFETY

It is intended that the PIR Repeater should be situated indoors and as close to the PIR unit as practicable. This will keep the mains wiring to a minimum. Although the audible warning device was situated inside the main unit in the prototype, it would be possible to site it any reasonable distance away. Light-duty twin wire could be used to make the connection – bell wire, for example.

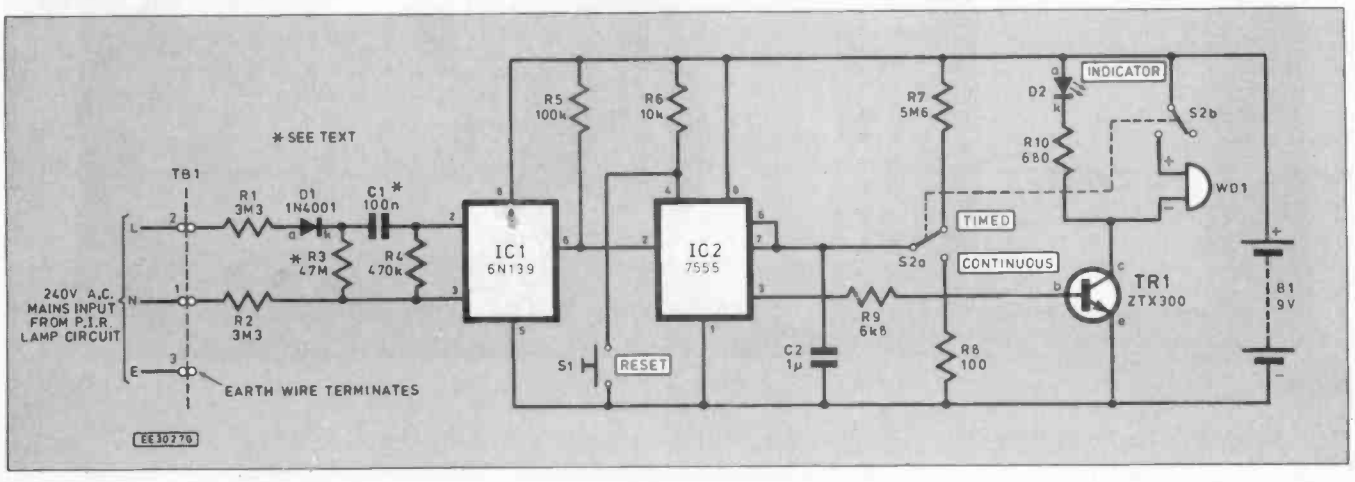
CIRCUIT DESCRIPTION

The complete circuit for the PIR Alarm Repeater is shown in Fig. 1. IC1 is an opto-isolator containing an infra-red l.e.d. (connected to pins 2 and 3) on the one hand, and a photodiode and a pair of transistors in Darlington configuration on the other. The photodiode section is electrically isolated from the rest of the i.c. but is coupled optically. When current flows through the l.e.d. it emits infra-red light which illuminates the internal photo-diode. The transistors switch on and the output, pin 6, goes low.

In this circuit, the l.e.d. operates from current derived from the mains when the PIR unit is triggered. The rest of the circuit is battery-operated. Thus, IC1 provides total mains isolation which is **essential for safety reasons**.

When the PIR unit is triggered, its internal relay operates and the "make" contacts allow mains current to flow to the existing light or lights. The Repeater is connected in parallel with the lamp and so current also flows through resistor R1 and the network consisting of diode D1, capacitor C1 and resistors R3 and R4.

Fig. 1. Complete circuit diagram for the PIR Alarm Repeater. It is most important that only the specified high voltage components be used for C1 and R3.



Diode D1 allows only positive half-cycles to pass and C1 is charged very quickly. This allows a current pulse to flow to IC1 pin 2, through the internal l.e.d. and complete the circuit to the mains Neutral line via pin 3 and R2. This triggers the transistor section of IC1.

TIMING

The low state of IC1 pin 6 is applied to the trigger input (pin 2) of the monostable circuit centred on CMOS timer, IC2 and associated components. The trigger input is kept normally high through R5 but when it goes low, IC2 switches on with the output, pin 3, going high (positive supply voltage).

With switch S2 in the TIMED position, S2a allows current from the supply through R7 to charge capacitor, C2. At a certain point, IC2 switches off with these two components setting the operating time.

The timing may be increased (or reduced) by using a higher (or lower) value for R7. Each megohm will give a timing of a little more than one second. For very long timings, C2 could be increased in value but note that a good quality polyester or similar non-electrolytic capacitor should be used.

While the output is high, current flows from pin 3 into transistor TR1 base through current-limiting resistor R9. TR1 therefore switches on and the l.e.d. D2, operates through current-limiting resistor R10. Also, S2b allows current to flow through the audible warning device, WD1.

When the mains load eventually switches off, capacitor C1 discharges through resistors R3 and R4 in a few seconds and is thus made ready for further operation. While discharging, R3 and R4 form a potential divider and, using the values specified, this ensures that the maximum reverse voltage across the IC1 internal diode is not exceeded.

If switch S2 is set to the CONTINUOUS position, S2a prevents current from flowing from supply positive to capacitor C2. Also, C2 is virtually short-circuited through low-value resistor R8. This means that IC2 pins 6 and 7 will always remain low and pin 3 will remain high indefinitely. At the same time, S2b disconnects WD1. Resetting is achieved by making IC2 reset input, pin 4, low momentarily (it is kept normally high through R6) by pressing push-to-make switch, S1 (RESET).

The audible warning device, WD1, should be chosen to provide a loud warning combined with a low current requirement. A piezo-electric solid-state buzzer operating at 3kHz approximately was used in the prototype unit. Do not use a buzzer which requires external drive circuitry since this would not work in this circuit.

HIGH VOLTAGE COMPONENTS

Resistor R3 should be of a type capable of having peak mains voltage (340V approximately) minimum placed across it. Use one listed in the supplier's catalogue as a "high voltage" resistor – as well as being available in the high value required, it will have a high working voltage.

Note that in the case of R1 and R2, one resistor is placed in the mains input Live wire and the other in the Neutral. In the event of any catastrophic failure, even with Live and Neutral mains input wires interchanged, any current between the two or to Earth after TB1 will be limited to a very low value.

The value specified for R1 and R2 was correct for the prototype unit. However, if the circuit fails to work properly at the testing stage, they may need to be changed in value.

It is essential to use the correct type of capacitor for C1. This is either of metallised polypropylene, polyester or PETP construction specially made for connecting directly to the mains. These are available as mains interference suppressor capacitors and may be designated X, X2 or Y-class in suppliers' catalogues. No other type of capacitor may be used.

CONSTRUCTION

It is essential, for safety reasons, that no **metal parts appear on the outside of the case**. The switches must be housed in plastic – although a metal fixing nut on a plastic body is acceptable. The fixings used to secure the circuit panel and terminal block must be made of nylon.

The battery holder must be of the fully-enclosed type with a hinged front cover. The battery may then be replaced without removing the lid of the case and without switching off the mains.

If the lid of the case needs to be removed for any reason, the mains must first be isolated at the main switch. Note also that after the circuit has operated, capacitor C1 is left charged at peak mains voltage. Since this could deliver a nasty shock, it must be allowed to discharge before touching the underside of the circuit panel. Allow one minute to be on the safe side.

Construction of the PIR Repeater is based on a circuit panel made from a piece of 0.1 inch matrix stripboard, size 14 strips x 33 holes. Fig. 2 shows full top and underside details.

Begin by cutting the material to size and drilling the four mounting holes as indicated. Follow with the track breaks and

COMPONENTS

Resistors

R1, R2	3M3 (2 off)
R3	47M "high voltage" resistor (see text)
R4	470k
R5	100k
R6	10k
R7	5M6
R8	100
R9	6k8
R10	680

All 0.25W 5% carbon

See SHOP TALK Page

Capacitors

C1	0µ1 (100n) mains suppressor capacitor – see text
C2	1µ polyester layer

Semiconductors

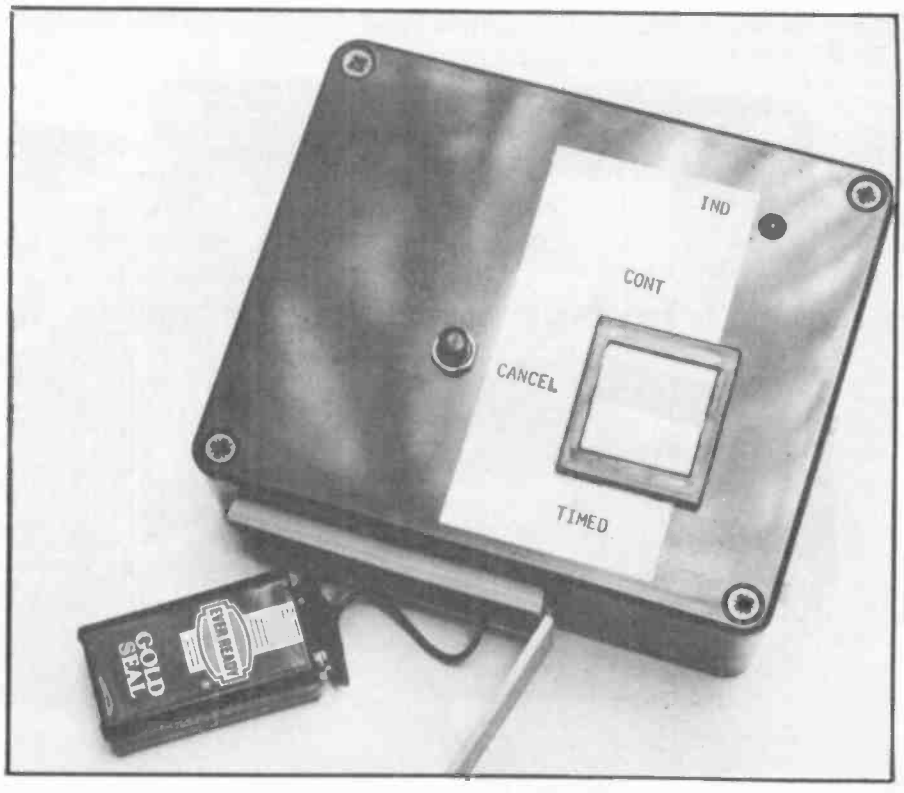
D1	1N4004 1A 400V
D2	5mm red l.e.d.
TR1	ZTX300 *npn* silicon
IC1	6N139 high gain opto-isolator
IC2	7555 low-power CMOS timer

Miscellaneous

WD1	Piezo-electric buzzer – 3kHz 1kΩ – see text
S1	Miniature push-to-make switch
S2	DPDT rocker switch
B1	9V PP3 battery and battery holder – fully enclosed type with hinged cover
TB1	3A screw terminal block – 3 sections required.

Stripboard 0.1 inch matrix size 14 strips x 33 holes; 8-pin d.i.l. integrated circuit socket (2 off); plastic box size 118mm x 98mm x 45mm external; 6 BA 25mm nylon fixing (7 off); plastic spacer 15mm long (5 off); strain relief bush

Approx cost guidance only **£15**



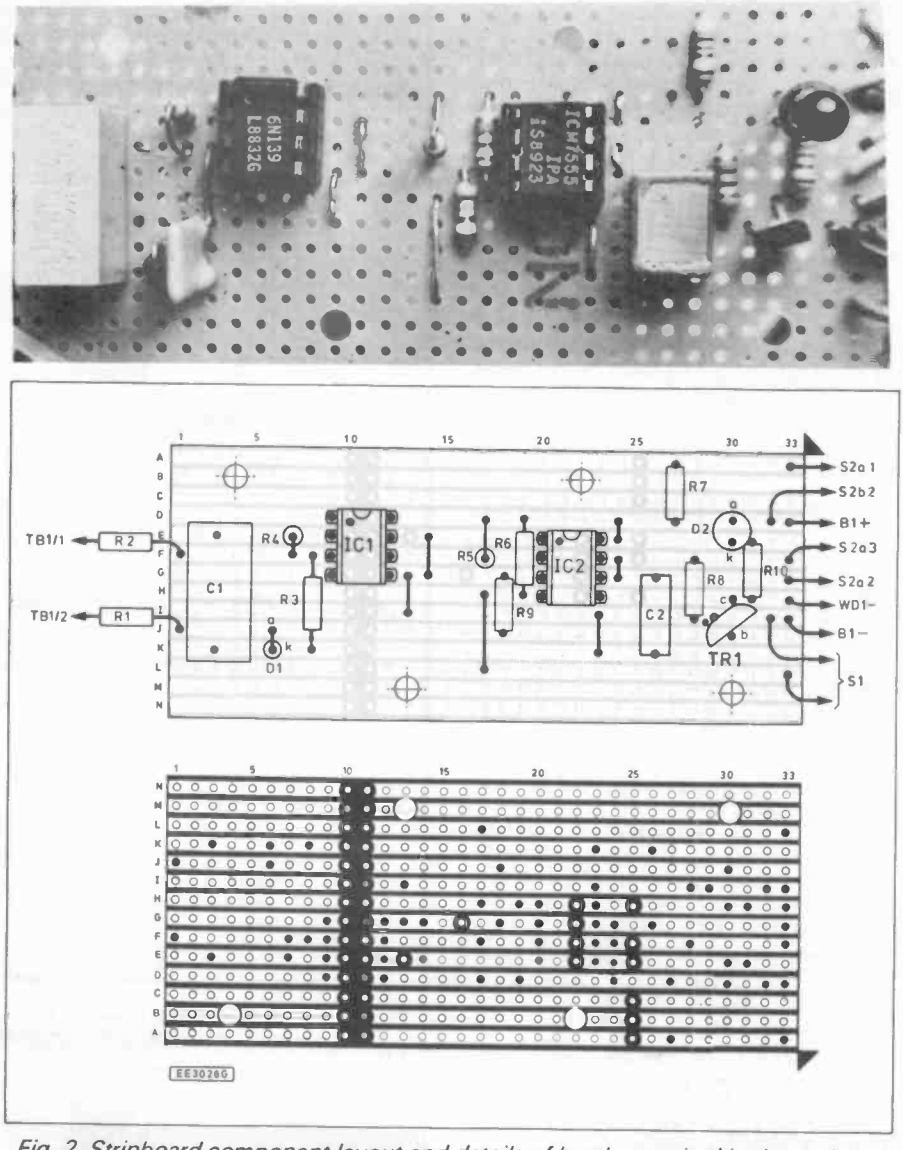


Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks. The double row of breaks is to ensure that the low voltage section (right) is completely isolated from the mains section (left). For added safety you could stick insulating tape over the mains section copper tracks.

inter-strip link wires. Note that for safety, the double row of track breaks across the board at hole positions 10 and 11 must be carefully checked – this is because they isolate mains voltage from the battery-powered section of the circuit.

Solder the two i.c. sockets into position and follow with all on-board components observing the polarity of diodes D1 and D2. Note particularly the method of connecting resistors R1 and R2 at one end – leave the other ends free. Short pieces of plastic sleeving must be placed on the end leads.

Solder 10cm. pieces of light-duty stranded connecting wire to copper tracks *A, D, F, G, I* and *L* along the right-hand side of the circuit panel. Use of different colours here, for example rainbow ribbon cable, will help in preventing errors. Connect the positive wire of the battery connector to strip D and the negative one to strip *I*. Connect the negative (black) wire of the buzzer WD1 to strip *H*.

CASE

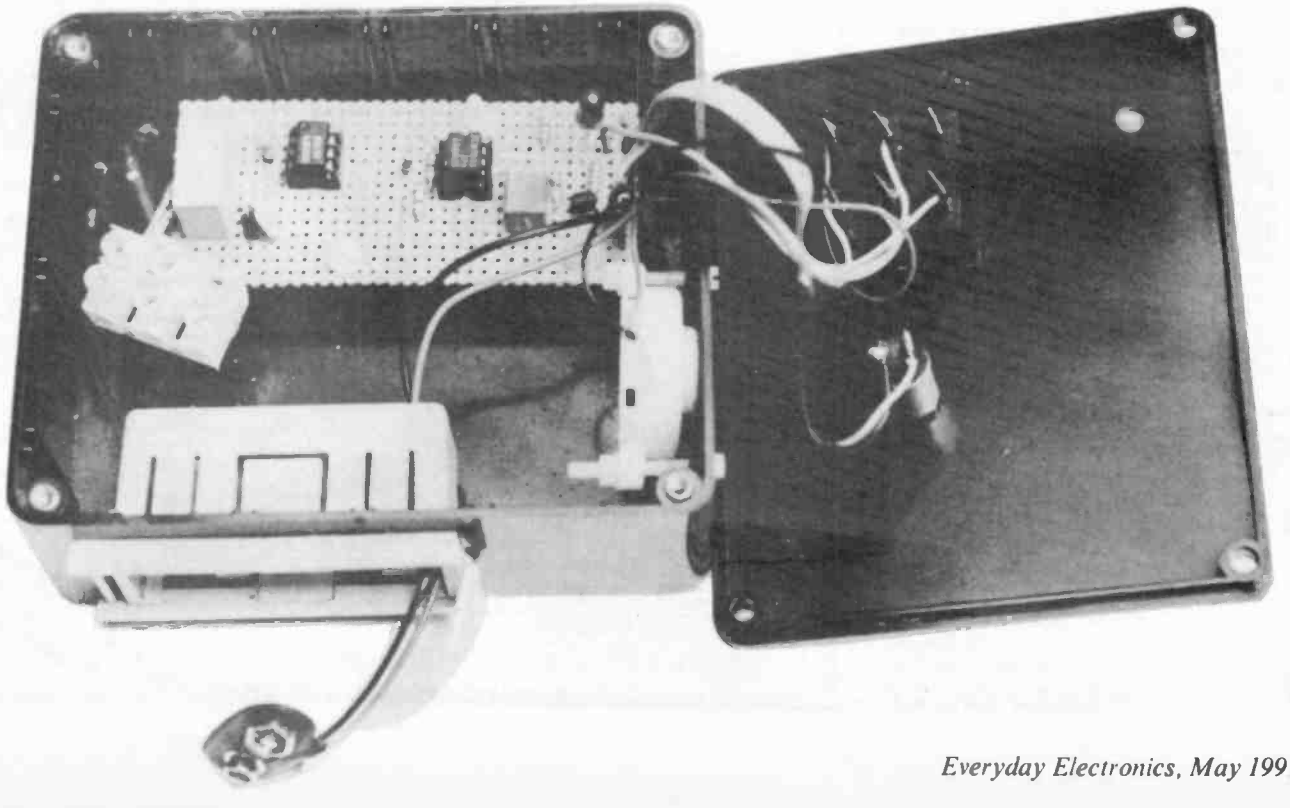
Prepare the case by making the large hole in the side for the battery holder. Drill mounting holes in the base to align with those already made in the circuit panel.

Measure the position of D2 carefully on the lid and drill a hole for this component to show through. Drill a hole for the three-way terminal block, TB1, also for the switches and the mains input wire – make this large enough to accommodate the strain relief bush to be fitted later.

Drill holes for WD1 mounting and make a larger one between the fixing holes for the sound to pass through. If the audible warning device is to be mounted remote from the main unit, drill a hole to secure the additional two-way piece of 3A screw terminal block needed for the connections and a hole for the interconnecting wire to pass through.

Refer to Fig. 3, mount all remaining components and complete the interwiring. Mount the circuit panel and TB1 on plastic spacers approximately 15mm long so that

The completed PIR Repeater Unit showing layout of components inside the case and the battery compartment clipped into one of the side panels.



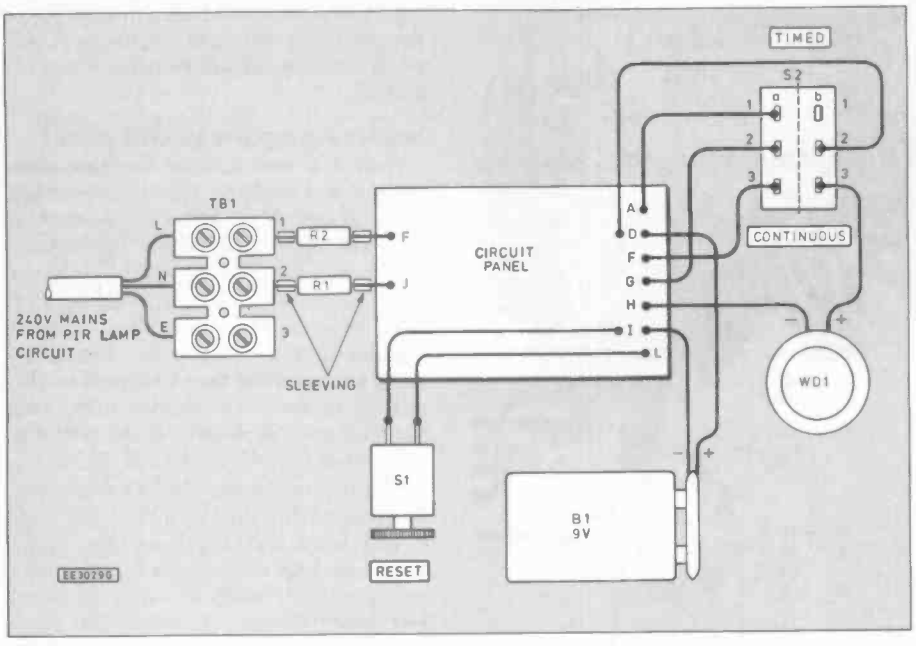


Fig. 3. Interwiring from the circuit board to all off-board components. It is vital that insulating sleeving be placed over resistors R1 and R2 as mains supply is present at these points.

l.e.d. D2 will just show through the hole in the lid. Switch S2 to TIMED. Place the battery in its compartment and connect it up. The unit will probably self-trigger – cancel by pressing S1 (RESET).

INSTALLATION

Before proceeding, switch off the mains at the fusebox and remove the fuse feeding the Neutral terminals that is, those connecting the light. Make the additional connections here using 1mm² PVC sheathed mains cable.

Route the wire to the unit, pass it through the hole in the box and secure it using the strain relief bush. Connect the wires to TB1/1 (Live) TB1/2 (Neutral) and TB1/3 (Earth). Note that the earth wire terminates at TB/3.

Make a final check of all wiring before replacing the lid, looking particularly for trapped wires and possible short-circuits. When satisfied replace the lid and switch on the mains. The PIR unit will self-trigger and the unit should operate – cancel using S1.

Wait for the PIR unit to switch off then trigger it several times in the usual way. You will need to wait for a few seconds between operations for C1 to discharge. Check that the circuit operates correctly in both TIMED and CONTINUOUS modes.

INPUT RESISTORS

The value of resistors R1/R2 was correct in the prototype unit and has quite a wide tolerance. If the circuit does not work properly, first make a thorough check for errors before assuming that these components need to be changed in value.

However, if after such a check, the unit triggers but the buzzer remains on instead of switching off after the preset time it may be that R1 and R2 need to be increased in value. If it fails to trigger they may need to be reduced. If all is well, the Passive Infra-Red Repeater may be put into permanent service. □

PIR installation. This must also be done before removing the lid of the box for any reason.

You will need to connect a mains wire between the unit and either the existing light or the PIR unit itself – whichever is more convenient. If making the connections to the PIR unit, remove the terminal cover and locate the output Live and

PROJECT DEVELOPMENT FOR GCSE

The heat is now on! In this, the penultimate article in a series of six, a GCSE assessor looks at the soldering-up process and the building of the project into its box.

LAST month we looked at final plans for the layout of your circuit panel. You should now have most of the components to hand and be ready to start soldering! If you have done no soldering before, it is important that you practise using scrap material first. There will probably be some suitable old components lying around. You will need a fine-tip soldering iron and a supply of resin cored solder.

Access is also needed to some small tools such as side cutters, pliers, wire strippers and a spot-face cutter (if using stripboard). You will also need a small reel of 24 s.w.g. tinned copper wire (for making inter-strip links if using stripboard). A magnifying glass and a desoldering pump would also be useful.

Before plugging in the soldering iron, check the condition of the bit. If it is pitted, it should be filed until smooth. Now plug it in and wait for it to reach operating temperature. It is always best to use a proper soldering iron stand. If you do not have a proper stand hook the iron onto something that will not be damaged by the heat and where it is away from the working area so you do not burn yourself or your clothing.

When the iron is hot, apply a little solder to the tip. You will see some blue smoke and the molten solder will flow evenly across the bit. This is called "tinning the bit" and prepares it ready for use.

Practice makes perfect

The following information assumes that you are using stripboard – however, most of it applies to other forms of construction too. When soldering, both surfaces – that is, the component lead and the copper surface of the circuit board – must be clean. If necessary gently rub the circuit board surface with fine emery cloth until it appears shiny. Scrape any dull-looking component leads with a craft knife blade. Good preparation will save a lot of trouble later.

Push a component through a hole from the plain side of the scrap stripboard and apply the soldering iron tip and solder to the copper strip and wire both at the same time. Move the tip a little as you do this and you will see the solder flowing around the joint evenly and cleanly. Remove the solder and soldering iron and wait for the joint to cool naturally. If it is bright and shiny the joint is probably sound. If it looks grey and has a cracked or dirty appearance, it is a "dry" joint and you will have to start again.

Dry joints have a high electrical resistance and are likely to fail or behave erratically in service. If the solder gathers itself into a ball, it may be that the surfaces are still dirty. Beginners often apply the solder to the soldering iron bit and then carry it to the joint. This is poor practice and will lead to bad joints. Another cause of bad joints is allowing components to move while the solder is solidifying. I am not going to say more about soldering – you will soon pick it up with practice.

Cut the circuit panel to size and drill the mounting holes if required. Smooth the edges then make any track breaks using the spot-face cutter. Check using a magnifying glass that the tracks being cut are really broken. Do not use the cutter so violently that you seriously weaken the material.

Next, solder the inter-strip link wires into position and follow with any i.c. sockets. Note that integrated circuits should not be soldered direct to the circuit panel – they could be damaged by the heat and would then be difficult to remove and replace.

Soldering up the circuit panel

Now it is time to start inserting components and soldering them into position. It is a good rule to solder components in minimum time – particularly semiconductors such as diodes and transistors. On the other hand, "dabbing" the soldering iron in an effort to reduce the effect of heating usually results in a lower temperature being produced but for a longer time. This actually causes more damage in the long run. One good application of the soldering iron will do the job quickly and effectively.

Modern components are far less likely to be damaged than they used to be, but there is still some risk. Light-emitting diodes should be kept on long leads since these components are easily damaged by excessive heat. Where practicable, the leads of high-sensitive components should be gripped with fine-nose pliers between their body and the circuit panel. This technique will shunt the heat away from the device.

Be Careful

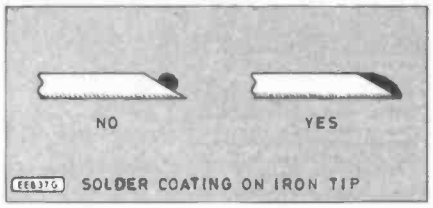
Follow your plan and work slowly and carefully – errors may be difficult to find later and **components could be damaged if wrongly connected.** It sometimes happens that the order of soldering components is important since once one device is in position it may be physically difficult to insert another. Make sure nothing is under strain. If components are supposed to be mounted flat on the circuit panel make sure that this is really so. Long leads, unless kept long for some specific purpose, spoil the appearance of the circuit panel and could cause short-circuits. Use side cutters to remove the excess end lead on the copper strip side of the circuit panel. Check with a magnifying glass that slivers of copper have not curled round from the cropped-off end to touch another copper strip.

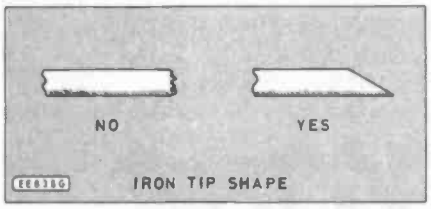
If excess solder forms on a joint, or if you need to remove a component, the best plan is to use a desoldering pump. This will take off most of the solder and the component may then be removed with little effort.

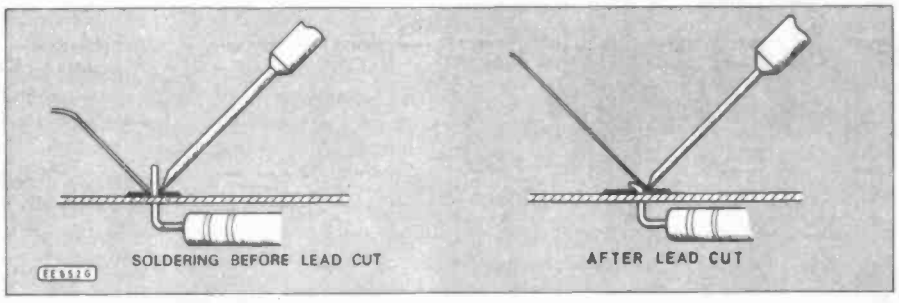
When the circuit panel is complete, make a thorough check of the following points; that each component is of the correct value, has the correct polarity (if applicable) and is in the right place. Check that all link wires are in position and all track breaks are complete. Also check that all soldered joints are sound and no scraps of solder have "bridged" any copper tracks.

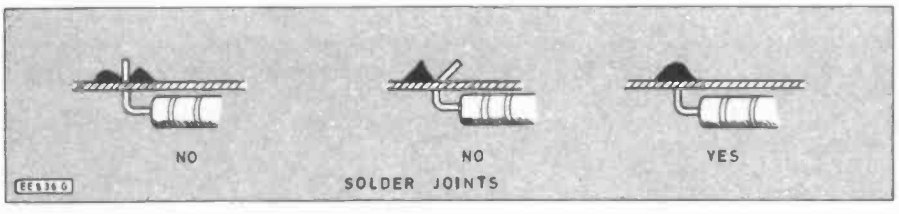
Mounting the panel

Mounting the circuit panel in the box will be easy if you have planned this out beforehand. You will either slide it into the slots or secure it with small fixings using the holes already drilled for the purpose. The position of all off-board components such as potentiometers and switches should be thought out carefully to provide a good appearance as well as









making it easy to connect them to the circuit panel.

For maximum credit, you should think of ways of imposing least strain on the wires when the lid is removed. It may be a good idea to keep the lid itself free of mounted components so this may be removed without bending any wires at all. Wires should be routed with care – they should not be excessively long but neither should they be so short that they are under strain. Some wires may be twisted together to improve the appearance.

Wires may be connected to the circuit panel by means of terminal pins or they may be soldered direct. If soldered direct, the end few millimeters should be stripped of insulation, the wire passed through the hole to the other side and soldered to the copper strip as if it were a component. The end should then be cut off using side cutters. It is important to use light-duty stranded wire for the interwiring – the single strand type soon breaks when bent a few times. Note that using lengths of wire of different colours is good practice and helps to avoid errors.

Safety

If your project is mains-operated (that is, if the low voltage supply is derived from a mains transformer) then **strict safety procedures must be followed.** Firstly, the project must be built in an **earthed metal box.** The transformer must be mounted on the metalwork and a solder tag used on one of its fixings to **earth the box and the transformer core.** A proper strain relief bush must be provided on the mains lead to prevent the metal case from cutting the insulation and also to prevent it from pulling fee – *do not tie a knot in the lead or knot a piece of string round it* instead.

The input wire must be of proper mains type having adequate rating. A neon indicator *must* be provided which lights whenever the unit is plugged into the mains – that is, it should be connected before the mains switch and fuse. The mains switch itself should be of the double-pole (isolating) variety. Fuses should be provided on both the mains input and low-voltage output from the transformer secondary. Finally, all internal mains connections must be shrouded so that it is impossible to touch them. **In all cases, have the circuit checked by your supervisor before plugging it in.**

Circuit Trials

You must now do trials on the circuit and report on its performance against each point of the specification. Remember, tables and figures are needed. A statement like "the circuit fully met the specification" will not do. Report the evaluation work carefully. You need to make a statement of why it does not fulfil any particular points and what could perhaps be done to make it do so. In this way you will receive most – if not all – the credit.

It sometimes happens that a hairline crack develops in a copper track. This may be due to having bent the board accidentally. Occasionally the crack is so thin that it is almost impossible to see it. This shows itself on test by intermittent operation of the circuit or failure to work at all. Copper tracks may be checked using a multi-tester set to a low resistance range.

Testing from one end of the suspect strip to the other should indicate virtually zero resistance if the track is good. If broken, the meter will indicate a high resistance or give a variable reading especially when the board material is gently flexed. The track is easily repaired by soldering a short wire bridge across the crack. Do not simply use a blob of solder for the repair – this is not always effective and can fail again.

If you have time, the external controls should be labelled. Dry print lettering may be used on self-adhesive labels. These stick to metal and plastic better than most types of glue.

Photographs

For some examinations boards you need at least one photograph of the completed artefact. You could supply more – one of the circuit panel itself, another of the view inside of the box and yet another of the outside. All photographs should be close-ups with the subject matter filling the frame. The assessor does not expect professional quality pictures. On the other hand, seriously faulted ones will lead to lower credit.

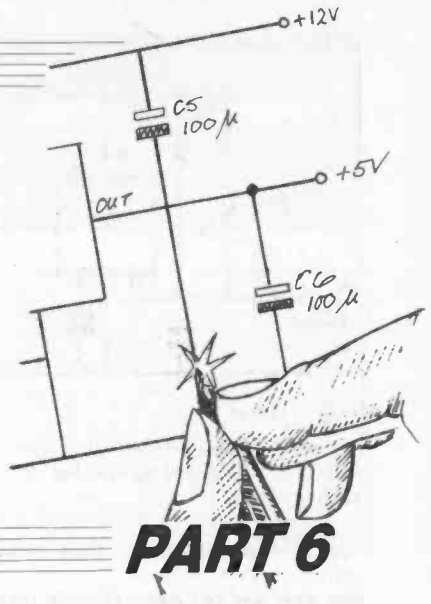
Avoid photographs which are so out of focus or so seriously under-exposed or over-exposed that the detail cannot be seen. It is useful to include a scale – for example, a ruler, a coin or even your hand – in the photograph to show relative size.

Report Update

It is now time to re-examine your report folder to see that your diary is sufficient. Perhaps a new title page is needed. Do not forget the bibliography if you have not acknowledged your sources of information as you have gone along. MEG needs a report in the form of a piece of extended prose and your diary should be sent with this. In other cases the diary forms the complete report.

That's all for this month. Some readers will be leaving us soon and I wish them the best of luck with the written papers. Others will be preparing to hand in their work. Unfortunately, at this time **things sometimes go wrong and dealing with such eventualities is the subject of next month's final article.**

The Maplin "Starter Tool Kit" is excellent for beginners at £19.95



DESIGN YOUR OWN CIRCUITS

Timers

MIKE TOOLEY BA

PART 6

This sixth part deals with one of the most versatile yet often under-rated types of integrated circuit available, the humble timer. Our design problem is based on a darkroom timer whilst our companion project deals with the construction of a Pulse Generator.

Introduction

In previous parts of this series we have dealt with two of the most useful types of electronic device; the bistable and the operational amplifier. The ubiquitous 555 timer combines both of these functions within a common 8-pin d.i.l. package and, whilst this particular chip will doubtless already be well known to most readers (the device is often used as a means of producing a reasonably accurate time delay), it can be used in many other applications including tone generators, audible warning indicators, d.c. to d.c. converters, and ultrasonic transmitters!

The 555 is essentially a hybrid device which very effectively combines analogue and digital circuitry within a single device (see Fig. 6.1). The analogue part of the chip comprises two operational amplifiers connected as comparators in conjunction with an internal resistive potential divider chain. The outputs of the two comparators are connected to an R-S bistable element, the $\overline{Q}$ output of which drives a buffer amplifier and a transistor switch which is used to discharge an external timing capacitor.

The standard 555 timer operates from d.c. supply rail voltages of between 4.5V and 15V (a CMOS version is available which operates over the range 3V to 18V). This wide range of operating voltages means that the 555 is equally at home operating from a 5V TTL supply rail as it is operating from a battery-derived +9V rail, or from a 12V to 13.8V vehicle supply.

The 555 timer may be configured (by means of external circuitry) to operate in one of two modes; monostable ("one-shot") mode and astable (continuous pulse generation) mode.

555 Modes

In the case of monostable operation, the one-off pulses produced are similar to those generated by the 74121 monostable pulse generator (see Part Five) but with the added advantage of improved accuracy and stability when long monostable periods are required. The 555 requires a falling edge trigger (of adequate amplitude) applied to the TRIGGER input (pin-2). On receipt of this signal, the device generates a monostable timing period and the signal at its OUTPUT pin (pin-3) is taken high during this time. At the end of this period, the OUTPUT signal reverts to its low state (0V). The monostable timing period may be aborted by means of a RESET input (pin-4).

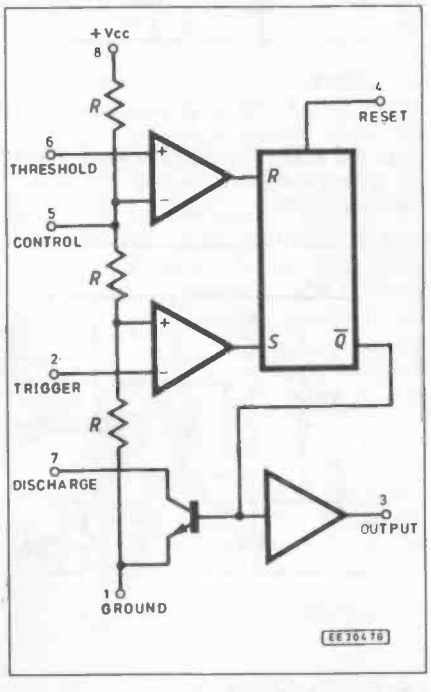


Fig. 6.1 internal arrangement of the 555 timer

In astable mode, the 555 operates as a free-running oscillator in which the signal at the OUTPUT comprises a continuous train of pulses with a pulse repetition frequency (p.r.f.) and duty cycle determined by the value of two external resistors and the value of timing capacitor applied. The output signal may be interrupted by taking the RESET signal low.

Pulse terminology

For those that may be unfamiliar with the terms which are used to describe pulse waveforms, the following terminology is applied:

Pulse repetition frequency (p.r.f.). The pulse repetition frequency (p.r.f.) of a pulse waveform is simply the number of pulses which occur in a given interval of time (invariably one second). A waveform with a p.r.f. of 10Hz will comprise a train of pulses in which 10 pulses appear every second.

Pulse period. The period of a pulse waveform is the time taken for one complete cycle of the pulse. The pulse period is equal to the reciprocal of the pulse repetition frequency (p.r.f.). Hence, a signal having a p.r.f. of 10Hz will have a period of 0.1s.

Duty cycle. The duty cycle of a pulse waveform is simply the ratio of "on" time to "on" plus "off" times. Duty cycle is often expressed as a percentage and hence a symmetrical square wave ("on" time equals "off" time) has a duty cycle of 50 per cent.

Mark-to-space ratio. The mark to space ratio of a pulse waveform is the ratio of "on" time to "off" time. A symmetrical square wave ("on" time equals "off" time) has a mark-to-space ratio of 1:1 (or "unity").

Pulse width. The pulse width of a rectangular waveform is the time duration of the "on" time of the pulse. Since the edges of the pulse may not rise and fall instantaneously (due to limitations in the speed of switching and the presence of stray capacitive reactance) the pulse width is usually

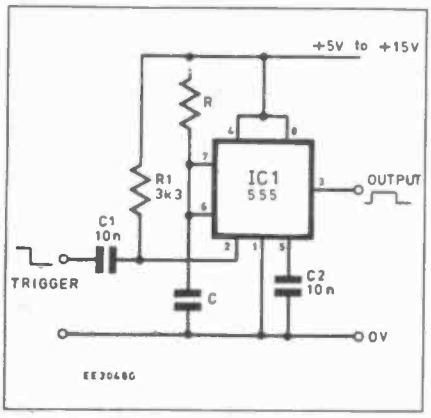


Fig. 6.2 555 timer operating in monostable mode

measured at the 50 per cent amplitude points.

Rise time and fall time. The rise time and fall time of a pulse is normally taken as the time interval between the 10 per cent to 90 per cent and 90 per cent to 10 per cent amplitude points respectively. An "ideal" pulse would exhibit zero rise and fall times!

Monostable 555 timer circuit

A standard 555 timer is shown in Fig. 6.2 connected in monostable mode. The monostable timing period is initiated by a falling edge (i.e a "high" to "low" transition) applied to the TRIGGER input (pin-2). When this signal is received, and the TRIGGER input voltage falls below 1/3 of the supply voltage, the OUTPUT (pin-3) goes high for a period which is given by:

$$t_{ON} = 1.1\ R\ C$$

(where t_{ON} is in seconds, C is in farads, and R is in ohms)

It is important to note that the pulse applied to the TRIGGER input must be of sufficient amplitude ($0.66 \times V_{CC}$) and of short duration ($t_{TRIG} < 0.25 \times t_{ON}$).

Components R1 and C1 provide a means of shaping a trigger signal into the form of a sharp (differentiated) edge with the requisite characteristics to effectively trigger the 555. If the chip is to be triggered by a rising (rather than falling) edge, the circuit of Fig. 6.3 may be employed. This circuit is somewhat more sensitive than the previous arrangement in that the amplitude of the trigger signal need only be 1V, or so, in order to produce effective triggering.

The nomograph shown in Fig. 6.4 provides readers with a simple method of determining the values of R and C needed to produce a given monostable timing period. The example shows how a monostable pulse of 10ms duration can be produced by a value of C of 100n together with a resistor, R, of 91k. The recommended range of values for R is between 1k and 1M and C between 10n and 10µ. Outside these ranges, operation may be somewhat less predictable.

Question 1: A 555 timer is to be used to generate a pulse of duration 100µs. If a 10n capacitor is to be used, determine a suitable value for R.

Relay outputs

The standard 555 timer is capable of producing an output current of up to 200mA. This allows a 555 device to directly

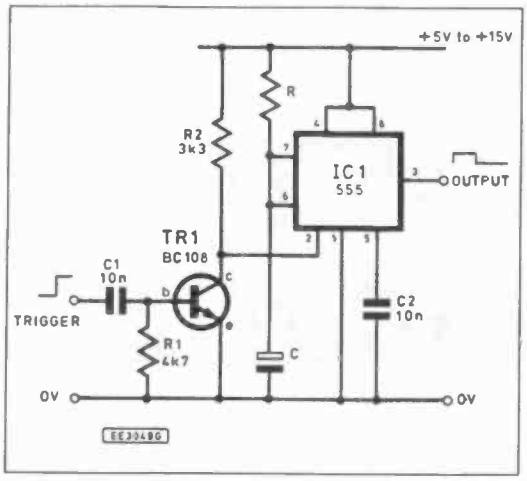


Fig. 6.3 Modification of Fig. 6.2 in order to provide triggering on a rising (rather than a falling) edge.

operate a relay connected to its output. Figs. 6.5 and 6.6 show two possible arrangements. The relay in Fig. 6.5 is energised during the monostable timing period whilst that in Fig. 6.6 is de-energised during the monostable timing period.

A shunt connected diode, D1, is fitted in both circuits in order to absorb the back e.m.f. which is generated whenever current is switched through an inductive relay load. In either case, the relay should be rated for the supply voltage used (typically between 9V and 12V) and should have a coil resistance of typically between 200 and 500ohms.

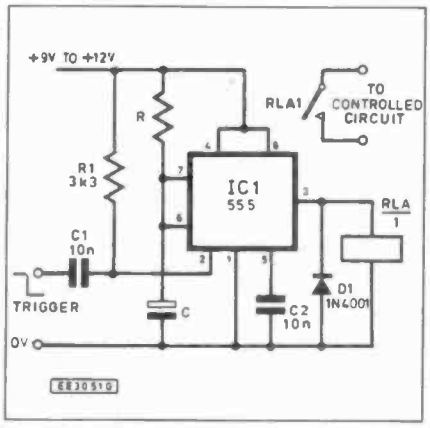


Fig. 6.5 555 monostable circuit driving a relay (energised during the monostable period)

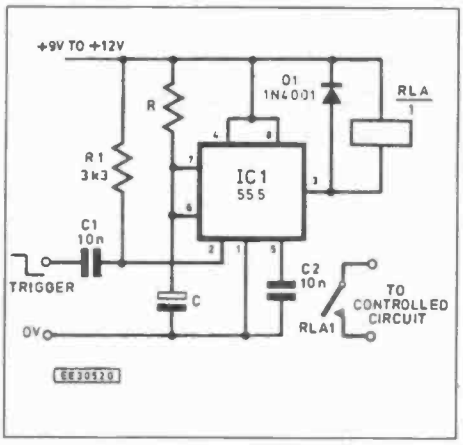


Fig. 6.6 555 monostable circuit driving a relay (de-energised during the monostable period

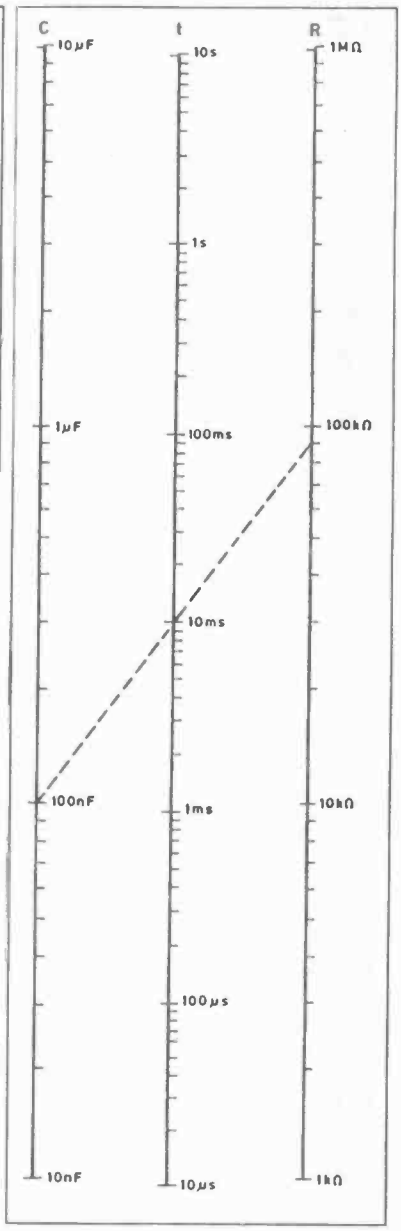


Fig. 6.4 Nomograph for the circuit of Fig. 6.2

Astable 555 timer circuit

A standard 555 timer is shown in Fig. 6.7, connected in astable mode. The TRIGGER input (pin-2) is derived from the capacitor and connected to the

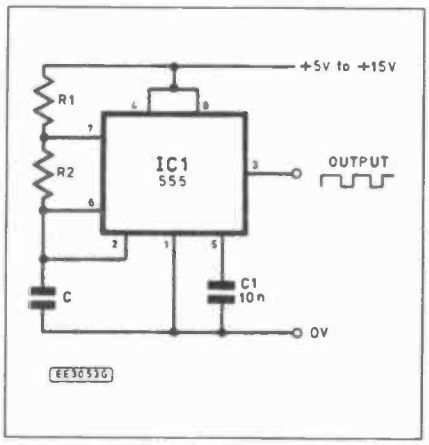


Fig. 6.7 555 timer operating in astable mode

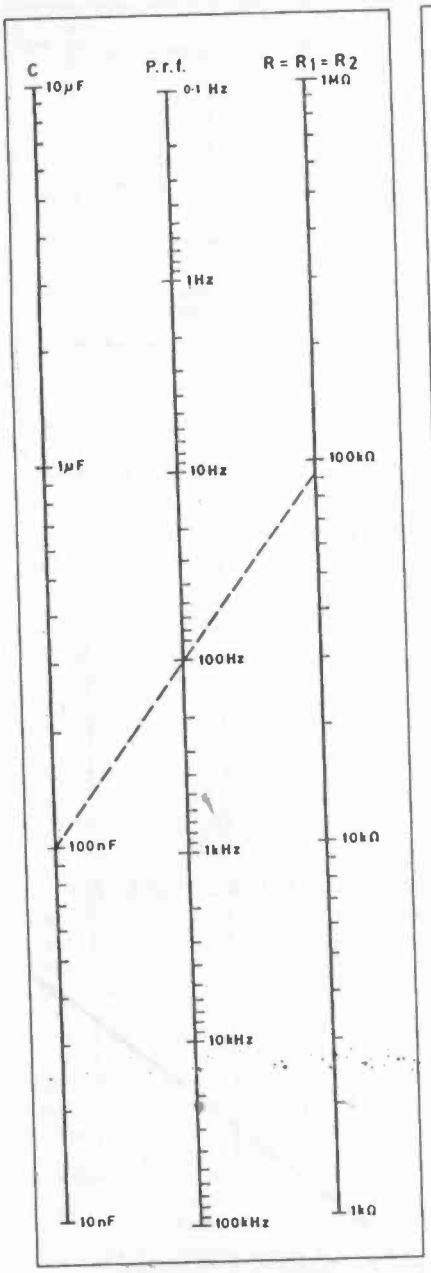


Fig. 6.8 Nomograph for the circuit of Fig. 6.7

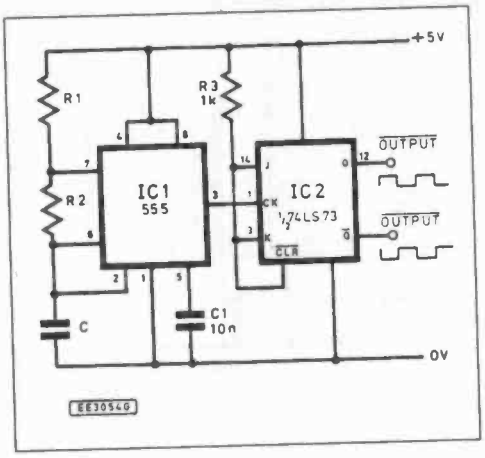


Fig. 6.9 555 timer and J-K bistable producing a perfect square wave output

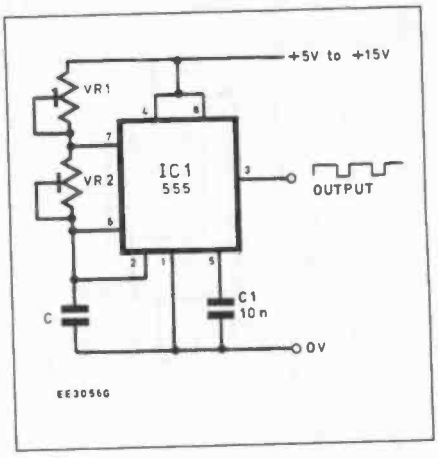


Fig. 6.10 555 astable circuit with coarse adjustment of output duty cycle

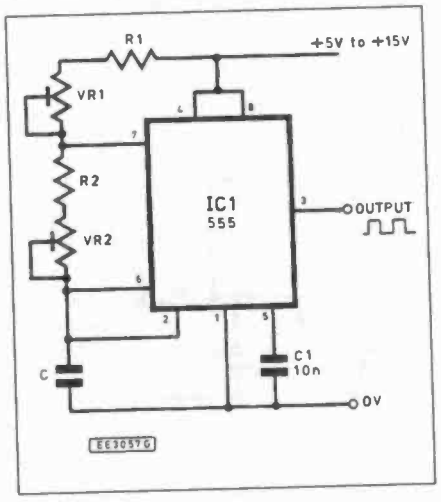


Fig. 6.11 555 astable circuit with fine adjustment of output duty cycle

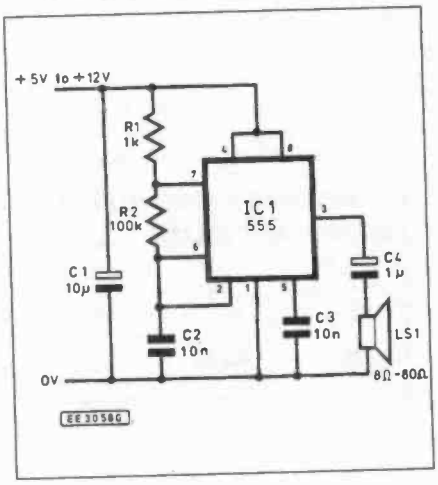


Fig. 6.12 Audible warning indicator based on a 555 astable circuit

THRESHOLD input (pin-6). In this arrangement, it is important to note that the timing capacitor, C, is charged through R1 and R2 (connected in series) but is discharged through R2 alone. The signal at the OUTPUT (pin-3) will go high during the charging time and low during the discharge time. The cycle of charge and discharge will repeat continuously and thus the output will continue for as long as the RESET input (pin-4) is taken high.

The time for which the OUTPUT (pin-3) is high will be given by:

$$t_{ON} = 0.693\,(R1 + R2)\,C$$

Whilst the time for which the OUTPUT is low will be given by:

$$t_{OFF} = 0.693\,R2\,C$$

The period of the output signal is thus:

$$t = t_{ON} + t_{OFF} = 0.693\,(R1 + 2R2)\,C$$

whilst its p.r.f. is:

$$\text{p.r.f.} = \frac{1.44}{(R1 + 2R2)\,C}$$

(where t, t_{ON} and t_{OFF} are in seconds, C is is farads, and R1 and R2 are in ohms)

The nomograph shown in Fig. 6.8 provides readers with a simple method of determining the values of R1, R2 and C needed to produce a given pulse repetition frequency. The example shows how a p.r.f. of 100Hz can be produced by a value of C of 100n together with resistors, R1 and R2, of 91k. As with the monostable 555 circuit, the recommended range of values for R is between 1k and 1M and C between 10n and 10µ. Outside these ranges, operation may be somewhat less predictable.

Question 2: A 555 timer operating in astable mode is to be used to generate a signal having a p.r.f. of 10kHz using a capacitor of 10n. Determine the required values of R1 and R2 (assumed equal).

Question 3: Determine the "on" and "off" times for the signal in Question 2.

Question 4: Determine the duty cycle for the waveform in Question 2.

Mark-to-space ratio

It is important to note that the mark-to-space ratio of the output signal produced by a 555 timer can never be less than unity (i.e. 1:1). If, however, R2 is made very much larger than R1, the output waveform of a timer can be made to resemble a reasonably symmetrical square wave.

If it is *essential* that a perfect square wave is produced (e.g. from a variable frequency astable timer in which the ratio of R2:R1 cannot remain constant), the output of a 555 can be used to clock a J-K bistable (in which case the output signal will be exactly half the frequency of that of the p.r.f. generated by the 555). Fig. 6.9 shows a typical arrangement.

Duty cycle adjustment

The circuit of Fig. 6.10 shows how the "on" and "off" times of the signal produced by a 555 timer connected in astable mode may be varied. It is important to note that the settings of *both* VR1 and VR2 will affect the "on" time whilst the setting of VR2 alone governs the "off" time. Where fine (rather than coarse) adjustment of the "on" and "off" times is required, fixed resistors (R1 and R2) may be connected in series with variable resistors (VR1 and VR2, respectively) as shown in Fig. 6.11.

Audible output

The 555 timer connected in astable mode can be used to generate an audible output (as an alternative to using a piezo-electric transducer). A typical circuit arrangement is shown in Fig. 6.12. This circuit will operate with any small loudpeaker of between 8 and 80ohms impedance and produces a reasonably loud output at approximately 720Hz. Note that it is important to a.c. couple the loudspeaker by means of C4.

Ultrasonic transmitter

A 555 timer connected in astable mode makes an ideal driver for an ultrasonic transducer. Such devices typically require a drive of several volts pk-pk at 40kHz (±1kHz). Fig. 6.13 shows a driver circuit in which VR1 is adjusted for maxi-

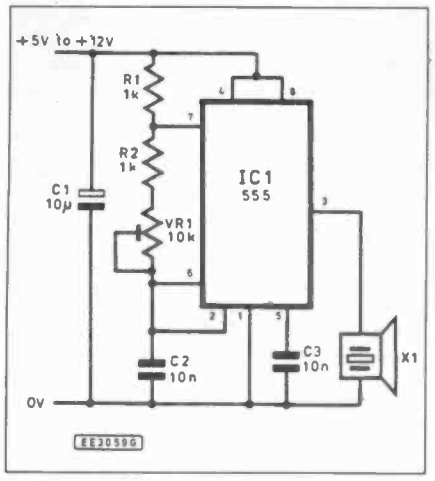


Fig. 6.13 Ultrasonic transmitter based on a 555 astable circuit

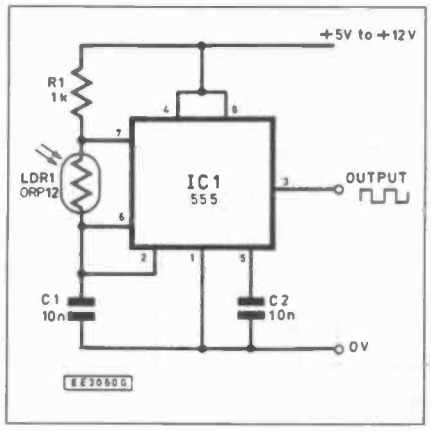


Fig. 6.14 Light to frequency converter based on a 555 astable circuit

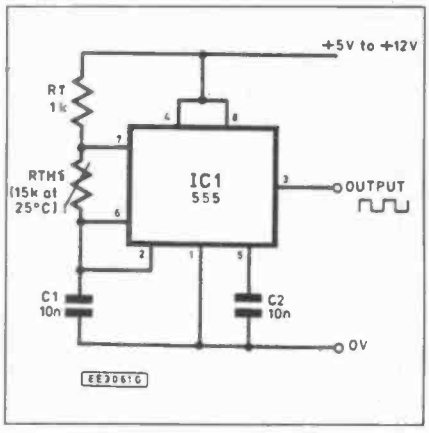


Fig. 6.15 Temperature to frequency converter based on a 555 astable circuit

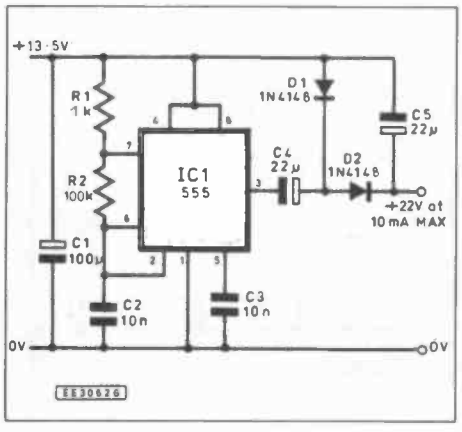


Fig. 6.16 D.C. to d.c. converter producing 22V output at 10mA max.

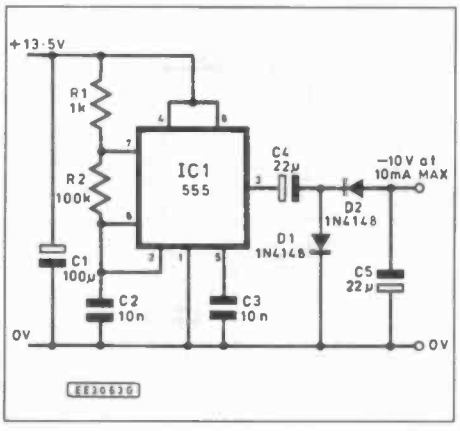


Fig. 6.17 D.C. to d.c. converter producing -10V output at 10mA max.

mum supply current (corresponding to the resonant frequency of the transducer, X1). In order to maintain the fequency accurately, C2 should be a high stability polystyrene type.

Instrumentation applications

The 555 astable configuration can be used in a number of measurement and instrumentation applications in which it is necessary to convert a physical parameter (such as light level, temperature etc) into pulse repetition frequency.

A light level to frequency converter is shown in Fig. 6.14. In this circuit the p.r.f. at the output varies from virtually d.c., when the light dependent resistor (LDR1) is in total darkness, to around 100kHz when the light dependent resistor is subjected to a bright light source (100W lamp at 20cm).

A temperature to frequency converter is shown in Fig. 6.15. In this circuit the p.r.f. at the output varies from about 2.5kHz at 0 degrees C to around 80kHz at 100 degrees C. The thermistor used exhibits a resistance of nominally 15k at 25 degrees C.

D.C. to d.c. converters

It is sometimes necessary to produce several d.c. supply rails within portable equipment which is designed to operate from a single battery source. Provided that the current demand on secondary voltage rails is not excessive, a 555 timer connected in astable mode can provide a source of a.c. for subsequent rectification and smoothing. Fig. 6.16 shows how a +22V d.c. rail can be generated from a nominal 13.5V vehicle d.c. supply. The current drawn from the 22V rail should be limited to around 10mA maximum. The astable p.r.f. is approximately 720Hz.

The circuit of Fig. 6.17 shows how a −10V d.c. rail can be generated from a nominal 13.5V vehicle supply rail. The current demand from this rail should again be limited to about 10mA and the astable p.r.f. is the same as that of the previous circuit.

Note that the "raw" d.c. rails produced by the d.c. to d.c. converters shown in Figs. 6.16 and 6.17 would, in practice, usually require regulation. A simple shunt Zener diode stabiliser (see Part One) should suffice in most cases.

Variants of the 555

Several variants of the standard 555 timer are available to the designer. These include a low-power CMOS device which is both pin and function compatible with its standard counterpart. By virtue of its CMOS technology, the device operates over a somewhat wider range of supply voltages (2V to 18V) and consumes minimal standby operating current (120µA typical for an 18V supply). It is important to note that, by virtue of the low-power CMOS technology employed, the device does not have the same output current drive possessed by its standard counterpart. It can, however, supply up to two standard TTL loads.

A dual version of the standard 555 (housed in a 14-pin d.i.l. package) is available in the form of the 556 device. The two internal timers may be used entirely independently but share a common pair of supply connections. The 556 is also available in a low-power CMOS form. This device is pin and function compatible with the standard 556 but consumes significantly less power and operates over a slightly wider supply voltage range.

Supply decoupling

Since the 555 timer is capable of switching appreciable currents very rapidly, this can place a considerable transient demand upon the supply and, whilst such a demand can usually be met in the long term, the supply rail can usually benefit from additional decoupling in the vicinity of the 555 by means of an electrolytic capacitor of reasonably large value (e.g. 100µ). This capacitor should be fitted as close to pin-8 as is practicable and its negative connection should be returned to the 0V rail by means of a substantial conductor or appropriate width of p.c.b. copper foil.

General Purpose Timer module

Our General Purpose Timer module has been designed to satisfy a variety of requirements and is based on a 555 timer circuit which may be configured (by means of p.c.b. links) for operation in either monostable or astable modes (with or without external reset).

The complete circuit of the General Purpose Timer module is shown in Fig. 6.18. Control inputs are connected by means of a 5-way p.c.b. header (PL1) and outputs are available by means of a 3-way p.c.b. header (PL2). The state of the output is indicated by means of an l.e.d. (D2) which may be fitted on the p.c.b. or connected externally and linked to the p.c.b. by means of wires of appropriate length.

Four p.c.b. links are provided and these have the following functions:

Link	Fitted	Not fitted
LK1	Continuous operation	External reset
LK2	Monostable mode	Astable mode
LK3	Astable mode	Monostable mode
LK4	Monostable mode	Astable mode

(Note that VR1 is not required for monostable mode)

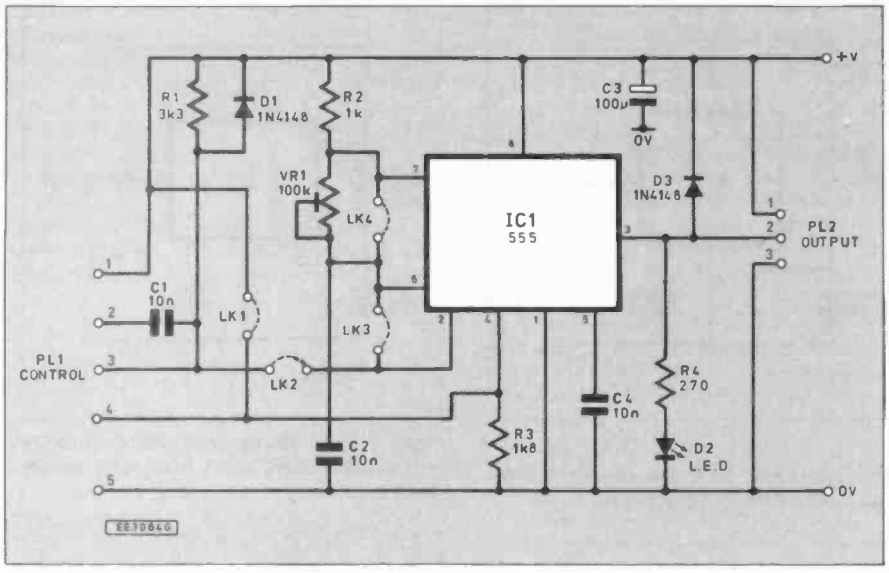


Fig. 6.18 Complete circuit diagram for the General Purpose Timer module

The connections to the control input at PL1 are as follows:

Pin No.	Function
1	$+V_{CC}$
2	Trigger (a.c. coupled)
3	Trigger (d.c. coupled)
4	External reset
5	Ground

The p.c.b. layout for the General Purpose Timer module is shown in Fig. 6.19.

The General Purpose Timer module can be configured in accordance with the circuits described previously and the values of R2, VR1 and C2 may be selected according to the formulae and nomographs provided.

In order to provide readers with some "food for thought", Figs. 6.20 and 6.21 show how the module can be connected as a monostable timer (with "start" and "reset" inputs derived from push-buttons) whilst Fig. 6.22 shows how the module can be operated in astable mode as a simple Morse code practice oscillator (in this case the output should be connected to a loudspeaker along the lines shown in Fig. 6.12).

Programmable timers

For more sophisticated applications or when accurate monostable timing periods in excess of 10s, or so, are required, the humble 555 timer should be discarded in favour of a device which uses pulse counting techniques rather than a C-R relaxation circuit. Such devices are generally referred to as "programmable" timers since the clock frequency is internally divided by a pre-set value in order to determine the precise value of time delay generated.

The LS7210 is a programmable timer which can provide a programmable delay which can range from a few milliseconds to several hours. The device operates from a d.c. supply of between +5V and +15V and is based on CMOS technology.

The internal arrangement of the LS7210 is shown in Fig. 6.23. The chip incorporates a five stage binary divider which is fed from a clock signal, which may either be generated externally or produced by an on-chip oscillator circuit. The actual value of frequency division applied is made programmable by means of five "weighting factor" inputs, the logical state of these inputs determines the divisor applied to the clock signal.

COMPONENTS

See SHOP TALK Page

Resistors

R1	3k3
R2	1k (see text)
R3	1k8
R4	270 (see text)

All 0.25W ±5 per cent carbon types.

Potentiometer

VR1	100k preset (not required for monostable mode – see text)

Capacitors

C1,C4	10n polyester (2 off)
C2	10n (see text)
C3	100µ radial elect. 25V

Semiconductors

D1,D3	1N4148 (2 off)
D2	Red l.e.d.
IC1	555

Miscellaneous

PL1	5-way straight p.c.b. header (0.1inch pitch)
PL2	3-way straight p.c.b. header (0.1inch pitch)
LK1,LK2, LK3	0.3inch p.c.b. jumpers (made from tinned copper wire – see text)

Printed circuit board available from the *EE PCB Service*, order code EE743; 0.04inch terminal pins (2 required).

Approx cost guidance only **£6**

The LS7210 can operate in four different modes; delayed operation, delayed release, dual-delay, and monostable (one-shot). The operating mode is determined by the status of the two mode selecting inputs A and B (pins 1 and 2 respectively) according to the following truth table:

Mode selecting input A (pin-1)	B (pin-2)	Mode selected
0	0	Monostable (one-shot)
0	1	Delayed operation
1	0	Delayed release
1	1	Dual delay

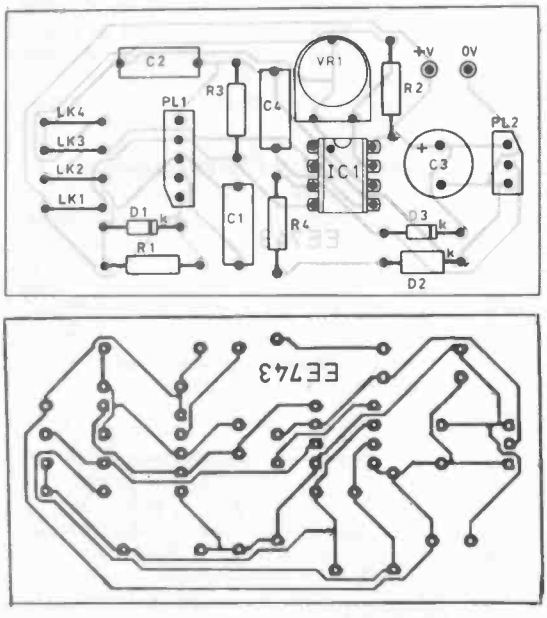


Fig. 6.19 P.C.B. layout for the timer module

General Purpose Timer module specifications

Modes of operation:	Astable (continuous pulse train) or monostable (one-shot pulse)
Supply voltage:	5V to 15V (see note)
Supply current:	50mA (typical - see note)
Maximum astable pulse repetition frequency:	>100kHz
Output rise/fall time:	0.1µs (typical)
Output current:	200mA (maximum – see note)
Output voltage:	within 1V of positive supply voltage
Control inputs:	a.c. trigger, d.c. trigger, reset

Note: The supply voltage may range from 3V to 18V and supply current may be considerably reduced by fitting a CMOS 555 device. In such cases, the maximum output current will be restricted to 100mA maximum.

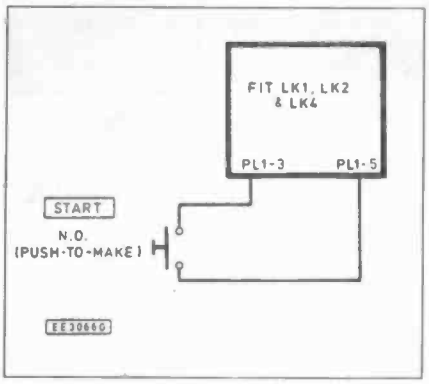


Fig. 6.20 Module configured for monostable operation with push-to-start input

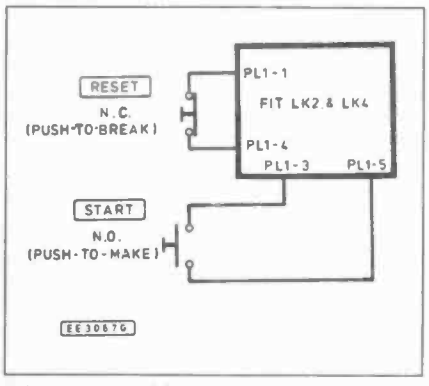


Fig. 6.21 Module configured for monostable operation with push-to-start and push-to-reset inputs

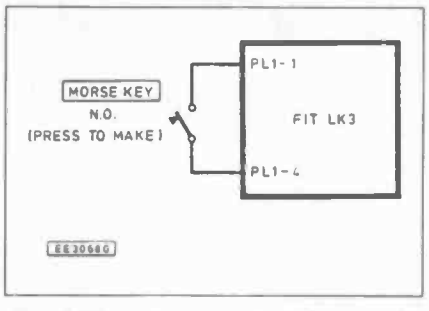


Fig. 6.22 module configured for astable operation as a simple Morse code practice oscillator

The four modes of operation may be summarised as follows:

Monostable (one-shot) mode: The output goes high (logic 1) for a period which is determined by the logical state of the weighting factor inputs whenever a falling trigger edge is received. The device effectively behaves as a retriggerable monostable. (Note that falling edges of the trigger signal are ignored in this mode).

Delayed operation mode: The output goes low (logic 0) immediately upon receipt of a rising trigger edge. When the trigger edge next falls, the output remains low (logic 0) for a period which is determined by the logical state of the weighting factor inputs. Thereafter, the output goes high once more.

Delayed release mode: When a rising trigger edge is received, the output remains high for a period which is determined by the logical state of the weighting factor inputs. The output then goes low and remains low until the next falling trigger edge appears, whereupon the output reverts to its normal high (logic 1) state.

Dual delay mode: After the arrival of a rising trigger edge, the output remains high (logic 1) for a period which is determined by the logical state of the weighting factor inputs. The output then changes to logic 0. When the trigger edge next falls, the output remains low (logic 0) for an identical period before reverting to logic 1.

Clock frequency

When the internal clock circuit is used, the frequency of oscillation is determined by a simple C-R arrangement. The clock frequency can range from about 0.01Hz to 100kHz (C-R values ranging from 100p to 10µ and 10k to 10M). The value of clock frequency is given (approximately) by the relationship:

$$f = \frac{K}{C \times R}$$

Where f is the clock frequency, C is the capacitance (in farads), R is the resistance in ohms, and K is a constant which ranges from about 0.9 to 1.1 (depending upon supply voltage). Where precise timing intervals are required, it is possible to make use of an external clock (which may be crystal controlled) or to provide a means of accurately trimming the oscillator frequency (either by use of a variable resistor connected in series with a fixed timing resistor or by means of a variable capacitor connected in parallel with the fixed timing capacitor).

The weighting factor which determines the frequency divisor and hence the time delay at the output may be determined from the equation:

$$t = \frac{1 + (1023 \times N)}{f}$$

where t is the output delay time (in seconds), f is the clock frequency (in Hz) and N is the selected weighting factor.

The formula can be re-arranged in order to determine the value of weighting factor in order to generate a particular time interval.

Hence:

$$N = \frac{(f \times t) - 1}{1023}$$

where N is the required weighting factor, f is the clock frequency (in Hz), and t is the desired time delay (in seconds).

The weighting factor, N, is determined by the logical state of the inputs at pins 8 to 12, according to the following table:

Pin	Weighting	Value
8	MSB	16
9	LSB+3	8
10	LSB+2	4
11	LSB+1	2
12	LSB	1

It is important to note that the inputs to pins 8 to 12 are "active low" and thus the quoted weighting values apply when the respective inputs are taken to ground (logic 0). The weighting factor inputs are fitted with internal pull-up resistors and hence an unused input will automatically assume a logic 1 state.

Question 5: An LS7210 programmable timer is to be used to generate an accurate time delay of 410ms from a 50kHz clock. What weighting factor should be applied and what should be the logical state of each of the weighting factor inputs? Fig. 6.24 shows a typical timer arrangement based on an LS7210.

Design Problem

This month's design problem (as with all of the design problems presented in this

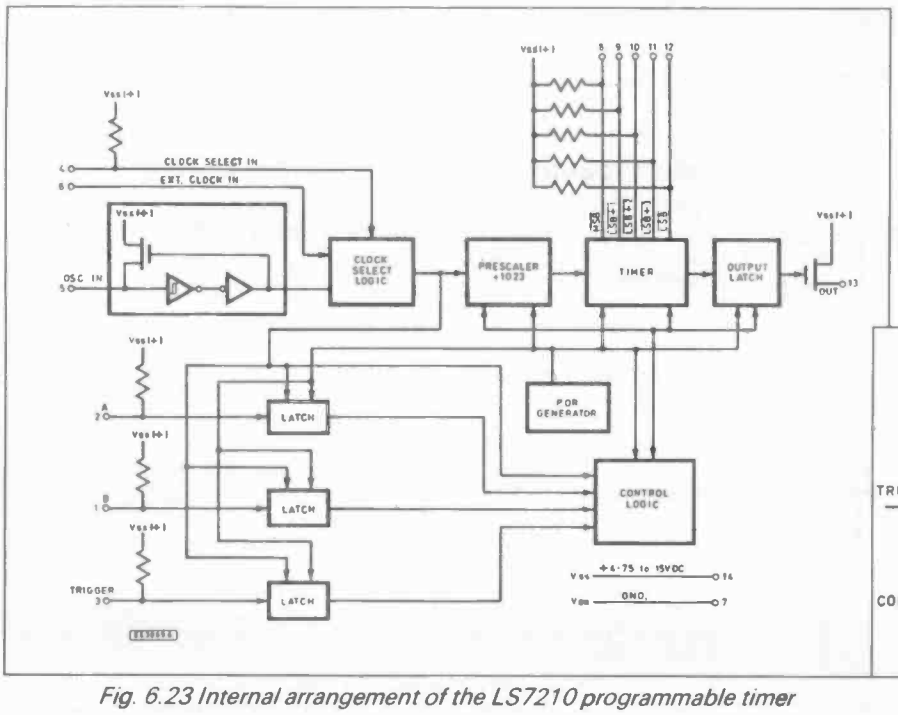


Fig. 6.23 Internal arrangement of the LS7210 programmable timer

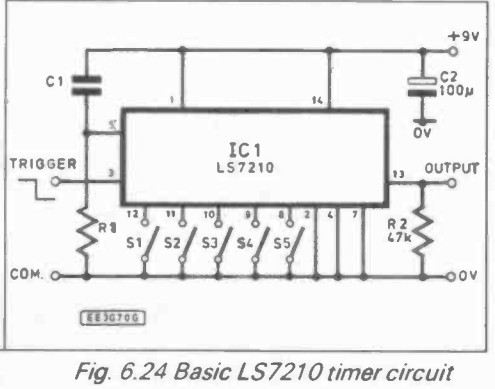


Fig. 6.24 Basic LS7210 timer circuit

series) is designed for readers who would welcome the opportunity of tackling a little "homework". The exercise may be tackled purely "on paper" or may be used as the basis of a complete constructional project.

This month's problem arises from the need for a means of reasonably accurately timing a photographic process with an audible output to alert the user at the end of the pre-set timing interval.

A darkroom timer is to be designed according to the following target specification:

Time intervals: *switch selected from 30 seconds to 7.5 minutes in 30 second increments.*
Visual output: *standard l.e.d.*
Audible output: *piezoelectric transducer (requiring a supply of between 3V and 16V of nominally 5mA).*
Supply: *single 9V battery (PP3)*

Cumulative index to modules

Title	Part	Function/specification
Dual output power supply module	1	Dual ±5V, ±12V or ±15V regulated power supply rated at 1A max. output
723 variable power supply module	1	Single variable output of +2V to +37V at up to 5A max. Output voltage and current limit are set by means of pre-set controls.
L200 variable power supply module	1	Single variable output of +2.7V to +35V at up to 2A max. Inutput voltage and current limit are set by means of variable controls.
General purpose transistor amplifier module	2	Pre-defined voltage gain and frequency response. Low/medium input impedance, low output impedance. Requires a single 9V d.c. supply at 2mA nominal.
General purpose operational amplifier module	2	Pre-defined voltage gain and frequency response. Two stages may be used independently (e.g. for stereo operation) or connected in tandem. Requires a dual supply of between ±5V and ±15V at 10mA nominal.
High-quality power amplifier module	3	Fixed gain medium/high power class AB audio amplifier capable of operating with very low distortion. Recommended load impedance 8ohm. Requires a dual supply of between ±12V and ±20V at up to 2A.
TBA820 i.c. amplifier	3	Versatile i.c. low/medium power for general purpose applications. Requires a single supply rail of between +5V and +15V.
Sine wave oscillator	4	Low distortion sine wave oscillator capable of providing outputs over the range 50Hz to 50kHz. Frequency and amplitude adjustable. Requires +12V to +15V supply at 10mA (nominal).
8038 waveform generator	4	Provides sine, square and triangle outputs adjustable the range 0.01Hz to 20kHz. Requires ±9V supply at 10mA.
Digital counter module	5	Single stage decade counter with seven-segment l.e.d. display. Standard TTL input levels. Requires +5V supply at 90mA.
General purpose timer module	6	Astable or monostable mode timer circuit configured by wire links. Extenal trigger (both a.c. and d.c.) and reset inputs. Output up to 12V at 200mA. Requires a single supply rail of between +5V and +15V.

Answers to questions in Part Six

Question 1: R = 9.1k
Question 2: R1 = 9.1k, R2 = 9.1k
Question 3: $t_{ON} = 66.7ns$, $t_{OFF} = 33.3ns$
Question 4: Duty cycle $= t_{ON}/(t_{ON} + t_{OFF}) = 2/3 = 0.667$
Question 5: Using the expression,

$$N = \frac{(f \times t) - 1}{1023}$$

provides a value of N equal to 20. This value can be achieved by tying pin-8 (weighting factor 16) and pin-4 (weighting factor 4) to ground (total weighting factor, 16+4=20). The other weighting factor inputs (pins 9, 11 and 12) can be left unconnected because they are pulled high internally, see Fig. 6.26.

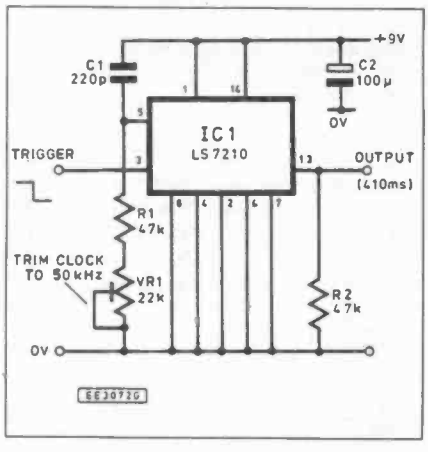


Fig. 6.26 Solution to Question

Next month: Next month's instalment deals with radio circuits; our accompanying constructional project features a radio receiver.

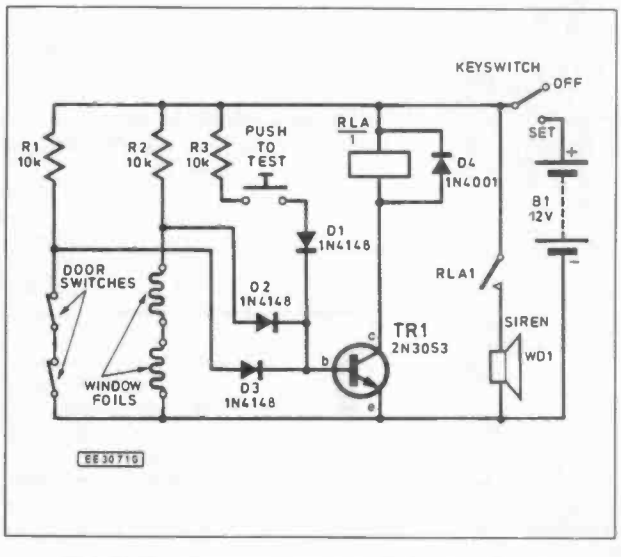


Fig. 6.25 Answer to last month's Design Problem

Answer to last month's design problem:

An intruder alarm is to be designed according to the following target specification:

Door sensors:
Number of sensors: 2
Sensor type: *Microswitch (open when door opens)*
Window sensors:
Number of sensors: 2
Sensor types: *Aluminium foil strip (breaks when window broken)*
Alarm:
Type of transducer: *Siren (requires 12V d.c. at 2A)*
Control switch:
Type of switch: *Keyswitch (with one set of change-over contacts)*
Aluminium foil tapes: 2
Power supply: *12V lead-acid battery*

Design a suitable alarm circuit based on the above specification. Include in your circuit a "test" button so that the user can check that the siren is operational.

One solution to last month's design problem is shown in Fig. 6.25.

ROBOT ROUNDUP

Nigel Clark

SORTING

Flight Electronics has introduced two new packages for use in the teaching of industrial control. They are both based on a fairly simple checking and sorting system but with the ability to change the specifications.

The less complex of the two is the MPSR1 Sorter Unit. I do not know what the initials stand for but the device, using gravity, channels coloured beads past two sensors. The sensors check the colour or the presence of the beads to count them. On the basis of the inputs four solenoids either open or close channels to guide the beads to the desired location.

The company says that the device simulates a standard industrial counting and sorting system illustrating how different types of components can be dispensed and subsequently resorted.

It can be interfaced with IBM PCs or compatibles and Flight's microprocessor training systems. Software is also provided which allows the user to define each element of the sequence and is said to be simple enough to enable the unit to be set up quickly and demonstrated. This all comes for a total package price of about £450.

TRAINING

The ICT1 Industrial Control Trainer also from Flight Electronics has been designed as a complete training package for teaching programmable logic control. In quite a neat configuration it allows the study of on-off control, sensor feedback, d.c. motor conveyor belt dispensing and assembly methods.

It is designed to show a simple industrial process in which two components are first sorted then brought together to make an object which is evaluated for sorting into acceptable objects and rejects.

This unit includes two conveyors, gravity feeds and optical sensors as well as two simple components. An on-board interface allows it to be connected to any micro with six digital inputs and six digital outputs. There is also a manual including various exercises which can be attempted. The total system costs more than £2,000.

The sorting conveyor with sensors can be obtained separately for £600. Flight says the system can be programmed to run a single test, run an assembly test or a continuous assembly test sequence, giving students the opportunity to be given exercises of varying complexity.

Flight also supplies other more simple control systems, a washing machine simulator, traffic lights and d.c. motor control. In addition it provides an introductory training scheme for programmable controllers, this is about £500.

MORE SENSORS

Philip Harris Education has expanded its range of sensors, bringing out a completely new series intended for younger children. Its Blue Box sensors backed up by its EMU, Easy Memory Unit, have been around for some time. Now it has introduced seven sensors and accompanying software under the First Sense banner. The aim is to produce something simple, easy to use and attractive to give children an enjoyable introduction to the use of sensors.

At the same time Philip Harris has launched what it calls the Universal Interface which, the company says, can be used with almost any computer found in schools, including the Nimbus, Archimedes, BBCs and IBM compatibles. Combined with the interface all children have to do is to connect the sensor to the interface, load the software and start to investigate.

The sensors are designed to fit comfortably in the hand and are powered from the interface. Up to four sensors can be fitted at once and the software allows for the storing of information and its depiction on screen as a bar chart, a line graph or a table of readings.

The sensors can measure temperature, light, humidity, pressure, sound, rotation and position. They can be obtained separately at a variety of prices but the full range with the interface and software costs about £500.

A First Sense Basic Kit is being sold, including the interface and temperature, light and sound sensors and manual for about £250, with software and connections extra. Philip Harris emphasises that First Sense is not a substitute for its existing Blue Box range which is still being developed. The Universal Interface, available on its own at £125, is compatible with the Blue Boxes and EMU.

Philip Harris Education launch First Sense with the help of Bob Holness, the presenter for the Blockbusters *TV show. Pictured with Bob is Frances Clemson (7 years) and Jonathan Shepherd (10 years).*

FIXED

Viewers of BBC's *Jim'll Fix It* will have spotted the robot arm which dispenses the pendants to those taking part, giving a little tune and speaking a few words as it does so. You probably recognised it as UMI's RTX scara arm, which at a basic price of £8,200 for this six axis arm makes it an expensive addition to the popular show.

GOLD

Economatics' "Control by Design" package took the Gold Award in the secondary section of this year's Educational Technology Awards. The judges said that not only did they consider it to be the most impressive entrant in the category but it was the one to receive the most nominations.

Control by Design, which enables pupils to design and test control systems on screen, was the only winner in the control technology area. The other products to receive awards were software in areas such as mathematics and word processing.

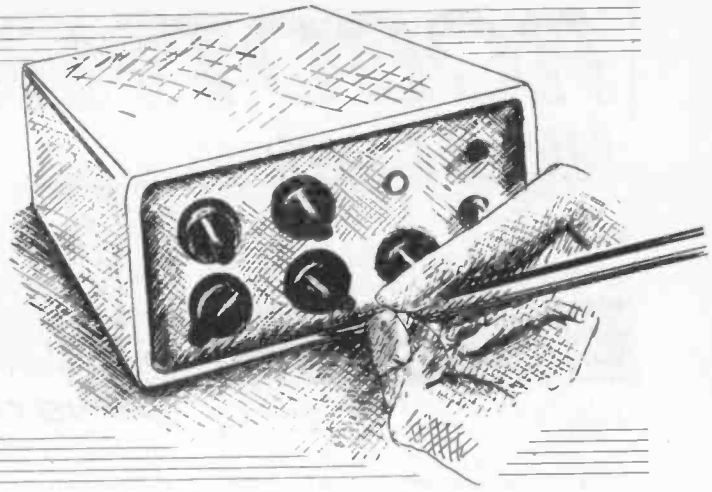
The awards are given each year with primary and secondary categories and three prizes in each. They are designed to reward the creators of innovative products. Nominations come from teachers and the winners chosen by a panel of educationalists.

Sponsored by the British Education Equipment Association, BBC Educational Computing and Technology and EMAP International Exhibitions, the awards were handed out at the BETT Exhibition in London earlier this year.

Valiant Technology officially launched its control console at the BETT show. The board based on the keyboard for the Roamer, with a few additions is available for about £150. With a memory capacity of 650 instructions it can execute thousands of commands, making use of the REPEAT function, including five musical tempos and five octaves.

Teach-In '91 Project

PULSE GENERATOR



MIKE TOOLEY BA

This companion project to our Design Your Own Circuits series shows how the ubiquitous 555 timer can be used to form the basis of a simple yet highly versatile Pulse Generator. As with all of the practical constructional projects in this series, a number of modifications are suggested.

A SOURCE of rectangular pulses of variable amplitude, frequency and duty cycle can be extremely useful when testing a wide range of digital and analogue circuits. Our Pulse Generator makes an ideal companion to the *Waveform Generator* which was described in the March 1991 edition of *Everyday Electronics* (for back numbers see the Editorial page). Together, these two instruments provide all of the signals required for testing the vast majority of circuits which the electronic hobbyist will wish to tackle.

The Pulse Generator is based on two standard 555 timers and two commonly available transistors yet provides a source of pulses with period adjustable from 14s to approximately 14µs in six decade ranges with widths adjustable from 7s to approximately 7µs (also in six decade ranges). Three outputs are provided; two are TTL compatible (5V peak output) whilst the third is variable in amplitude over the range 0V to approximately 8V peak.

CIRCUIT DESCRIPTION

The complete circuit of the Pulse Generator is shown in Fig. 1. IC1 is connected in astable mode with VR1 providing continuous adjustment of the pulse repetition frequency and S1 providing selection of one of six decade timing capacitors, C1 to C6. The output of IC1 (a reasonably symmetrical square wave) is applied to the trigger input of IC2 by means of the pulse forming network, C8, D1 and R4.

A second 555 timer, IC2, operates in monostable mode with output period made continuously adjustable by means of VR2. S2 provides six decade switched ranges of timing capacitance, C9 to C14. The output of IC2, comprising a pulse train of adjustable duty cycle, is fed to VR3 which provides adjustment of the output level present at SK1.

Transistor TR1 is an inverter which provides the inverted TTL output signal at SK2. A further inverter provides the non-inverted TTL output (in-phase with the variable output available at SK1) at SK4. The collector supply voltage of TR1 and TR2 is fixed at 5.1V (by means of Zener diode, D2) in order to ensure that the outputs present at SK2 and SK4 are TTL compatible.

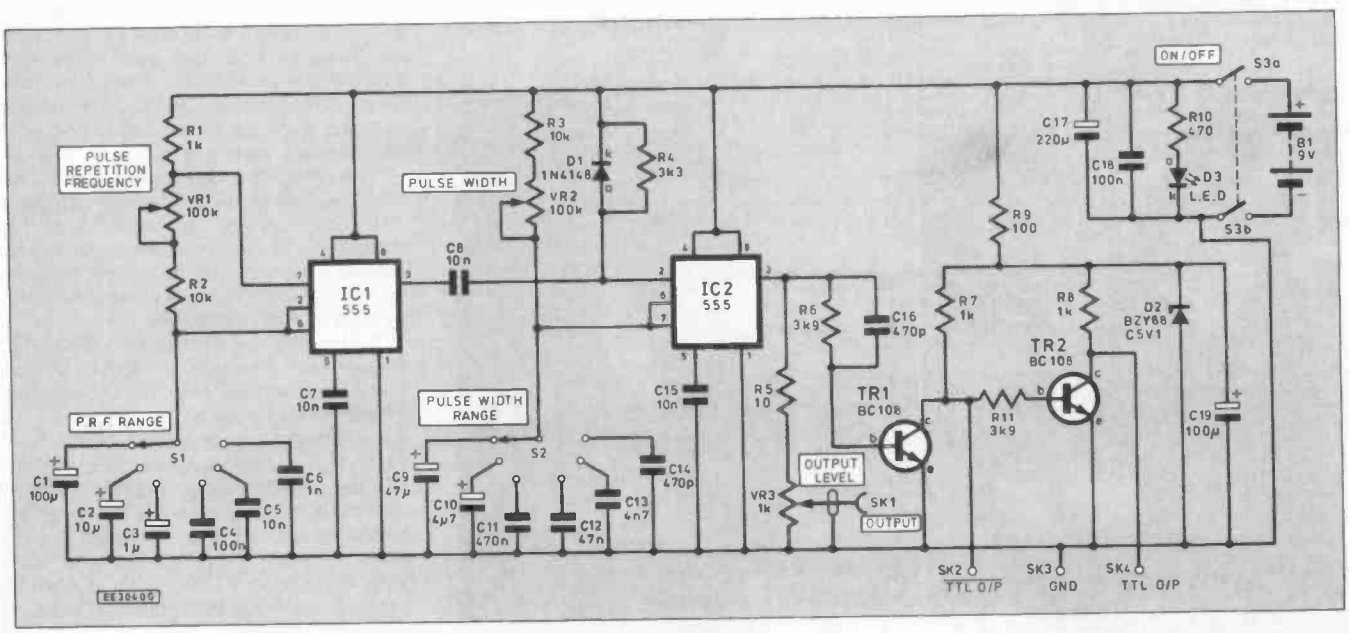


Fig. 1. Complete circuit of the Pulse Generator

Specifications

Pulse period:	variable from 14s to 14µs in six decade ranges
Pulse width:	variable from 7s to 7µs in six decade ranges
Pulse amplitude:	variable from 0V to 8V peak
TTL outputs:	separate inverted and non-inverted outputs at standard TTL levels (5V pk)
Rise and fall times:	less than 0.1µs (variable output) less than 0.2µs (TTL outputs)
Supply voltage:	9V (PP6 or PP7 recommended)
Supply current:	65mA (typical)

COMPONENTS

Resistors

R1,R7, R8	1k (3 off)	
R2, R3	10k (2 off)	
R4	3k3	
R5	10	
R6, R11	3k9 (2 off)	
R9	100	
R10	470	

See SHOP TALK Page

All resistors are 0.25W ± 5%

Potentiometers

VR1,VR2	100k p.c.b. mounting
VR3	1k p.c.b. mounting

Capacitors

C1	100µ axial elect. 25V
C2	10µ axial elect. 35V
C3	1µ axial elect 35V
C4	100n tubular polyester
C5	10n tubular polystyrene
C6	1n tubular polystyrene
C7, C8, C15	10n polystyrene (3 off)
C9	47µ axial elect. 25V
C10	4µ7 axial elect. 35V
C11	470n tubular polyester
C12	47n tubular polyester
C13	4n7 tubular polystyrene (2 off)
C14,C16	470p tubular polystyrene
C17	220µ radial elect. 25V
C18	100n polyester
C19	100µ radial elect. 16V

Semiconductors

D1	1N4148
D2	BZY88 C5V1
D3	red l.e.d. (with mounting clip)
TR1,TR2	BC108 (2 off)
IC1,IC2	555 (2 off)

Miscellaneous

S1,S2	1P 6W rotary switch (1P 12W with rotation stop suitably adjusted –2 off)
S3	DPDT miniature toggle switch
SK1	chassis mounting 50ohm BNC female connector
SK2,SK3, SK4	2mm sockets (red, white, black)
PL1,PL2, PL3	5-way straight p.c.b. headers (0.1inch pitch) and matching "free" connectors (3 off)

ABS enclosure (to suit individual constructor's preference – see text); printed circuit board, available from the *EE PCB Service* order code EE742; plastic p.c.b. fixing pillars with self-tapping No. 6 fixing screws (2 off); snap-fit battery connector (to suit PP6, PP7 or PP9 battery as appropriate); 8-pin low-profile d.i.l. sockets (2 off); knobs to suit (5 off); connecting wire etc.

Approx cost guidance only **£18** *excl. case and batt.*

The Pulse Generator operates from a single +9V d.c. supply rail derived from a dry battery (PP6, PP7 or PP9).

CONSTRUCTION

Construction of the Pulse Generator is very straightforward. With the exception of the front panel mounted controls, l.e.d., range capacitors and output connectors, all of the components are assembled on a single-sided printed circuit board measuring approximately 118 x 48mm. The layout of the printed circuit board is shown in Fig. 2.

Components should be assembled on the printed circuit board in the following sequence; p.c.b. headers, d.i.l. sockets, link (using tinned copper wire of 24 or 26 s.w.g.), resistors, capacitors, and diodes. As with all of our projects, it is vitally important to ensure that all of the components are correctly located. Furthermore, in the case of the polarised components (such as the electrolytic capacitors, diodes and the two integrated circuits) it is absolutely essential to ensure that each component is correctly orientated.

When construction of the printed circuit board has been completed (and before inserting the two integrated circuits into their respective sockets) it is well worth carrying out a careful visual check of both the upper and lower sides of the board. The

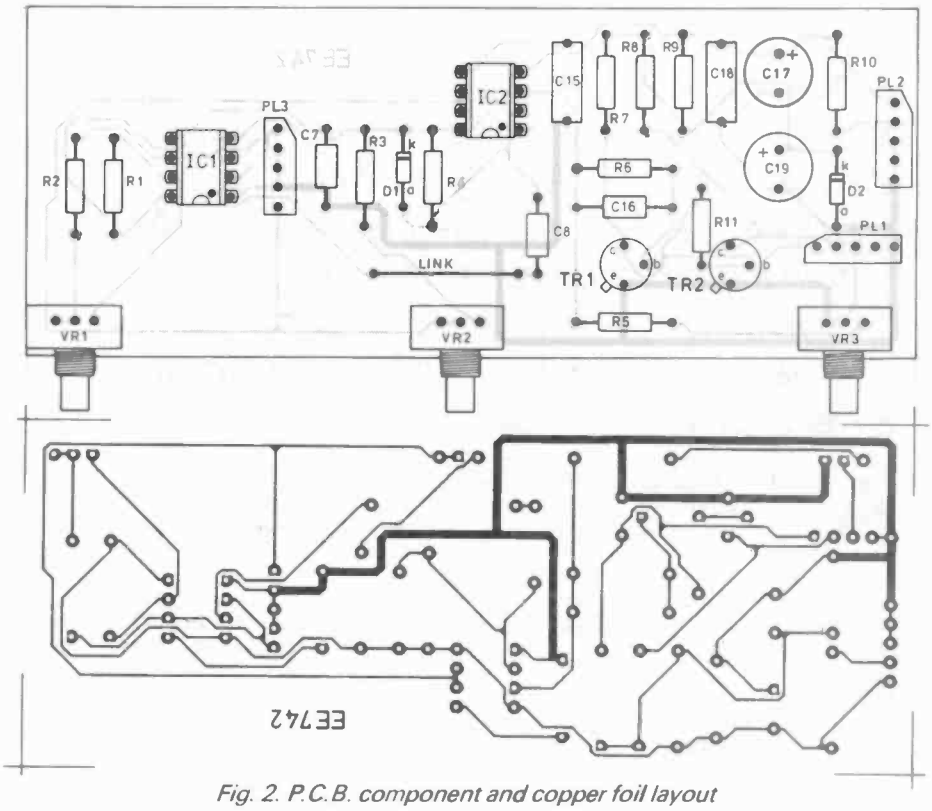
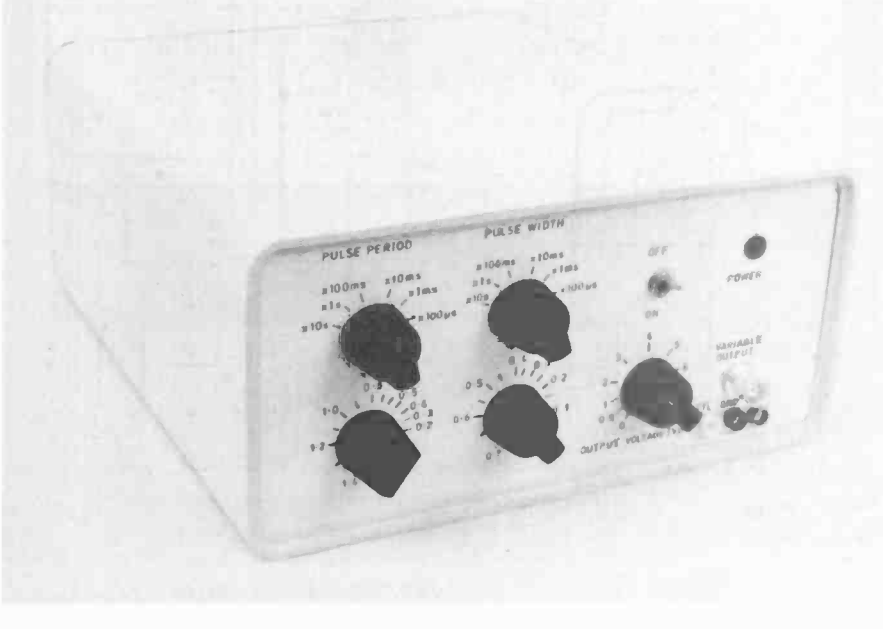
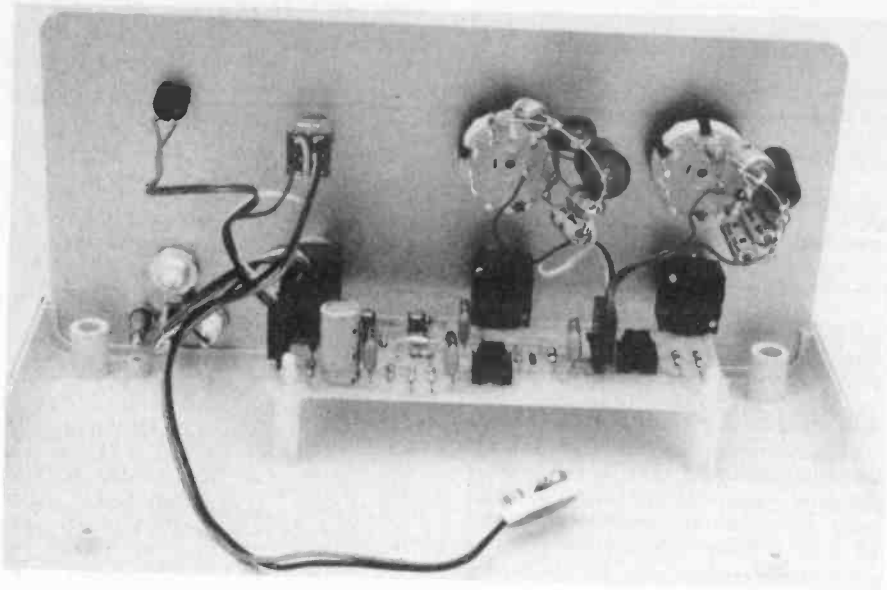
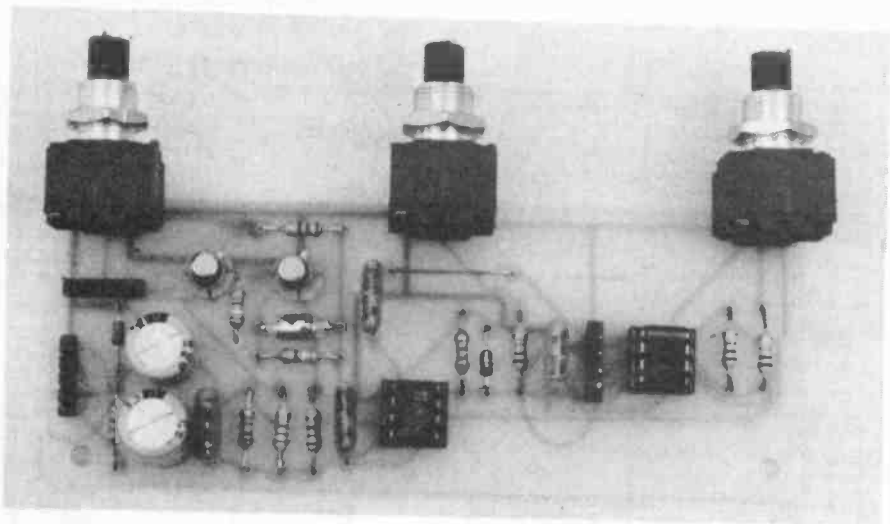


Fig. 2. P.C.B. component and copper foil layout







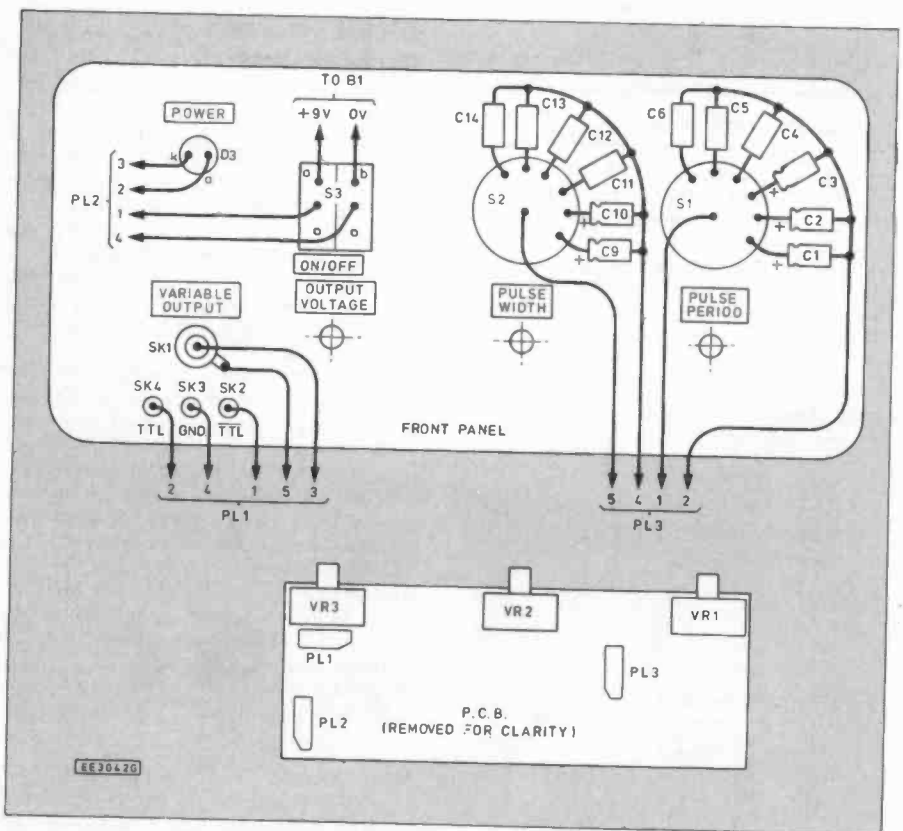


Fig. 3. Capacitor mounting and inter-wiring diagram

upper (component) side of the printed circuit board should be examined to ensure that the components have been correctly located whilst the lower (copper track) side of the board should be checked to ensure that there are no dry joints or solder bridges between adjacent tracks. This simple precaution will only take a few minutes to carry out but can be instrumental in preventing much heartache at a later stage!

WIRING

In order to minimise the number of connections from the p.c.b. to the front panel, the twelve timing capacitors, C1 to C6 (for the astable circuit), and C9 to C14 (for the monostable circuit), are mounted on the rotary switches, S1 and S2 respectively (see Fig. 3). Note that the negative connections of the electrolytic capacitors (and outer foil connections of the tubular polystyrene capacitors) should be taken to the common, 0V, connection.

When assembly of the printed circuit board has been completed, the two integrated circuits, IC1 and IC2, should be inserted into their holders (taking care to observe the correct orientation in each case).

CASE

The Pulse Generator should be housed in an ABS enclosure with aluminium front and rear panels. The enclosure used for the prototype instrument measured approximately 220 × 230 × 105mm however the precise dimensions of the enclosure are unimportant provided adequate room is made available on the front panel for the various controls, switches and output connectors and the enclosure is large enough to accommodate the 9V battery (or an a.c. mains power supply unit).

The front panel should be carefully marked out before drilling and cutting takes place. As usual, there is nothing particularly critical about the layout of the unit and constructors may wish to experiment with the location of the front panel controls, output connectors and l.e.d. indicator. Fig. 4 shows the front panel layout and markings used in the prototype.

Once the front panel has been drilled to accommodate the controls and output connectors, the p.c.b. can be mounted (by means of the control shafts of VR1, VR2 and VR3). The rear of the p.c.b. should be supported above the base of the plastic enclosure by means of two snap-fit p.c.b. mounting pillars.

A battery holder (for a PP6, PP7 or PP9 9V battery) can be manufactured from simple L-shaped aluminium brackets secured to the base and/or rear of the case.

CONNECTORS

Connections to the printed circuit board are made using three five-way 0.1inch pitch printed circuit board headers. PL1 is used to connect the four output connectors (SK1 to SK4) whilst PL2 provides a connection for the on/off switch (S3) and l.e.d. (D3). A third 5-way connector, PL3, provides a means of connecting the rotary switches (S1 and S2) and timing capacitors (C1 to C6 and C9 to C14).

The recommended method of terminating the female connectors which mate with the headers was described in the first of our constructional projects which appeared in the December 1990 issue of *Everyday Electronics*.

Coloured stranded 0.1inch pitch ribbon

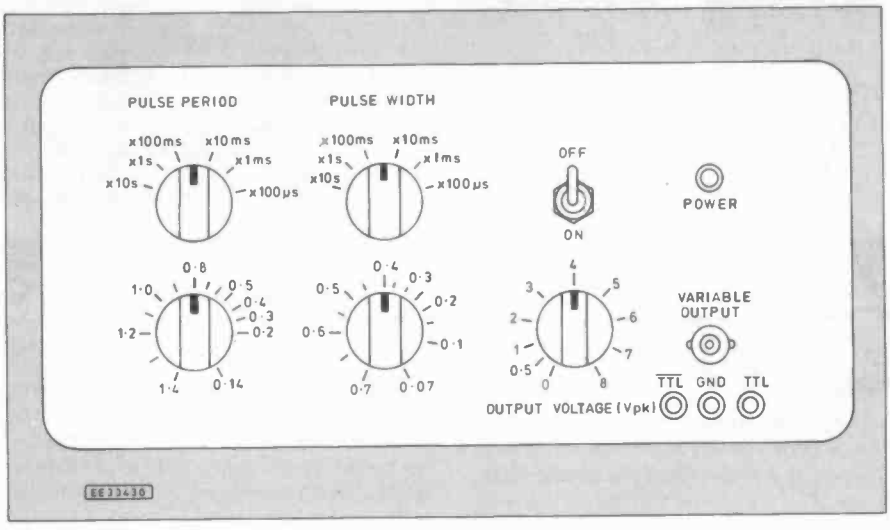


Fig. 4. Recommended front panel layout

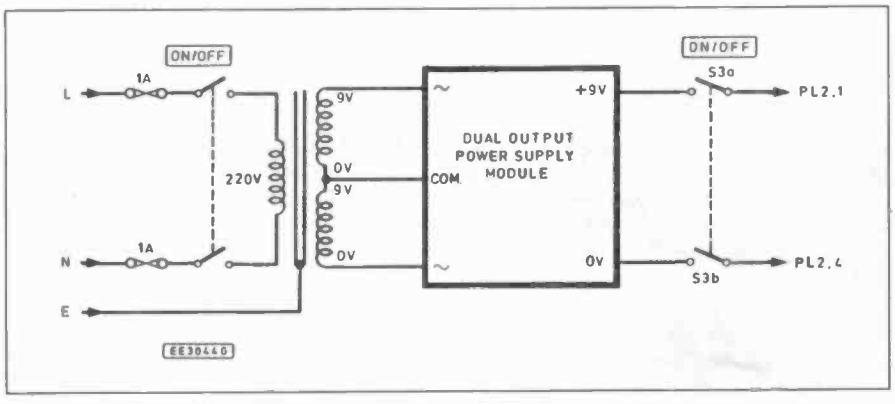


Fig. 5. Modification of the Pulse Generator for mains operation

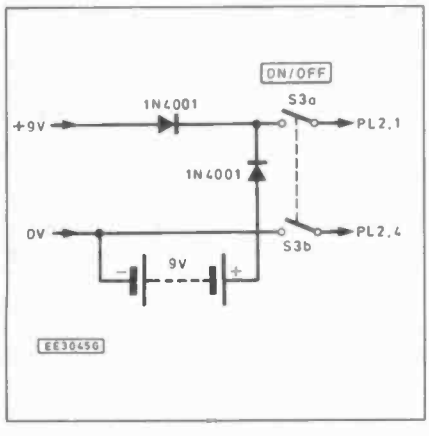


Fig. 6. Modification of the Pulse Generator for mains/battery operation.

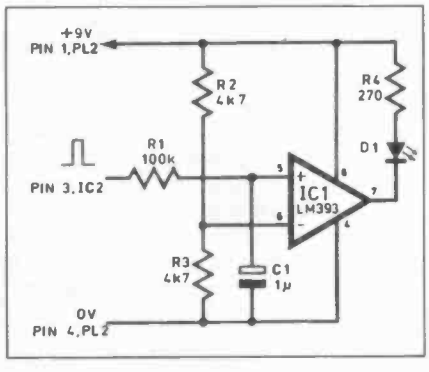


Fig. 7. Valid pulse indicator

cable is used to make connections to the front panel. The following colour coding is recommended:

PL1

Pin	Colour	Connection to:
1	Brown	SK2 (inverted TTL)
2	Red	SK4 (non-inverted TTL)
3	Orange	SK1 (variable output)
4	Yellow	SK3 (ground)
5	Green	Ground connection on SK3

PL2

Pin	Colour	Connection to:
1	Blue	S3a selector (+9V)
2	Violet	D3 anode
3	Grey	D3 cathode
4	White	S3b selector (0V)
5	none	not used

PL3

Pin	Colour	Connection to:
1	Brown	S1 selector
2	Red	C1 to C6 (common connection)
3	none	not used
4	Yellow	C9 to C14 (common connection)
5	Green	S2 selector

TESTING

Before testing the Pulse Generator, it is important to carefully check the wiring of the p.c.b. and the front panel mounted components. A 9V battery (PP6, PP7 or PP9) should be connected to the unit and a milliammeter inserted to measure the supply current in the positive supply rail.

Switch the unit "on" and measure the supply current. This should be in the range 55mA to 80mA. If the supply current is not within this range, disconnect the supply and carefully check all the wiring and the p.c.b.

MODIFICATIONS

Several useful modifications may be made to enhance the performance of the basic Pulse Generator circuit. The suggestions made here are provided as "food for thought" and should make a starting point for further development. Constructors are invited to report their own modifications to be incorporated in the Readers' Feedback which will appear in the final part of our Design series.

Mains operation

The Pulse Generator can be very easily adapted for mains operation. A suitable mains supply is the Dual Output Power Supply module which appeared in Part One of the series. The module should be fitted with a single 7809 regulator (IC1) and used in conjunction with a transformer having two secondaries rated at 9V, 0.25A (or greater). Fig. 5 shows the necessary circuit modifications.

Mains/battery operation

The Pulse Generator can also be readily adapted for dual mains/battery operation with automatic changeover to battery operation in the event of supply failure or disconnection of the mains. Fig. 6 shows the necessary changes to the circuit.

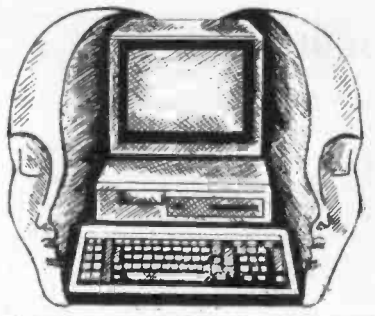
Valid pulse indicator

Lastly, Fig. 7 shows how an additional circuit can be added in order to determine whether the Pulse Generator is producing a valid output waveform (the waveform is invalid whenever the pulse duration *exceeds* the pulse period). It is not always easy to determine whether the settings of VR1, VR2, S1 and S2 are valid and this additional circuit can assist the user by producing a rapid visual indication of the status of the output waveform.

The i.c. (IC1) acts as a comparator and its output goes low (and l.e.d. D1 becomes illuminated) whenever the duty cycle of the input is less than 50 per cent. This corresponds to normal operation of the Pulse Generator. When the duty cycle is greater than 50 per cent, the l.e.d. becomes extinguished and it is then necessary to visually check the control settings to ensure that the selected pulse duration is not greater than the pulse period. Due to the limitation of the averaging circuit (R1 and C1), D2 will flash "on" and "off" at very low pulse repetition frequencies. □

Next month: The project for next month's Teach-In '91 series will be a Radio Receiver. The Teach-In '91 series itself covers radio circuits.

INTERFACE



Robert Penfold

IN THIS month's *Interface* article we turn our attention to the Atari ST computers. I mentioned in previous articles that some modern sixteen bit computers do not offer the same sort of expansion potential as most of the old eight bit designs, especially for those who are interested in user constructed add-ons.

In my opinion at any rate, the Atari ST computers are amongst the worst offenders in this respect. It would be untrue to suggest that they have no user add-on potential at all, but they do represent a relatively difficult prospect, and are ultimately less expandable than many computers of the past.

Port In A Storm

The Atari STs are by no means short of ports, and the computer is actually bristling with them. MIDI IN, OUT, and THRU ports are included, although in a non-standard form which condenses them into just two 5-way DIN sockets.

The usual parallel printer and serial ("Modem") ports are also included, together with disk drive, joystick/mouse, and monitor ports. Last, and by no means least, there is a cartridge port.

Despite having all these ports, there are none that are really what could be considered ideal for user add-ons. With the Atari STs you have to make the best of what is available.

The serial ports of many computers seem to be underutilized, and in many cases never actually used at all. This makes the ST serial port an obvious candidate for user add-ons. This is a standard IBM PC style serial port having the usual 25-pin D-plug. Connections to this port are therefore made via a 25-pin female D-connector.

High level languages for the STs usually provide excellent support for the serial port, making it easy to set the required word format and baud rate. It is also easy to read and write to this port. It is port 1 in ST terminology, and with most BASICs the INP and OUT instructions are used to read and write to the ports. For instance, OUT 1,45 would write a value of 45 to the serial port.

Interfacing to a serial port is not totally straightforward since any add-on is likely to deal with parallel data rather than raw serial data. However, a UART such as the 6402 is basically all that is needed in order to provide the necessary serial-to-parallel and parallel-to-serial conversions.

This subject will not be pursued further here, as it is something that was covered fairly comprehensively not so long ago in some of the *Beeb Micro* series of articles.

Printer Port

The printer port provides what is potentially a better means of interfacing to user add-ons, as it deals directly in parallel data. It provides an eight-bit parallel output with "Strobe" and "Busy" handshake lines.

It is a largely IBM PC compatible port, using the standard 25-pin female D-type connector with the usual method of connection. Connections are therefore made to this port by way of a 25-pin male D-type connector.

One slight problem is that most users will probably already have this port connected to a printer. Switching units that permit a single printer port to be connected to one or other of two printers are available, and these represent an easy method of switching between a printer and a user add-on. For this application a simple unit based on a mechanical switch is probably better than some form of electronic or automatic switching unit.

For those who are unfamiliar with the handshaking arrangement used on parallel printer ports it should perhaps be explained that the strobe line is an output, and the busy line is an input. The strobe output pulses low when fresh data is placed on the data lines, and this pulse can be used to latch the data into an eight bit flip/flop, transparent latch, or whatever.

This line is not necessarily needed with user add-ons, because the data outputs of the printer port are latching types. They can therefore directly operate l.e.d.s, relay drivers, etc.

The busy line is a handshake input which can be used to provide a hold-off if data is being sent at a rate which is too high for the receiving device to digest it properly. It is taken low to permit a flow of data, or high to provide a hold-off.

Again, with user add-ons this line might be unnecessary, since most add-ons will probably be able to keep up with the flow of data without any difficulty. It cannot simply be ignored though, as it will drift to the high state, providing a hold-off. In order to enable a continuous flow of data to the parallel port this line must be tied to one of the port's ground terminals.

Parallel Input?

From BASIC an OUT instruction to port 0 can be used to write data to the parallel port. The eight data lines of the printer port are provided by one of the two input/output ports of the YM-2419 sound chip. In fact it is port B that provides the eight data lines, while port A is used to furnish outputs for the serial port and the disk drive interface, as well as providing the strobe line of the printer interface.

Incidentally, the YM-2419 would seem to be an exact equivalent to the more familiar AY-3-8910 sound chip which has been used in several home computers and projects for the home constructor. As the chip has ports which can be set as inputs or outputs, it should be possible to set the printer port as an eight bit input.

The YM-2419 has sixteen registers, but these do not take up sixteen addresses in the memory map (the 68000 used in the STs has memory mapped I/O circuits). Instead, one address is used to select the desired register, and it is also used for reading data from the chip. A second address is used for writing data to the sound chip. These are the two addresses:

&FF8800	Read data/Register select
$FF8802	Write data

Bit 7 of register 7 controls the direction of port B. This bit is normally set at 1 in order to have port B as an eight bit output, but it can be set as an input port if 0 is written to this bit. Note that the eight lines must all be inputs, or all be outputs, and that no form of split operation is supported.

In theory, in order to use the printer port as an input type you must first write a value of seven to $FF8800 in order to select port seven. Then read this port at $FF8800, deduct 128 from the return value, and write the answer (usually 126) to address $FF8802. This sets the port as an input type.

Next a value of fifteen is written to address $FF8800 in order to select register fifteen (port B). This port can then be read at address $FF8800, but a write operation to this address to select register fifteen must always precede such a read operation. Remember that the computer might select a different register, and you can only be sure of reading the right one by selecting it and then reading it immediately.

In practice this all seems to be something less than 100 per cent successful. The computer will do its best to put things back the way they were as soon as you change things. This is not really surprising, and many computers resist any direct tampering with certain items of hardware.

The printer port seems to be unusable as an input unless some way of preventing this interference from the firmware can be found. As yet I have not found a way around this problem. Direct control of the sound chip could still be worthwhile as a means of rapidly writing data to the port.

MIDI

The MIDI (Musical Instrument Digital Interface) ports are intended for use with suitably equipped synthesisers, electronic pianos, etc. If you have no interest in using them with musical instruments, then I suppose that they prove a possible means of interfacing to your own projects. The MIDI ports are port 2 with normal ST programming languages, and from BASIC they can be accessed using the INP and OUT commands.

A MIDI port is basically just a serial type, much like a standard RS232C interface. However, the word format is standardised at one start bit, eight data bits, one stop bit, and no parity. The baud rate is 31250 baud, which enables data to be exchanged at a rate of over three thousand bytes per second. No form of handshaking is used.

It is possible to interface to the MIDI ports using a UART, but there is a slight complication in that MIDI uses opto-isolated inputs. MIDI uses a five milliamp current loop system, and not the usual plus and minus 12 volt levels of an RS232C signal.

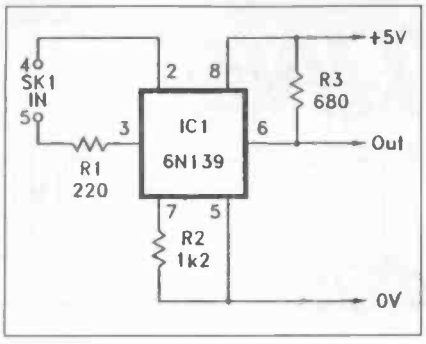


Fig. 1. A simple MIDI input stage for a UART.

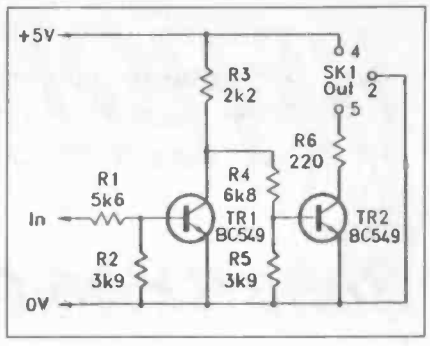


Fig. 2. A circuit that enables a UART to drive a MIDI input.

Interfacing MIDI signals to a UART is not difficult though. Fig. 1 shows a suitable output stage, while Fig. 2 shows a circuit that enables a UART to drive a MIDI input.

Cartridge Port

On the face of it, the cartridge port is a general purpose expansion port which is ideal for user add-ons. Closer inspection shows that matters are not quite as straightforward as they might at first appear.

Not all the control lines are available at this port. In particular, the read/write line is absent.

There is a further problem in that the area of the memory map occupied by this port is "read only". If you try writing to any addresses in this block the "Glue" chip generates a bus error!

I am told that there is a way around this problem, but no one has been able to tell me how this is achieved. If any *Everyday Electronics* reader knows the answer to this, perhaps they would let us in on the secret.

SHOP TALK

with David Barrington

More Power

To compliment their range of MOSFET amplifier modules, **BK Electronics** have just launched a 450W r.m.s. version. It features an integral power supply (including a toroidal mains transformer), d.c. loudspeaker protection, two second anti-thump circuitry and a cooling fan.

With a choice of input sensitivities available, it delivers 450W r.m.s. into 4 ohms and 315W into 8 ohms. The standard version has a 500mV input and the Professional Equi p ment Compatible version a 775mV input for full power.

For further information and prices contact **BK Electronics, Dept EE, Unit 1/5, Comet Way, Southend-on-Sea, Essex SS2 6TR.** ☎ *0702 527572.*

Modular Disco Lighting System

There are a couple of items that may cause readers concern when shopping around for parts to build the *Switched Power Output Module*, the first of the *Modular Disco Lighting System* projects. But first, due to mains voltage being present, extreme care must be taken when working on or testing the unit.

The 3A solid-state opto-coupled relay used in the model is a Huntleigh type supplied by **Farnell** *(☎ 0532 636311)*, stock code 103-577. Another suitable "relay" made by FR Electronics is available from **Verospeed** *(☎ 0800 272555)*, code 258-35089D. A 2.5A version, which is the same physical size, is stocked by **Eletromail** *(☎ 0536 204555)* code 348-431.

The 6VA mains transformer was also supplied by Electromail, code 207-756. Other transformers can be used but, before purchasing, check the connecting details to see if it will fit on the p.c.b. The mains neon indicators should be the type that includes a "dropper" resistor.

The Bulgin type sockets are stocked by most of our component advertisers, but the *circular* 10-pin video chassis plug and socket may prove difficult to find. One source is Electromail.

The metal instrument case, including chassis plate, is the Maplin Blue case 233, code XY48C. To some readers, this case may seem fairly expensive and they may adopt an alternative but, for safety, it MUST be a METAL case.

The printed circuit board for the Switched Power Output Module is obtainable from the *EE PCB Service*, code EE739 (see page 340).

BUDGET

PRICES IN THIS ISSUE DO NOT ACCOUNT FOR ANY VAT CHANGES AS A RESULT OF THE BUDGET.

Digital LCD Thermostat

The TCM2W display sensor module (£9.85), which forms the "heart" of the *Digital LCD Thermostat*, is only available from **Magenta Electronics.** The 24V (10A 240V a.c. contacts) relay is also available from the same source.

A complete kit of parts (£29.95) for the combined Thermostat and Power/Relay boards, including punched and printed thermostat front panel, printed circuit boards and parts for the optional alarm, is available from **Magenta Electronics, Dept EE, 135 Hunter Street, Burton-on-Trent, Staffs DE14 2ST** *(☎ 0283 65435)*. Add a further £2 for postage and packing.

The two printed circuit boards are available as a pair or individually from the *EE PCB Service*, codes EE740 and EE741.

Passive IR Repeater

The high gain split-Darlington opto-isolator 6N139 used in the *Passive, IR Repeater* appears in most components catalogues and should not cause any purchasing difficulties.

It is essential to use only the specified capacitor for C1. This is either of metallised polypropylene, polyester or PETP construction specially made for direct connection to the mains supply. These are usually sold as mains interference suppressor capacitors and may be designated X, X2 or Y-class.

No other type may be used. If any readers have difficulty in locating a supplier they are currently listed by **Electrovalue, Cricklewood, Marco, Maplin, Greenweld** and **Omni Electronics.**

It is also most important that a "High Voltage" metal film resistor be used for R3. These should now be widely available and hot cause any problems. The one used in the prototype model was purchased from Maplin, code V47M (HVRes 47M).

The piezoelectric warning device was chosen because of its low current requirement coupled to its high sound output. The one used in the model has an integral drive circuit, a resonant frequency of 3kHz, an impedance of one kilohm and operates from 3V to 24V d.c.

Do not use a buzzer which requires external drive circuitry it would not work in this circuit. A suitable device is the Maplin "High Power Buzzer", code FK84F (HP Buzzer).

Smoke Alarm Repeater

The audible warning device for the *Smoke Alarm Repeater* should be chosen for its loudness; small, cheap buzzers will give disappointing results. Do not use a buzzer which requires external drive circuitry – this would not work in the present circuit. A suitable device is the Maplin "High Power Buzzer", code FK84F (HP Buzzer).

Teach-In '91

The only item, this month, that could cause a purchasing problem for followers of the Teach-In '91 series *Design Your Own Circuits*, is the CMOS timer i.c. used in the *Timer Module*. This i.c. is currently only listed by **Tandy** and can be ordered (code 276-1307) at any of their shops.

All the components required for the *Pulse Generator* back-up project seem to be standard items and should not cause any sourcing nightmares.

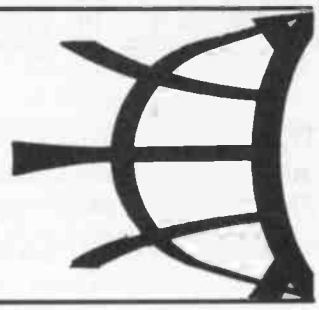
The printed circuit boards for both projects can be obtained from the *EE PCB Service*, codes EE743 and EE742 respectively

Personal Stereo Power Indicator

We do not expect any component buying problems for the *Personal Stereo Power Indicator* project.

The "log scale" (3dB steps) LM3915 display driver i.c. should be available from most good component stores. The 10-segment l.e.d. bargraph display should also be readily available.

REPORTING AMATEUR RADIO



Tony Smith G4FAI

THE YEAR OF THE NOVICE

The Radio Society of Great Britain has designated 1991 "The Year of the Novice" to mark the introduction of the new amateur radio Novice licence. As explained previously, (EE, August 1990), there are two classes of licence with significantly reduced examination requirements permitting amateur operation on limited frequencies, using low power transmitters.

A Novice B licence will permit operation on v.h.f. frequencies above 30MHz, and a Novice A licence, which requires a Morse test of 5w.p.m., allows further frequencies to be used below 30MHz. Before taking the examination, candidates must successfully complete a 30 hour practical training course (each containing no more than four students) organised by the RSGB. I will provide more information about the course next month.

The first examination will be held by the City & Guilds of London Institute on June 3rd. Other dates this year are September 16th, and December 9th. Details of courses available can be obtained from Senior Novice Licence Instructors in each county. Details of these Instructors, a list of C&G examination centres nationwide, and further information about the Novice licence, can be obtained by sending an s.a.e. to RSGB, Lambda House, Cranborne Road, Potters Bar, EN6 3JE.

The frequencies available to Novice operators will permit international communications under favourable circumstances, and represent a fine opportunity to those who think that amateur radio might be an interesting hobby, but are unwilling to study for the full Radio Amateurs' Examination just to find out if it is!

To obtain *all* the operating privileges and frequencies available within the hobby, it will still be necessary to take the full examination at some future date. If you have become "hooked" on amateur radio by that time, however, the exam will represent no real obstacle at all!

NEW RSGB VIDEO

To promote the Novice licence, the RSGB has launched a new two-part video made by Yorkshire Television. Part 1, *Amateur Radio – The Hobby of the Space Age*, portrays the hobby as a pastime that can be enjoyed by anyone, and part 2, *How to Become a Radio Amateur*, provides information on the practical aspects of getting on the air.

The video has been sent to all radio clubs affiliated to the RSGB, and local club Secretaries will be pleased to arrange showings for prospective Novice students of all ages, youth groups, schools, and so on. Details of clubs providing this service are obtainable from RSGB headquarters, address as above.

SUPPORT IN HIGH PLACES

Following the loss of part of the American 220MHz amateur band to commercial interests recently, a bill intended to protect amateur radio frequency allocations has been introduced by Congressman Jim Cooper, who, according to one of his assistants, talking to the *W5YI REPORT*, wants "to make sure ham operators have a strong voice in Congress, because they aren't like the most powerful companies in the world, they don't have large lobbying forces up here in Washington".

The essence of this unprecedented bill is that the Federal Communications Commission (FCC) shall not be permitted to diminish existing allocations of spectrum to the amateur radio service after January 1, 1991, and shall provide equivalent replacement spectrum to the service for any frequency reallocated after the same date. With all the uncertainty over frequency allocations, which are due to be discussed at next year's World Administrative Radio Conference, it would be reassuring to have similar proposed legislation in the UK!

At the time of writing it is not known what progress the bill is likely to make thorough Congress. Although not aimed at any particular industry it is feared that spectrum-related industry interests may object to the principle proposed and lobby against it.

SOVIETS MAINLY HOMBREWERS

In a recent article in *Amateur Radio*, journal of the Wireless Institute of Australia, Yury Zolotov, UA3HR, a prominent Soviet amateur, provided some interesting information on the current state of amateur radio in the USSR.

Apart from the more traditional modes, Soviet amateurs are allowed to experiment with the newer forms of communication such as packet radio and computer based information networks. However, he estimates that 99 percent of all radio amateurs use home-made transmitters or receivers. Some groups use "industrial type" professional equipment, "a poor substitute for amateur sets" while "as for imported transceivers, there are only a few of them in the country".

It is apparently difficult to obtain suitable metal tubing to make antennas, which "explains the wide use of cubical quad aerials, using wooden poles and wires which are easily available.

"Lack of amateur radio equipment hampers activities in schools, although schoolboys of all grades are eager to take up radio as a hobby . . . Even so, the amateur movement is very popular and not confined to amateur communications.

"Nationwide exhibitions of home-made radio devices are held once every two years. Hundreds of exhibits show amateurs' ingenuity in various fields: radio communications, computer technology, science and medicine.

"A large number of exhibits are designed to help with studies at school, college, or university. Usually there are many domestic radio sets, as well as control and measuring instruments. Special juries award the best exhibits diplomas and valuable prizes."

AMSAT WORLD LEADER IN MICROSATS

The Radio Amateur Satellite Corporation (AMSAT) hosted an amateur satellite tutorial and presentation at the Federal Communications Commission (the US radio licensing and regulatory authority) earlier this year. According to the *W5YI REPORT* this was intended to make FCC policymakers aware of the social benefits of amateur use.

During the session it was reported that AMSAT, which claims world leadership in small satellite technologies, applications and education, has placed more spacecraft into orbit using Ariane (the French rocket) than any other organization. Launches cost $50,000 for each *Microsat* and $150,000 for a Phase III satellite. "That's cheap by aerospace standards, but very expensive for the amateur community when they have to come up with the cash."

"The work is done almost exclusively by volunteers. We are able to attract some of the top people in various disciplines to come and work on projects.

Many are radio amateurs, but, in the most recent projects we've undertaken, many of the people who have helped us are not amateurs. They're people from the aerospace community who see what we're doing and think it's worthwhile."

It was also reported that RS-14, a joint Soviet/German satellite, due to become *OSCAR-21* was, at that time, awaiting launch. Later this year, the STS-37 Space Shuttle mission will have an all-ham crew and experiments will include voice and packet communications and slow-and-fast-scan amateur TV. Other nations developing further Microsat satellites include Italy, Australia and Mexico.

In Britain, information about AMSAT can be obtained by sending an s.a.e. to AMSAT UK, 94 Herongate Road, London E12 5EQ. Over 20 books and 30 software programmes are currently available to both members and non-members (10 per cent discount for members). These include *The New Guide to Oscar Operation*, at £3.60, plus postage, and the new *MIR (USSR space station) Technical handbook*, £4.75, plus postage. A full catalogue costs £2, which includes a £3 voucher against a first purchase.

DIRECT BOOK SERVICE

The books listed have been selected as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full ordering details are given on the last book page.

MORE BOOKS NEXT MONTH—MORE BOOKS NEXT MONTH

AUDIO & MUSIC

SYNTHESIZERS FOR MUSICIANS
R. A. Penfold
Modern synthesizers are extremely complex, but they mostly work on principles that are not too difficult to understand. If you want to go beyond using the factory presets or the random poking of buttons, this is the book for you.

It covers the principles of modern synthesis—linear arithmetic as used by Roland, phase distortion (Casio), Yamaha's frequency modulation, and sampling—and then describes how the instruments are adjusted to produce various types of sound—strings, brass, percussion, etc. The theoretical side of synthesis is treated in an easy to understand way—the technical information being restricted to what you need to know to use your instrument effectively.
168 pages **Order code PC105** **£6.95**

AUDIO
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Analysis of the sound wave and an explanation of acoustical quantities prepare the way. These are followed by a study of the mechanism of hearing and examination of the various sounds we hear. A look at room acoustics with a subsequent chapter on microphones and loudspeakers then sets the scene for the main chapter on audio systems—amplifiers, oscillators, disc and magnetic recording and electronic music.
320 pages **Order code BP111** **£3.95**

INTRODUCTION TO DIGITAL AUDIO
Ian Sinclair
Digital recording methods have existed for many years and have become familiar to the professional recording engineer, but the compact disc (CD) was the first device to bring digital audio methods into the home. The next step is the appearance of digital audio tape (DAT) equipment.
All this development has involved methods and circuits that are totally alien to the technician or keen amateur who has previously worked with audio circuits. The principles and practices of digital audio owe little or nothing to the traditional linear circuits of the past, and are much more comprehensible to today's computer engineer than the older generation of audio engineers.
This book is intended to bridge the gap of understanding for the technician and enthusiast. The principles and methods are explained, but the mathematical background and theory is avoided, other than to state the end product
128 pages **Order code PC102** **£5.95**

MAKE MONEY FROM HOME RECORDING
Clive Brooks
Now that you've spent a fortune on all that recording gear, MIDI and all, wouldn't it be nice to get some of it back? Well here's the book to show you how,

It's packed with money making ideas, any one of which will recoup the price of the book many times over. Whether you have a fully fledged recording studio at home, or just a couple of stereo cassette recorders and a microphone, you'll be able to put the ideas in this book into practice and make money.
105 pages **Order code PC104** **£5.95**

TESTING & TEST GEAR

ELECTRONIC TEST EQUIPMENT HANDBOOK
Steve Money
The principles of operation of the various types of test instrument are explained in simple terms with a minimum of mathematical analysis. The book covers analogue and digital meters, bridges, oscilloscopes, signal generators, counters, timers and frequency measurement. The practical uses of the instruments are also examined.

Everything from Audio oscillators, through R, C & L measurements (and a whole lot more) to Waveform Generators and testing Zeners. A truly comprehensive book for the hobbyist, student, technician and engineer.
206 pages **Order code PC109** **£8.95**

HOW TO TEST ALMOST EVERYTHING ELECTRONIC—2nd EDITION
Jack Darr and Delton T. Horn
Describes electronic tests and measurements—how to make them with all kinds of test equipment, and how to interpret the results. New sections in this edition include logic probes, frequency counters, capacitance meters, and more. (An American book.)
190 pages **Order code T2925** **£9.05**

GETTING THE MOST FROM YOUR MULTIMETER
R.A. Penfold
This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.
In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.
96 pages **Order code BP239** **£2.95**

MORE ADVANCED USES OF THE MULTIMETER
R.A. Penfold
This book is primarily intended as a follow-up to BP239, (see above), and should also be of value to anyone who already understands the basics of voltage testing and simple component testing. By using the techniques described in chapter 1 you can test and analyse the performance of a range of components with just a multimeter (plus a very few inexpensive components in some cases). Some useful quick check methods are also covered.

While a multimeter is supremely versatile, it does have its limitations. The simple add-ons described in chapter 2 extend the capabilities of a multimeter to make it even more useful. The add-ons described include an active r.f. probe, a high resistance probe, an a.c. sensitivity booster, and a current tracer unit.
84 pages **Order code BP265** **£2.95**

TEACH-IN THEORY & REFERENCE

EVERYDAY ELECTRONICS DATA BOOK
Mike Tooley BA
(published by EE in association with PC Publishing)
This book is an invaluable source of information of everyday relevance in the world of electronics. It contains not only sections which deal with the essential theory of electronic circuits, but it also deals with a wide range of practical electronic applications.

It is ideal for the hobbyist, student, technician and engineer. The information is presented in the form of a basic electronic recipe book with numerous examples showing how theory can be put into practice using a range of commonly available "industry standard" components and devices.

A must for everyone involved in electronics!
256 pages **Order code DATA** **£8.95**

ELECTRONICS TEACH-IN 88/89—INTRODUCING MICROPROCESSORS
Mike Tooley BA (published by *Everday Electronics*)
A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303). The book contains everything you need to know including full details on registering for assessment, etc.

Sections cover Microcomputer Systems, Microprocessors, Memories, Input/Output, Interfacing and Programming. There are various practical assignments and eight Data Pages covering the most popular microprocessor chips.

An excellent introduction to the subject even for those who do not wish to take the City and Guilds assessment.
80 pages (A4 size) **Order code TI-88/89** **£2.45**

ELECTRONICS TEACH-IN No.4 INTRODUCING DIGITAL ELECTRONICS (published by *Everyday Electronics*)
Michael J. Cockcroft
Although this book is primarily a City & Guilds Introductory level course (726/301), approximately 80% of the information forms a very basic introduction to electronics in general. It therefore provides an excellent introductory text for beginners and a course and reference book for GCSE students.

Full details on registering for C&G assessment, details of assessment centres, components required and information on the course in general are given.

The City & Guilds introduction to module 726/301 reads: "A candidate who satisfactorily completes this module will have a competence to identify basic components and digital integrated circuits and connect them together to form simple working circuits and logic units." This provides an excellent introduction to the book
112 pages (A4 size) **Order code TI4** **£2.95**

ELECTRONICS TEACH-IN No. 3 — EXPLORING ELECTRONICS (published by *Everyday Electronics*)
Owen Bishop
Another EE value for money publication aimed at students of electronics. The course is designed to explain the workings of electronic components and circuits by involving the reader in experimenting with them. The book does not contain masses of theory or formulae but straightforward explanations and circuits to build and experiment with.

Exploring Electronics contains more than 25 useful projects, assumes no previous knowledge of electronics and is split into 28 easily digestible sections.
88 pages (A4 size) **Order code TI3** **£2.45**

THE ILLUSTRATED DICTIONARY OF ELECTRONICS—4th EDITION
Rufus P. Turner and Stan Gibilisco
With more than 27,000 terms used in electronics today, this collection is THE most comprehensive dictionary available. Including all practical electronics and computer terms, it is as up-to-date as the latest advances in the field itself! Tables and data on subjects most often consulted for projects and experiments are included. Other conversion tables include English/metric and metric/English conversions for units of measurement of energy, power and volume, and Fahrenheit/Celsius temperature conversion charts.

Setting this edition apart from other electronic dictionaries is its emphasis on illustration. Featuring more than complete definitions, this fourth edition includes over 450 detailed drawings and diagrams.

All entries are listed in alphabetical order. Abbreviations and initials are listed in sequence with whole words. All terms of more than one word are treated as one word. (An American book.)
648 pages **Temporarily out of print**

ELECTRONICS—A "MADE SIMPLE" BOOK
G. H. Olsen
This book provides excellent background reading for our *Introducing Digital Electronics* series and will be of interest to everyone studying electronics. The subject is simply explained and well illustrated and the book assumes only a very basic knowledge of electricity.
330 pages **Order code NE10** **£4.95**

PRACTICAL ELECTRONICS CALCULATIONS AND FORMULAE
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Bridges the gap between complicated technical theory, and "cut-and-tried" methods which may bring success in design but leave the experimenter unfulfilled. A strong practical bias—tedious and higher mathematics have been avoided where possible and many tables have been included.

The book is divided into six basic sections: Units and Constants, Direct-current Circuits, Passive Components, Alternating-current Circuits, Networks and Theorems, Measurements.
256 pages **Order code BP53** **£3.95**

MICROELECTRONIC SYSTEMS N2 CHECKBOOK
R. Vears
The aim of this book is to provide a foundation in microcomputer hardware, software and interfacing techniques. Each topic is presented in a way that assumes only an elementary knowledge of microelectronic systems and logic functions. The book concentrates on 6502, Z80 and 6800 microprocessors and contains 60 tested programs, 160 worked problems and 250 further problems.
Order code NE04N **£8.95**

TEACH-IN, THEORY & REFERENCE

PRACTICAL DIGITAL ELECTRONICS HANDBOOK
Mike Tooley (Published in association with *Everyday Electronics*)

The vast majority of modern electronic systems rely heavily on the application of digital electronics, and the *Practical Digital Electronics Handbook* aims to provide readers with a practically based introduction to this subject. The book will prove invaluable to anyone involved with the design, manufacture or servicing of digital circuitry, as well as to those wishing to update their knowledge of modern digital devices and techniques. Contents: Introduction to integrated circuits; basic logic gates; monostable and bistable devices; timers; microprocessors; memories; input and output devices; interfaces; microprocessor buses. Appendix 1: Data. Appendix 2: Digital test gear projects; tools and test equipment; regulated bench power supply; logic probe; logic pulser; versatile pulse generator; digital IC tester; current tracer; audio logic tracer; RS-232C breakout box; versatile digital counter/frequency meter. Appendix 3: The oscilloscope. Appendix 4: Suggested reading. Appendix 5: Further study.

208 pages **Order code PC100** **£6.95**

ELECTRONICS-BUILD AND LEARN
R. A. Penfold

The first chapter gives full constructional details of a circuit demonstrator unit that is used in subsequent chapters to introduce common electronic components—resistors, capacitors, transformers, diodes, transistors, thyristors, fets and op amps. Later chapters go on to describe how these components are built up into useful circuits, oscillators, multivibrators, bistables and logic circuits.

At every stage in the book there are practical tests and experiments that you can carry out on the demonstrator unit to investigate the points described and to help you understand the principles involved. You will soon be able to go on to more complex circuits and tackle fault finding logically in other circuits you build.

120 pages **Order Code PC103** **£5.95**

DATA & COMPONENT IDENTIFICATION

INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE
A. Michaels

Helps the reader to find possible substitutes for a popular selection of European, American and Japanese transistors. Also shows material type, polarity, manufacturer and use.

320 pages **Order code BP85** **£3.50**

CHART OF RADIO, ELECTRONIC, SEMICONDUCTOR AND LOGIC SYMBOLS
M. H. Banani, B.Sc.(Eng.)

Illustrates the common, and many of the not-so-common, radio, electronic, semiconductor and logic symbols that are used in books, magazines and instruction manuals, etc., in most countries throughout the world.

Chart **Order Code BP27** **£0.95**

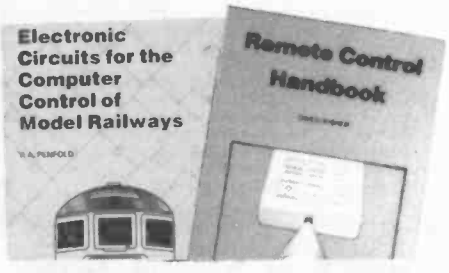
CIRCUITS & DESIGN

ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF MODEL RAILWAYS
R.A. Penfold

Home computers may easily be applied to the control of model railways and really quite sophisticated control, which needs only simple programming, is not too difficult to achieve. The main problem lies in interfacing the computer to the layout, but fortunately it is not too difficult or expensive to build suitable interfaces, and this book shows you how.

The projects consist of various types of controller, including a high quality pulse type, as well as circuits for train position sensing, signal and electric points control etc. The use of computers does not have to be restricted to massive layouts. Something as simple as an oval of track with a single siding can be given a new dimension by adding computer control and much fun can be had from these relatively simple set-ups.

88 pages Order code BP180 **£2.95**



REMOTE CONTROL HANDBOOK
Owen Bishop

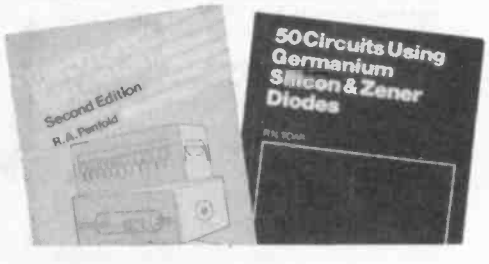
Remote control systems lend themselves to a modular approach. This makes it possible for a wide range of systems, from the simplest to the most complex, to be built up from a number of relatively simple modules. The author has tried to ensure that, as far as possible, the circuit modules in this book are compatible with one another. They can be linked together in many different configurations to produce remote control systems tailored to individual requirements. Whether you wish simply to switch a table lamp on and off, or to operate an industrial robot, this book should provide the circuit you require.

226 pages Order code BP240 **£3.95**

COIL DESIGN AND CONSTRUCTION MANUAL
B. B. Babani

A complete book for the home constructor on "how to make" RF, IF, audio and power coils, chokes and transformers. Practically every possible type is discussed and calculations necessary are given and explained in detail. Although this book is now rather old, with the exception of torroids and pulse transformers little has changed in coil design since it was written.

96 pages **Order Code 160** **£2.50**



30 SOLDERLESS BREADBOARD PROJECTS – BOOK 1
R. A. Penfold.

Each project, which is designed to be built on a "Verobloc" breadboard, is presented in a similar fashion with a brief circuit description, circuit diagram, component layout diagram, components list and notes on construction and use where necessary. Wherever possible, the components used are common to several projects, hence with only a modest number of reasonably inexpensive components, it is possible to build in turn, every project shown. Recommended by BICC-Vero.

160 pages **Order Code BP107** **£2.95**

BOOK 2 – All projects use CMOS I.c.s but the items on component identification etc., are not repeated from Book 1

160 pages Order code BP113 **£2.25**

ELECTRONIC CIRCUITS HANDBOOK
Michael Tooley BA

This book aims to explode two popular misconceptions concerning the design of electronic circuits: that only those with many years of experience should undertake circuit design and that the process relies on an understanding of advanced mathematics. Provided one is not too ambitious, neither of these popularly held beliefs is true.

Specifically, this book aims to provide the reader with a unique collection of practical working circuits together with supporting information so that circuits can be produced in the shortest possible time and without recourse to theoretical texts.

Furthermore, information has been included so that the circuits can readily be modified and extended by readers to meet their own individual needs. Related circuits have been grouped together and cross-referenced within the text (and also in the index) so that readers are aware of which circuits can be readily connected together to form more complex systems. As far as possible, a common range of supply voltages, signal levels and impedances has been adopted.

As a bonus, ten test gear projects have been included. These not only serve to illustrate the techniques described but also provide a range of test equipment which is useful in its own right.

277 pages Order code NE05 **£16.95**

AUDIO IC CIRCUITS MANUAL
R. M. Marston

A vast range of audio and audio-associated i.c.s are readily available for use by amateur and professional design engineers and technicians. This manual is a guide to the most popular and useful of these devices, with over 240 diagrams. It deals with i.c.s such as low frequency linear amplifiers, dual pre-amplifiers, audio power amplifiers, charge coupled device delay lines, bar-graph display drivers, and power supply regulators, and shows how to use these devices in circuits ranging from simple signal conditioners and filters to complex graphic equalizers, stereo amplifier systems, and echo/reverb delay line systems etc.

168 pages Order code NE13 **£12.95**

HOW TO DESIGN ELECTRONIC PROJECTS
R. A. Penfold

The aim of this book is to help the reader to put together projects from standard circuit blocks with a minimum of trial and error, but without resorting to any advanced mathematics. Hints on designing circuit blocks to meet your special requirements are also provided.

128 pages **Order code BP127** **£2.25**

50 CIRCUITS USING GERMANIUM SILICON AND ZENER DIODES
R. N. Soar

Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most simple and inexpensive of components—the diode. Includes the use of germanium and silicon signal diodes, silicon rectifier diodes and Zener diodes, etc.

64 pages **Order Code BP36** **£1.50**

KEY TECHNIQUES FOR CIRCUIT DESIGN
C. G. Loveday C.Eng MIERE

Deals with designing electronic circuits from scratch covering concepts such as target specifications, component selection (passive, discretes and i.c.s), the design cycle, derating and so on. Numerous design examples are given and several reader exercises all with fully worked solutions. The approach is essentially non-mathematical.

128 pages Order code BM1 **£6.95**

DESIGNING WITH LINEAR ICs
G.C. Loveday

A book that deals with the design of the vital area of analog circuitry covering design with modern linear integrated circuit devices. The first chapter introduces the reader to important design techniques, test strategies, layout, and protection and also includes a section on the use of a typical CAD tool. There are separate chapters that cover in depth the use of op-amps, comparators and timers each with detailed design examples and reader exercises. A final chapter brings all the previous work together in a number of complete design problems with fully worked solutions. The text is essentially non-mathematical and is supported by many diagrams.

180 pages Order code BM3 **£8.95**

TIMER/GENERATOR CIRCUITS MANUAL
R. M. Marston NEW

This manual is concerned mainly with waveform generator techniques and circuits. Waveform generators are used somewhere or other in most types of electronic equipment, and thus form one of the most widely used classes of circuit. They may be designed to produce outputs with sine, square, triangle, ramp, pulse, staircase, or a variety of other forms. The generators may produce modulated or unmodulated outputs, and the outputs may be of single or multiple form.

Waveform generator circuits may be built using transistors, op-amps, standard digital ICs, or dedicated waveform or "function" generator ICs.

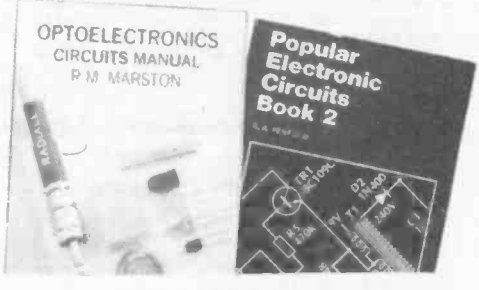
The manual is divided into eleven chapters, and presents over 300 practical circuits, diagrams and tables. The subjects covered include: Basic principles; Sine wave generators; Square wave generators; Pulse generator circuits; "Timer IC" generator circuits; Triangle and sawtooth generators; Multi-waveform generation; Waveform synthesizer ICs; Special waveform generators; Phaselocked loop circuits; Miscellaneous "555" circuits.

267 pages Order Code NE18 **£12.95**

OPTOELECTRONICS CIRCUITS MANUAL
R. M. Marston

A useful single-volume guide to the optoelectronics device user, specifically aimed at the practical design engineer, technician, and the experimenter, as well as the electronics student and amateur. It deals with the subject in an easy-to-read, down-to-earth, and non-mathematical yet comprehensive manner, explaining the basic principles and characteristics of the best known devices, and presenting the reader with many practical applications and over 200 circuits. Most of the i.c.s and other devices used are inexpensive and readily available types, with universally recognised type numbers.

182 pages Order code NE14 **£12.95**



A MICROPROCESSOR PRIMER
E. A. Parr, B.SC., C.Eng., M.I.E.E.

Starts by designing a small computer which, because of its simplicity and logical structure, enables the language to be easily learnt and understood. The shortcomings are then discussed and the reader is shown how these can be overcome by changes and additions to the instruction set. In this way, such ideas as relative addressing, index registers, etc., are developed.

96 pages Order code BP72 **£1.75**

POPULAR ELECTRONIC CIRCUITS –BOOK 1
POPULAR ELECTRONIC CIRCUITS –BOOK 2
R. A. Penfold

Each book provides a wide range of designs for electronic enthusiasts who are capable of producing working projects from just a circuit diagram without the aid of detailed construction information. Any special setting-up procedures are described.

BOOK 1 *160 pages* Order code BP80 **£2.95**
BOOK 2 *160 pages* Order code BP98 **£2.95**

CMOS CIRCUITS MANUAL
R. M. Marston

Written for the professional engineer, student or enthusiast. It describes the basic principles and characteristics of these devices and includes over 200 circuits.

All the circuits have been designed, built and fully evaluated by the author; all use inexpensive and internationally available devices.

187 pages Order Code NE12 **£12.95**

PROJECT CONSTRUCTION

ELECTRONIC PROJECTS BOOK 1

Published by *Everyday Electronics* in association with Magenta Electronics.
Contains twenty of the best projects from previous issues of EE each backed with a kit of components. The projects are: Seashell Sea Synthesiser, EE Treasure Hunter, Mini Strobe, Digital Capacitance Meter, Three Channel Sound to Light, BBC 16K Sideways Ram, Simple Short Wave Radio, Insulation Tester, Stepper Motor interface, Eprom Eraser, 200MHz Digital Frequency Meter, Infra Red Alarm, EE Equaliser Ioniser, Bat Detector, Acoustic Probe, Mainstester and Fuse Finder, Light Rider – (Lapel Badge, Disco Lights, Chaser Light), Musical Doorbell, Function Generator, Tilt Alarm, 10W Audio Amplifier, EE Buccaneer Induction Balance Metal Detector, BBC Midi Interface, Variable Bench Power Supply, Pet Scarer, Audio Signal Generator.
128 pages **Order code EP1** **£2.45**

HOW TO DESIGN AND MAKE YOUR OWN P.C.B.s
R. A. Penfold
Deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.
80 pages **Order code BP121** **£2.50**

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING
R. A. Penfold
We have all built projects only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.
96 pages **Order code BP110** **£2.50**

ELECTRONIC SCIENCE PROJECTS
O. Bishop
These projects range in complexity from a simple colour temperature meter to an infra-red laser. There are novelties such as an electronic clock regulated by a resonating spring, and an oscilloscope with solid-state display. There are scientific measuring instruments such as a pH meter and an electro-cardiometer. All projects have a strong scientific flavour. The way they work, and how to build and use them are fully explained.
144 pages **Order code BP104** **£2.95**

BEGINNER'S GUIDE TO BUILDING ELECTRONIC PROJECTS
R. A. Penfold
Shows the complete beginner how to tackle the practical side of electronics, so that he or she can confidently build the electronic projects that are regularly featured in magazines and books. Also includes examples in the form of simple projects.
112 pages **Order code No. 227** **£1.95**

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ESSENTIAL READING FOR PC HARDWARE ENTHUSIASTS

- Building your own PC XT or AT?
- Upgrading an existing PC?
- Want to know what makes them tick?
- YOU NEED "PC-DIY"

Summary of contents:

The book contains a wealth of information about PC hardware and gives practical advice for PC builders and upgraders. Written in a light-hearted style, it is suitable reading for beginners but includes information for the more experienced too.

There are eight chapters; the first is a brief introduction. The second chapter gives a potted history of the PC range, and details some of the characteristics of each model. Chapter three will be of particular interest to those who are undecided about which type of PC to build. It gives the pros and cons of all the usual combinations of cases, boards and display types.

The fourth chapter is where the real work of assembling the parts is described. It includes many practical tips not published elsewhere. If the beast won't go when you have built it you need to read chapter 5!

If you already have a PC, but it has failed in some way, chapter six may help, whereas chapter seven deals with upgrades, to existing machines. Software is briefly discussed in chapter eight and there are Appendices with useful data. The book has 112 pages and is in paperback format.

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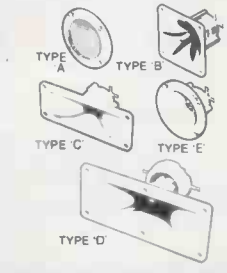
PIEZO ELECTRIC TWEETERS-MOTOROLA

PIEZO ELECTRIC TWEETERS — MOTOROLA

Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized HI-fi speakers. **Price £4.90 each + 50p P&P.**

TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £5.99 each + 50p P&P.**

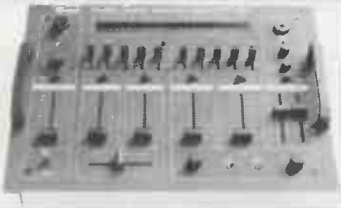
TYPE 'C' (KSN6016A) 2"x5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £6.99 each + 50p P&P.**

TYPE 'D' (KSN1025A) 2"x6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £9.99 each + 50p P&P.**

TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £5.99 each + 50p P&P.**

LEVEL CONTROL Combines on a recessed mounting plate, level control and cabinet input jack socket. 85x85mm. **Price £3.99 + 50p P&P.**

STEREO DISCO MIXER

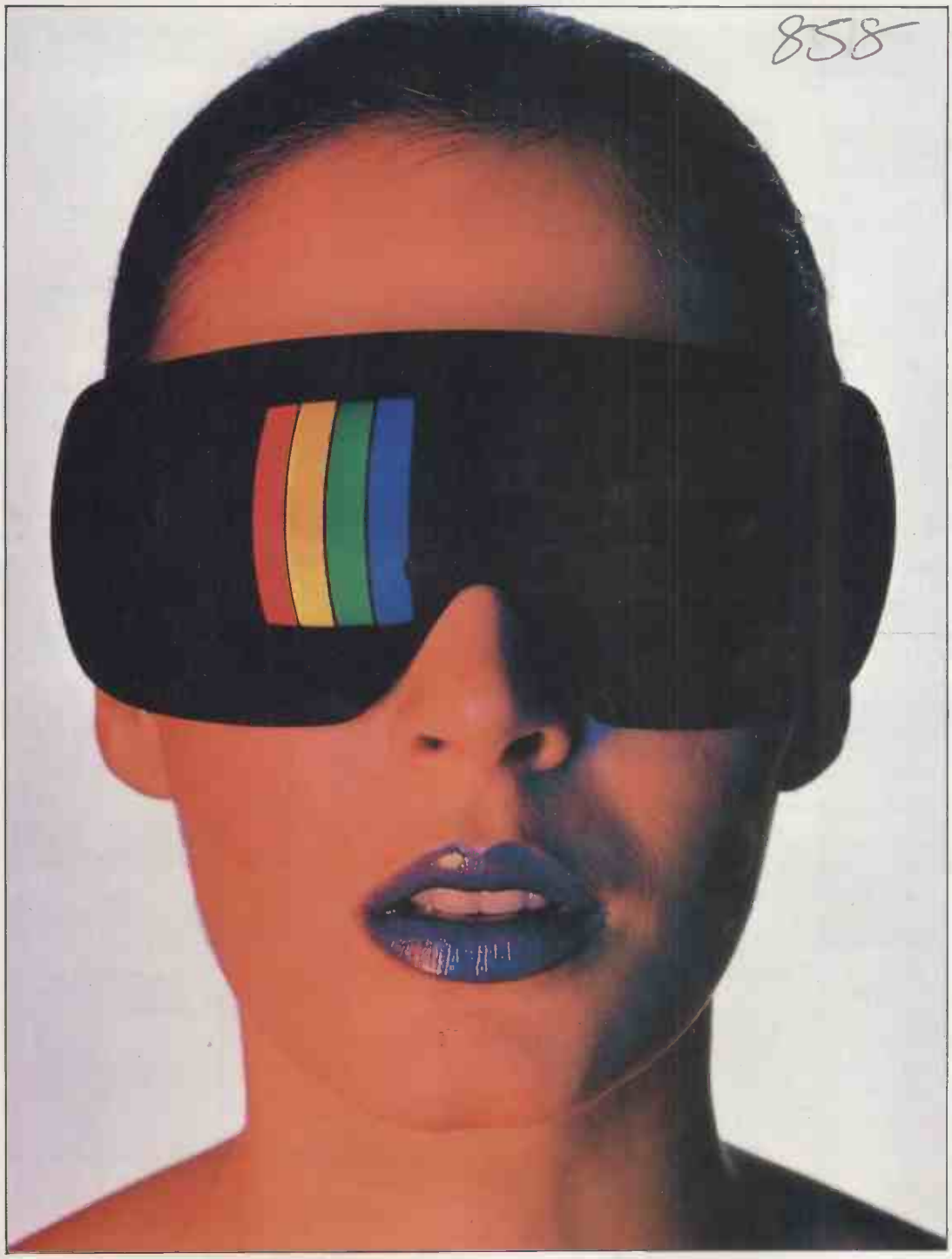


STEREO DISCO MIXER with 2 x 5 band L & R graphic equalisers and twin 10 segment L.E.D. Vu Meters. Many outstanding features 5 Inputs with individual faders providing a useful combination of the following:—
3 Turntables (Mag). 3 Mics. 4 Line including CD plus Mic with talk over switch Headphone Monitor. Pan Pot L. & R. Master Output controls. Output 775mV. Size 360x280x90mm. Supply 220-240v.
Price £134.99 — £4.00 P&P

POSTAL CHARGES PER ORDER £1.00 *MINIMUM*. OFFICIAL ORDERS WELCOME FROM SCHOOLS, COLLEGES, GOVT. BODIES, ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER. VISA ACCESS ACCEPTED BY POST, PHONE OR FAX

B. K. ELECTRONICS Dept EE

UNIT 5, COMET WAY, SOUTHEND-ON-SEA, ESSEX. SS2 6TR
TEL: 0702-527572 FAX: 0702-420243



NICAM

...set your sights on a better sound!

Experience a new sensation. An experience that opens up a whole new spectrum of sound.

Put yourself on stage at the Albert Hall, surrounded by a great orchestra. Imagine the sound you will hear, every nuance, every note; or travel up the Nile with an intrepid explorer, a journey not only full of breathtaking beauty and colour, but rich in the sounds of another continent; or capture the hidden gasps of 100,000 hardened fans at Wembly for the F.A. Cup Final, when the ball skims the crossbar with the last kick of the match; follow with your ears as well as your eyes, dodging the bullets, as your favourite hero battles out of yet another tight corner, it's just like being in a cinema!

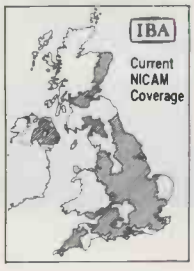
Nicam hi-fi stereo will turn your living-room into a living room of sound! You don't settle for second best with television picture quality, why settle for second best in television sound quality? Nicam sound is the new high quality digital stereo sound system, pioneered by BBC, ITV and TV/video manufacturers. In fact so good is Nicam it is comparable to the superb sound reproduction of the compact disc, when played through your existing hi-fi arrangement. If your television hasn't got a built-in Nicam decoder, you will need the Maplin Nicam Tuner System. Ultimately almost all of your favourite programmes will be broadcast in superb hi-fi quality stereo-sound. Without a Maplin Nicam Tuner you won't be able to capture every sound to its full.

Nicam hi-fi stereo. Catch your breath, open your eyes, and pin back your ears! It's what your hi-fi system was made for . . . It's what your ears are made for!

DIGITAL STEREO TV SOUND FROM YOUR HI-FI

The complete kit contains all the components required to build the unit. However you will also need: a power supply, 12V at 600mA regulated e.g. **YZ21X** at £8.95; a co-ax Y adaptor e.g. **FS23A** at £1.20; a co-ax lead to connect to your TV or video; RW36P 2m long at £1.28, JW39N 5m long at £1.98, or JW40T 10m long at £2.95; a phono lead to connect to your hi-fi e.g. RW50E at 98p or a SCART/Peritel lead JW36P at £4.95. An infra-red remote control kit is also available LP20W at £29.95.

Complete kit LP19V only £139.95 incl. VAT + £1 mail-order handling charge.



Maplin ELECTRONICS

CREDIT CARD HOTLINE

0702 554161

For a friendly welcome and the very best of service why not visit our shops in Birmingham, Brighton, Bristol, Leeds, London (Edgware and Hammersmith), Manchester, Newcastle-upon-Tyne, Nottingham, Reading, Southampton and Southend-on-Sea.

Subject to availability. Prices subject to change.

Digital stereo sound companion for your TV set.