EVERYDAY
ELECTRONICS
JULY 1991
INCORPORATING ELECTRONICS MONTHLY
£1.50

ULTRASONIC PROXIMITY METER

12V NICAD CHARGER

SIMPLE MODEL SERIES

PROJECT 1 – POLICE CAR

FLASH!

WHIRR!!!

BLEEP!!

07
9 770262 361003

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 override 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

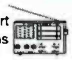
VIDEO SENDER UNIT Transmit both audio and video signals from either a video camera, video recorder or computer to any standard TV set within a 100' range! (tune TV to a spare channel). 12v DC op. £15.00 ref 15P39 Suitable mains adaptor £5.00 ref 5P191

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 **NOW ONLY £19.00!! REF 19P14.**



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

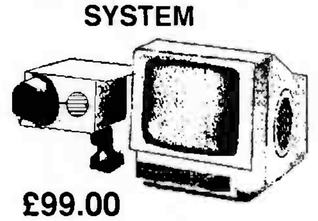
7 CHANNEL GRAPHIC EQUALIZER plus a 60 watt power amp! 20-21KHZ 4-8R 12-14v DC negative earth. Cased. £25 ref 25P14.

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



£99.00

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 builtin 2 way intercom. £99.00 ref 99P2.

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.

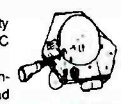
MOSFETS FOR POWER AMPLIFIERS ETC. 100 watt mosfet pair 2SJ99 and 2SK343 £4.00 a pair with pin out info ref 4P51. Also avaliable is a 2SK413 and a 2SJ118 at £4.00 ref 4P42.

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.

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 models 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.

GAS POWERED SOLDERING IRON AND BLOW TORCH Top quality tool with interchangeable heads and metal body. Fully adjustable, runs on lighter gas £10.00 ref 10P130

SMOKE ALARMS Ionization type 5 year warranty complete with battery only £5.00 ref 5P206

ANSWER MACHINES BT approved remote message playback, intergral push button phone, power supply and tape. Exceptional value at £45.00 ref 45P2

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

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 £6.00 ref 6P59

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 Snail 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.

BARGAIN NICADS AAA SIZE 200MAH 1.2V PACK OF 10 £4.00 REF 4P92, PACK OF 100 £30.00 REF 30P16

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.

BULL ELECTRICAL

250 PORTLAND ROAD HOVE SUSSEX BN3 5QT TELEPHONE 0273 203500

MAIL ORDER TERMS: CASH PO OR CHEQUE WITH ORDER PLUS £2.50 POST PLUS VAT.

PLEASE ALLOW 10-14 DAYS FOR DELIVERY

VISA

FAX 0273 23077

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.

TRANSMITTER RECEIVER SYSTEM originally made for nurse call systems they consist of a pendant style transmitter and a receiver with telescopic aerial 12v. 80 different channels. £12.00 ref 12P26

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.

SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

VOL. 20 No. 7 JULY 1991

EVERYDAY ELECTRONICS

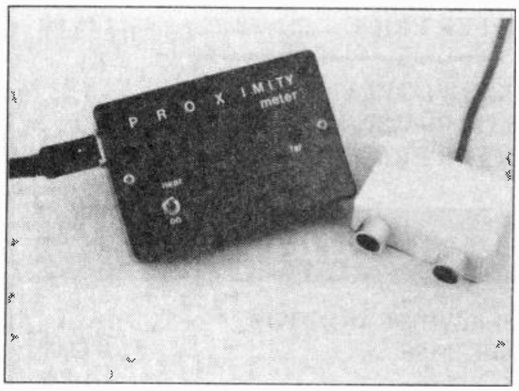
INCORPORATING ELECTRONICS MONTHLY

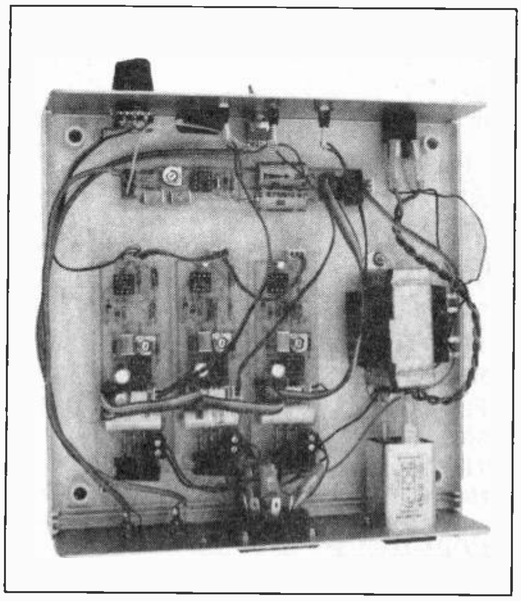
ABC

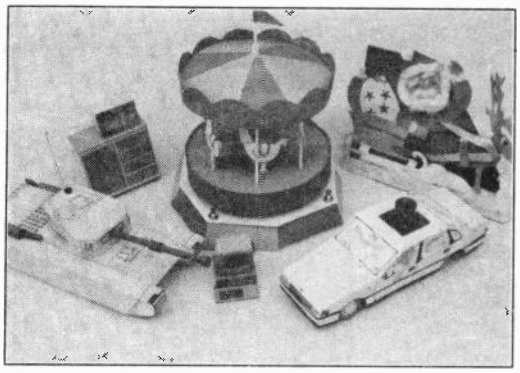
The No 1 Magazine for Electronic & Computer Projects

ISSN 0262 3617

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







Projects

Series

Features

Our August '91 issue will be published on Friday, 5 July 1991. See page 411 for details.

JUST A SMALL SELECTION FROM OUR RANGE OF OVER 120 KITS

KIT No:	DESCRIPTION:	PRICE £(EA)
1001	0.2 WATT FM TRANSMITTER	4.25
1006	800 WATT MUSIC TO LIGHT	5.10
1009	1 WATT FM TRANSMITTER	5.53
1013	AM-FM-VHF RECEIVER	13.62
1014	3X700 WATT WIRELESS MUSIC-TO-LIGHT	11.06
1018	GUITAR TREMELO	7.24
1022	METAL DETECTOR	4.25
1026	RUNNING LIGHTS	8.51
1028	4 WATT FM TRANSMITTER	14.46
1034	CAR BATTERY CHECKER	2.98
1036	TRANSISTOR TESTER	3.83
1037	DISCO STROBO LIGHT	11.49
1038	AM-FM AERIAL AMPLIFIER	2.98
1049	ULTRASONIC RADAR	15.31
1055	FM RECEIVER USING TDA7000	12.76
1059	TELEPHONE AMPLIFIER	8.51
1065	INVERTOR 12V D.C. TO 12V A.C	21.27
1069	12V D.C. FLOURESCENT TUBE UNIT	5.53
1073	V O X	6.38
1075	ELECTRONIC DICE WITH L.E.D.'S	6.80
1111	LOGIC PROBE	3.83
1114	ELECTRONIC LOCK	7.66
1119	TELEPHONE LINE RECORDING	4.25
1125	TELEPHONE LOCK	6.80
1129	NEGATIVE ION GENERATOR	14.46
1130	TELEPHONE "BUG" DETECTOR	3.41
1203	MINI FM TRANSMITTER WITH MIC (SUPPLIED READY ASSEMBLED)	4.25

All kits contain a Silk Screened high quality P.C.B. components, solder, wire and FULL instruction sheet.

SPECIAL OFFER
60 MEG TAPE STREAMER
DC600 - 5.25" TRAY
SUITABLE FOR ALL IBM COMPATIBLES
PRICE: £188.00

FLOPPY DISC DRIVES

3.5"	1.44M	INTERNAL	£48.00
3.5"	720K	INTERNAL	£40.00
5.25"	1.2M	INTERNAL	£48.00
5.25"	1.2M	EXTERNAL	£51.00
5.25"	360K	EXTERNAL	£27.00

ACCESSORIES

5.25" ADAPTOR KIT FOR 3.5" F D D	£8.00
5.25" TRAY FOR 3.5" F D D	£5.50
POWER LEAD FOR 3.5" F D D	£3.50
IDC PIN TO EDGE CONNECTOR PCB	£4.50
CONTROLLER CABLE FOR F D D	£4.00
POWER SPLITTER	£4.50
HARD DRIVE CABLES	£6.00
MICRO 'T' SWITCH - RS232	£7.45

END OF LINES

MODEMS - V22 BIS - 2400 BPS
AUTO DIAL - AUTO ANSWER - FULL DUPLEX
AUTO REDIAL - TONE & PULSE DIALLING
BT APPROVAL - BABT APPROVAL
SUPPLIED WITH EAZILINK COMMS PACKAGE
MC2400 - INTERNAL £55.00
PC2400 - EXTERNAL £85.00

3.5" - 720K EXT FLOPPY DISC DRIVE
NEW - GREY CASE - BY WELL KNOWN OEM
SPECIAL OFFER PRICE £26.00

5.25" - 360K INT FLOPPY DISC DRIVE
NEW - GREY OR BLACK - WELL KNOWN OEM
SPECIAL OFFER PRICE £24.00

JUST ARRIVED

12" VGA PAPER WHITE MONITOR
TILT & SWIVEL BASE £115.00
WITH 8 BIT VGA CARD £160.00

GRAPHICS CARDS
OAK 8 BIT VGA £56.00
CGA - F/L CARD -
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286-16 L/S 21MHz £116.00

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256K x 9 80mS £14.00
1 MEG x 9 80mS £42.00

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£2.75

NEXT MONTH

FREE 16 PAGE GREENWELD SUMMER SALE CATALOGUE SUPPLEMENT

Once again we are pleased to give away a catalogue supplement full of bargain offers of special interest to Everyday Electronics readers.

PEDOMETER

A pedometer measures the number of paces walked, giving a rough idea of the actual distance. Since this figure can only ever be approximate, this low cost project should give quite acceptable results.

The unit clips onto the side of the walker's shoe with l.e.d.s showing the number of paces in 500s. This gives a maximum reading of 15,500 paces – around 13 miles.

PORTABLE PET SCARER

A hand held, improved output version of the very popular *Pet Scarer* design we published back in May '89.

OPTICAL COMMUNICATIONS LINK

Another outstanding design that ties up with our Teach-In '91 series *Design Your Own Circuits*. This fascinating use of opto-electronics will provide many hours of experiment.

EVERYDAY ELECTRONICS

AUGUST ISSUE ON SALE FRIDAY JULY 5, 1991

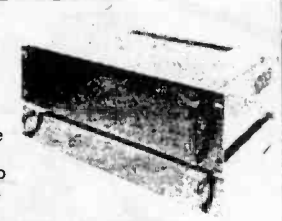
CRICKLEWOOD ELECTRONICS

NOTHING STOPS FOR CRICKLEWOOD

- ONE OF THE LARGEST RANGES OF COMPONENTS IN THE UK
- FAST AND EFFICIENT SAME DAY PERSONAL SERVICE
- VERY COMPETITIVE PRICES, QUANTITY DISCOUNTS AVAILABLE
- NO MINIMUM ORDER

Over 13,000 different components from all over the world

19" RACK CASES



★ Suitable for instruments, high quality amplifiers and many other applications that demand strength and professional finish ★ New improved construction and finish ★ Black anodised aluminium front panels ★ Separate front mounting plate, no fixing screws visible of the front and the side of the enclosure ★ Heavy gauge front panel is of brushed aluminium finish enhanced with two professional handles ★ With ventilation slits and plastic feet ★ Rear box manufactured from 1.1mm steel finished in black. Rack mounting or free standing. Comes in quick assembly flat package.

Order Code	Panel Size WH (inch)	Rear Box W H D	Weight	Price £
U112	19 x 1.75	17 x 1.5 x 12	2.5kg	24.95
U212	19 x 3.5	17 x 3.0 x 12	3.3kg	29.75
U312	19 x 5.25	17 x 5.0 x 12	4.0kg	31.95
U412	19 x 7.0	17 x 6.5 x 12	4.6kg	34.95

Please add £3.00 P&P for the first item and £1.50 for each additional item
Please add VAT to above prices — Overseas orders welcome

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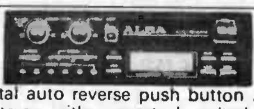

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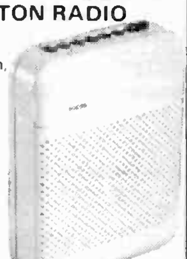

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Transmitters listed on this page are not licensable in the UK.

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120dB PIEZO SIREN (optional for Micro-pressure & Volt Drop Alarms) £13.35

MICRO-PRESSURE TRIGGER

This module adds MICRO-PRESSURE sensing to any volt drop operated alarm simply by connecting two wires across the vehicle's 12v supply. Use it to upgrade an existing alarm or combine the benefits of both systems.

MICRO-PRESSURE TRIGGER DIY parts kit £10.95 Assembled £14.95

VOLT DROP CAR ALARM DIY parts kit £14.90 Assembled £20.95

TOTAL ENERGY DISCHARGE IGNITION

Our unbeatable Extended C.D.I. system retains the contacts for easy fitting. The contacts operate at low current whilst the 12v supply is converted to 370v for a super power spark with improved starting, performance and economy. Includes contact bounce filter, voltage regulator (full output at only 6 volts), timing L.E.D. and standard/electronic change over switch.

TOTAL ENERGY DISCHARGE IGNITION DIY parts kit £22.75 Assembled £28.45

All the above include cable, connectors and clear, easy to follow instructions. All kits include case, PCB, everything down to the last washer, even solder.

All prices now include post, packing and VAT on U.K. orders. Same prices apply to all European countries. For delivery outside Europe please add £3.

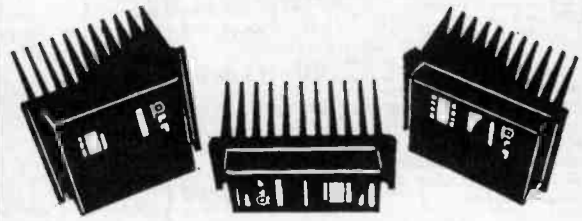
Telephone orders accepted with VISA or ACCESS payment. Order direct (please quote ref. E17) or send for more details from :-

ELECTRONIZE DESIGN **Tel. 021 308 5877**

2 Hillside Road, Four Oaks, Sutton Coldfield, B74 4DQ

ILP AMPLIFIERS FROM JAYTEE

The UK Distributor for the complete ILP Audio Range



BIPOLAR AND MOSFET MODULES

The unique range of encapsulated amplifier modules with integral heatsink.

HY30	15W Bipolar amp	£12.62	HY248	120W Bipolar amp (8 ohm)	£27.38
HY60	30W Bipolar amp	£12.62	HY364	180W Bipolar amp (4 ohm)	£42.86
HY6060	30W Stereo Bipolar amp	£26.46	HY368	180W Bipolar amp (8 ohm)	£42.86
HY124	60W Bipolar amp (4 ohm)	£20.69	MOS128	60W Mosfet amp	£44.04
HY128	60W Bipolar amp (8 ohm)	£20.69	MOS248	120W Mosfet amp	£50.68
HY244	120W Bipolar amp (4 ohm)	£27.38	MOS364	180W Mosfet amp	£81.69

PLATE AMPLIFIERS

Bipolar and Mosfet modules with the same electronics as above amplifiers housed in a different extrusion without heatsink.

HY6060P	30W Stereo Bipolar amp	£21.76	HY364P	180W Bipolar amp (4 ohm)	£28.35
HY124P	60W Bipolar amp (4 ohm)	£16.14	HY368P	180W Bipolar amp (8 ohm)	£28.35
HY128P	60W Bipolar amp (8 ohm)	£16.14	MOS128P	60W Mosfet amp	£39.69
HY244P	120W Bipolar amp (4 ohm)	£21.91	MOS248P	120W Mosfet amp	£43.37
HY248P	120W Bipolar amp (8 ohm)	£21.91	MOS364P	180W Mosfet amp	£72.44

Note: These modules require additional heatsinks

POWER SUPPLIES

Comprising toroidal transformer and DC board to power the ILP amplifier modules.

PSU30 Pre-amplifier	£11.80	PSU542 HY248	£29.94
PSU212 1 or 2 HY30	£21.04	PSU552 MOS248	£32.29
PSU412 HY6060, HY124, 1 or 2 HY60	£23.65	PSU712 HY244(2)	£34.38
PSU422 HY128	£25.90	PSU722 HY248(2)	£35.51
PSU432 MOS128	£27.13	PSU732 HY364	£35.51
PSU512 HY244, HY128(2)	£28.81	PSU742 HY368	£37.80
PSU522 HY124(2)	£28.81	PSU752 MOS364, MOS248(2)	£37.80
PSU532 MOS128(2)	£29.94		

PRE-AMPLIFIER MODULES

These encapsulated modules are now supplied with 0.1" pin connectors for direct mounting into pcb/veroboard

HY6-1	Mono pre-amplifier	£10.01
HY66-1	Stereo pre-amplifier	£16.91
HY83-1	Guitar pre-amplifier with overdrive and reverb	£19.67

POWER SLAVES

These cased amplifiers are supplied assembled and tested in 60 and 120 watt Bipolar or Mosfet versions.

US12	60 watt Bipolar (4 ohm)	£83.73	US32 60 watt Mosfet	£114.39
US22	120 watt Bipolar (4 ohm)	£92.93	US42 120 watt Mosfet	£125.62

Prices include VAT at the new rate of 17.5% and carriage

VISA Access

Quantity prices available on request

Write or phone for free Data Pack

Jaytee Electronic Services

143 Reculver Road, Beltinge, Herne Bay, Kent CT6 6PL

Telephone: (0227) 375254 Fax: 0227 365104

PACKS PACKS

LOTS MORE IN OUR CATALOGUE!

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

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

K805 M2 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

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

K708 Voltage Regulators. This is an excellent pack, made up from a huge variety of the +ve, -ve, fixed and variable regulators from 1.2V to 37V, 100mA to 5A, plastic and metal.
Price .... 20 for £6.95

K709 Bridge Rectifiers. Another superb value pack - could include anything from ½ amp to 35A, 25V to 1000V, plastic and metal.
Price .... 20 for £5.95

K710 SCR's & TRIACS. Big mixture could include all types from TO92 plastic up to DO5 stud mounting with a chance of everything in between! 25V to 1000V, 100mA to tens of amps. Marvellous value.
Price .... 25 for £4.95

K711 74 Logic Pack. All brand new full spec devices from basic gates to complex logic. May include 54 & 64 types as well as 74 in L, LS, S, ALS, H, HC, HCT, etc.
Price per pack of 100 .... £6.00

K712 Crystals. Mostly HC60 and HC18U in a wide variety of frequencies from a few hundred kilohertz to many megahertz and the odd crystal oscillator module or two.
Price .... 20 for £4.95

K713 Fuseholders. Panel and chassis mounting from a basic clip to high current enclosed types for 15, 20 and 32mm fuses.
Price for pack of 50 .... £4.00

K714 Power Supply Capacitors. All cans, mostly computer grade including popular values like 10,000µ 40V etc. Big mix of values and voltages up to 100V or more and 50,000µF.
Price for box of 25 .... £12.50

K536 Bonanza Pack of 74 series chips on panels. 200+ chips, may inlude L, LS, H, HC, HCT etc. (These are actually the Z8900 computer panels with all the memory missing.)
Price £7.00

GLUE GUNS

87-0400 Hot melt glue gun. Electronically controlled heating element which melts the long stick of glue when inserted. Trigger feed. Mains operated. Normally sells for £8.60.
Our price £4.95
Glue sticks - pack of 10 .... £1.00

Multiturn Trimpots from 14p - details in B/L 68.

Grey ribbon cable 100ft reels.
Z30176 14 way £6.00
Z30197 16 way £8.00

Bulk LED's from 2p - See B/L 68.

NEW THIS MONTH

SIMPLE MODEL SERIES

As featured in this magazine. See Page 438 for details of special offer !!
All kits available separately.
Easiwire £15.00 **Police Car £5.95**

ASCII KEYBOARD

5V supply, switch on board changes output to emulate AT or XT keyboards. 94 keys, but 18 do not have caps. 20 keys have removeable tops. Size 350 × 145mm.
Order Code Z8922
Price £12.00

NEW SMPSU

Z8921 'Apricot' PSU. Beautiful unit 160 × 110 × 55mm with switched IEC mains inlet. Made by Astec, BM43024. 120/240V input. Outputs +5V @ 2.5; +12V @ 2A.
Price £12.95

LCD DISPLAY

Z2123 8 digit 10mm high. No edge connector, so
ONLY .... £1 100+ 0.50

MODEL RAILWAY PSU

Z8897 Panel 185 × 105mm with mains I/P & 2 × 5V 1A outputs + fully variable 0-12V 1.5A output (needs 3 components (supplied) to be fitted). 5 × 12V relays with 10A c/o contacts controlled by transistor circuits. Screw terminals on I/P and O/P. Supplied with circuit and wiring diagram.
Price £19.95

1991 CATALOGUE + SPRING SUPPLEMENT

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

The 1991 Greenweld Catalogue is out NOW!

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- ★ Quantity pricing for bulk buyers
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- ★ 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.

Stepper Motors

Superb little 12V motor by Airpax. 35mm dia × 21mm deep with a 16 tooth 9.5mm dia gear wheel mounted on the 2mm dia spindle. Fixing centres 42mm. 7½°, 48 step. 100+ price is £9.04.
Order Code Z5045
Prices .... £4.00 100+ 2.50

Mercury Switches

Metal enclosed, in case 7.5mm dia × 9mm long. 10mm flange one end.
Order Code Z2118
Prices .... 2 for £1.00
100+ 0.25; 1k+ 0.18

4 Digit Displays

LCD 4 digit 12.5mm high with low batt and clock symbol. Complete with edge connector. Can you believe the price?!
Order Code Z2119
Prices .... £1.00 each
25+ 0.60; 100+ 0.45; 1k+ 0.35

Driver Chips

For above display. Type ICM 7211 AMIPL, this is a 4 digit LCD decoder driver (µP interface). List £3.69.
Order Code Z2120
Prices £2.00
100+ 1.50; 1k+ 1.20

Motor Panels

PCB 92 × 31mm with mercury tilt switch, 2 VTL 10D2 opto slotted switches, length of 11 core cable with socket and stepper motor as described above.
Z5046
Prices .... £3.50 100+ 2.20

Controller Boards

PCB 175 × 122mm containing a wealth of components - 80C39 CPU, 4 × TL066, TL094, CMOS and 74 series chips, 8 × TO126 transistors, 13 TO92 transistors and lots of R's and C's etc - also a 3V lithium battery. 3 connectors on it go to (a) card reader (b) motor panel & (c) display panel which is identical to our Z027 (P111 of Catalogue).
Order Code Z5047
Prices .... £3.50 100+ 1.75

Opto Slotted Switch

Vactel Type VTL 10DI - IR emitter and detector can be removed from the plastic housing if required. An extremely cheap version of TIL100/TIL38!
Order Code Z2122
Prices .... Pack of 5 £1.00
100+ 0.10; 1k+ 0.07

CAMERA BONANZA!

Job lot of returns - famous manufacturer. All are complete and look OK, only minor faults.

Z5028 110mm Manual models include 110LF and 110TF, many have built in flash.
Prices .... £3.50 ea 5 for £14.00

Z5029 110mm Motor driven. Models include 110IF. **Prices** ... £4.00 ea 5 for £16.00

Z5030 35mm Manual. Models include 35HL, 806, 35CT, DL10, DL7. Most have built in flash. **Prices** .... £4.50 ea 5 for £18.00

Z5031 35mm Motor driven. Models include DL15, 35EM, 35EFM, 35ESM, most with built in flash. **Prices** .... £5.50 ea 5 for £22.00

Z5032 Broken cameras. These have parts missing. A parcel of 6 assorted, all 35mm including manual, motor driven, autofocus, twin lens types. **Price** £15.00

Also some brand new cameras and lenses - SAE for details.

GREENWELD
ELECTRONIC COMPONENTS

To avoid confusion over different VAT rates, all our 1 off prices will include VAT @ 15% until further notice. Add 2.17% to total. Quantity prices do not include VAT. P&P £2.00 per order. Min Credit Card £5. No CWO min. Official orders from Education welcome; min invoice charge £10.00. Payment is accepted by cheque, postal order, cash, including foreign currency bank notes, book tokens, Access, Visa, Connect. Our stores have enormous stocks of components and our trade counter is open from 9-5.30 from Mon-Sat. Come and see us!

Tel: (0703) 236363
Fax: (0703) 236307

27D PARK ROAD, SOUTHAMPTON, SO1 3TB

SWITCH MODE PSU's

Totally enclosed Astec Unit 175 × 136 × 65mm with switched and fused IEC inlet.
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

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 requre 50V I/P for 5V 19.5A O/P.
Prices .... £7.95; 25+ 5.20; 100+ 3.89

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

NI-CAD BATTERIES

Regular stocks: AAA £1.20; AA 99p; C £2.20; D £2.30; PP3 £3.95

Z4150 Ex mobile radio battery. 58 × 63 × 33mm case (sometimes damaged) contains 8 × AA size rechargeable Nicads. These can be removed by breaking the case open. Each cell rated 1.2V 600mA.
Price £3.00

Z4149 As above but 84 × 66 × 33mm. There are again 8 cells but they are longer than AA size, being 73mm long. Each cell rated 1.2V 900mA.
Price £4.50

AAA Nicads by Sanyo

SUPERDEAL PRICE!! These superb quality batteries are rated 1.2V 200mAh, and may be charged at 20mA or quick-charged at 60mA. Normally costing around £1.50 each, we can offer these at the SUPERDEAL prices below:
Z2117 AAA Nicad £1.00
25+ 0.75 100+ 0.60

Sealed Lead Acid Batteries

YUASA NP6-12. 12V 6Ah sealed lead acid battery. These have been regularly trickle charged whilst in store. Size 150 × 95 × 65mm. List price £28.00
Order Code Z8918
Prices .... £14.95 10+ 11.20

YUASA NP10-6. 6V 10Ah, size 150 × 95 × 50mm. List £18.00.
Order Code Z8920
Prices .... £10.00 10+ 6.00

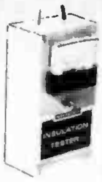
½Meg Memory Board

Z8900 Massive panel 460 × 400mm smothered in chips. Could be a complete computer judging by the IC's on the board. Made by Whitechapel Computer Works. Contains at least the following (some panels have extra chips): 64 × 4164-15 RAM's; over 200 74LS, F and other logic chips; 3 × 4016-3, 2 × 8253-5, 8251, 2 × 5516, 6 xtals, 3 × 'D' plugs and sockets. 3 × DIN 64 way socket, + R's, C's etc. Price equivalent to 4164's @ 30p each and rest of chips @ 3p each!
Price £25.00

Z4397 R5232 data cable - 25 'D' plug to 25'D' socket 6 feet long. All pins connected. These are identical to our Cat. No. P2875 @ £4.95 except for some very minor corrosion on socket casing.
Half price .... Just £2.50

Z5048 Panel 275 × 178mm containing some excellent components: 2 × D8243 I/O expander, 8035 CPU, 8253 timer, 2651 USART all in sockets, 2 × 2111A-4 RAM, 25 mostly CMOS chips, 8 × TO126 transistors, 5 × TO92 transistors, R's, C's etc; 26W IDC plug, 2 × 34W IDC plugs, 2 xtals.
Only £3.00

INSULATION TESTER



EE APRIL 85

A reliable electronic tester which checks insulation resistance of wiring appliances etc., at 500 volts. The unit is battery powered simple and safe to operate. Leakage resistance of up to 100 Megohms can be read easily. One of our own designs and extremely popular.

KIT REF 444 **£22.37**

PET SCARER

EE MAY 89

Produces high power ultrasound pulses. L.E.D. flashes to indicate power output and level. Battery powered (9V–12V or via Mains Adaptor).

KIT REF 812 **£14.81**

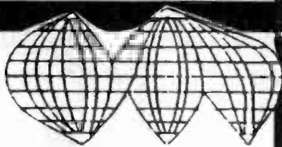
Mains Adaptor £2.02

DIGITAL CAPACITANCE METER

EE DEC 85

Simple and accurate (1%) measurement of capacitors from a few pF up to 1,000 μF. Clear 5-digit LED display indicates exact value. Three ranges – pF, nF, and μF. Just connect the capacitor, press the button and read the value.

KIT REF 493 **£49.95**



3 BAND SHORT WAVE RADIO

EE AUG 87

Covers 1.6–30 MHz in 3 bands using modern miniature coils. Audio output is via a built-in loudspeaker. Advanced design gives excellent stability, sensitivity and selectivity. Simple to build.

KIT REF 718 **£30.30**

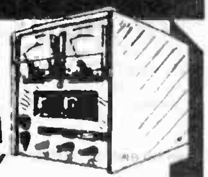
DIGITAL COMBINATION LOCK

EE MAR '91

Digital combination lock with a 12 key keypad. 4 digit code operates 250V-16A SPCO relay. A special anti-tamper circuit allows the relay to be mounted remotely from the keypad without any loss of security. Can be operated in many modes (latching/unlatching, manual/automatic setting, continuous/momentary output, etc.). Article describes operation as Vehicle Immobilising security system. Low current drain. *Kit includes drilled case.*

KIT REF 840 **£19.86**

MOSFET VARIABLE BENCH 25V 2.5A POWER SUPPLY



EE FEB 88

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.

KIT REF 769 **£56.82**

DIGITAL FREQUENCY 200 MHz METER

EE NOV 86

An 8 digit meter reading from AF up to 200 MHz in two ranges. Large 0.5" Red LED display. Ideal for AF and RF measurements. Amateur and C.B. frequencies.

KIT REF 563 **£71.47**

ACOUSTIC PROBE

EE NOV '87

A very popular project which picks up vibrations by means of a contact probe and passes them on to a pair of headphones or an amplifier. Sounds from engines, watches and speech travelling through walls can be amplified and heard clearly. Useful for mechanics, instrument engineers and nosey parkers!

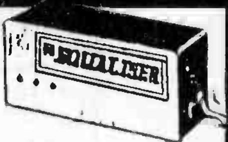
KIT REF 740 **£20.01**

4 CHANNEL LIGHT CHASER

EE Jan '90

A 1000W per channel chaser with zero volt switching, hard drive, inductive load capability, mic sound sensor and sophisticated 'beat' detector. Chase steps to music or auto when quiet. Variable speed and mic. sens. LED mimic on front panel. Switchable for 3 or 4 channels. P552 output. Ideal for rope lights, pin spots, disco and display lighting.

KIT REF 833 **£32.13**



EE EQUALISER

EE MAY '87

A mains powered Ioniser with an output of negative ions that give a refreshing feeling to the surrounding atmosphere. Negligible current consumption and all-insulated construction ensure that the unit is safe and economical in use. Easy to build on a simple PCB.

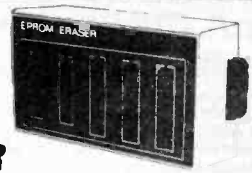
KIT REF 707 **£17.75**

MICROCONTROLLER LIGHT SEQUENCER

EE DEC '90

A superb kit with pre-drilled painted and silk screen printed case for a really professional finish. This kit uses a microcontroller I.C. to generate 8-channel light sequences. Sequences are selected by keypad from over 100 stored in memory. Space for 10 user programmed sequences up to 16 steps long also available. 1000 watts per channel, zero volt switching, inductive load capability. Opto-isolated for total safety. Many other features. Complete kit includes case, PCBs, all components and hardware.

KIT REF 838 **£57.17**



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 **£28.51**

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	£15.58
KIT REF 560 DISCO LIGHTS	£22.41
KIT REF 561 LAPEL BADGE	£11.65

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

Including headphones **£45.95**

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 **£17.16**

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

The No.1 Magazine for Electronic & Computer Projects

VOL. 21 No. 7 JULY '91

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

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SPECIAL MODELS SERIES

This month we start a new series of projects that are, as far as we are aware, unique in their form of construction and presentation. The electronics involved in these projects have been specifically designed to fit inside cardboard models for which we also provide constructional details. The series thus provides two areas of hobby interest, electronics combined with the construction of simple models.

Because of this unique approach – one which we hope will interest many "new" readers to have a go and build up their electronic projects – we decided to use the Vero Easiwire solderless wiring system as a means of constructing the circuitry. This system has a number of advantages for those who are inexperienced in project building, namely that we can supply printed component layouts on cardboard and (obviously!) no soldering is required.

Unfortunately the series very nearly floundered when we discovered that BICC-Vero Electronics Ltd., had decided to discontinue Easiwire. Fortunately, we have subsequently found two suppliers who have good stocks of Easiwire and who have combined with us to provide a *Simple Models Series Special Offer*. This enables you to purchase an Easiwire at well below the original price – or even to get one *Free* if you buy enough of the inexpensive project kits for the series, see page 438 for all the details.

We hope this unusual series will inspire a number of new recruits to build some electronics for their models (whatever the models are) or even some electronics hobbyists to venture into the world of model making. The two hobbies do seem to complement each other very well.

COMING SOON

Our other regular series *Teach-In '91 – Design Your Own Circuits* has attracted considerable interest, this type of theory series seem to be more and more popular with EE readers. With this in mind and to assist with learning/teaching of science, in line with recent innovations in education, we will be running a series of articles entitled *Information Technology and AT12* commencing in the November '91 issue.

This series will again be of interest to everyone who wants to learn about electronics, but it has been specifically designed to follow the structure of Attainment Target 12 (AT12) in the Science National Curriculum. If you have any interest in this area, please make sure you do not miss Part One. **You have been warned!**

SUBSCRIPTIONS

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ULTRASONIC PROXIMITY METER

CHRIS WALKER

Experimental project that can be customised to individuals own requirements. Applications include personnel proximity detector and motorist's parking aid.

ELECTRONIC distance measuring devices using an ultrasonic sound beam are readily available at d.i.y. stores these days. Featuring a digital readout in a choice of metric or imperial units, they claim to make measuring a cinch by eliminating the need for a helper to hold the other end of the tape.

In the authors experience, these ultrasonic measurers are a contrivance of limited practical use. They can only measure to a relatively large sound-reflecting object and the user can never be sure that the reading displayed corresponds to the object in question. Reflections from "foreign" objects are quite common. Many people end up fetching out the old steel tape to check the digital reading!

Ultrasonic distance measurers do, however, have plenty of application in other fields. The Ultrasonic Proximity Meter described here consists of a sensor unit and a display unit linked by a cable which can be several metres long. The display is made up of a row of eight light emitting diodes forming a "dot" bargraph which shows the distance between the sensor unit and any "sound-reflecting" surface.

The maximum range, i.e. the distance at which the eighth l.e.d. lights up, is adjustable from about 2m down to 0.1m (the shorter range giving higher display resolution). In addition to a visual display, the unit can be made to act as a proximity switch to sound an alarm or operate a relay when one particular l.e.d. switches on.

APPLICATIONS

The Ultrasonic Proximity Meter is designed as an open-ended project to be customised to readers own requirements. Applications are numerous and include:

Fluid level measurement. In this use the sensor would be mounted at the top of a tank, directed downwards so that the ultrasound is reflected off the surface of the liquid. The display would directly show the fluid level and could also warn of overflow or low-level conditions.

Personnel proximity detector. For detecting people standing near to a door or shop counter etc.

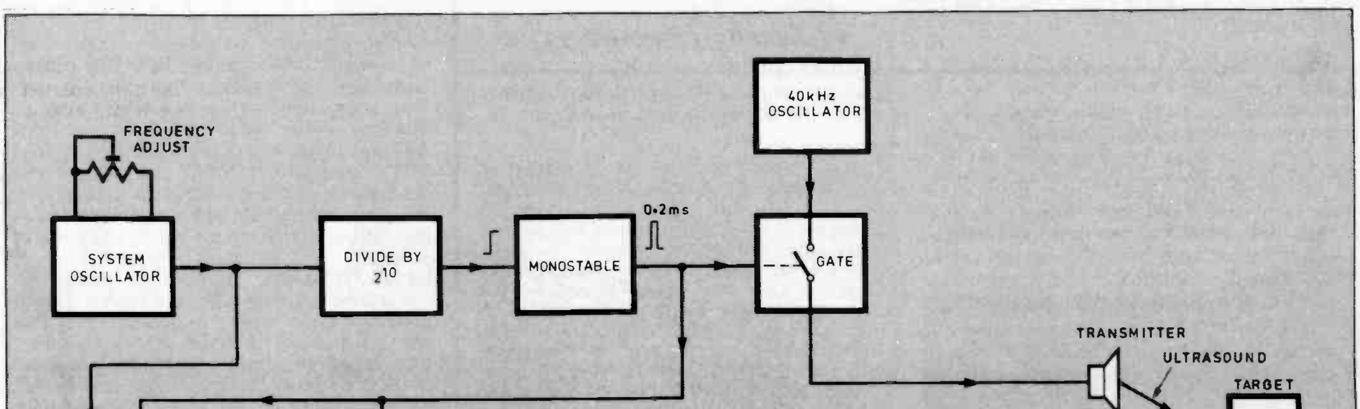
Proximity detector for robotic systems.

Parking aid for the motorist. With the sensor unit mounted low on the garage wall, this device should allow the driver to position the car close to the wall without modifying the smooth contours of the bodywork!

REVERSING METER

This project actually started its life as a reversing meter for the motorist. It was intended to mount the sensor unit on the vehicle's rear bumper so that the display would indicate the distance to an object behind when reversing. Like so many other

Fig. 1. System block diagram for the Ultrasonic Proximity Meter.



designs, however, this one worked great on the bench but when installed on the car, two major problems arose.

Most significantly, it was going to prove very difficult to protect the ultrasonic transducers from the onslaught of water, mud and salt spray experienced at the rear of the vehicle. Regular car washing added to the need for robust environmental protection. The designer dabbled with several ideas for aerodynamically shaped housings and solenoid operated waterproof hatches to protect the transducers.

However, in addition to the dirt problem, it was discovered that the transducers do not operate very satisfactorily in freezing winter temperatures. Constructors who may like to use the Proximity Meter on the outside of the car will have to overcome these problems.

HOW IT WORKS

The block diagram of the complete system is shown in Fig.1. Basically, the unit relies on the fact that sound waves travel at a speed of about 330m/s through air.

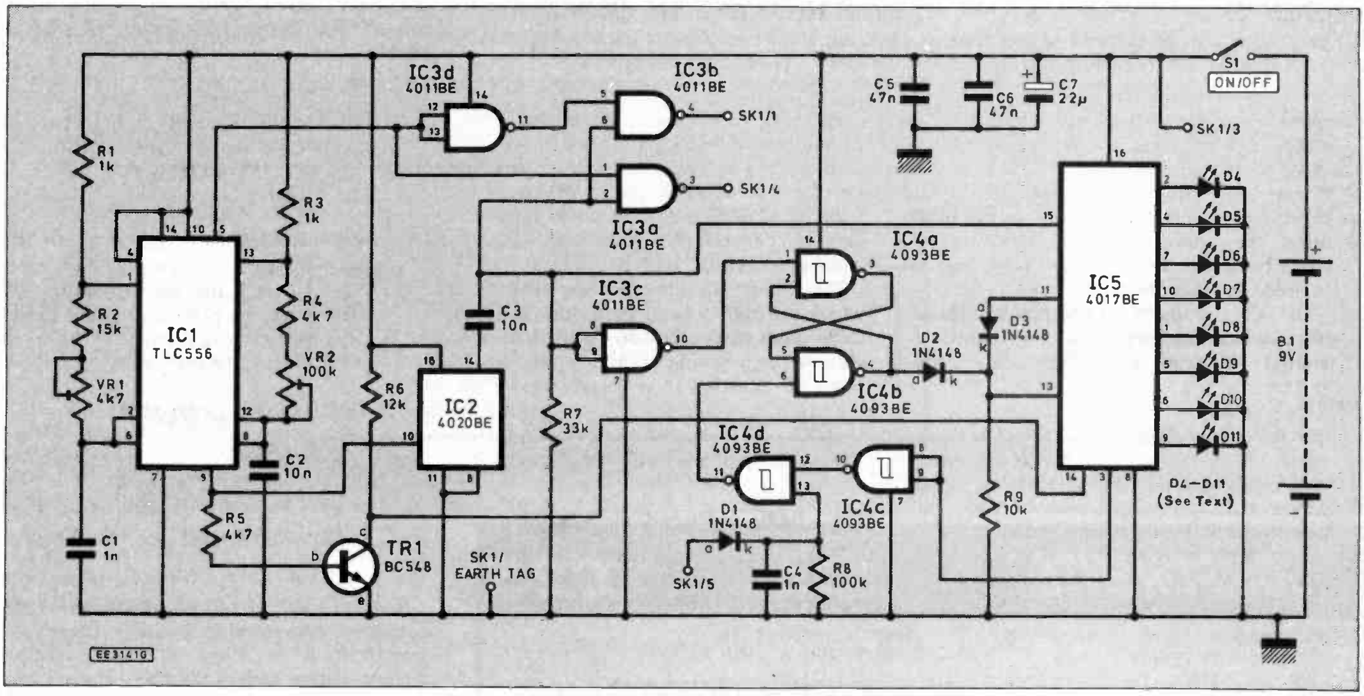


Fig. 2. Circuit diagram of the proximity meter Display Unit.

By timing how long it takes a pulse of ultrasonic sound waves to travel from the transmitter, reflect off the target object and return to the receiver, the circuit can calculate how far away the target is.

By using high frequency sound at 40kHz (which is above the human range of hearing), the system is less likely to suffer interference from everyday noises. Also, ultrasound is fairly directional and thus ideally suited to this kind of application.

The frequency of the system oscillator is adjustable and this has the effect of varying the usable detection range as mentioned earlier. This frequency is divided by 2^{10} and, on every rising edge of the resultant signal, the monostable section generates a pulse which feeds a 0.2ms burst of 40kHz signal to the ultrasonic transmitter.

At the same instant, the monostable output pulse *resets* the Johnson counter and *sets* the flip-flop. The flip-flop output goes high and *enables* the counter which then proceeds to count upwards, clocked by the system oscillator.

The counter continues to increment until the ultrasound pulse arrives back at the receiver transducer. After amplification and filtering, this pulse *resets* the flip-flop which causes the counter to freeze and display its current state on one of the eight display l.e.d's. This output is displayed until the next pulse from the monostable once again resets the counter and initiates the next timing sequence.

The Johnson counter has ten outputs (although only eight are used for the display) which go "high" in sequence on every clock pulse. Since the distance from the transducers to target determines the time taken for the reflected pulse to be received, this distance also determines how many clock pulses are used to increment the counter which, in turn, decides which l.e.d. in the bargraph becomes illuminated at the end of every cycle.

CIRCUIT DESCRIPTION

The circuit diagram of the display unit is shown in Fig.2. One half of the dual oscillator IC1 employs resistors R1 and R2, preset potentiometer VR1 and capacitor C1 to generate the 40kHz carrier frequency at pin 5 for the ultrasonic transmitter. VR1 allows the actual frequency to be trimmed to match the resonant frequency of the transducer.

The other half of IC1, along with resistors R3 and R4, preset VR2 and capacitor C2 generates the system oscillator signal at pin 9 which is adjustable using VR2 from about 700Hz to 13kHz. This signal is fed into the clock input of IC2 (pin 10), a 14-stage ripple counter.

The output from the tenth stage (pin 14) of IC2 is connected to capacitor C3. Every time pin 14 goes high, the voltage at the junction of C3 and resistor R7 rises to a logic 1 level but rapidly drops as C3 charges up via R7. With the values given the voltage stays "high" for about 0.2ms.

This pulse is used to pass the 40kHz carrier signal through NAND gate IC3a and an inverted version of the carrier signal through gate IC3b. The antiphase outputs from these two gates "push and pull" current through the ultrasonic transducer X1 which is mounted in the sensor unit. Connection to this unit is made via socket SK1.

The 0.2ms pulse is also used to reset the Johnson counter IC5 (pin 15) and, after inversion through gate IC3c, the pulse acts to set the bistable flip-flop created by NAND gates IC4a and IC4b. When set,

the output at pin 4 IC4b goes "low" and this allows the INHIBIT pin on IC5 (pin 13) to relax to 0V through pull-down resistor R9.

The counter IC5 can now start to increment, receiving clock pulses at pin 14. Note that transistor TR1 is used to invert the system clock signal before it is fed to IC5. This is necessary because IC5 features a rising edge triggered clock, whilst the frequency divider IC2 is falling edge triggered. Inverting the clock ensures that the whole system stays synchronised.

COUNTER AND DISPLAY

After the first clock pulse at pin 14 IC5 l.e.d. D4 lights, after the second pulse l.e.d. D5 and so on up to l.e.d. D11 which lights after the eighth pulse. If no target object is detected after this time, the ninth clock pulse will cause the counter to increment to its final state where pin 11 IC5 goes high. This pulls the INHIBIT pin (pin 13 IC5) high via diode D3 which stops the counter, preventing it from overflowing back to zero.

The counter can be stopped at any time prior to this by the returning ultrasound pulse. After amplification in the Sensor Unit, the 40kHz signal is presented to SK1 pin 5. The positive half cycles of the signal pass through diode D1 and cause capacitor C4 to charge up so that the voltage at pin 13 IC4d rises to a logic 1 level.

When the 40kHz signal stops, capacitor C4 discharges via resistor R8 and pin 13 IC4d drops to 0V. Providing pin 12 IC4d is high, the presence of received ultrasound will cause pin 11 IC4d to go low and reset the flip-flop, causing pin 4 IC4b to go high and inhibit counter IC5.

Pin 12 IC4d stays low whilst the zeroth stage output from the counter (pin 3 IC5) is high. This means that any ultrasound received before the first increment of the counter will be ignored. This is important, otherwise sound picked up by the receiver transducer directly from the transmitter without first being reflected off the target would cause the flip-flop to be immediately reset.

Capacitors C5 to C7 decouple the power supply lines and help to remove the glitches which occur as the ultrasonic pulse is transmitted and as the display l.e.d's turn on and off. C5 is placed near the flip-flop and C6 and C7 close to the counter chip.

Current consumption is between 25mA and 40mA depending on whether the l.e.d's are illuminated. For intermittent use, a 9V PP3 battery is adequate, but continuous use will dictate the need for a larger battery or mains derived power supply. The circuit will operate down to 5V but the supply should *not* exceed 10V.

No current limiting resistors are used for the l.e.d's D4 to D11. This is because the outputs from the 4017 CMOS counter cannot supply more than a few milliamps for each l.e.d. The use of high brightness l.e.d's is, therefore, recommended.

REMOTE SENSOR

The circuit diagram of the Sensor Unit is shown in Fig.3. IC6 is a low noise, f.e.t. input, quad operational amplifier package. Section IC6c is not used.

Op.amp section IC6d is wired as a voltage follower. It provides no voltage gain but it buffers the input signal from the receiver transducer X2. Op. amp IC6a, resistors R11 and R12 and capacitor C8 act as a high-pass filter/amplifier, providing a gain of 100 above a frequency of about 34kHz.

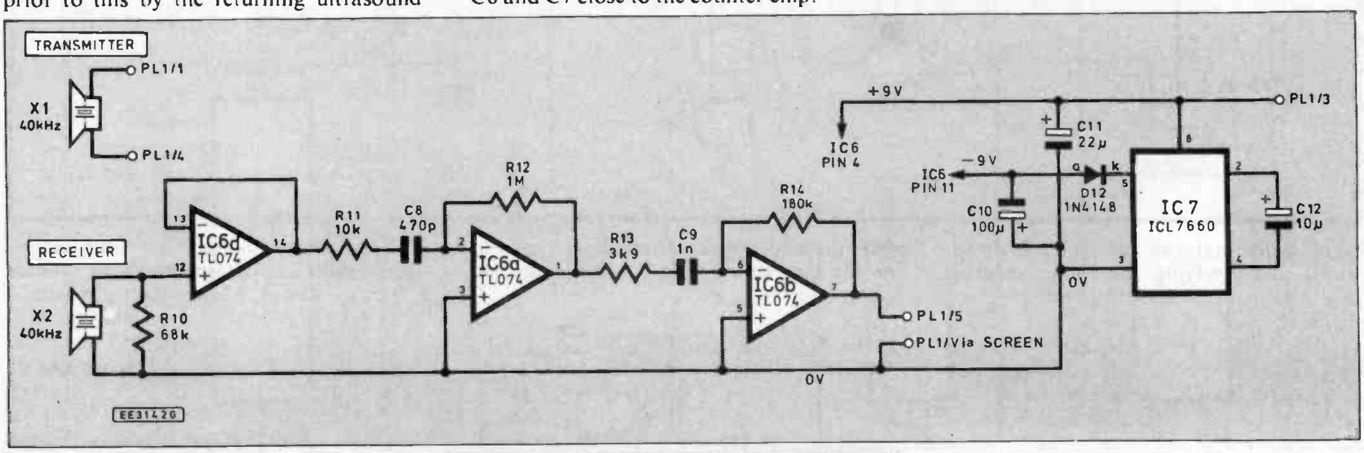


Fig. 3. Circuit diagram for the Sensor Unit.

COMPONENTS

Approx cost guidance only **£25**

Resistors

R1, R3	1k (2 off)
R2	15k
R4, R5	4k7 (2 off)
R6	12k
R7	33k
R8	100k
R9, R11	10k (2 off)
R10	68k
R12	1M
R13	3k9
R14	180k
*R15, *R16	2k2 (2 off)

All 0.6W 1% metal film or 0.25W 5% carbon film

See SHOP TALK Page

Potentiometers

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

Capacitors

C1, C4, C9	1n polyester layer (3 off)
C2, C3	10n polyester layer (2 off)
C5, C6	47n metallised polyester film (2 off)
C7	22µ axial elect., 25V
C8	470p polystyrene
C10	100µ axial elect., 35V
C11	22µ radial elect., 25V
C12	10µ radial elect., 63V
*C13	4µ7 axial/radial elect., 25V

Semiconductors

D1, D2, D3, D12, *D13	1N4148 silicon diode (5 off)
D4-D11	High brightness light emitting diode (8 off)
TR1	BC548 *npn* silicon transistor
*TR2	TIP122 *npn* power Darlington transistor
IC1	TLC556 dual CMOS timer
IC2	4020BE ripple counter
IC3	4011BE quad NAND
IC4	4093BE quad NAND Schmitt trigger
IC5	4017BE 10-stage counter
IC6	TL074 quad f.e.t.-input op-amp
IC7	ICL7660 voltage converter

Miscellaneous

X1, X2	40kHz Ultrasonic transducer transmitter/receiver pair
S1	Single-pole toggle switch
PL1	5-pin DIN plug
SK1	5-pin panel-mounting DIN socket

Plastic cases, size 116mm x 78mm x 36mm and 72mm x 50mm x 25mm; 8-pin d.i.l. socket; 14-pin d.i.l. socket (4 off); 16-pin d.i.l. socket (2 off); 4-core individually screened cable; battery clip; 9V battery (see text); flexible multi-coloured connecting wire; solder pins; solder etc.

Printed circuit boards available from *EE PCB Service*, codes EE753 and EE754.
*Optional components for external add-on driver circuit, see Fig.6.

Resistors R13 and R14, IC6b and capacitor C9 provide another stage of amplification for ultrasonic signals, resulting in a further gain of 50. The output from this stage (pin 7 IC6) is fed via a *screened* cable to plug PL1 which connects to socket SK1 in the Display Unit.

A negative supply generator IC7 creates a −9V rail for the op-amps. Diode D12 and capacitor C12 are used by this chip. Capacitors C10 and C11 provide further decoupling and smoothing in the vicinity of the amplifier circuits.

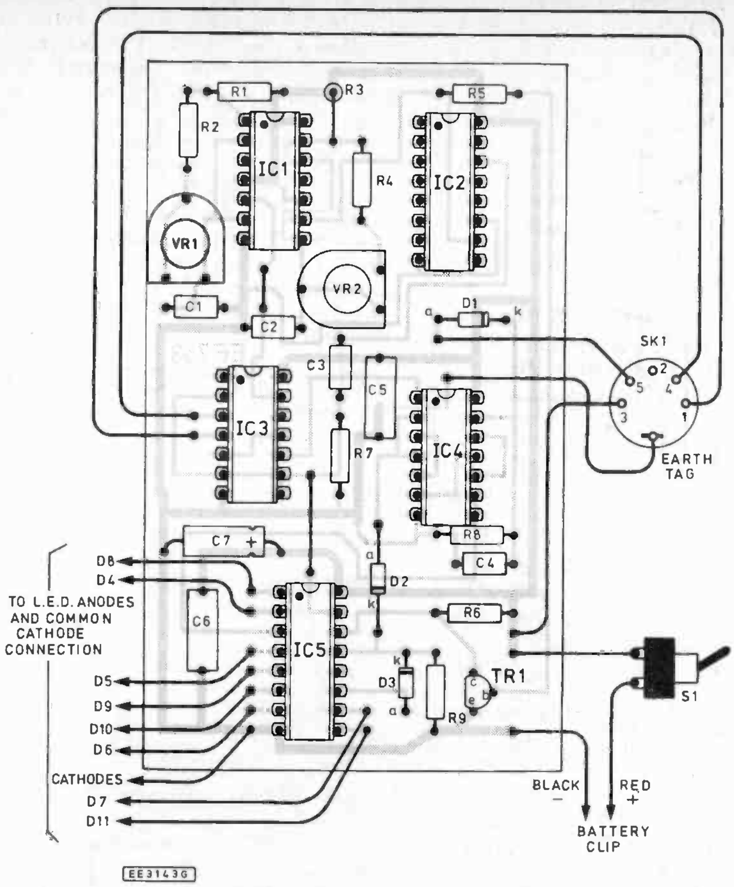
CONSTRUCTION

The Ultrasonic Proximity Meter is built on two printed circuit boards (p.c.b.s). These boards are available from the EE PCB Service, codes EE753 and EE754.

The component layouts and full size copper foil master patterns are shown in Fig.4 and Fig.5. Note that the widths of both p.c.b.s are identical, so they can be manufactured as a single board and carefully cut using a hacksaw after etching.

Start construction by assembling the larger, Display Unit p.c.b., referring to Fig.4. Take care when soldering as very thin tracks pass between the i.c. pads in two places on this board and it is easy to bridge across these.

If you do make a mistake, excess solder can be removed either by holding the



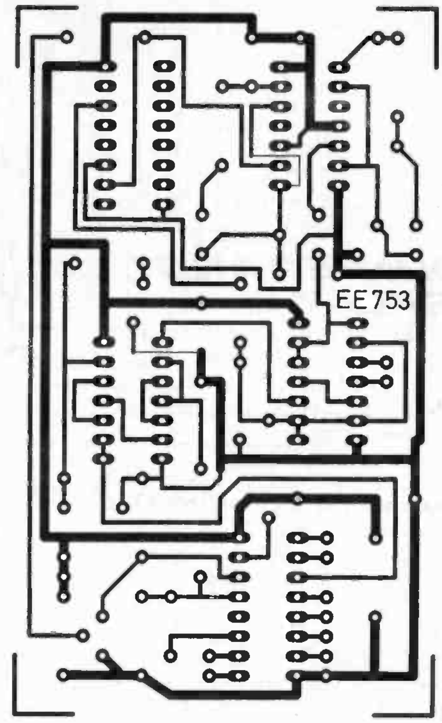


Fig. 4. Printed circuit board component layout and full size copper foil master pattern for the Display Unit.

board horizontal with the track side downwards and applying the *clean* soldering iron bit so that solder runs off the track down the iron, or you can use a solder-sucker. Do not, however, rely too often on either method. The copper tracks are only bonded to the fibreglass board with adhesive and they will soon lift off if excess heat is applied.

Some over-enthusiastic solder-suckers also have a habit of devouring the tracks! The solder-sucker is a useful but rather harsh tool and it is best not to make mistakes in the first place.

Insert the two wire links onto the display p.c.b. and then solder in five d.i.l. sockets for IC1 to IC5. These sockets occupy most holes on the p.c.b. and help the constructor to orientate himself more easily on the board and reduce the risk of putting the other components in the wrong places.

All the other components can now be added in any convenient order. The electrolytic capacitor C7 has + and − leads which must be located as shown.

Diodes D1 to D3 must also be inserted the correct way around. The cathode (k) lead is marked by a thin band around the diode body. These components are sensitive to excess heat when soldering so avoid frying them by keeping the iron on the joint for no more than about three seconds. This advice also applies to transistor TR1 and this component also has to be orientated correctly with the flat side on its case adjacent to resistor R9.

When soldering the two preset potentiometers VR1 and VR2 you may find that it is difficult to prevent solder running through the holes in the p.c.b. and up the legs of the presets. The designer finds it best to solder these devices in two stages.

First apply just enough solder to hold the preset in place, allow the joints to cool and then re-apply the iron and solder to "fill out" the solder joint. Do not leave the iron on for long or the solder wjll run up the preset's leg.

FLYING LEADS

Sixteen off-board flexible lead connections have to be made to various other components. It will be found most convenient, at this stage, if terminal pins are inserted into the p.c.b. for this purpose.

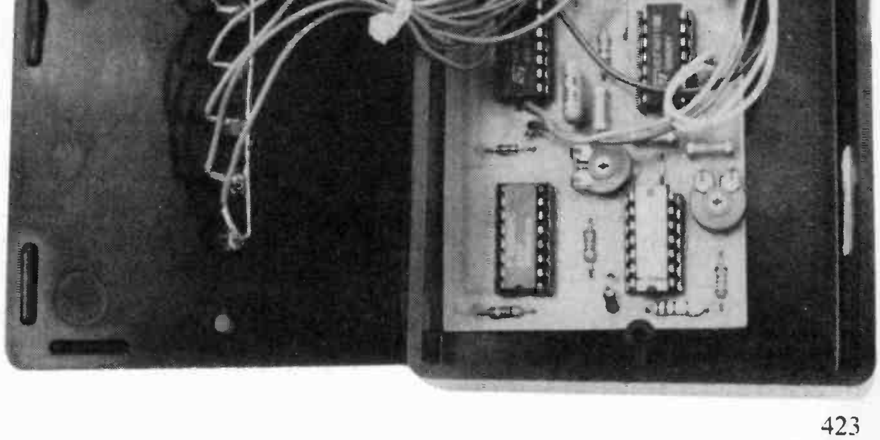
The flying leads are later soldered to these pins on the component side of the board. Alternatively, you can solder about 10cm lengths of wire directly to the solder pads but, using this technique, the wires tend to break off if they are manipulated excessively.

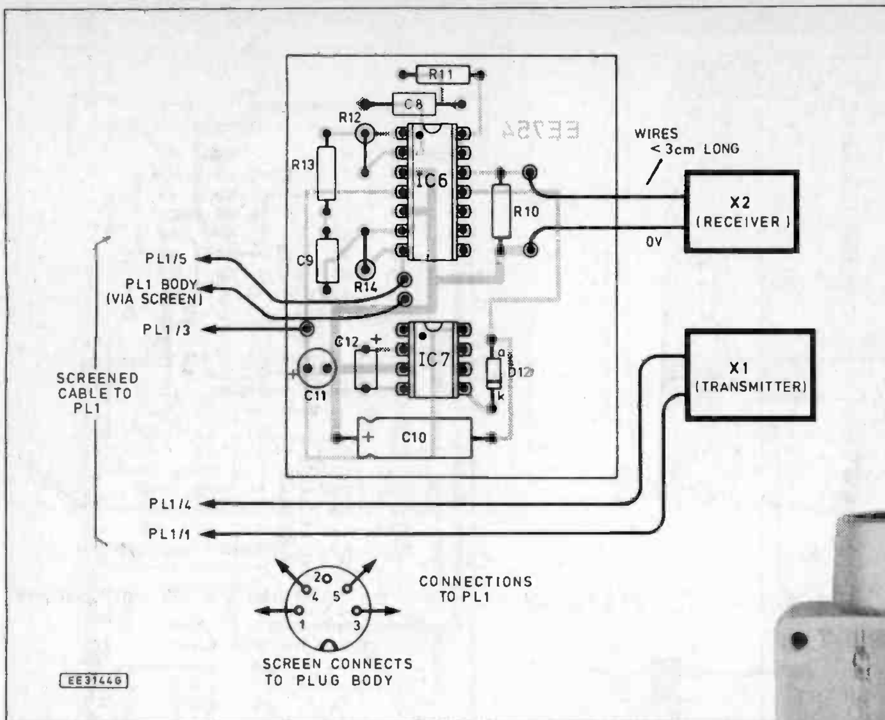
The prototype Display Unit is housed inside an ABS box measuring about 116mm x 78mm x 36mm. Mount the eight l.e.d.'s D4 to D11 side-by-side in the lid of the box along with the on/off switch S1. A 5-pin DIN socket SK1 is mounted in one end of the box base.

All the cathode (k) leads of the l.e.d's should be soldered together and connected to the "common" connection on the p.c.b. The cathode leads are marked by a small "flat" edge on the body of the device, but you will need to look closely for this before the l.e.d's are clipped into their plastic panel-mounting clips.

The eight anode leads are then linked to the p.c.b. in the order shown, D4 is the

Wiring to display diodes.





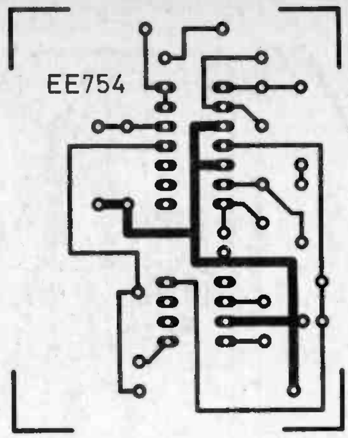
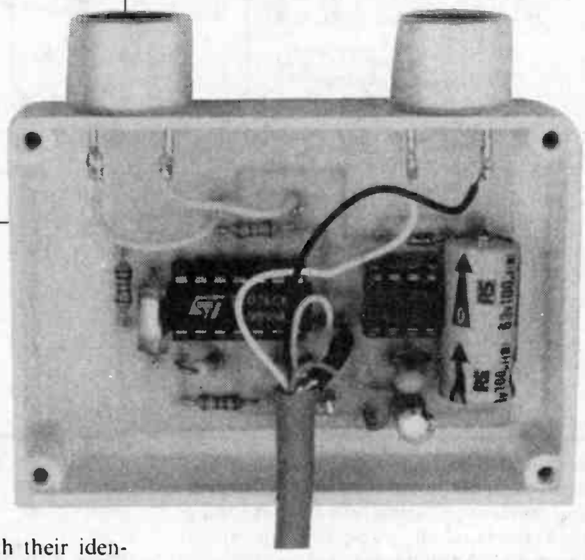


Fig. 5. Printed circuit board component layout and full size (top right) copper foil master pattern. The connections to the screened link cable DIN plug are also shown.



(right) The completed circuit board mounted in a small plastic case. The ultrasonic transducers are glued to one side panel and the screened lead is held in the recess by the lid.

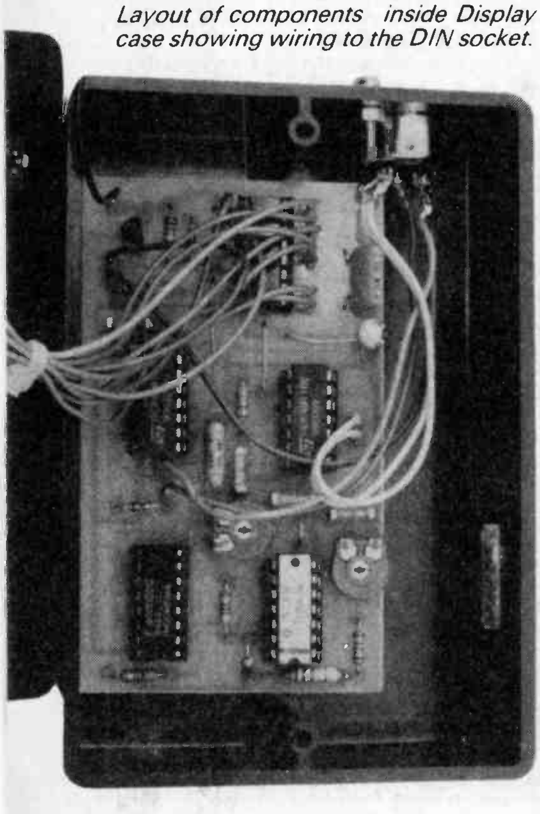
"near" (minimum range) l.e.d. and D11 is the "far" (maximum range) indicator. Like other semiconductors, l.e.d's can be damaged with too much heat during soldering.

The five i.c.s can now be inserted into their sockets. All of them are CMOS devices and, although they are quite robust, they are susceptible to damage from static electricity. Discharge your body by touching an "earthed" object before handling the chips and then try not to touch their pins.

On new i.c.s the two rows of pins are usually splayed out too wide to fit in the sockets and they require gentle bending by pressing the entire row on a hard, flat surface. All five devices lie in the same direction on the circuit board with their identification notches positioned as shown.

In the prototype the battery was held in place inside the box with a doubled-sided sticky pad. The p.c.b. was sufficiently anchored by its own flying leads.

Layout of components inside Display case showing wiring to the DIN socket.



SENSOR UNIT

Assemble the Sensor Unit p.c.b. according to Fig.5. Use d.i.l. sockets for the two i.c.s and carefully ensure that the three electrolytic capacitors, C10 to C12, are orientated correctly along with the diode D12.

The prototype sensor is housed in a plastic case measuring 72mm x 50mm x 25mm. The ultrasonic transducers X1 and X2 are glued onto the outside of this case with their leads protruding through small holes drilled in the side panel. The centres of the transducers should be positioned between 4cm and 5cm apart.

It is important to identify which transducer is the transmitter and which is the receiver as they are electrically different. Your component supplier should be able to tell you which one is which.

The receiver, X2, is linked to the sensor p.c.b. by two very short lengths of wire no more than 3cm long. The "earth" connection of the transducer (that is the one connected to its metal case) goes to 0V on the circuit board.

SCREENED CABLE

A 4-core individually screened cable links the display and sensor units. Attach a 5-pin DIN plug to one end of the cable. The screen in the cable connects to the metal body of the plug by trapping it under the cable grip and squeezing the jaws of the cable grip around the screen and cable using pliers. The four cores are connected to the plug as shown in Fig.5.

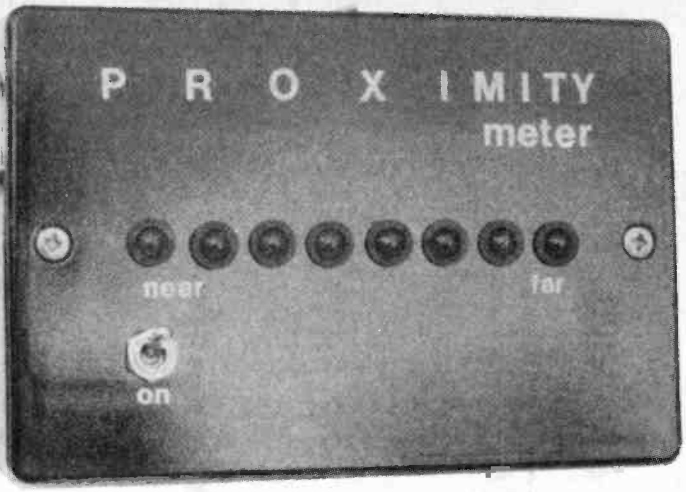
At the other end of the cable, two of the cores connect directly to X1, the transmitter transducer. Polarity of this transducer is not important. The remaining two cores and the screen connect to the p.c.b. as shown. Insert the two i.c's into their sockets at the end of assembly.

TESTING and ADJUSTMENTS

To test that the Ultrasonic Proximity Meter is working correctly, plug the sensor cable into the DIN socket, connect a battery and switch S1 on. Turn the two display presets VR1, VR2 to about mid-position and point the Sensor Unit away from any close objects.

It should be possible to see all eight l.e.d.s briefly flash about once every second each time an ultrasonic pulse is transmitted. If nothing happens go back and check all your work; soldering, component location and interwiring.

If l.e.d. D4 stays on even when the Sensor is far from any object then it is possible that ultrasound from X1 is passing directly to X2 and causing the latter to resonate for a short time after the 0.2ms pulse is transmitted. This problem can usually be solved by wrapping X1 in sound absorbing foam rubber. Self-adhesive draught-excluding strip is useful for this purpose. For some reason, although I am not sure why, this difficulty seems more acute at very low temperatures.



Front panel layout of the Display Unit.

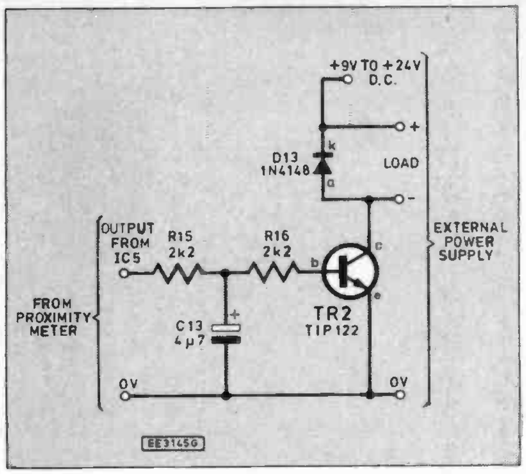


Fig. 6. External output driver circuit diagram.

Now turn VR2 fully anticlockwise and place the Sensor about 2m in front of a large reflecting surface such as a wall. VR1 should be adjusted to bring the transducers into resonance so that the Proximity Meter reliably detects the wall at its maximum range. VR1 needs no further adjustment, but VR2 can now be set to give the required operating range/display resolution.

Target detection is most efficient when the surface of the object is perpendicular to the sensors, and hard surfaces are more reflective than soft ones; a liquid surface is an excellent reflector. As mentioned towards the beginning of this article, the transducers are not waterproof so unsheltered outdoor operation of the sensors is not recommended.

OUTPUT DRIVER

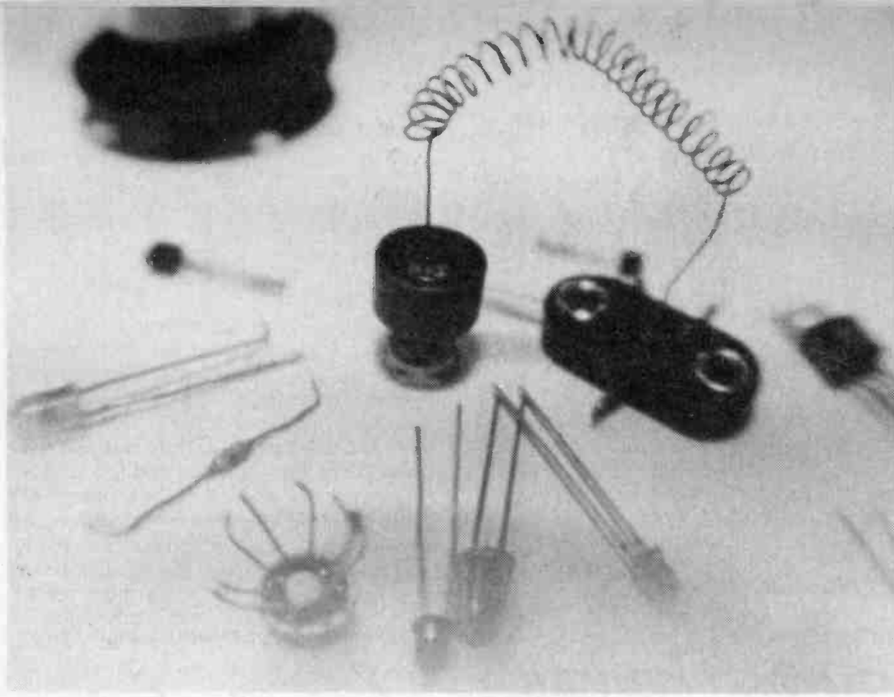
Any one or more outputs from the Johnson counter IC5 can be used to operate a relay or warning device etc. For example, if the Ultrasonic Proximity Meter is used to monitor the level of water in a tank then one output can be used to switch on a solenoid water valve to replenish the tank contents if the level drops too low. In addition, another output can be made to sound an alarm if the level becomes too high.

An add-on circuit used to drive an output device is shown in Fig.6. Note that the relevant l.e.d. must be disconnected and replaced by this circuit.

Transistor TR2 is a Darlington device which provides the very high gain necessary to boost the low current sourcing ability of the CMOS output from IC5. Capacitor C13 smooths out the brief "drop-outs" which occur every time the ultrasound pulse is transmitted and diode D13 removes any high-voltage back e.m.f. which could be generated when inductive loads (e.g. relay coils) are switched off.

The transistor can safely switch load voltages up to about 24V d.c. at a maximum current of 5A. Since, in use, the transistor is either switched off or fully on, it should not dissipate much power, but heatsinking may be necessary if the device is run close to its limits.

Readers wishing to control higher currents/voltages or a.c. loads should use this circuit to drive a relay coil and then use the relay contacts to switch the load. □



FROM FISH TO CHIPS

James F. Fowkes

WHEN the Trojan wars were being fought in Greece, long before the rise of the Roman empire, shocks from "torpedo" fish (which belong to the skate family) were being used to cure gout and rheumatism. These fish generate electric shocks from an organ in their heads to defend themselves.

But the first example of a "man-made" electric shock must surely be in the Old Testament of the Holy Bible. Three thousand years ago, just after the period we now call the Bronze Age, in the second book of Samuel, 6, 7: "... Uz-zah put forth his hand to the ark of God and took hold of it (to steady it) when the oxen shook it. And God smote him for his error; and there he died ..."

The Old Testament defines an Ark as a wooden chest, and in Exodus 25, 10, and 37, 1, it even details its construction. It would appear to be a very efficient, if primitive means of storing electricity.

And it describes the construction of clothing for the priests who carried the ark, too. In Exodus 39, 3- there is a remarkable resemblance to that worn by modern-day linesmen/electricians working on extra high voltage lines, and to that worn by atomic power station employees working in "hot" areas; even to the earthing chains ...

ELECTRA

But what we know now of the science of electricity really started in 585 BC, not long after the first of the Olympic Games began from the Temple of Zeus, in Greece.

A man named Thales who lived in a town called Miletus became known as "one of the seven wise men" after he discovered that amber would attract other materials when it was rubbed. The name given to amber and other bright minerals in those days was Elektra – or "electron".

Only a hundred years later a Roman scholar named Leucippus tried to describe how the Universe was held together. And two hundred years after that Democritus, who became known as the "Father of physics", was teaching atomic theory. ("Atoma" is Greek for indivisible).

Nothing really exciting happened then until about the middle of the 15th century, when Shakespeare was producing his great works, and Drake sailed the Spanish Main – and defeated the Armada.

At Colchester, in Essex, a Doctor William Gilbert was made Court Physician to Queen Elizabeth, and given the task of investigating those early Greek experiments. He was able to electrify many more materials and coined the word "electricity".

FRANKLIN

By the 17th century Benjamin Franklin, who was a philosopher and a journalist as well as a statesman, had shown how electricity could be collected from a kite flown in clouds during a storm.

Soon balloons were used instead of a kite, and even fishing rods held from upstairs windows in vain attempts to collect electricity; the more ignorant even collecting rain-water in jam-jars.

People learned to be more careful in these experiments after a Professor Riehmann, of St. Petersburg, was killed by a bolt of lighting. Then spark-gaps were fitted – closer to the point of discharge than to the observers.

In 1886 the Abbe Nollet is reported to have discharged a Leyden jar through an entire regiment of 1,500 men linking hands, who "all received a violent shock in the arms and shoulders".

John Dalton developed the atomic theory in about 1803. He reasoned that the smallest particle cannot be further subdivided without changing the element.

In 1837 Charles Wheatstone, at King's College in London's Strand, developed the line telegraph. It utilised the famous code consisting of dots and dashes invented by Samuel Morse.

WIRELESS

Before the end of the century experiments were being conducted in wireless telegraphy using a telephone coherer (soon discarded for a galena crystal and catswhisker) to receive signals from a spark transmitter.

In 1908 Lord Rutherford established the electrical structure of matter and was awarded the Nobel prize, and Niels Bohr extended his work so far as to evolve the "Quantum Theory" several years later.

Not long afterwards the famous author, J. B. Priestley (b.1894), explained how he killed rats with batteries constructed from seven square feet of coated surface – and cats, with a four and a half square yard coating.

Sugar, eggs, fruit, etc., become luminous in the dark, when given an electrostatic charge.

After the first world war, in the East End of London and other big cities, stalls were being erected outside shops. On them traders constructed radio receivers (called wireless sets then) to demonstrate their simplicity to an enthusiastic public.

VALVES

Before very long thermionic valves had superseded crystal sets, and the weekly ritual to the "electric shop" to get one's batteries charged became commonplace.

In the RAF museum at Cranwell, the first Services radio receiver was preserved; it was a crystal receiver.

Components were fitted with terminals in those days and screwed to a "breadboard", connection being made with 16 gauge copper wire. This was inevitably bulky and soon became superseded by soldered joints, which introduced a new technique to the enthusiastic amateur, who soon became adept with clumsy soldering irons, tins of flux, and plumbers solder.

By 1937 the crystal was almost forgotten. Many complex thermionic valves had been invented for specific purposes – and could be bought new from as little as four (old) pence – only two new pence.

In the German "People's set" four valves were incorporated in one glass envelope, but it was found expensive to replace.

Then came war. Higher frequencies (shorter wavelengths) were used to economise in airspace and made way for microwave Radar. But the interelectrode capacitance of thermionic valves was limiting high frequency performance and the crystal – now silicon – came back into its own as a microwave demodulator diode.

TRANSISTOR

The Bell Telephone Laboratories added a second catswhisker to the diode in 1946 to introduce the trans(fer)-(res)istor.

Most retailers would only supply these primitive semiconductors to order because of their high cost. By 1950 a simple germanium audio transistor (an OC70, or "red spot") cost between £2-£3 (about half of an average week's wage), and amateur societies like the RSGB were providing information to enable members to construct their own crude devices.

In similar fashion to the thermionic valve several transistors were amalgamated into one envelope; the "integrated circuit" – soon to be lovingly nicknamed "the chip" – had arrived.

Now we can incorporate more than ten million components onto a single "chip" using lithographic techniques. Gold "wire", used to join them, may be only several atoms thick – and less than thousandths of an inch wide.

But the silicon microchip has almost reached its limits of miniaturisation. Investigations into gallium arsenide began in the mid-'50's, and it was found to be much faster (capable of higher frequencies) than silicon, and able to work at temperatures more than 80 degrees C. above that at which silicon breaks down.

In 1983, a contract from Defense Advanced Research Projects Agency enabled the Rock-

An early static electricity experiment is shown utilising a coil and two Leyden jars (one jar has been removed to show "static collector"). Inset reveals the lead coating, both inside and outside of the jar, which forms a capacitor. Other components shown are a switch (to earth the aerial when not in use); a microwave valve; coils and capacitors (the tiny dots behind the phones are latter-day capacitors); a Morse key; an early "Solon" soldering iron – and a tin of "Fluxite".

well Corporation to investigate gallium arsenide integrated circuits. Within three years they were producing 6K gate arrays (6000 transistors connected to each other to store digital information).

In 1985 Honeywell (a subsidiary of Rockwell) claimed to have produced the fastest ever transistor, using gallium arsenide. Taking measurements from a ring-oscillator at room-temperature, each stage was switched in 11.6 trillionths of a second (11.6 picoseconds).

GaA devices recover from high-energy radiation breakdown much quicker than silicon, and will detect (and generate) light; making them very useful for telephone, medical, and other fibre-optic devices.

MOLECULAR ELECTRONICS

Molecular electronics, involving organic chemistry, was conceived in the mid'70's. It utilises biochemistry to design molecules for the basic elements of a computer system, and involves switching them by modulated laser beams. The optical connections would have to be aligned exactly so that they focus onto the correct input and output molecules.

Since the molecular computer involves a three-dimensional structure, both ROM and RAM can be assembled to a very high density, permitting memories of a gigabyte or more. This opens up a whole new field of uses, from medically implanted monitors (that will immediately diagnose and treat any infection or emergency) to environmental monitoring.

But now those 6K gates of the '80's have led to the development of Gallium Arsenide *optical* switching elements arranged in clusters, and are each capable of processing 1,000,000,000 (one billion) pieces of information every second.

(Light emitting diodes l.e.d's, can be seen in many applications; but laser diodes generate a more concentrated radiation of uniform wavelength. Photodiodes, using a similar method of manufacture, can be tuned to detect that same wavelength).

PHOTONICS

Scientists working for the Bell Laboratories in America have developed a computer which uses laser beams to carry its information through optical switching clusters. This permits it to run at up to 1,000 times faster than silicon-based electronic computers; it is only limited by the speed of light.

Capable of processing multiple instructions instantaneously, "clock" chip speeds (bit speeds) will be replaced by photons (light particles) – travelling at 186,300 miles per second – equivalent to more than one hundred million *instructions* per second. The computer will incorporate lasers, prisms, diffraction gratings and lenses which will accelerate, concentrate and focus the photon beam. This new technology has been called "photonics". Recent advances made in super conductivity – at near-ambient temperatures – may soon eliminate the 'time constant' from our equations.

We have reached the stage where we need computers to design computers. The atomic theories of the ancients have been replaced with twentieth century quantum mechanics. This involves the merge of microelectronics with biochemistry.

It was recently reported that the American Navy was experimenting with the idea of using dolphins in warfare.

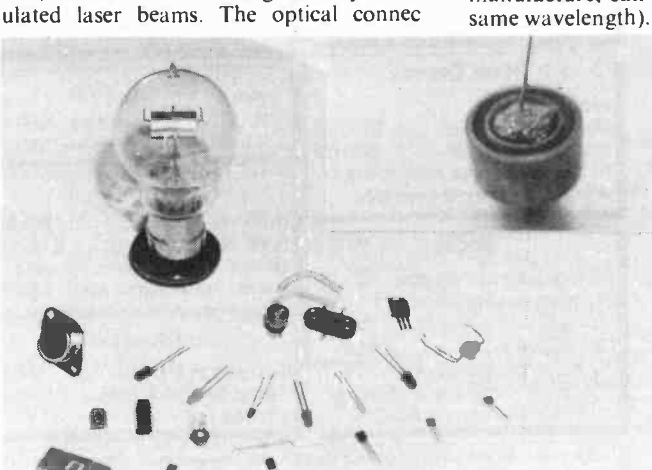
Nobody has proved yet whether dolphins are related to skate.

***Historical Note:**

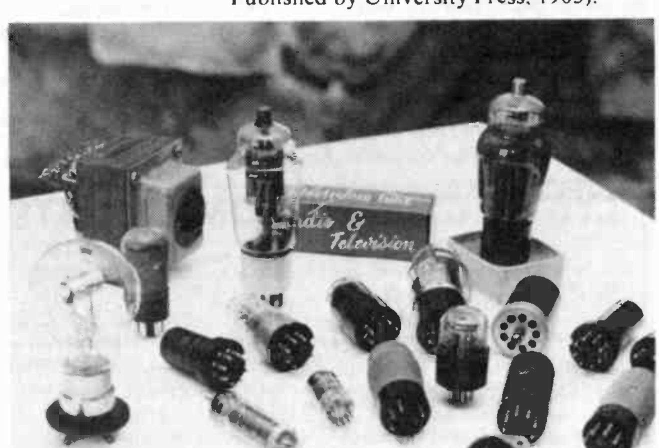
Sir Oliver Lodge's coherer:

If a glass tube have two platinum wires sealed into its ends, and be filled with metallic filings, the electrical resistance between the wires is, in the normal state of the tube, very great. If, however, electromagnetic radiation is falling on the tube, the resistance is much diminished, and a current will pass through a relay circuit including a battery, a galvanometer, and the coherer. If the coherer be kept constantly tapped, so as to shake the filings, it returns to its initial state of high resistance when the waves cease, and the current through it is stopped.

(From: *The Theory of Experimental Electricity*, by W. Whetham MA FRS, Fellow of Trinty College, Cambridge; Published by University Press, 1905).



An early thermionic "bright-emitter" triode valve, circa 1907; a galena crystal and catswhisker (point-contact shown in inset); and a miscellany of more modern diodes, l.e.d.s and transistors; some integrated circuits and an EPROM.



This selection of thermionic valves spans nearly sixty years of valve technology. A "semi-shrouded" mains transformer is shown in the background which was used to supply power to these valves. This (typical) one can supply 300-0-300V at 100mA, 6.3-0-6.3V at 6A, and 4V at 3A.

SHOP TALK

with David Barrington

Police Car – Simple Model Series

The new "model making" series commencing this month will have a wide appeal across a broad spectrum of our readers and it combines two interesting hobbies in one – namely electronics and models. There will be whimsical models and realistic scale models. So if you have some model makers amongst your friends who would like an easy "hands-on" introduction to electronics – pass the word around!

Assembly and wiring of the electronics is by the use of the Easiwire wire-wrapping system, which means no soldering. The models and circuits are built up on *printed* card, which can be obtained from the Editorial Offices for the sum of £2 (including postage) for the Police Car (other models prices to be announced as each one is published). You can, of course, photostat the published diagrams on to your own card.

To help with assembly, **Greenweld Electronic Components** (☎ *0703 236363*) and **Bull Electrical** (☎ *0273 203500*) are putting together complete kits of parts, including printed cards, as each model appears. The first in the series is the *Police Car*, with siren, flashing beacon and indicators, and a kit will cost £5.95 plus £1 postage. – See *Special Offer* page 438.

The above mentioned companies have large stocks of Easiwire solderless wiring packs and have agreed to make these available to EE readers who order kits from them. If you purchase any one *single* kit an Easiwire pack will set you back just £5. However, if you are prepared to order four or more of the kits listed they will supply a Easiwire kit *FREE*. When the wire-wrap kit was first introduced to the UK market by BICC-Vero they were advertised at £15, including postage.

For those readers who wish to go their own way, all the components for the *Police Car* appear to be standard off-the shelf items, with the exception of the high intensity light emitting diode (l.e.d.). The only source we have been able to locate, apart from above, which lists a Yellow l.e.d. with the correct specification (30mcd) is **Electromail** (☎ *0536 204555*), the mail order arm of RS Components. This is quoted as stock code 587-844.

It may be possible to use an Ultrabright or Superbright l.e.d., but they have *NOT* been tried in the model. These seem to have a higher rating, but only Red versions appear to be stocked by advertisers.

It is quite possible that in some areas, the LM3909 l.e.d. flasher/oscillator chip, which drives the siren, flashing beacon and indicators, may prove difficult to locate. If this is the case then **Maplin** can supply, code WQ39N (LM3909 LED Flash/Osc.), and it is also currently listed by **Cirkit**, **Greenweld** and **Omni** to name but a few.

Disco Lighting System Modular

We do not expect any component buying problems to be encountered by constructors of the *Masterlink*, this month's *Disco Lighting System* module.

The metal instrument case for this module is the same for all modules in the series and is the **Maplin** Blue case 233, code XY84C. Other cases can be used but they must be of the same dimensions or greater and be METAL. It is also essential that the case be "earthed".

The printed circuit board is available from the *EE PCB Service*, code EE752.

12V NiCad Charger

The adjustable voltage regulator type L200 called for in the *12V NiCad Charger* appears in most components catalogues and should not be difficult to locate locally. Be careful when mounting the heatsinks on the regulators as the metal "tabs" are also connected to the ground pin 3.

The combination of battery holder(s) for the NiCads will depend on battery size used and will have to be adapted and soldered together as required. The one in the model takes ten AA size in two groups of five, one above the other, and is listed as a 12V NiCad Battery Box.

It is most important, for safety considerations, that 3A minimum rating cable be used where indicated. Also, to avoid any possibility of short circuits across the copper tracks, the circuit board should be mounted using nylon fixings and have insulating material, such as cardboard, taped to the bottom of the metal case below the board.

Ultrasonic Proximity Meter

We cannot foresee any component problems when shopping for parts for the *Ultrasonic Proximity Meter*. The 40kHz ultrasonic transducers are usually advertised as pairs and *MUST* be purchased as such.

It is important to identify which transducer is the transmitter and which is the receiver (usually marked with a T and R) as they are electrically different. Consult your supplier if in any doubt.

The two printed circuit boards for this project are available as a pair from the *EE PCB Service*, codes EE753(Display) and EE754(Sensor), see page 468.

Teach-In '91

This month, it looks as though the semiconductor devices could possibly cause followers of the Teach-In '91 series, *Design Your Own Circuits*, certain local supply difficulties.

The only listing for the MC3041 triac opto-isolator, with internal "zero crossing" circuit, used in the *Disco Lights Controller* and *Solid-State Switch Module* is from **Electromail** (☎ *0536 204555*) code 301-628. Maplin carry a very similar device, but it has not been tested in the model.

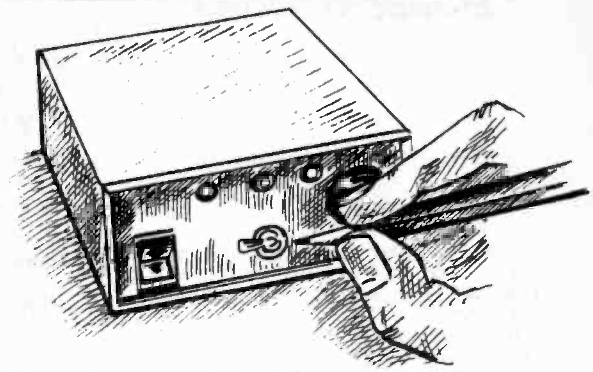
The 600V 8A triac type BTA08-600B is also listed by the above company and **Maplin**, code UK54J. The mounting tab is isolated from the pins, so no mounting kit is required. The IEC 6A chassis filter plug, with integral fuseholder, is stocked by Electromail, code 210-291, and listed at £10.99.

The printed circuit boards are available from the *EE PCB Service*, see page 468. The Disco Lights Controller boards are coded EE755 (PSU/MIC. Preamp.) and EE756 (Low, Mid, High, Filter/Triac; three boards). The Solid State Switch p.c.b. is coded EE757.

PLEASE TAKE NOTE

Three-Transistor Tremolo Unit
(April '91)

For the circuit of the *Three-Transistor Tremolo* to function correctly, it has been found that the l.e.d. D1 MUST be the low current (2mA) type.



DISCO LIGHTS CONTROLLER

MIKE TOOLEY BA

This companion project to our circuit design series features a three-channel Disco Lights Controller. As with all of our practical projects, a number of modifications are suggested so that the more intrepid constructor can customise the unit to his or her own particular requirements.

OUR Disco Lights Controller provides a means of controlling three separate light channels (each rated at up to 300W) and is thus ideal for party and small-function use. The circuit can derive its input from one of several sources including the "auxiliary" output on the main amplifier, the loudspeaker output from the main amplifier, or from a microphone placed in close proximity to the loudspeaker system itself. The Disco Lights Controller has been designed for safe and reliable operation and uses readily available components.

Important Note: This project involves components which operate directly from the a.c. mains. It is essential that constructors adopt safe working practices when testing and operating this unit. In particular, it is important to ensure that the metal panels of the case are properly earthed and that all live connections are adequately insulated. Constructors should not attempt to make any connections to the unit nor should they work on the filter/triac boards when the unit is "live" and connected to the mains supply.

CIRCUIT DESCRIPTION

The simplified block schematic for the Disco Lights Controller is shown in Fig. 1. In most applications, the Disco Lights Controller will derive its input either from an "auxiliary" output on the main amplifier or directly from one (or both) of the loudspeaker outputs (see "Modifications" for details of a stereo loudspeaker signal combiner). In some other applications it may not be possible to make a direct connection to the audio equipment and thus a separate low-level "microphone" input is provided.

After preamplification (if required) the audio signal is fed to three active filters based on operational amplifiers. These filters separate the audio signal into three separate bands corresponding to "low" (20Hz to 400Hz approx.), "middle" (400Hz to 1.2kHz approx.) and "high" (1.2kHz to 20kHz), as shown in Fig. 2.

The output of each filter stage is rectified and passed to a C-R "hold" circuit with a decay time constant of approximately 50ms. The output from the hold circuit is

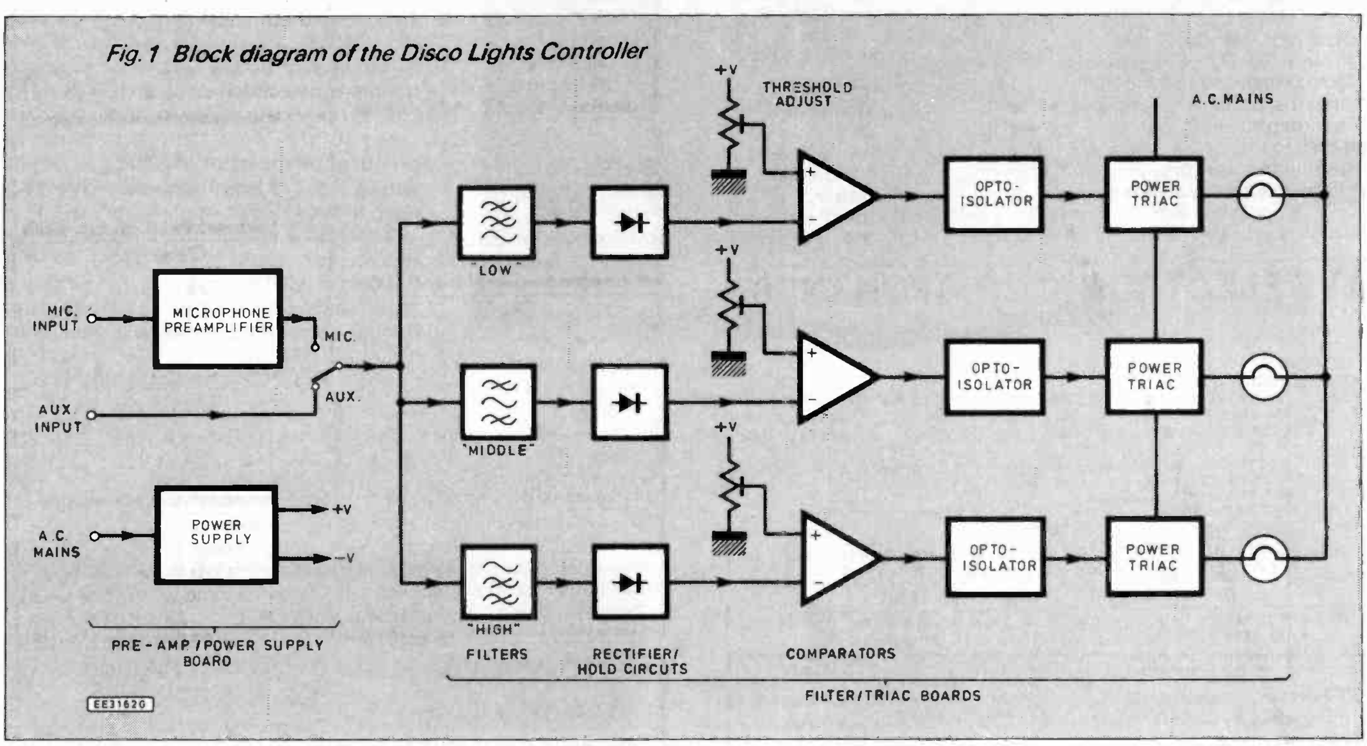


Fig. 1 Block diagram of the Disco Lights Controller

Specifications

Frequency response:	"Low" channel, 20Hz to 400Hz (approx.) "Mid" channel, 400Hz to 1.2kHz (approx.) "High" channel, 1.2kHz to 20kHz (approx.)
Aux. input impedance:	10kilohm (approx.) at 1kHz
Aux. sensitivity:	100mV r.m.s. (typical)
Mic. input impedance:	50kilohm (approx.) at 1kHz
Mic. sensitivity:	5mV r.m.s. (typical)
Max. load (per channel):	300W
Max. load (total):	1kW
Supply:	220V to 240V a.c. mains (at 5A maximum)

fed to the input of a comparator stage (with adjustable threshold). The output of the comparator drives an optically coupled triac (featuring zero-axis crossing triggering). This triac then drives a high-power mains triac which switches current in the external tungsten filament lamp loads for each channel.

In the complete circuit diagram (Fig. 3) components are numbered on the following basis:

1 to 99	chassis, front and rear panel mounted components
100 to 199	"low" channel filter/triac p.c.b.
200 to 299	"mid" channel filter/triac p.c.b.
300 to 399	"high" channel filter/triac p.c.b.
400 to 499	pre-amplifier/power supply p.c.b.

The low-level "microphone" input from SK2 is applied to a conventional inverting operational amplifier stage (IC401a) which provides a voltage gain of approximately five and an input impedance of approximately 50k. The output of this stage is then applied to an adjustable gain amplifier stage (IC401b) which provides a maximum voltage gain of approximately 50. The resulting signal level at the output of IC401b is then typically in the range 200 to 500mV r.m.s.

The three filter stages IC101, IC201 and IC301 (for the "low", "mid" and "high" frequency ranges respectively) are each based on a single-stage operational amplifier. The output from each stage is fed to a voltage doubler rectifier arrangement (D101/D102, D201/D202 and D301/D302). The output of each rectifier arrangement is fed to a parallel C-R "hold" circuit (R105/C106, R205/C206 and R305/C306). The resulting voltage is applied to the input of a comparator stage (IC102, IC202 and IC302), the reference input of which is made adjustable (by means of VR101, VR201 and VR301 respectively).

When the rectified voltage produced by each rectifier/hold arrangement exceeds the pre-set threshold voltage, the output of the respective comparator (pin-7) goes low. This causes a current of approximately 19mA to flow in the series connected channel indicator and opto-isolator l.e.d. associated with the channel in question.

The triac output of the opto-isolator has an internal zero-axis crossing detector which is instrumental in minimising transient disturbances and noise generated on the a.c. supply rail. The triac is triggered into conduction no more than 10ms after the signal at the output of its respective comparator stage is taken low.

The low-power triac within each opto-isolator is connected so that it, in turn, provides a triggering current pulse to the power triac associated with the channel in question (CSR101, CSR201 and CSR202). A "snubber" circuit (R110/C109, R210/C209 and R310/C309) is connected across the a.c. switching terminals associated with each triac. This C-R arrangement helps to reduce the rise time of the fast switching transients produced by the triacs and thus can help to reduce radiated noise and radio frequency interference (RFI).

A simple dual-rail power supply/bridge rectifier arrangement (T1, D401 to 404, C404 and C405) provides the necessary unregulated d.c. supply rails required by the operational amplifiers and com-

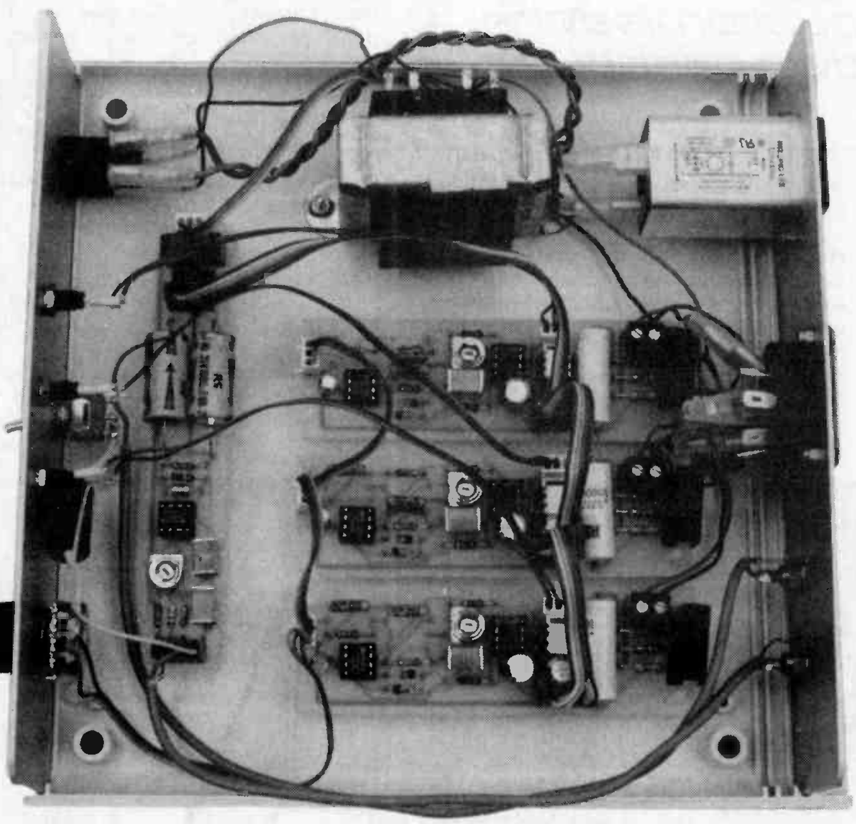
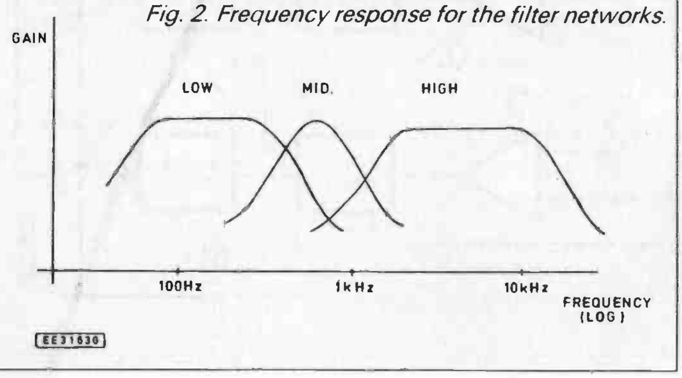
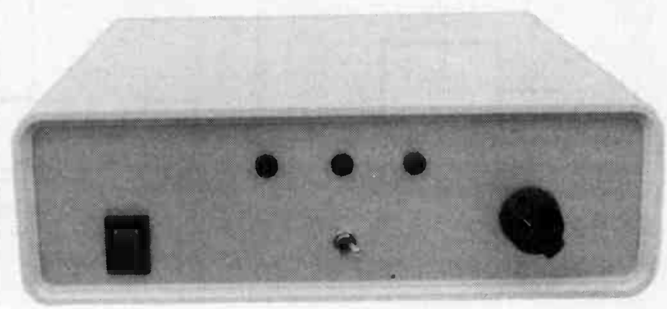


Fig. 2. Frequency response for the filter networks.





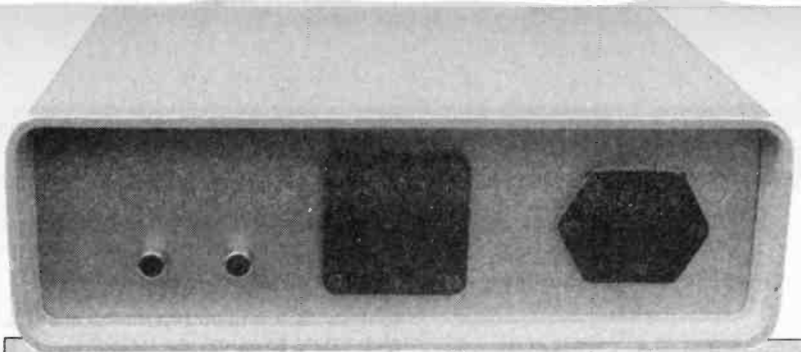
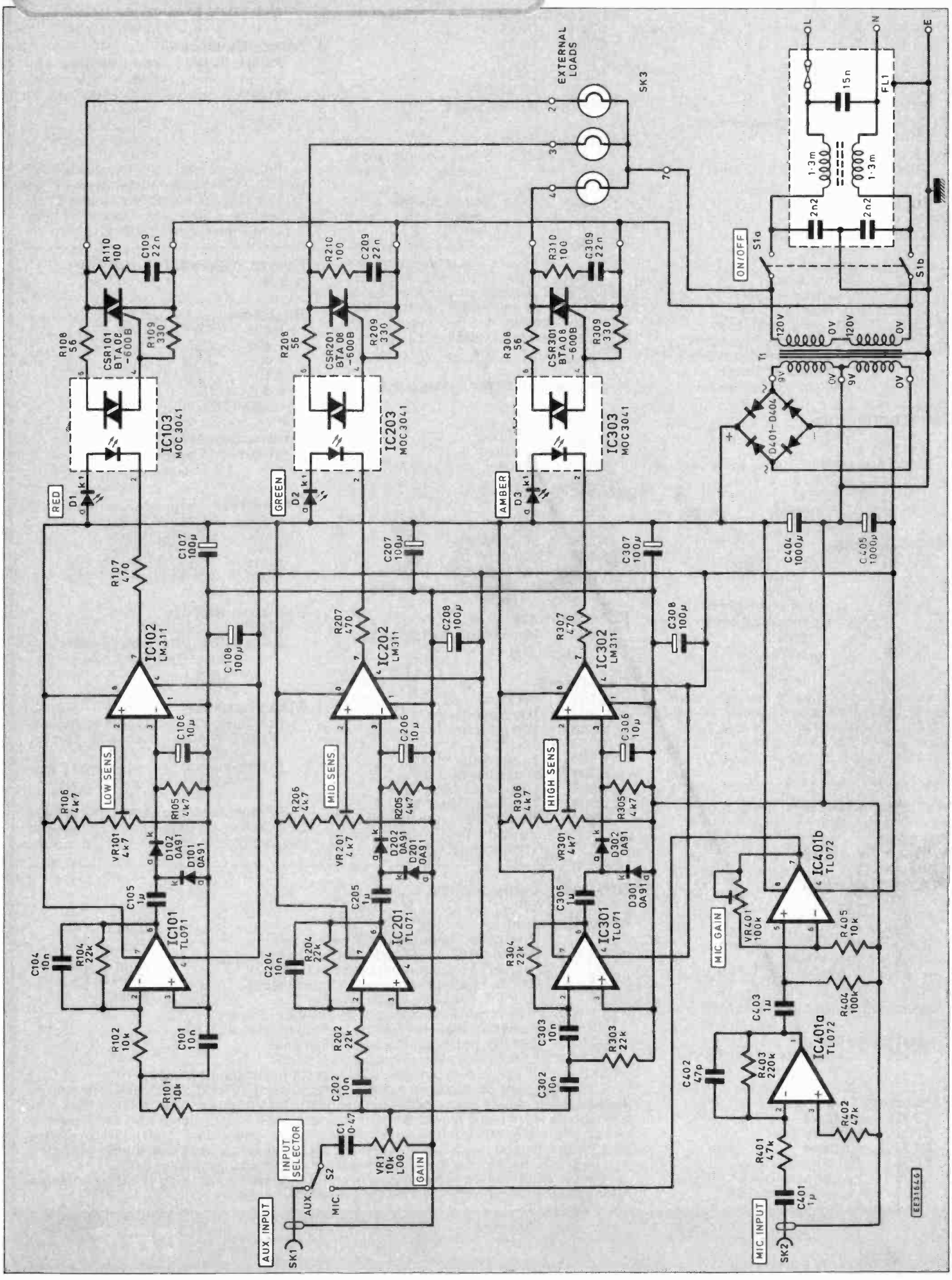


Fig. 3. (below) Complete circuit of the Disco Lights Controller.



COMPONENTS

Low channel filter/triac p.c.b.

Resistors

R101	10k
R102	10k
R103	not fitted
R104	22k
R105	4k7
R106	4k7
R107	470
R108	56 0.5W 5%
R109	330 0.5W 5%
R110	100 0.5W 5%

All 0.25W ±5% unless otherwise stated

Potentiometers

VR101 1k miniature horizontal pre-set

Capacitors

C101	10n polyester
C102	not fitted
C103	not fitted
C104	10n polyester
C105	1µ polyester layer
C106	10µ radial elect 16V
C107	100µ radial elect. 16V
C108	100µ 16V radial elect. 16V
C109	22n 1000V polypropylene (rated for 350V continuous a.c. operation)

Semiconductors

D101	OA91
D102	OA91
IC101	TL071
IC102	LM311
IC103	MOC3041
CSR101	BTA08-600B

Miscellaneous

PL101, PL102	3-way straight p.c.b. header (0.1 inch pitch)
PL104	5-way straight p.c.b. header (0.1 inch pitch)
PL103	2-way p.c.b. mounting screw terminal

Printed circuit board available from the *EE PCB Service*, order code EE756; TO220 clip-on heatsink (24 deg.C/W); 6-pin low-profile d.i.l. socket (1 off); 8-pin low-profile d.i.l. sockets (2 off)

Mid channel filter/triac p.c.b.

Resistors

R201	not fitted
R202	22k
R203	not fitted
R204	22k
R205	4k7
R206	4k7
R207	470
R208	56 0.5W 5%
R209	330 0.5W 5%
R210	100 0.5W 5%

All 0.15W ± 5% unless otherwise stated.

Potentiometers

VR201 1k miniature horizontal pre-set

Capacitors

C201	not fitted
C202	10n polyester
C203	not fitted
C204	10n polyester
C205	1µ polyester layer
C206	10µ radial elect. 16V
C207	100µ radial elect. 16V
C208	100µ radial elect. 16V
C209	22n 1000V polypropylene (rated for 350V continuous a.c. operation)

Semiconductors

D201	OA91
D202	OA91
IC201	TL071
IC202	LM311
IC203	MOC3041
CSR01	BTA08-600B

Miscellaneous

PL201, PL202	3-way straight p.c.b. header (0.1 inch pitch)
PL204	5-way straight p.c.b. header (0.1 inch pitch)
PL203	2-way p.c.b. mounting screw terminal

Printed circuit board available from the *EE PCB Service*, order code EE756; TO220 clip-on heatsink (24 deg.C/W); 6-pin low-profile d.i.l. socket (1 off); 8-pin low-profile d.i.l. sockets (2 off)

High channel filter/triac p.c.b.

Resistors

R301	not fitted
R302	not fitted
R303	22k
R304	22k
R305	4k7
R306	4k7
R307	470
R308	56 0.5W 5%
R309	330 0.5W 5%
R310	100 0.5W 5%

All 0.25W ± 5% unless otherwise stated

Potentiometers

VR301 1k miniature horizontal pre-set

Capacitors

C301	not fitted
C302	10n polyester
C303	10n polyester
C304	not fitted
C305	1µ polyester layer
C306	10µ radial elect. 16V
C307	100µ radial elect. 16V
C308	100µ radial elect. 16V
C309	22n 1000V polypropylene (rated for 350V continuous a.c. operation)

Semiconductors

D301	OA91
D302	OA91
IC301	TL071
IC302	LM311
IC303	MOC3041
CSR301	BTA08-600B

Miscellaneous

PL301, PL302	3-way straight p.c.b. header (0.1" pitch)
PL304	5-way straight p.c.b. header (0.1" pitch)
PL303	2-way p.c.b. mounting screw terminal

Printed circuit board available from the *EE PCB Service* order code EE756; TO220 clip-on heatsink (24 deg.C/W); 6-pin low-profile d.i.l. socket (1 off); 8-pin low-profile d.i.l. sockets (2 off)

Power supply/preamplifier p.c.b.

Resistors

R401	47k
R402	47k
R403	220k
R404	100k
R405	10k

All 0.25W ± 5%

Potentiometers

VR401 1k miniature horizontal pre-set

Capacitors

C401	1µ polyester layer
C402	47p polystyrene
C403	1µ polyester layer
C404	1000µ axial elect. 25V
C405	1000µ axial elect. 25V

Semiconductors

IC401	TL072
D401-D404	1.6A bridge rectifier (e.g. SKB2/02L5A)

Miscellaneous

PL401, PL402, PL403, PL405	5-way straight p.c.b. headers (0.1 inch pitch)
PL405	3-way straight p.c.b. header (0.1 inch pitch)

Printed circuit board available from the *EE PCB Service*, order code EE755; 8-pin low-profile d.i.l. socket

Off-board components

Miscellaneous

D1	Red panel mounting l.e.d. (with bezel)
D2	Green panel mounting l.e.d. (with bezel)
D3	Amber panel mounting l.e.d. (with bezel)
S1	D.P.D.T. mains rocker switch (illuminated)
S2	D.P.S.T. miniature toggle switch
T1	12VA mains transformer with 240V a.c. primary and two secondary windings each rated at 9V 0.6A
VR1	10k log. potentiometer and pointer knob
SK1, SK2	Chassis mounting phono sockets (2 off)
SK3	8-way non-reversible mains socket (and matching plug)

0.25 inch push-on blade receptacles (and covers) (11 off); Enclosure (to suit individual constructor's preference – but see text); 10mm plastic p.c.b. fixing pillars with self-tapping No. 6 fixing crews (8 off); 3-way straight 0.1 inch pitch p.c.b. "free" connectors (7 off); 5-way straight 0.1 inch pitch p.c.b. "free" connectors (5 off); IEC 6A chassis plug (with filter and fuseholder – see note); 5A 20mm quick-blow mains fuse; Mounting nuts and bolts, transformer frame earthing tag and front and rear panel (3 off);
(**Note:** Whilst not essential, the use of an IEC 6A chassis filter plug (FL1) with integral fuseholder is strongly recommended for use with this project.)

See SHOP TALK Page

Approx cost guidance only **£65** *plus case*

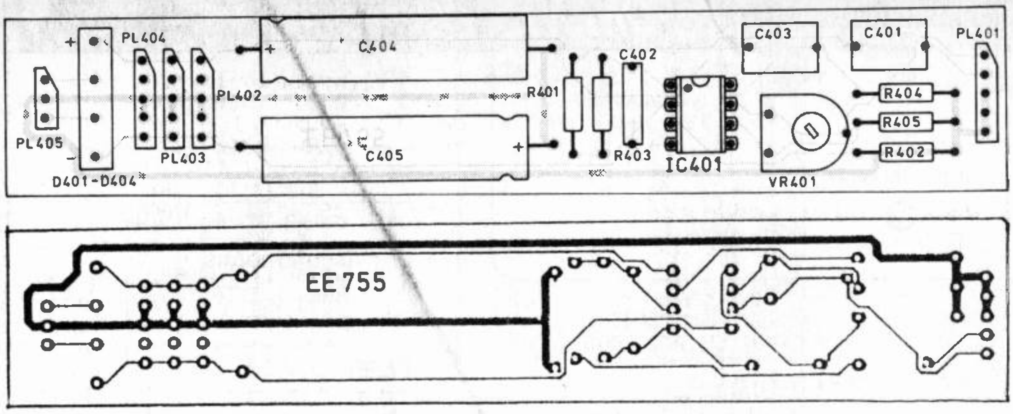


Fig. 4. Preamplifier/ power supply p.c.b. copper foil and component layout.

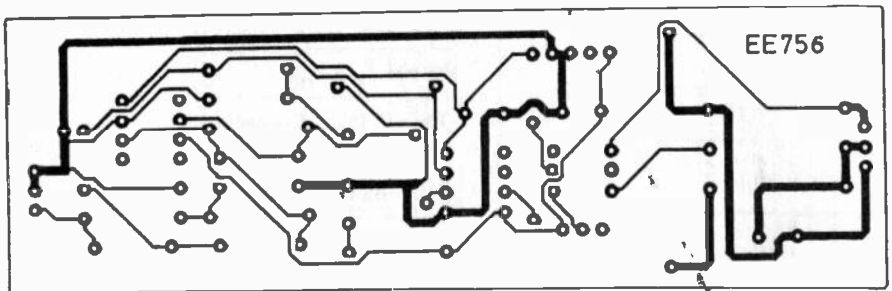


Fig. 5. Filter/triac p.c.b. copper foil layout.

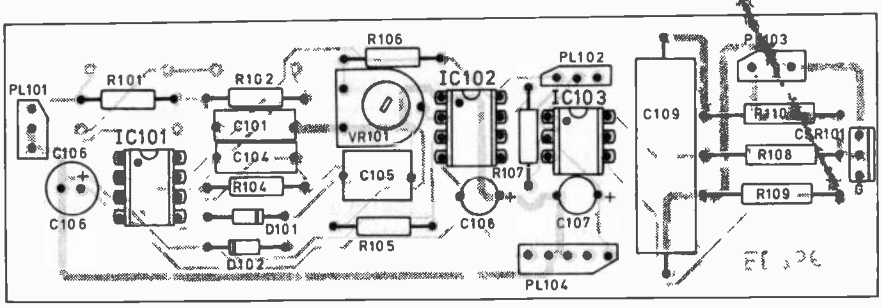


Fig. 6(a). "Low" range filter/triac p.c.b. layout.

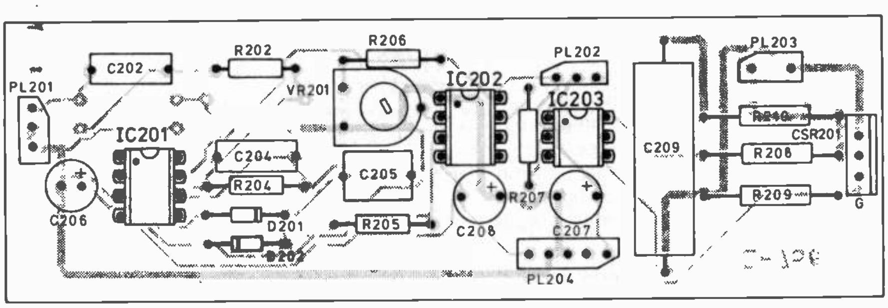


Fig. 6(b). "Mid" range filter/triac p.c.b. layout.

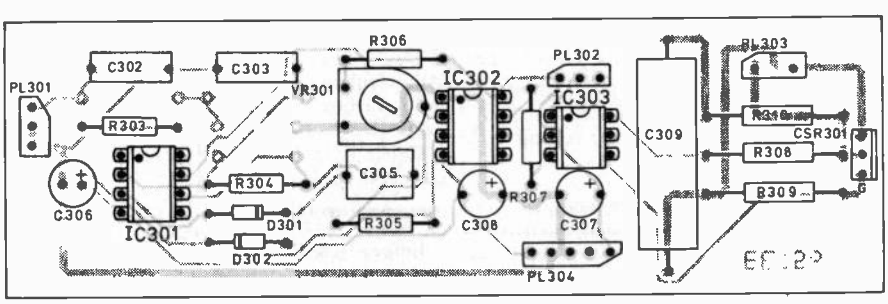


Fig. 6(c). "High" range filter/triac p.c.b. laybout.

parators. In order to further minimise noise and RFI (which may otherwise be fed back into the mains supply) a low-pass mains filter (FL1) is incorporated.

CONSTRUCTION

Construction of the Disco Lights Controller is relatively straightforward. With the exception of the front and rear panel mounted components and the mains transformer, all of the components are assembled on four single-sided printed circuit boards. One of these boards is used for the power supply and pre-amplifier whilst the remainder contain the active filters, comparators, opto-isolators and triacs associated with each of the three channels.

The copper foil and component layout of the preamplifier/power supply printed circuit board is shown in Fig. 4. Fig. 5 shows the copper foil layout of each of the filter/triac printed circuit boards. Note that the same *copper foil* layout is used for all three channels.

The component side layout for each of the filter/triac boards is shown in Fig. 6a, b and c. Note that, by virtue of the different filter arrangements employed, not all of the components are fitted on each channel.

Components should be assembled on the four printed circuit boards in the following sequence; p.c.b. headers, p.c.b. screw terminals (if required), d.i.l. sockets, preset resistors, resistors, capacitors, and triacs. 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, integrated circuits and triac) it is absolutely essential to ensure that each component is correctly orientated.

When construction of the printed circuit boards has been completed (and before inserting the 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 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!

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

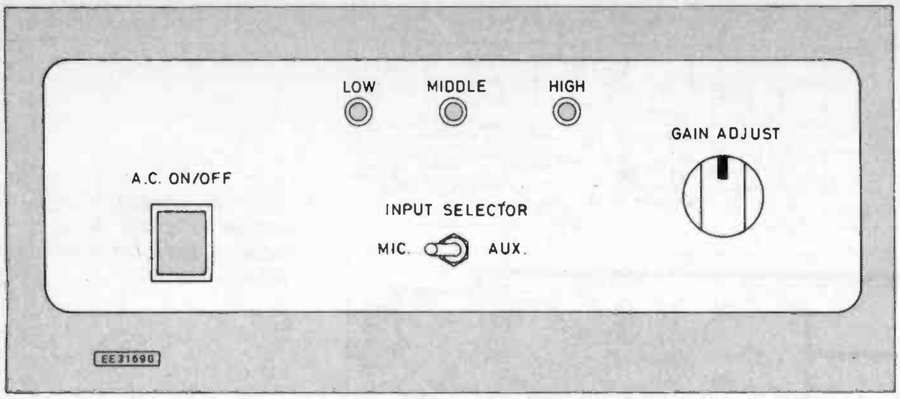


Fig. 7. Recommended front panel layout.

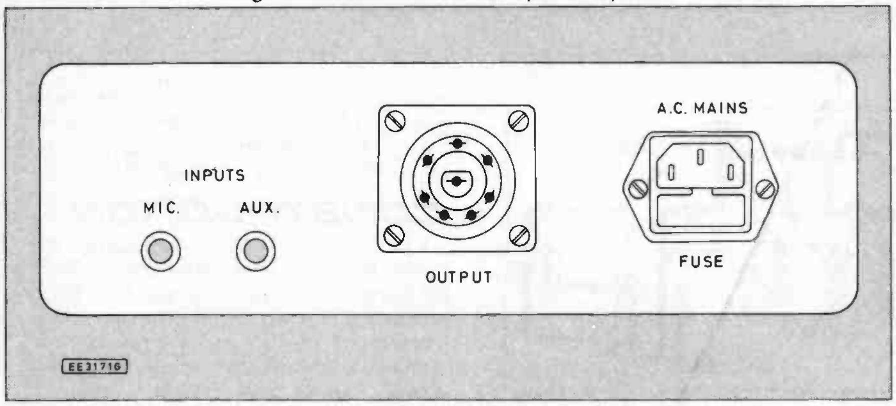


Fig. 8. Recommended rear panal layout.

CASE

The Disco Lights Controller should be housed in an ABS enclosure with aluminium front and rear panels. The enclosure used for the prototype unit measured approximately 220 x 230 x 70mm and was fitted with detachable front and rear aluminium panels. In practice, the precise dimensions of the enclosure are unimportant provided adequate room is made available to accommodate all four of the printed circuit boards along with the mains transformer.

The front and rear panels 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 and l.e.d. channel indicators. Figs. 7 and 8 show the front and rear panel layouts and markings used in the prototype.

Once the front and rear panels have been drilled to accommodate the controls, indicators and sockets, the four printed circuit boards can be mounted by means of four plastic snap-fit p.c.b. mounting pillars secured to the base of the enclosure.

Connections to the printed circuit boards are made using various 0.1 inch pitch printed circuit board headers and p.c.b. mounting screw terminals, as follows:

Connector	Type	Function reference
PL101	3-way	Signal input to "low" channel filter/triac board
PL201	3-way	Signal input to "mid" channel filter/triac board
PL301	3-way	Signal input to "high" channel filter/triac board
PL102	3-way	L.E.D. indicator output from "low" channel filter/triac board
PL202	3-way	L.E.D. indicator output from "middle" channel filter/triac board
PL302	3-way	L.E.D. indicator ouput from "high" channel filter/triac board
PL103	2-way	Triac output from "low" channel
PL203	2-way	Triac output from "mid" channel
PL303	2-way	Triac output from "high" channel
PL104	5-way	Power supply input to "low" channel filter/triac board
PL204	5-way	Power supply input to "mid" channel filter/triac board
PL304	5-way	Power supply input to "high" channel filter/triac board
PL401	5-way	Pre-amplifier signal input/output
PL402	5-way	Power supply output (to filter/triac boards)
PL403	5-way	Power supply output (spare)
PL404	5-way	Power supply output (spare)

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

PL101, PL201, PL301 (commoned)

Pin	Colour	Connection to:
1	Brown	VR1 (slider)
2	Red	VR1 (common end)
3	Orange	VR1 (body/front panel)

PL102

Pin	Colour	Connection to:
1	Green	D1 (anode)
2	Blue	D1 (cathode)
3	n.c.	

PL202

Pin	Colour	Connection to:
1	Green	D2 (anode)
2	Blue	D2 (cathode)
3	n.c.	

PL302

Pin	Colour	Connection to:
1	Green	D3 (anode)
2	Blue	D3 (cathode)
3	n.c.	

PL103

Pin	Colour	Connection to:
1	Red	SK3 2
2	Black	T1 (neutral) and PL203 2

PL203

Pin	Colour	Connection to:
1	Red	SK3 3
2	Black	PL103 2 and PL303 2

PL303

Pin	Colour	Connection to:
1	Red	SK3 4
2	Black	PL203 2

PL104, PL204, PL304 (commoned)

Pin	Colour	Connection to:
1	Brown	PL402 1
2	Red	PL402 2
3	Orange	PL402 3
4	Yellow	PL402 4
5	Green	PL402 5

PL401

Pin	Colour	Connection to:
1	Yellow	S2 (mic)
2	Coax.	SK2 (signal) inner
3	n.c.	
4	n.c.	
5	Coax.	SK2 (common) screen

PL402

Pin	Colour	Connection to:
1	Brown	PL104, PL204, PL304 1
2	Red	PL104, PL204, PL304 2
3	Orange	PL104, PL204, PL304 3
4	Yellow	PL104, PL204, PL304 4
5	Green	PL104, PL204, PL304 5

The internal wiring of the Disco Lights Controller is shown in Fig. 9.

TESTING

Before testing the Disco Lights Controller, it is important to carefully check the wiring of the printed circuit boards, mains transformer, and front and rear panel mounted components. A 5A quick-blow

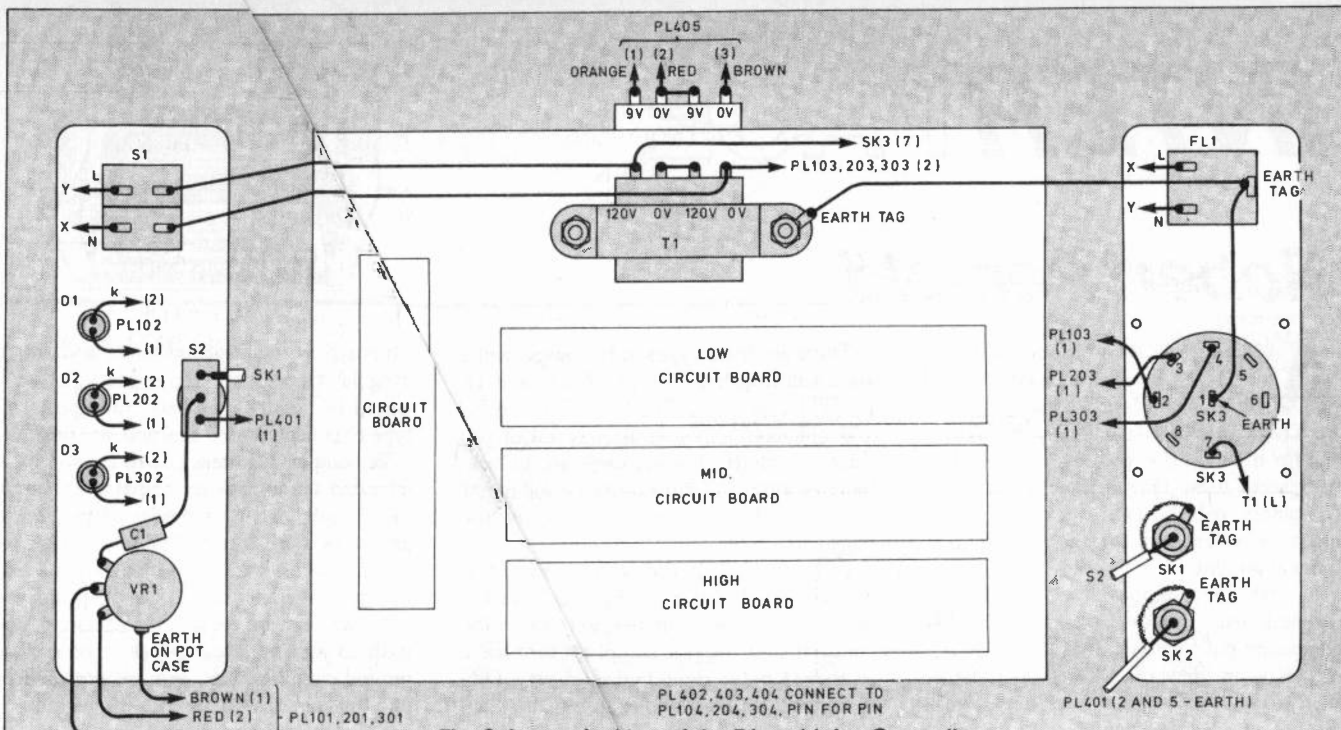


Fig. 9. Internal wiring of the Disco Lights Controller.

fuse should be fitted in the fuseholder but the initial testing should be carried out *without* connecting the disco lights to the unit.

The variable gain control (VR1) should be set to maximum-position whilst all three pre-set variable resistors should be set to mid-position. Connect the mains supply and switch the unit "on". The mains indicator (integral within the mains rocker switch) should be illuminated whilst all three of the channel indicator l.e.d.s (D1, D2 and D3) should be extinguished. If this is not the case, check S1, T1 (primary), FL1 and associated wiring.

Now measure the d.c. voltage across C404 and C405 (on the pre-amplifier/power supply p.c.b.). These voltages should be in the range +12V to +13.5V and -12V to -13.5V, respectively. If this is not the case, check T1 (secondary), PL5 and associated wiring before checking PL104, PL204, PL304 and each filter/triac p.c.b. in turn.

With no signal present, the settings of the three preset resistors should be advanced (turned clockwise) until each respective channel indicator l.e.d. becomes illuminated. Once this position has been found, the respective control should be backed-off slightly (anti-clockwise) until the l.e.d. in question just becomes extinguished. If one (or more) l.e.d.s fail to become illuminated, leave the preset control in question at its most extreme clockwise setting.

Having checked the l.e.d. indicators and adjusted the preset controls for maximum sensitivity, a signal should now be connected via the "auxiliary" input (SK1). For test purposes, the signal can be derived directly from the loudspeaker of a small portable radio or cassette player (leaving the speaker connected so that the signal can be heard). The input selector switch should be placed in the "aux" position and VR1 set to the minimum position.

Adjust the signal in the loudspeaker for moderate volume and advance the setting of VR1, noting the point at which each of the three channel indicator l.e.d.s become illuminated. Carefully adjust the three pre-set controls until the all three l.e.d.s flash in sympathy with the music at the same setting of VR1 (some experimentation may be necessary here in order to find the optimum setting depending upon the signal source used).

In order to test the microphone (low-level) input facility, disconnect the signal from the "auxiliary" input, switch the input selector to the "mic" position, and connect a dynamic microphone (of between 5k and 50k impedance) to the "microphone" input (SK2). Place the microphone close to the loudspeaker and adjust VR401 until the channel indicator l.e.d.s produce a satisfactory indication of the signal.

Finally, connect the disco lights to the unit and check that the lamps flash in sympathy with the music (and the channel indicator l.e.d.s). The disco lights should be wired as follows:

Pin	Connection
2	Channel 1 lamp(s) (neutral connection)
3	Channel 2 lamp(s) (neutral connection)
4	Channel 3 lamp(s) (neutral connection)
7	Common (line) connection to all lamps
8	Earth

(NB: The total load on any channel should not exceed 300W)

MODIFICATIONS

A number of modifications can be made in order to enhance the performance of the basic Disco Lights Controller. As always, 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.

Stereo Operation

The Disco Lights Controller can be very easily adapted for stereo operation by simply duplicating the circuit for left and right hand channels. A single mains transformer can be used (rated at 20VA) whilst S1 and VR1 should be replaced by double-pole and stereo-ganged components respectively.

Additional channels

The Disco Lights Controller can also be very easily modified to provide additional channels by simply adding additional filter/triac cards based on the mid-range filter network. As an example, the recommended configuration for a fourth channel ("upper-mid" frequency range) involves:

C502 4n7
C504 4n7
R502 27k
R504 27k

All other components remain the same.

Stereo loudspeaker signal combiner

In many practical applications it is convenient to drive the Disco Lights Controller directly from a loudspeaker output rather than from anywhere else. Unfortunately, such an arrangement can pose problems where the amplifier output is stereo (i.e. there are two separate loudspeaker channels) and the Disco Lights Controller is only configured for mono operation.

A stereo loudspeaker coupler that can be used to combine the "left" and "right" channel loudspeaker outputs in order to provide a composite (left/right) signal which can be fed to the auxiliary input of the the Disco Lights Controller is shown in Fig. 10. □

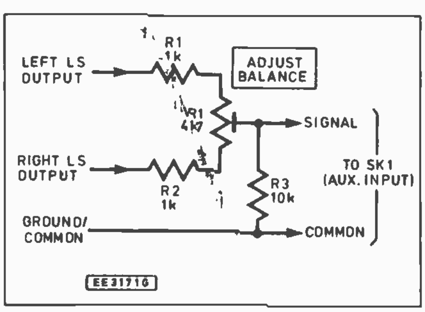


Fig. 10. Stereo loudspeaker signal combiner.

INTERFACE

Robert Penfold

ALTHOUGH it is not long ago that several *Interface* articles were devoted to the IBM PCs and compatibles, we are returning to these computers this month, and for the next two or three months. This may seem a bit unfair on users of other computers, but the PCs seem to generate much more feedback than any other computer at present.

In fact they probably generate more feedback from readers than all the other computers put together. This is perhaps not surprising in view of the large number of PCs in use today, and the relatively small amount of published information on interfacing to them.

On The Cards

In this months article we will consider the subject of PC prototyping cards. These vary from simple circuit boards that have no electronics at all until you add some, through to complex systems that have multi-output address decoding, buffering, and the ability to take several plug-in prototyping "daughter" boards. Here we will only be concerned with simple "passive" boards, but next month we will delve into active boards which have built-on address decoding.

If you look through some of the larger American computing magazines you are likely to find several advertisements for PC prototype cards, including some passive types at quite modest prices. Unfortunately, most of these cards are not imported into the U.K., and those that are mostly seem to cost substantially more in this country than in the USA. I may have overlooked something, but the only reasonably inexpensive PC prototyping cards I have been able to locate are the ones sold by Maplin.

There are three types in the range, which are a half length 8-bit type, plus 8- and 16-bit full length cards. The half length card at 216 millimetres long is actually about two thirds length (the full size cards are 333 millimetres long). All three cards are full height at about 100 millimetres or so excluding the edge connector.

Each terminal of the edge connector is brought out to an individual pad, and the pads are in two rows immediately above the connector. At the rear end of the card there is provision for right-angled 25-way DIN connector, plus some holes on a 0.1in. pitch for a connector block etc. This provides a convenient means of connecting prototype cards to the outside world.

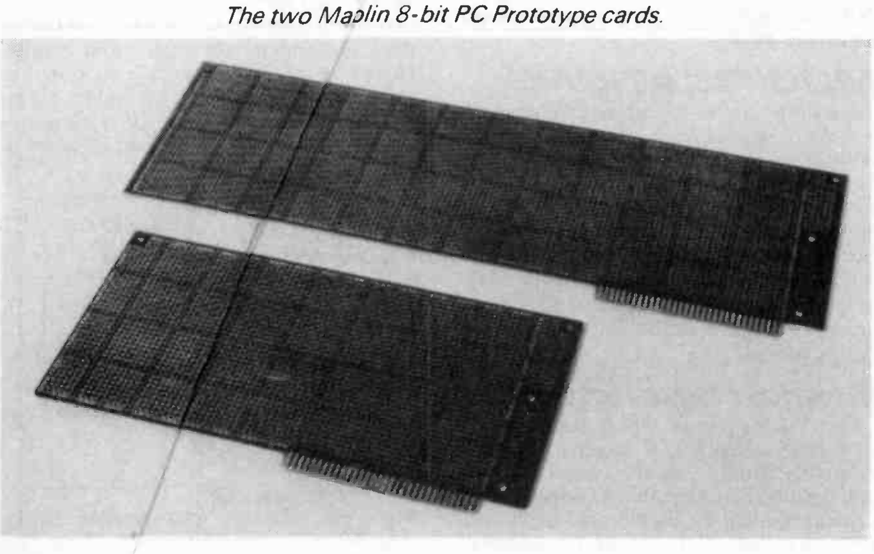
No fixing brackets are supplied with these cards, but prototype cards are not usually bolted in place. Continually bolting them in place and unscrewing them again is time consuming, and over a period of time could seriously wear the computer's mounting frame.

The main part of each card is covered with a matrix of one millimetre diameter through-plated holes on a 0.1in. pitch. Apart from power buses around the perimeter of the board, these holes are not joined together in stripboard fashion. The idea is presumably to use wire-wrapping techniques when building prototype circuits, or to simply wire them up using thin insulated wire.

At around £19 to £25 per board including VAT, these cards might not seem to be very reasonably priced. However, it is not realistic to expect them to cost about the same as a piece of stripboard having a similar area. These are tough fibreglass boards, not thin s.r.b.p. types.

Furthermore, they are doubled-sided with expensive through-plated holes, and are an irregular shape due to the edge connector. It would be totally unrealistic to expect this type of product to sell at stripboard prices.

The two Maplin 8-bit PC Prototype cards.



Remember that these boards are not really intended as the basis for a final unit, but are merely intended as a means of permitting prototype circuits to be tested. Having perfected a circuit it is then transferred to a custom printed circuit board, and the prototype card can then be reused. Of course, if you wish to avoid the complication of custom printed circuit boards, and are prepared to pay the cost of these boards, they could be used for the finished product.

I have not had a chance to make extensive use of these cards yet, but they seem to be good practical products. They are of excellent quality, and enable projects such as PIO ports to be easily tested out and perfected. However, even with quite simple circuits the end result is likely to be something of a "birds nest", but the aim is to check and perfect circuits, not to produce neat results.

It is easy to recommend these cards due to a lack of any obvious competition! About the only way of obtaining a reasonable PC prototype card system at a much lower cost is to take the do-it-yourself approach.

DIY Protocards

Over the past year or so I have experimented with a number of ideas for home constructed PC prototype cards. The obvious route is to produce something similar to the commercial prototype cards. This is difficult though, since the board would have to be very intricate in the area where the connections to the edge connector are made. Also, drilling all those thousands of holes could take an hour a day for weeks, and wear out numerous drill bits!

In order to be really practical for home construction a somewhat simpler form of card is required. One obvious simplification is to reduce the number of connections to the two by 31-way edge connector to the bare minimum.

Although there are 62 terminals on the edge connector, most of these do not connect to functions on the expansion bus that you will ever need. All that is required for most projects are the lower ten address lines, three control bus lines, the data bus, and the supply lines.

This simplifies things to the point where this area of the board presents no real problems, provided you are prepared to face up to a double-sided board. The board must be double-sided because the supply lines and two lines of the control bus are on the opposite side of the connector to the rest of the lines.

On the main part of the board there is no need for a complete matrix of holes. Some d.i.l. clusters connected to some pads are sufficient to accommodate TTL chips, a PIA chip, or whatever. A small area of pads and copper strips will accommodate transistor oscillators, amplifiers, etc. Provision for a 25-way D-connector for input/output lines is more than a little helpful.

This basic scheme of things enables quite a simple but effective PC prototyping card to be produced, such as the design in Fig.1 and Fig.2. The on-board legends help to identify the pads which connect to the edge connector, and should reduce mistakes when wiring up the card. A complete list of these connections, working from left to right as viewed in Fig.1, is as follows: A0, A1, A2, A3, A4, A5, A6, A7, A8, A9, (gap) IOR, IOW, −12V, AEN, +12V, D0, D1, D2, D3, D4, D5, D6, D7, 0V, +5V, and −5V.

It is advisable to fit the d.i.l. clusters with holders. Bear in mind that the 40-way cluster will also accept 24- or 28-pin devices. Also, the 20-pin clusters for instance, will accommodate 8-, 14-, 16-, or 18-pin d.i.l. devices. This makes the board at little more versatile than it might at first appear.

Single-side pins are fitted to the board at the pads which connect to the edge connector, and these are soldered on both sides of the board. Solder pins are also fitted to the pads that connect to the d.i.l. clusters, and these provide an easy means of wiring up prototype circuits using thin, multi-strand insulated wire. Of course, wire-wrapping methods can be used if preferred.

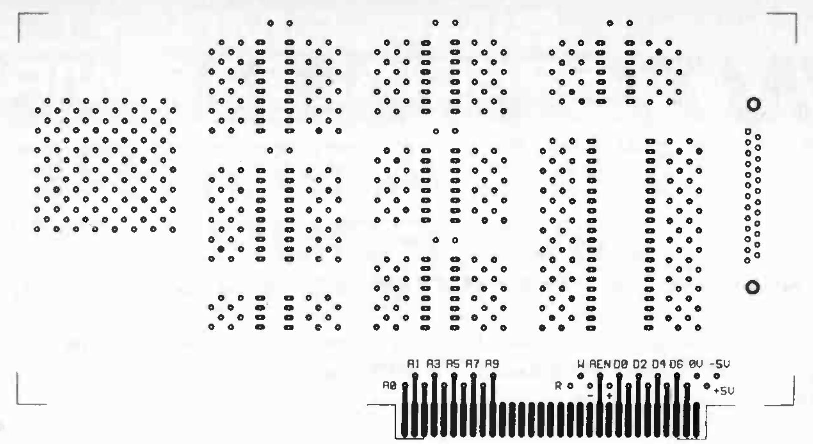


Fig. 1. The component side of the DIY PC Protocard.

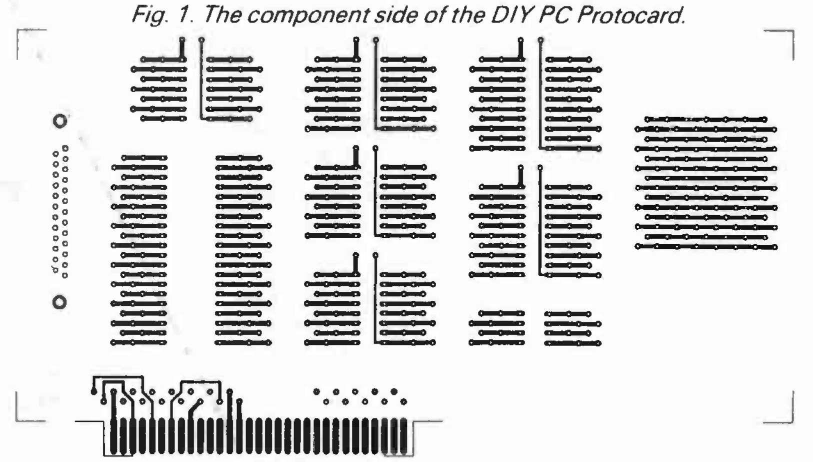


Fig. 2. The underside of the PC Protocard.

Decoupling Pads

You will notice that there are pairs of pads above most of the d.i.l. clusters. These will take 100n ceramic decoupling capacitors, which are likely to be a necessity when using TTL devices on the board. In most cases the pads will be found to connect to the right pins of the cluster, but in some cases a bit of hard-wiring and (possibly) track cutting will be needed.

This prototyping board is really only offered as a starting point. It should actually suit most PC prototyping quite well, but if you are making your own boards there should be little difficulty in modifying it to suit your precise requirements. You might prefer to have an extra 40-pin socket and fewer smaller sockets for example.

Strip-O-Board

My initial approach to PC prototype cards was to produce an edge connector plus pads, much like that in Fig.1 and Fig.2, but with only a small area of board above this. The basic idea was to bolt a piece of stripboard (or similar) to the edge connector. The prototype circuit would then be built on the stripboard, and wired up to the edge connector.

Although basically a good idea, it failed dismally in practice. The problem is that stripboard is not particularly strong. It is made from a thin s.r.b.p. material, and not from heavy grade fibreglass. Fitting and removing the card tends to break the stripboard away from the edge connector.

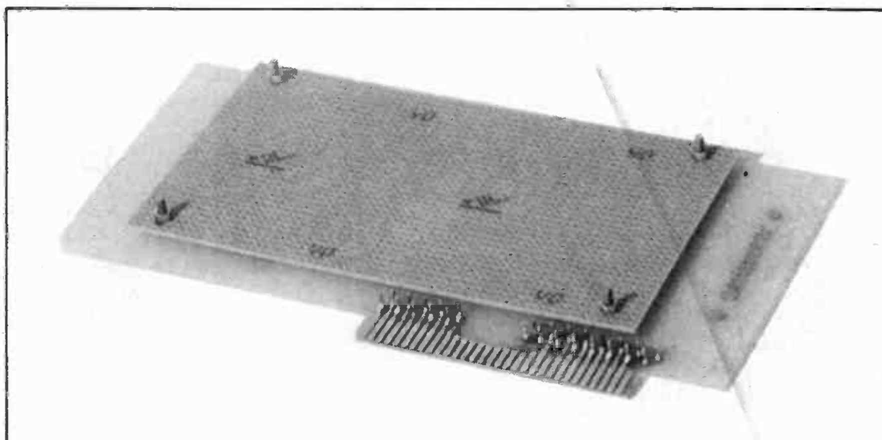
A more successful approach is to make a card like the one in Fig.1 and Fig.2, but to leave the main area of the board blank except for the 25-way D-connector pads. A hole is then carefully drilled in each corner of a suitable piece of stripboard.

Matching holes are then drilled in the PC card so that the stripboard can be bolted in place on the card. Use an extra nut on each mounting bolt to act as a short spacer between the card and the stripboard.

The advantages of this method are that the board is more securely held in place, and there is no need to hold the stripboard at all when fitting and removing the card. Provided you do not go at things in a "bull in a china shop" fashion, the stripboard should survive intact until the circuit has been perfected and thoroughly tested. A new stripboard can then be prepared and fitted to the card, which can be reused many times.

One useful refinement, but one which has not yet been tried, would be to cut a "window" in the card behind the piece of stripboard. The point of this is that it would facilitate changes to the circuit board without having to keep removing and refitting it to the card.

This would greatly speed things up, and would make the card much more convenient to use. Also, provided the stripboard and "window" are not made too large, this method should not weaken the card to the point where it is in danger of being broken in normal use.



The stripboard version of the DIY PC prototype card.

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- Micro Micro (Sept '91)........ plus £1 p&p ☐
- Centurion Tank (Oct '91)........ plus £1 p&p ☐
- Mini Microwave (Nov '91)........ plus £1 p&p ☐
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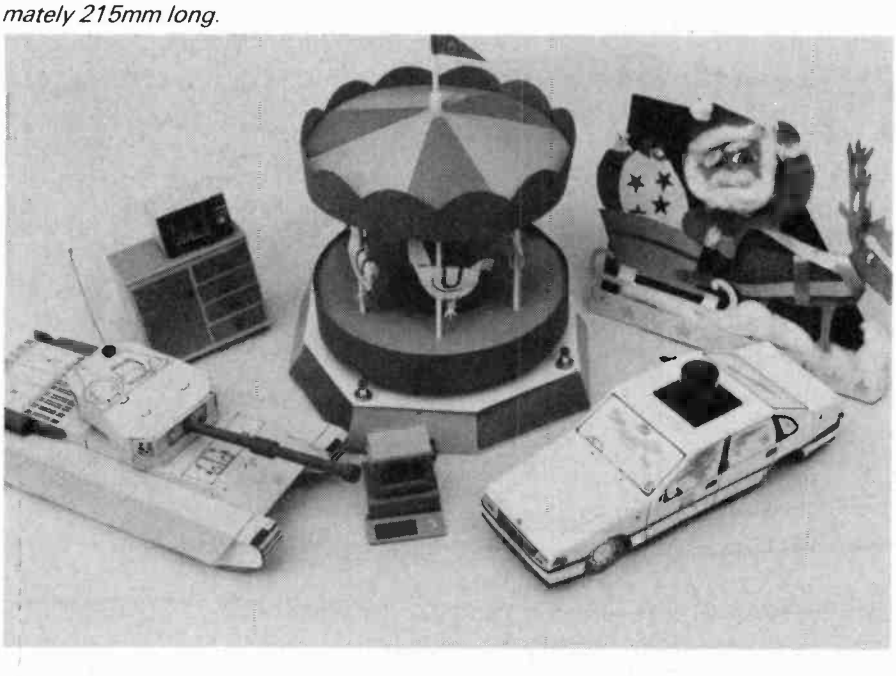
OWEN BISHOP

PROJECT 1

A novel series which combines two hobbies in one – electronics and model-making. Simple electronics circuits combined with easy-to-assemble models will cover a wide range of interests. There will be whimsical models and realistic scale models. There will be models for the railway enthusiast, miniature furniture for the doll's house, and toys for all ages. The models that form the first six parts of the series are; Police Car; Musical Roundabout; Micro Micro; Centurion Tank; Mini Microwave; Christmas Novelty.

The first six models of the series. To give an idea of scale the police car is approximately 215mm long.



In this series we use integrated circuits as much as possible to keep the wiring simple and to cut down on the size of the circuit boards. Assembly by the Vero Easiwire wire-wrapping system means that model-makers need not worry about soldering.

Circuit-boards made of card are provided by us. They show where all the components should go, so there should be no problems with getting everything to work first time. All projects are battery-powered for safety.

Models are made of easily handled materials such as cardboard, plastic, modelling compound and other inexpensive items that can be obtained from any modelling shop. You will also need some adhesives and paints or crayons.

Few tools are required other than a pair of scissors, a steel ruler and a craft knife.

THIS 1:20 scale model is based on the Vauxhall Cavalier SRi, which has a 2-litre 4-cylinder engine giving a top speed of 125 mph, and an acceleration from 0 to 60 in 8.9 seconds. The design shows the car trimmed in a general police livery but you can eaily substitute that of your local police force. The electronics provides the car with four flashing yellow indicator lamps, a blue flashing roof beacon, and a siren sound.

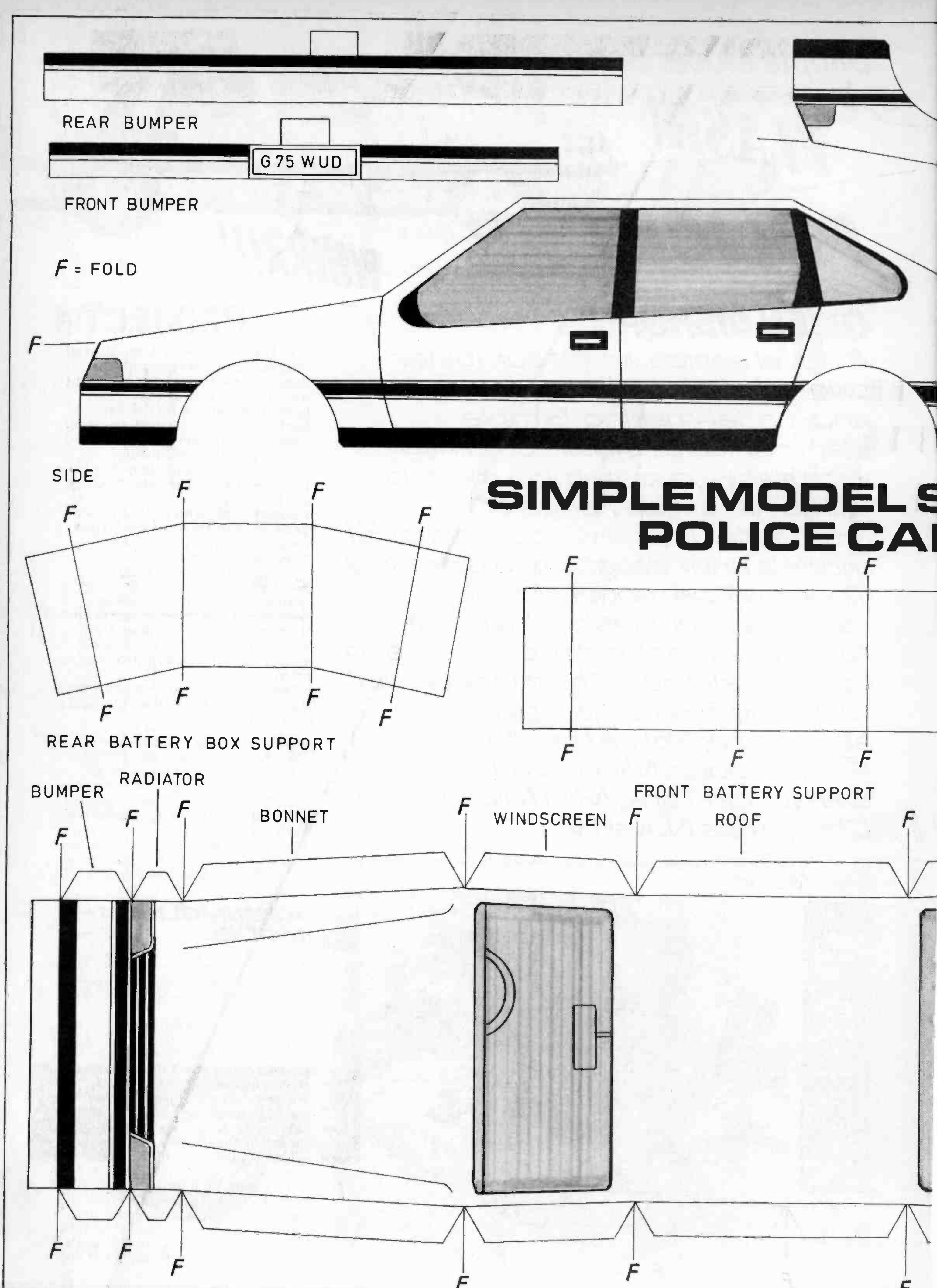
ASSEMBLING THE MODEL

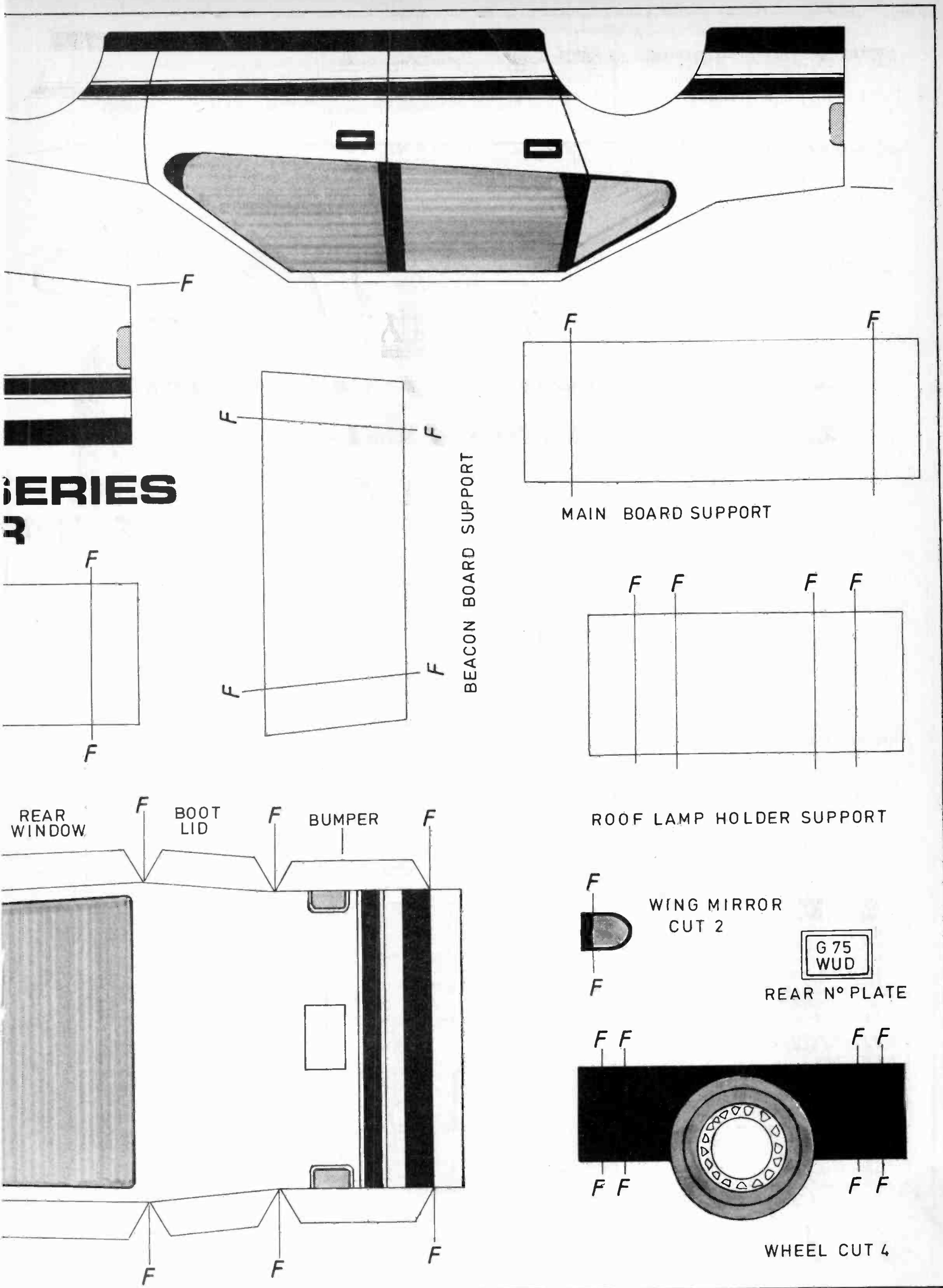
You can either photostat the layout for the car shown onto thin 400 g/m^2 card or send for the printed card – see components box, Shop Talk and the Special Offer page.

Cut out the two sides and the bonnet/roof/boot (BRB). Score (see box) along the FF lines. Fold the sides slightly along the FF line. Fold the flaps fully inward at either end of the BRB and stick them to the inside of the bumper area. This is to give extra strength to these ends. Fold the flaps along one side of the BRB at right-angles and glue these to one side of the car, folding the BRB where necessary. When the glue is dry, attach the other side in the same way.

It is preferable for the wheels to be made of thicker card, if you wish you can stick the wheel designs to another piece of card (about 400g/m^2) first to double the thickness. Cut out and score the wheels. Fold the double-flaps at right-angles and stick

SIMPLE MODEL S
POLICE CA





ERIES
R
MAIN BOARD SUPPORT
BEACON BOARD SUPPORT
ROOF LAMP HOLDER SUPPORT
REAR WINDOW
BOOT LID
BUMPER
WING MIRROR CUT 2
G 75 WUD
REAR Nº PLATE
WHEEL CUT 4
F

to the inside of the wings. Cut out the bumpers; fold the central flap back and stick it to the inner surface of the bumper. Bend the ends of the bumper gently to curve around the body. Then use a dab of glue on the central flap and the ends of the bumpers to hold them in place on the body.

Cut out the rear registration plate and colour its background using a yellow highlighting pen. Stick the plate to the rear panel of the body. Finally cut out and stick the external rear view mirrors in position on the front doors.

This completes the construction of the model except for some internal fittings and the lights. Before attempting these, we need to assemble the electronics.

HOW IT WORKS

The indicator lamps and siren are driven by a binary counter. The i.c. has an integral oscillator circuit. With the component values shown in Fig. 1 the clock frequency is 20kHz. This frequency is divided repeatedly by two in a chain of flip-flops in the i.c. The lower frequencies used in the circuit are:

Stage	Frequency
4	1.25kHz
5	625Hz
13	2Hz
14	1Hz

Stages 4 and 5 give the two notes of the siren's warble. The frequency of the warble is under the control of stage 14. The output from stage 14 is inverted by gate 1 (IC2a). The 1.25kHz signal goes to gate 2 (IC2b) and the 625Hz signal goes to gate 3 (IC2c). At any instant either pin 9 or pin 13 is high and the signal passes through *one* of the gates. At the same instant the output of the other gate is a steady high. Thus gate 4 (IC2d) receives a high on one of its inputs and an oscillating signal (1.25kHz or 625Hz) on the other.

The frequency changes as the output of stage 14 changes, alternating between high and low frequency once a second. The signal reaches the piezo-electric crystal which produces the two-tone sound.

Stage 13 output goes high for 0.25s, then low for 0.25s, repeating. When it is high, current flows to the base of TR1, turning it on. Current flows through the light-emitting diodes, making them turn on. in this way the l.e.d.s flash on and off twice a second.

The beacon flasher (Fig. 2) employs an i.c. specially intended as a lamp flasher. With the resistor and capacitor values shown, the lamp flashes on very briefly about once a second. The circuit operates on 6V, but it has been found possible to use a 3.5V lamp as the "on" period is very short. The result is the short high-intensity flash typical of such beacons.

MAIN CIRCUIT CARD

To commence construction of the circuit boards first cut out the board and, using the pointed tool in the Easiwire kit, punch through the holes where indicated. This is best done with the card laying flat on a thick piece of scrap cardboard.

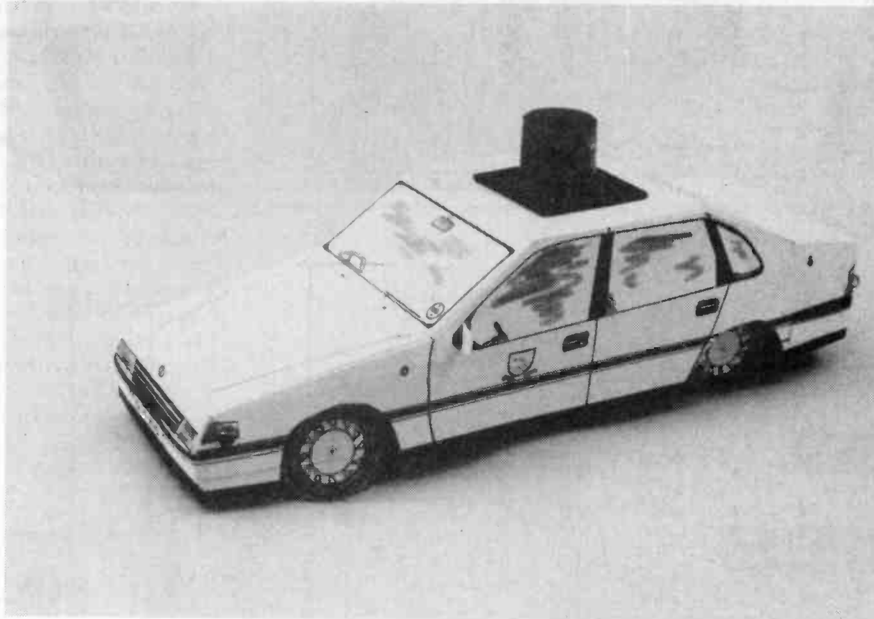
The main circuit board (Fig. 3) holds the circuit for the flashing indicator lamps and the siren. The lamps are high-intensity light-emitting diodes. The siren noise comes from a piezo-electric sounder. The type of sounder used in the prototype had a metal housing with three lugs. Cut a piece of card 30mm square and make slits for the lugs. Push the lugs through the holes and bend them firmly against the other side of the card.

If the sounder is unmounted leave it attached at present and attach it directly to the inside of the car body later. Push the twin leads from the sounder through the circuit card. Twist the leads from the battery clip around the +6V and 0V staples. Around the same staples twist leads of flexible wire about 80mm long. These are to conduct the power supply to the beacon board.

Mount the components on the circuit card and make the connections between the components, including the leads from the sounder, and from the battery clip. The l.e.d.s are connected in parallel to the card (at the staples) by a pair of flexible leads.

SCORING

Scoring makes it easier to bend the card neatly and sharply along a straight line. Place a ruler along the line and *either* run a blunt knife along the line to squeeze the card thinner, *or* run a sharp craft knife very carefully along the line to cut the card for about one quarter of its thickness. The second technique gives the sharper edge, but there is the risk of cutting too deeply and weakening the card at the fold. **Practise on a scrap of card first.**



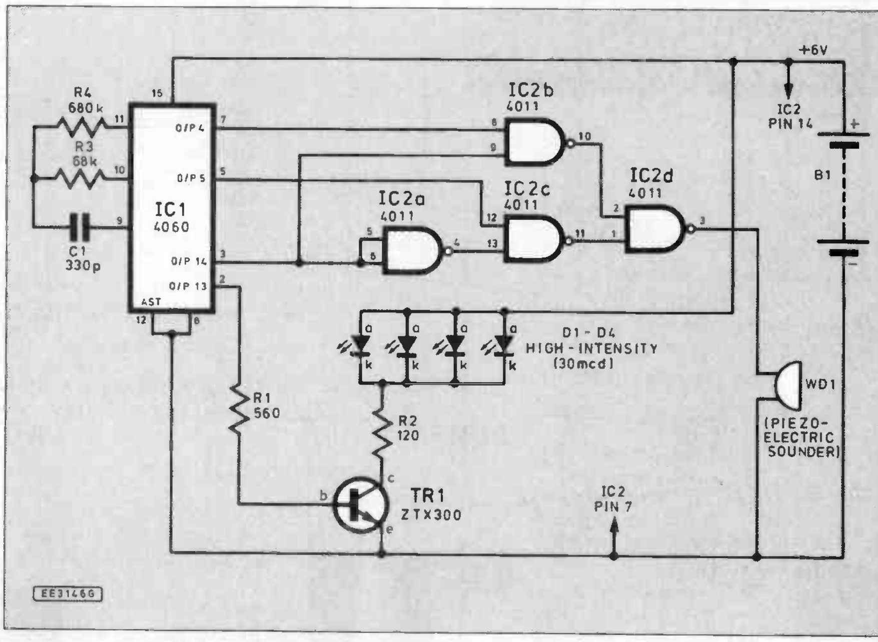


Fig. 1. Circuit diagram of the hazard flashers and siren section.

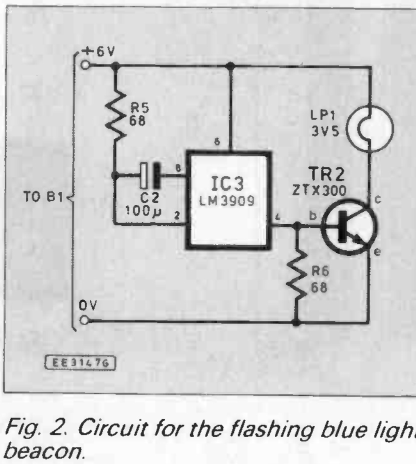


Fig. 2. Circuit for the flashing blue light beacon.

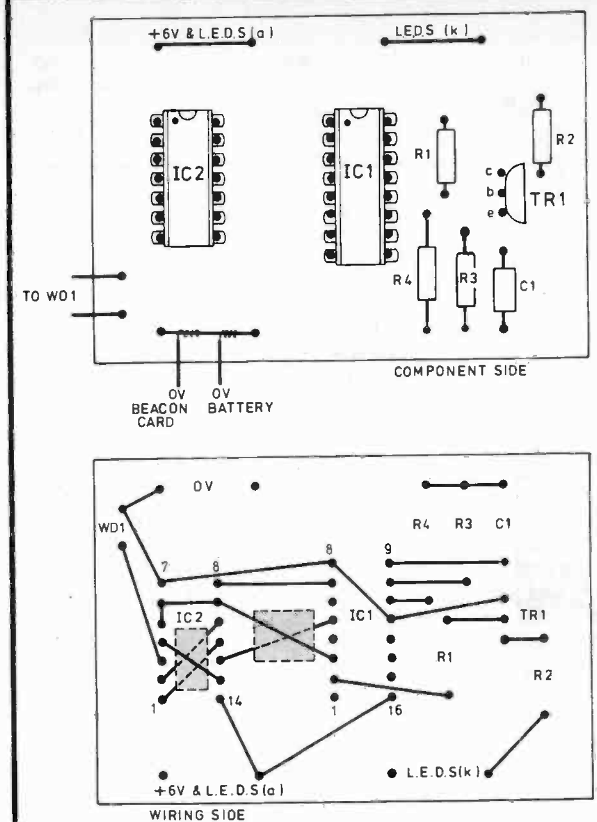


Fig. 3. Main circuit board construction, note the use of insulating tape.

WIRE-WRAPPING

Insert wire staples (from an ordinary office stapling machine) at the points where wires are to be connected to off-card components.

To mount the components, use a sharp point, such as the point of a drawing-compass or the pointed Vero utility tool, to pierce the circuit card where indicated. Push the leads of components (or the i.c. terminal pins) through the holes, so that the components lie flat against the component side of the card. Turn the card over to the wiring side and, if necessary, cut the leads to about 3mm long.

Plan the wiring so that, where several points have to be connected together this is done with a single long run of wire, not with separate lengths of wire for each connection. An example is the 0V line, which connects to six points.

The wrapping wire has no insulation. Where wires cross (e.g. between the i.c.s on the main board) first lay one wire in place. Cut a small rectangle of p.v.c. insulating tape and press this down over the wire, at the crossing point. The second wire may then be laid in place on top of the tape.

To connect to the staples, follow the sequence shown in Fig. 4. When all the wires have been wrapped, push the staple fully into the card and bend its ends flat with the card again.

Wire-wrapping joints are surprisingly strong and survive normal handling. To make them more secure, spray the completed board with a printed circuit lacquer.

COMPONENTS

Resistors
- R1 560
- R2 120
- R3 68k
- R4 680k
- R5, R6 68 (2 off)

See SHOP TALK Page

Capacitors
- C1 330p polystyrene
- C2 100µ elect. 12V

Semiconductors
- D1 to D 4 high-intensity (30mcd) light-emitting diodes, yellow (4 off)
- TR1, TR2 ZTX300 *npn* transistor (2 off)
- IC1 4060B CMOS 12-stage counter/oscillator
- IC2 4011 B CMOS quadruple 2-input NAND gate
- IC3 LM3909 l.e.d. flasher

Miscellaneous
- WD1 Piezo transducer, about 25mm diameter, with leads
- LP1 3.5V 0.15A round MES lamp

Batten-mounting socket for MES lamp, with screw terminals; 8-way d.i.l. socket; 14-way d.i.l. socket; 16-way d.i.l. socket; battery box, long AA type, approx. 109mm x 26mm x 16mm (4 x 1.5V); battery clip PP3; wire-wrapping wire; light-duty insulated cable (10/0.1); mains and beacon circuit cards available from *EE* (see Shop Talk) or see the Special Offer page.

Materials required

Sheet white cardboard, about 400g/m2 or printed model card – see Shop Talk or the Special Offer page; wire staples and stapling machine; clear adhesive (Bostick Clear etc); Easiwire wiring kit -see EE Special Offer.

Approx cost guidance only **£6**

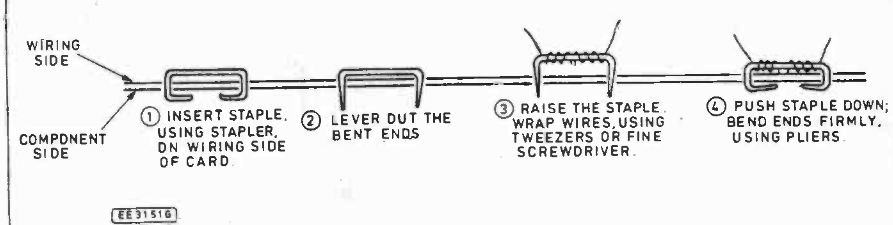
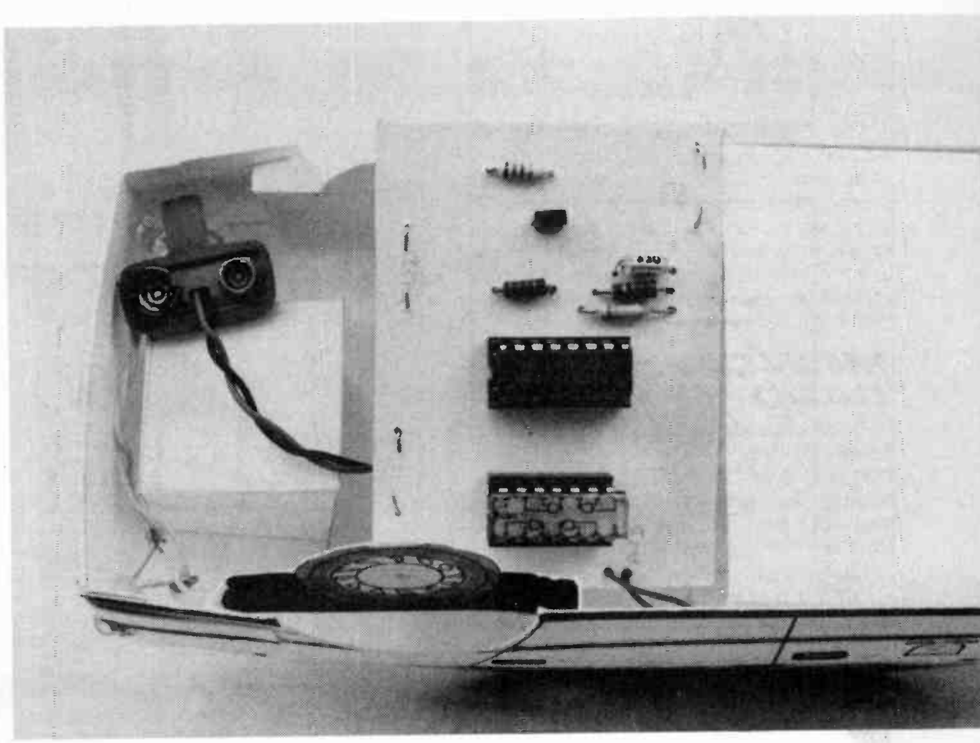


Fig. 4. Method of using staples to fix the flying lead connections.

The main circuit card removed from its mounting under the car. The final board layout differs slightly from this prototype.



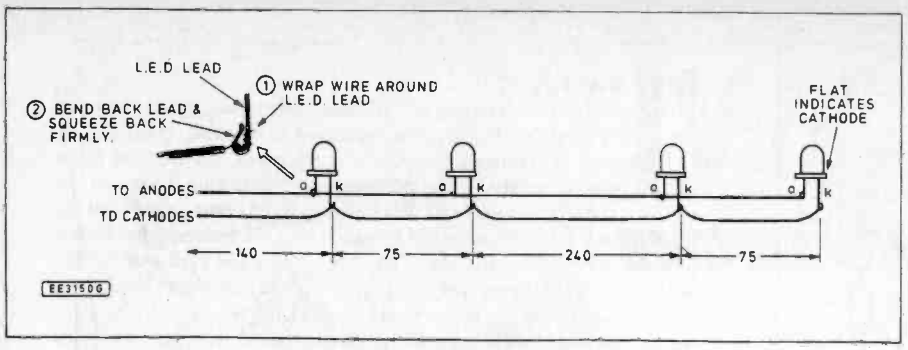


Fig. 5. Connection and wiring of the l.e.d.s.

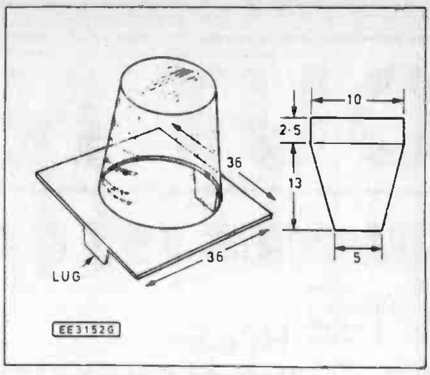


Fig. 7. Mounting the beacon light cover.

make sure that they are connected the right way round. Allow enough wire between the l.e.d.s to run between the corners of the car where the l.e.d.s will be mounted, Fig. 5. The figure shows how the connections may be made secure.

Power is provided by 4 AA cells in a "long" battery box, which fits into the space provided for it in the car. When the battery clip is pushed on to the terminals of the battery box, the l.e.d.s begin to flash and the sounder emits a two-tone "dee-dar-dee-dar . . ." wail. The volume of sound will be greater when the sounder is mounted in the car.

INSTALLING THE MAIN CARD

Remove the battery, but leave the l.e.d.s and sounder attached to the card. Cut holes in the car body where the indicator l.e.d.s are to go. These holes should be a tight fit. Place a dab of clear adhesive on each l.e.d. and push it through its hole from the inside.

Stick the card bearing the sounder or the sounder itself to the inside of the side of the car about level with the driver's door. Cut out the two battery box supports and stick them in position. Cut out the support for mounting the card, fold its flaps and stick them to the inside of the sides of the car, across from one side to the other. The support pulls the two sides of the car together at the bottom, giving the car a bulging outline when seen head-on.

BEACON CARD

Make holes in the beacon card for the component leads and i.c. pins (Fig.6). Connect two leads of flexible wire about 60mm long to the lamp holder screw terminals, and push their other ends through the holes in the card. Make the connections by wire-wrapping, as before. Twist the power leads from the main board around the staples. When the battery is connected to the battery clip the lamp flashes very brightly about once a second.

Cut out the beacon card support and glue this under the bonnet. Cut a hole about 10mm in diameter in the centre of the roof of the car and push the lamp holder up through this. Fix the holder in place by gluing the beacon support underneath it.

The beacon consists of a transparent plastic dome of suitable size and shape. The prototype used a cover taken from a domestic polish spray. This was of clear plastic. A thick waterproof marker pen, bright blue in colour, was used to coat the inside of the cover. Glue the rim of the dome to a square of thick card, painted black, with a hole in its centre (Fig. 7). Two lugs glued to the underside of the square are pushed through slits in the roof of the car. This allows the dome to be removed if necessary to change the bulb.

Rest the beacon card on its support, connect the battery and the police car is ready for patrol.

OTHER MODELS

The two circuits operate independently, so you can instal either one in the model, if you prefer not to have both. These circuits are also applicable to other models such as a fire-engine or an ambulance. You could fit them in a ready-made model. □

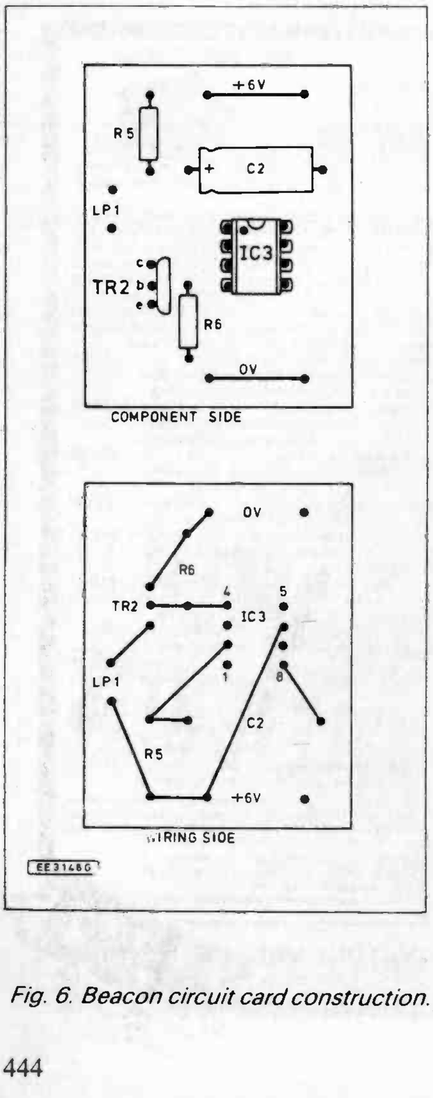
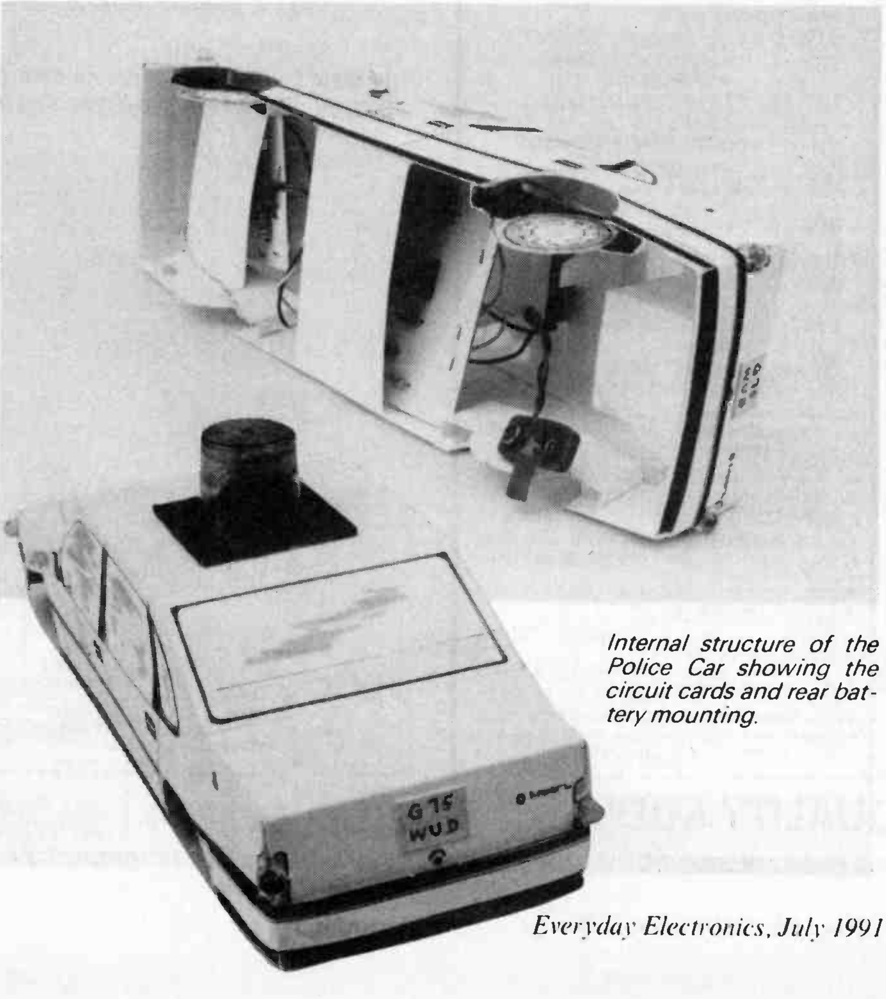
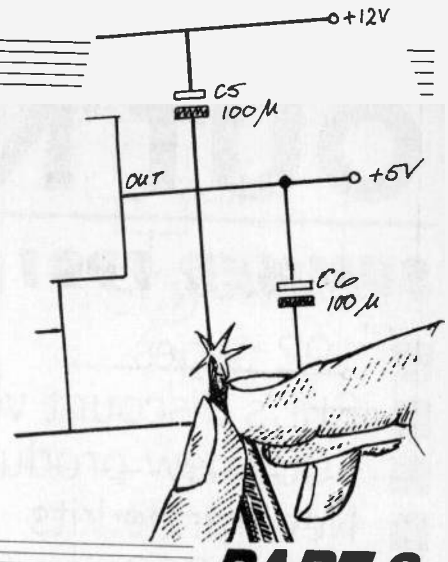


Fig. 6. Beacon circuit card construction.



Internal structure of the Police Car showing the circuit cards and rear battery mounting.



DESIGN YOUR OWN CIRCUITS

Power Control

MIKE TOOLEY BA

PART 8

This eighth part deals with power control. Our design problem is based on a CMOS logic interface whilst our companion project deals with the construction of a Disco Lights Controller.

MANY applications of electronics involve the control of appreciable levels of voltage and/or current. Typical examples in the domestic world are the motor speed controllers found in washing machines and the lamp dimmers which allow us to control the levels of illumination in our homes. Both of these applications are made mere childs' play with the use of a range of sophisticated solid-state power control devices.

This eighth part of our series introduces the devices in question and shows how they can be used in a variety of applications.

Amplification versus power control

The concept of amplification was dealt with in Part 2. In this part we showed how a relatively small voltage or current present at the input of an amplifier could be magnified using transistors and/or integrated circuits to produce a corresponding but much larger voltage or current at the output. This principle can be extended to provide a means of driving loads (rather than just loudspeakers) with appreciable levels of direct and/or alternating current.

Unfortunately, using a high quality (linear) power amplifier to drive loads such as solenoids and actuators is not a very cost-effective solution to the problem. Furthermore, many types of load, for a variety of reasons (not the least of which is safety!) have to be electrically isolated from the circuit which is controlling them.

Power switching devices

The switching device employed in a power control circuit is crucial to the successful operation of the circuit. The basic requirements for the device are:

★ There should be minimal power dissipation within the switching device (it should exhibit a very low resistance in the on/conducting state and a very high resistance in the off/non-conducting state)

★ The switching device should only require a very small input current in order to control a very much larger current (flowing through the load)

★ The switching device should operate very rapidly (i.e. the time between "on" and "off" states should be negligible)

★ During conduction, the switching device should be capable of continuously carrying the rated load current. It should also be capable of handling momentary surge currents (which may be an order of magnitude greater than the continuously rated load current).

★ In the non-conducting state, the switching device should be capable of continuously sustaining the peak value of rated supply voltage. It should also be capable of coping with momentary surge voltages (which may exceed the normal peak supply voltage by a factor of two, or more).

Relays

The traditional method of switching current through a load which requires isolation from the controlling circuit involves the use of an electromechanical relay. Such devices offer a simple, low cost solution to the problem of maintaining adequate isolation between the controlling circuit and the potentially lethal voltages associated with an a.c. mains supply.

Relays do, in fact, offer many of the desirable characteristics of an "ideal" switching device (notably a very low "on" resistance and virtually infinite "off" resistance coupled with a coil to contact breakdown voltage which is usually in excess of several kV). Unfortunately, the humble relay has a number of very serious disadvantages which mitigate against its use in a range of applications.

Paramount amongst the disadvantages of simple electromechanical relays are an inherently low switching speed coupled with the "contact bounce" which occurs during the transitory state which exists between the true "on" and "off" conditions. Furthermore, electromechanical relays are, by virtue of their moving parts and open contact sets, somewhat prone to failure when compared with their more modern solid-state counterparts.

Relay ratings

An important consideration when using relays (particularly at high d.c. voltages) is the arc which may form between the contacts when the contacts break. Arcing (ionisation breakdown of the air in the proximity the contacts) results in the generation of heat (which may literally burn out the contact surfaces) and radio frequency interference (RFI) which may be radiated over a wide area unless special precautions are taken. Readers should note that, because of susceptibility to arcing, a relay which is rated for, say, 250V a.c. operation will generally only be rated for d.c. operation at up to about 50V.

A typical electromechanical relay may be rated for around 1,000,000 operations, or more. To put this into context, if operated once every minute, the contact set on such a relay can be expected to give satisfactory operation for a period of about two years. It is important to note, however, that electromechanical relays are prone to both mechanical and electrical failure (the latter being more prevalent if the device is operated at, or near, its maximum rating).

Having said all this, in simple low-speed "on/off" switching applications, the conventional electromechanical relay can provide a highly cost-effective solution to controlling currents of up to about 10A, or more, at voltages of up to 250V a.c. and 100V d.c. Furthermore (unlike solid-state switching devices) relays are available with a variety of different contact sets, including single-pole (s.p.) on/off switching, single-pole chanegover (s.p.c.o.), double-pole chanegover (d.p.c.o.), and four-pole changeover (4p.c.o.).

The coils which provide the necessary magnetic flux to operate a relay are available for operation on a variety of voltages between 5V and 115V d.c. and 12V to 250V a.c. at currents of between 5mA and 100mA. A typical specification for a low-

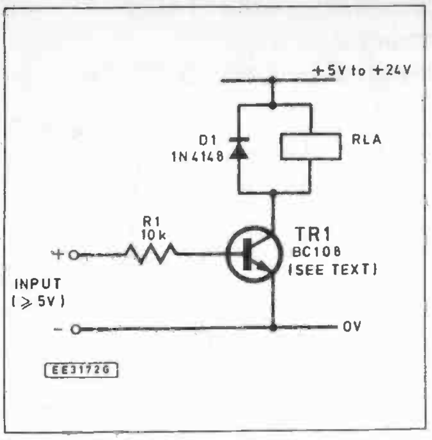


Fig. 8.1. A simple relay driver circuit.

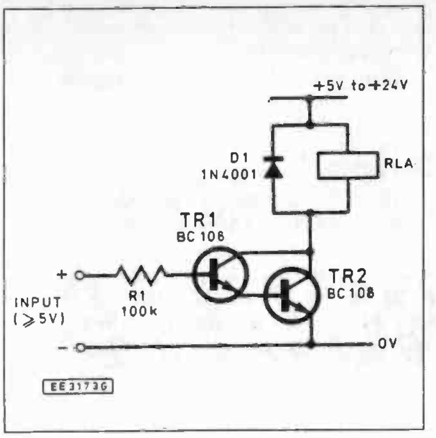


Fig. 8.2. Relay driver circuit based on a discrete Darlington arrangement.

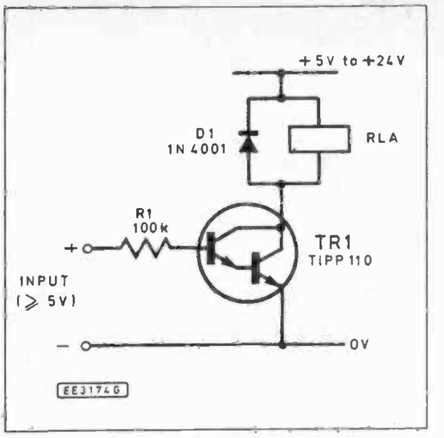


Fig. 8.3. Relay driver based on a plastic Darlington transistor.

voltage relay suitable for switching a mains connected load are as follows:

Contact rating: 5A, 30V d.c./250V a.c.
Coil rating: 12V (10.9V to 19.5V)
Coil resistance: 205 ohm
Electrical life: 200,000 operations (at full rated load)
Mechanical life: 10 million operations

Relay driver circuits

In many applications, a relay will require some form of interface to the circuit to which it is connected. Often such an interface need consist of nothing more than a single transistor, as shown in Fig. 8.1.

Almost any *npn* transistor with a current gain of 50, or more, can be used in the circuit of Fig. 8.1 however it is important to ensure that it is operated within its maximum collector current ($I_{C(MAX)}$) rating. The following devices are recommended:

Coil resistance	TR1
300 ohm to 500 ohm	BC142 (or equivalent)
500 ohm to 1.2k ohm	BC108 (or equivalent)

The circuit of Fig. 8.1 requires an input current of about 0.5mA when operated from a 5V source. In some applications it may be desirable to increase the sensitivity of the circuit in which case a Darlington driver stage can be used (see Fig. 8.2). The silicon diode, D1, is fitted in order to provide a current path which will absorb the back e.m.f. generated when the magnetic flux in the relay suddenly collapses when the transistor ceases to conduct.

A Darlington driver based on two (discrete) *npn* devices and which requires a current of only a mere 40μA at 5V in order to operate the relay is shown in Fig. 8.2. Fig. 8.3 shows an equivalent arrangement based on a plastic *npn* Darlington transistor. This circuit can be used with relays having coil resistances as low as about 200 ohm and will also operate reliably with an input current of as little as 40μA.

Question 1: If the circuit of Fig. 8.1 is to be operated from a CMOS logic circuit which operates from a +12V supply rail and can produce no more than about 500μA of drive current at 8V, specify the required value for R1.

Question 2: If, in Question 1, the relay coil has a resistance of 200 ohm, determine the minimum acceptable value of current gain for the transistor.

Thyristors

Thyristors provide an alternative means of switching a high voltage/high current load from a much smaller triggering current source. Thyristors (or "silicon controlled rectifiers" as they are sometimes called) are three-terminal devices which can switch very rapidly from a conducting to a non-conducting state. In the "off" state, the thyristor exhibits negligible leakage current whilst, in the "on" state the device exhibits very low resistance. This results in very little power loss within the thyristor even when appreciable power levels are being controlled.

Once switched into the conducting state, the thyristor will remain conducting (i.e. it is latched in the "on" state) until the forward current is removed from the device. It is important to note that, in d.c. applications this necessitates the interruption (or disconnection) of the supply *before* the device can be reset into its non-conducting state. However, where a thyristor is used with an alternating supply, the device will automatically become reset whenever the mains supply reverses. The device can then be triggered on the next half-cycle having correct polarity to permit conduction.

Like their conventional silicon diode counterparts, thyristors have anode and cathode connections (see Fig. 8.4). Control is applied by means of a gate terminal and the device is triggered into the conducting ("on" state) by applying a current pulse of sufficient magnitude (and rise time) to this terminal.

The following table summarises the characteristics of a variety of popular thyristors:

Type	$I_{F(AV)}$	V_{RRM}	V_{GT}	I_{GT}	Case style
2N4443	5.1A	400V	1.5V	30mA	TO220
2N4444	5.1A	600V	1.5V	30mA	TO220
BT106	1A	700V	3.5V	50mA	Stud
BT152	13A	600V	1V	32mA	TO220
BTX18-400	1A	500V	2V	5mA	TO5
BTY79-400R	6.4A	400V	3V	30mA	Stud
BTY79-600R	6.4A	600V	3V	30mA	Stud
BTY79-800R	6.4A	800V	3V	30mA	Stud
NO18-RH05	21A	500V	3V	100mA	Stud
NO18-RH08	21A	800V	3V	100mA	Stud
NO18-RH12	21A	1200V	3V	100mA	Stud
TIC106A	3.2A	100V	1.2V	200μA	TO220
TIC106B	3.2A	200V	1.2V	200μA	TO220
TIC106C	3.2A	300V	1.2V	200μA	TO220
TIC106D	3.2A	400V	1.2V	200μA	TO220
TIC106E	3.2A	500V	1.2V	200μA	TO220
TIC106M	3.2A	600V	1.2V	200μA	TO220
TIC106S	3.2A	700V	1.2V	200μA	TO220
TIC106N	3.2A	800V	1.2V	200μA	TO220
TIC116A	5A	100V	2.5V	20mA	TO220
TIC116B	5A	200V	2.5V	20mA	TO220
TIC116C	5A	300V	2.5V	20mA	TO220
TIC116D	5A	400V	2.5V	20mA	TO220
TIC116E	5A	500V	2.5V	20mA	TO220
TIC116M	5A	600V	2.5V	20mA	TO220
TIC116S	5A	700V	2.5V	20mA	TO220
TIC116N	5A	800V	2.5V	20mA	TO220
TIC126A	7.5A	100V	2.5V	20mA	TO220
TIC126B	7.5A	200V	2.5V	20mA	TO220
TIC126C	7.5A	300V	2.5V	20mA	TO220
TIC126D	7.5A	400V	2.5V	20mA	TO220
TIC126E	7.5A	500V	2.5V	20mA	TO220
TIC126M	7.5A	600V	2.5V	20mA	TO220
TIC126S	7.5A	700V	2.5V	20mA	TO220
TIC126N	7.5A	800V	2.5V	20mA	TO220
TICP106D	2A	400V	1V	200μA	TO92
TICP106M	2A	600V	1V	200μA	TO92

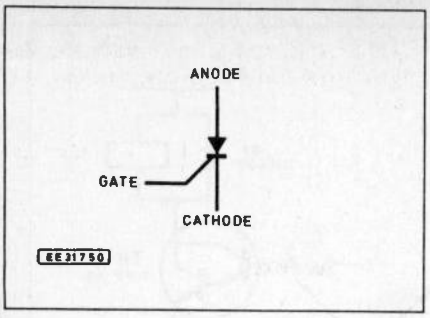


Fig. 8.4. Thyristor symbol.

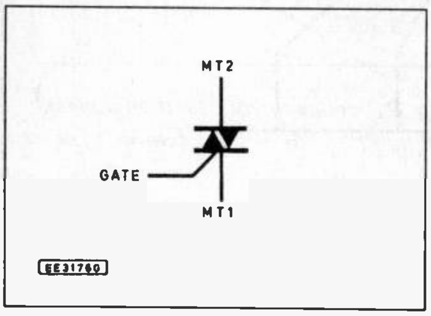


Fig. 8.5. Triac symbol.

Triggering requirements

When designing circuits based on thyristors as power control elements, trigger pulses should have the fastest possible rise times. Thyristors will turn on faster (and power dissipation within the device will be minimised) as gate current is increased. Signals with slow rise times or poorly defined edges are generally unsatisfactory for triggering purposes.

It is also important to ensure that sufficient gate current is made available to ensure effective triggering. This will normally require the designer to minimise the resistance/impedance of the gate driver circuitry as far as possible. At the same time, care should be taken to ensure that the peak value of gate voltage does not exceed the rated value for the device. Similarly, the pulse width of the trigger pulse applied to the gate of a thyristor must be kept short in order to minimise the gate power dissipation. Negative gate voltages should also be avoided in order to prevent power loss.

In a.c. applications, the thyristor triggering circuit should be designed so that it will provide effective triggering over a sufficiently wide angle of the applied a.c. supply voltage. Failure to observe this rule will generally result in an inadequate range of control.

Triacs

Triacs are a refinement of the thyristor which, when triggered, conduct on both positive and negative half-cycles of the applied voltage. Triacs have three terminals; main-terminal one (MT1), main terminal two (MT2) and gate (G), as shown in Fig. 8.5. Triacs can be triggered by both positive and negative voltages applied between G and MT1 with positive and negative voltages present at MT2 respectively. These modes are summarised in the following table:

Trigger mode	Conditions (w.r.t. MT1)
I+	MT2 +ve, G +ve
I−	MT2 +ve, G −ve
III+	MT2 −ve, G +ve
III−	MT2 −ve, G −ve

By virtue of the symmetry in triggering, triacs thus provide a means of controlling a.c. voltages over both positive and negative half-cycles. Thyristors, on the other hand, can only provide control on one, or other, of the half-cycles.

Diacs

In order to simplify the design of triggering circuits, a triac is often used in conjunction with a diac. This device is somewhat similar to a Zener diode having bi-directional properties. A typical diac conducts heavily when the applied voltage exceeds approximately ±32V. Once in the conducting state, the resistance of the diac falls to a very low value and thus a large value of current will flow (sufficient to trigger the triac to which it is connected).

Triac data

The following table summarises the characteristics of a variety of popular triacs:

Type	$I_{T(RMS)}$	V_{RRM}	V_{GT}	$I_{GT(TYP)}$	Case style
BT139	15A	600V	1.5V	5mA	TO220
BTA08-600B	8A	600V	1.5V	50mA	TO220*
BTA16-600B	16A	600V	1.5V	50mA	TO220*
BTA26-600B	25A	600V	1.5V	50mA	TO220*
TIC206M	4A	600V	2V	5mA	TO220
TIC216M	6A	600V	3V	5mA	TO220
TIC225M	8A	600V	2V	20mA	TO220
TIC226M	8A	600V	2V	50mA	TO220
TIC236M	12A	600V	2V	50mA	TO220
TIC246M	16A	600V	2V	50mA	TO220
TICP206D	1.5A	400V	2.5V	2.5mA	TO92
TICP206M	1.5A	600V	2.5V	2.5mA	TO92
TRI800-8	8A	800V	2.5V	20mA	TO220

* = isolated tab (such devices do not require insulating washers and can be mounted directly onto a grounded heatsink)

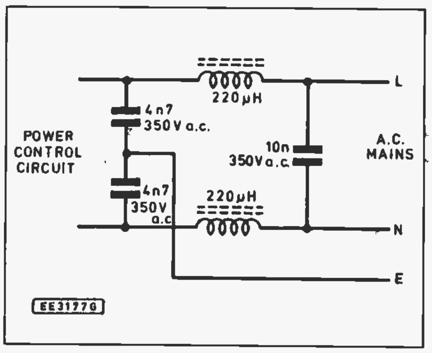


Fig. 8.6. Typical RFI filter.

Noise and radio frequency interference (RFI)

Thyristors and triacs switch on and off very rapidly. In a.c. power control applications, this rapid switching can result in transients which may be conveyed some distance via the a.c. mains wiring. To minimise such effects and prevent radiation of noise, an L-C filter should be fitted in close proximity to the power control device, as shown in Fig. 8.6.

Variable a.c. power control

Triacs make excellent variable a.c. power control devices. Fig. 8.7 shows a circuit for a lamp dimmer capable of handling a resistive (tungsten filament lamp) load of up to 1kW. At higher power levels (i.e. exceeding 150W) the triac will require a heatsink and the designer should consult the representative characteristic curves shown in Figs. 8.8 and 8.9 in order to determine the rating for such a device.

As an example, assume that we require a circuit to control a lamp rated at 500W on a 250V a.c. supply and that we do not wish the case temperature of the triac to exceed 60 deg.C (here we do not need apply the de-rating curve shown in Fig. 8.9). The following steps are required:

1. Determine the load current to be controlled.

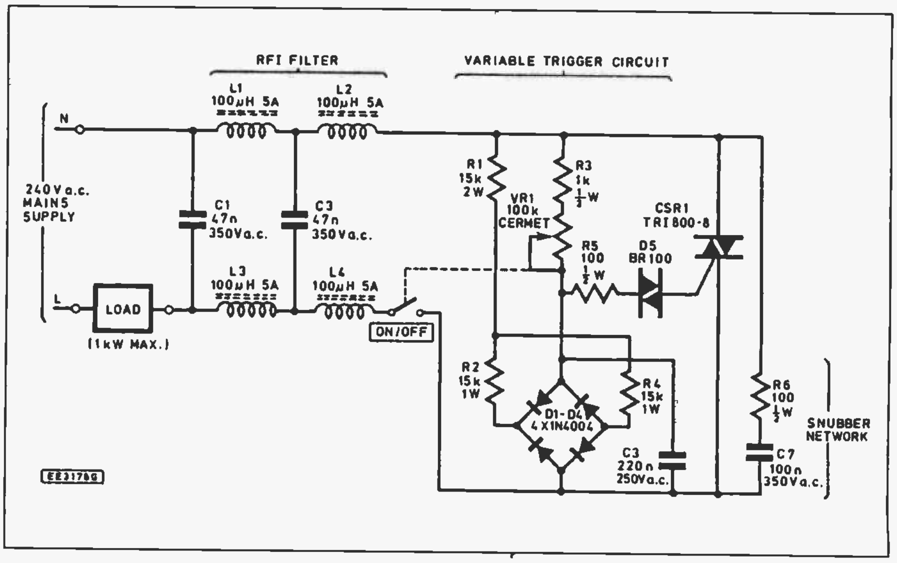


Fig. 8.7. Triac a.c. power controller for up to 1kW of tungsten filament lighting.

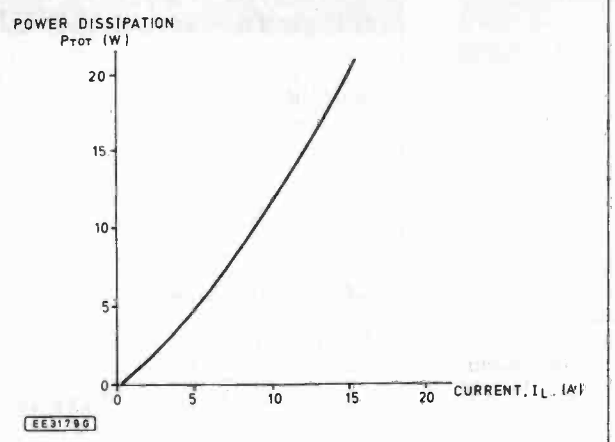


Fig. 8.8. Characteristic showing total power dissipation plotted against load current for a typical 8A triac.

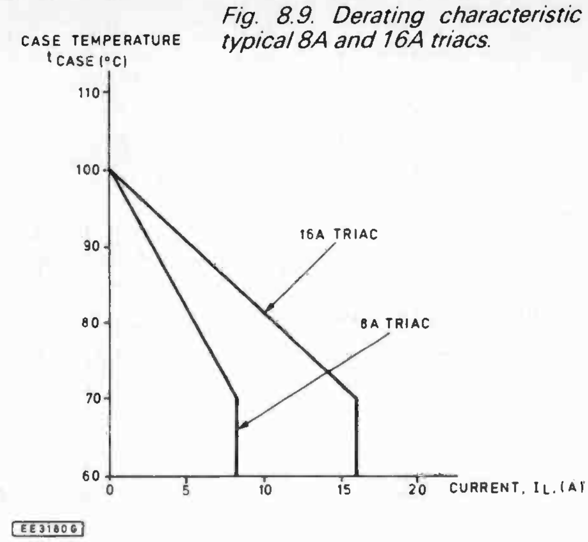


Fig. 8.9. Derating characteristic for typical 8A and 16A triacs.

$I_L = P_L/V_L$ thus $I_L = 500W/250V = 2A$

2. Determine the power dissipation within the triac (from Fig. 8.8):

The power dissipated will be approximately 2W.

3. Estimate the maximum ambient temperature for the unit.

In most cases, we can assume that this will be about 35 deg.C (allowing for the effect of localised heating).

4. Determine the difference between the maximum allowable case temperature and the maximum ambient temperature.

$t_{DIFF.} = t_{CASE(MAX)} - t_{AMBIENT(MAX)}$
$= 60-35 = 25$ deg.C

5. Determine the rating (thermal resistance) of the heatsink required:

$R_{TH} = t_{DIFF.}/P_{TOT} = 25/2 = 12.5$ deg.C/W

Hence, we require a heatsink with a rating of 12.5 deg.C/W, or less. It is important to note that we have ignored a number of factors in this example (such as the thermal resistance of the insulating washers, if fitted). Despite this, the method shown will prove to be sufficiently accurate for most applications.

Question 3: A BTA08-600B triac is to be used to control 1kW of tungsten filament stage lighting which operates from a 240V a.c. mains supply. Assuming that the case temperature of the triac is not to exceed 50 deg.C, determine the necessary heatsink rating.

Optical isolation

One of the most useful components to support the high power switching devices employed in modern power control circuits is the optically coupled triac and optically coupled thyristor (see Fig. 8.10 and Fig. 8.11). These devices provide a very high degree of electrical isolation between the controlling circuit and the load and comprise an encapsulated light emitting diode together with a light sensitive triac or thyristor. When the l.e.d. is illuminated, the triac or thyristor (as appropriate) is triggered into conduction.

Some of the most recent optically coupled triacs (such as the MOC3041) also contain a "zero axis crossing" detector. This circuit ensures that the triac is triggered at the most favourable point on the a.c. cycle, just as the voltage swings through the zero point. This arrangement greatly reduces the noise and radio frequency interference which would otherwise occur if the device were to be suddenly switched into conduction at, or near, the positive or negative peak of the a.c. cycle.

Solid-state switches

In recent years, there has been an increasing need to interface digital logic circuits and microprocessor I/O ports to mains operated loads. In order to meet this requirement, solid-state switches (or "solid-state relays") have been developed. These devices usually contain a triac, snubber network and opto- isolated driver (often incorporating zero-axis crossing trigger circuits).

Solid-state relays are available as encapsulated film circuits (rather than true integrated circuits) and typically have the following specification:

Input voltage:	3V to 24V
Input current:	2mA to 16mA
Maximum load current:	2.5A r.m.s. continuous
Isolation voltage:	4kV (minimum)

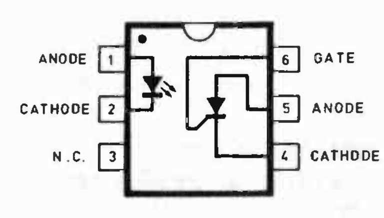


Fig. 8.10. Optically coupled thyristor.

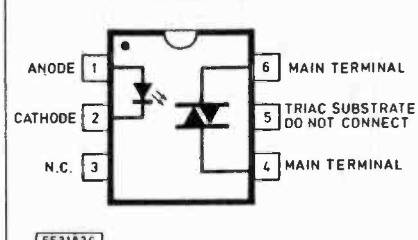


Fig. 8.11. Optically coupled triac.

Solid-State Switch Module

When used in conjunction with a power triac, an optically coupled triac can form the basis of a simple yet highly effective solid-state switch. Fig. 8.12 shows the complete circuit of a Solid-State Switch Module which can be used to control loads of up to 1kW. IC1 is an optically coupled triac which incorporates a zero-axis crossing detector. CSR1 is a power triac rated at 8A maximum load current.

The device specified uses a conventional TO220 encapsulation but, unlike many earlier devices, benefits from an isolated metal tab. This makes mounting to a heatsink more straightforward (there is no need for insulating washers and bushes) and the circuit is also inherently more safe as there is less likelihood of contact with a live metal surface.

Resistor R1 limits the current through the input of the opto-isolator whilst D1 provides a visual indication of the state of the circuit (useful when testing without a load connected). R5 and C1 constitute a snubber network and slow down the rate of switching (change of voltage with time) to an acceptable value. In order to increase the sensitivity of the circuit, an optional transistor driver stage (R2/TR1) is incorporated.

The copper foil and component p.c.b. layout of the Solid-State Switch Module is shown in Fig. 8.13. Connections to the Solid-State Switch Module are via a five-way header (PL1) for the input and d.c. supply and a two-way p.c.b. mounting screw terminal block (BT1) for the mains neutral and load connections.

Connections to PL1 are as follows:

Pin number	Function
1	+V supply (+5V to +12V)
2	Collector (ground to switch)
3	Base input (1V to switch)
4	Ground (0V)
5	Ground (0V)

Connections to BT1 are as follows:

Pin number	Function
1	Load
2	Neutral

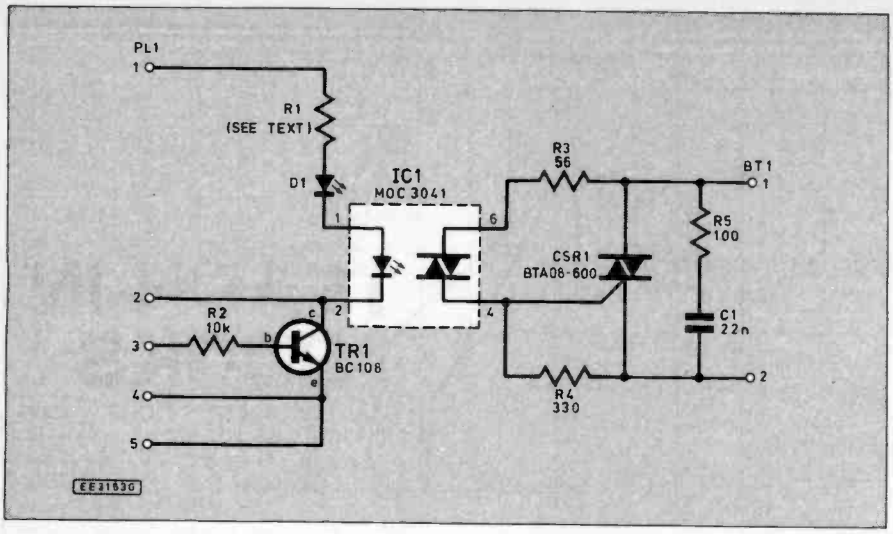


Fig. 8.12. Complete circuit diagram for the Solid-State Switch Module.

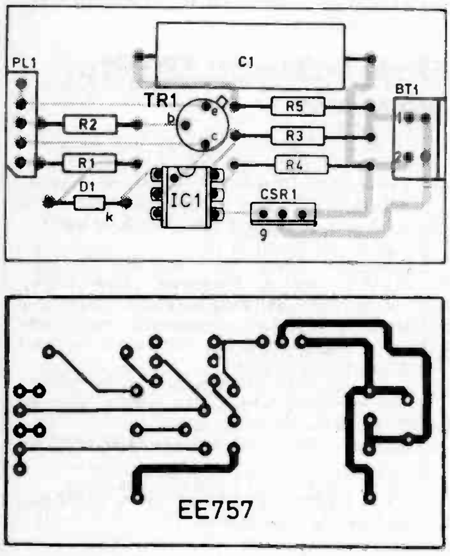


Fig. 8.13. P.C.B. track and component layout for the Solid-State Switch Module.

Values of R1 should be selected from the following table:

Supply voltage	R1
4V to 6V	220
6V to 9V	390
9V to 12V	560
12V to 18V	1k

Finally, Fig. 8.14 shows two operating configurations for the Solid-State Switch Module. Note that, in applications where the load to be switched exceeds about 150W, it will be necessary to fit a heatsink to CSR1. The rating of the heatsink can, however, be determined using the steps given previously.

Design Problem

This month's design problem (as with all of the design problems presented in this 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 involves designing an interface circuit:

A CMOS logic circuit operates from a +15V supply rail. One of the outputs is to drive a relay having a coil resistance of 700 ohm whilst another is to control an 240V a.c. lamp load of 60W. Assuming that the maximum current available from the logic is 50μA at 10V, design a suitable interface circuit.

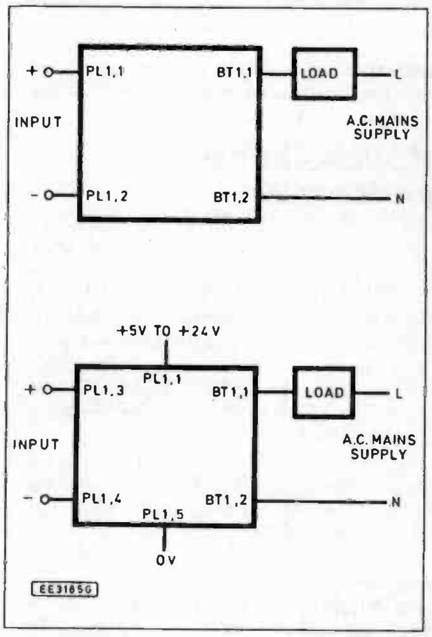


Fig. 8.14. Operating configurations for the Solid-State Switch Module (a) basic Solid-State Switch (R1 and TR1 not fitted) (b) sensitive Solid-State Switch (R1 and TR1 fitted).

Answers to questions in Part Eight

Question 1: 15 kilohm.
Question 2: 120.
Question 3: 3.75 deg.C/W (or less)

COMPONENTS

Resistors

R1	220 0.25W 5% carbon (see text)
R2	10k 0.25W 5% carbon
R3	56 0.5W 5% carbon
R4	330 0.5W 5% carbon
R5	100 0.5W 5% carbon

Capacitors

C1	22n 1000V

Semiconductors

CSR1	BTA08-600B
IC1	MOC3041
TR1	BC108
D1	Red l.e.d.

See SHOP TALK Page

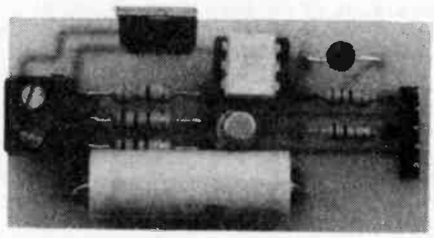
Miscellaneous

PL1 5-way straight p.c.b. header (0.1 inch pitch)
BT1 2-way p.c.b. mounting screw terminal block;
TO220 heatsink (see text); 6-pin d.i.l. i.c. socket; printed circuit board available from *EE PCB Service*, order code EE757.

Approx cost guidance only **£7.50**

Solid-State Switch Module specifications

Supply:	+5V to +24V at 20mA (max.)
Controlled voltage:	240V a.c.
Max. load:	1kW
Input current:	45μA (typical, 5V source) 10mA (typical – without transistor stage)



Answer to last month's design problem:

A simple medium-wave a.m. tuner (for use with the Bench Amplifier/Signal Tracer which we described in Part 3) is to have the following specification:

Tuning Range	*700kHz to 2MHz (specify the coil and capacitance required to cover this range.)*
Aerial input:	*Separate inputs for high and low-impedance aerials.*
Audio output	*100mV (typical) into 5 kilohm (the unit should incorporate an audio amplifier stage).*
Supply	*Single 9V battery (PP3).*

One solution to last month's design problem is shown in Fig. 8.15.

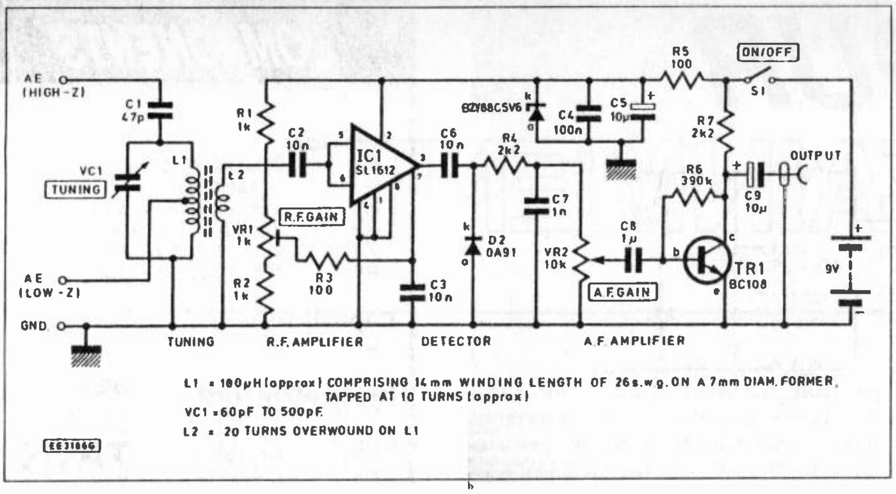


Fig. 8.15. Answer to last month's Design Problem.

Next Month: Next month's instalment deals with the fascinating world of optoelectronics. Our design problem features an automatic porth light whilst our accompanying constructional project features an optical communications link.

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 preset 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.
RF amplifier module	7	High gain r.f. amplifier module which can be used in a variety of applications, including receivers (both TRF and superhet) and test equipment. Requires a single supply rail of +9V.
Solid-State switch module	8	Solid-state switch capable of controlling a.c. mains loads rated at 240V 1kW maximum. The switch operates from an input of less than 100µA and requires a supply of between 5V and 24V.

FOR YOUR ENTERTAINMENT

by Barry Fox

Faxing Yourself

Over the years I have carted various portable computers and modems round the world on press trips, with the intention of sending back articles as electronic text by telephone line. But it is never as easy as it sounds.

So I bought myself a portable printer and started sending back text by fax. I would write the story, print it out in my room and ask the hotel office to fax it back to the UK.

But the printer is quite heavy. So last year I bought myself a new portable modem, the Discovery 2448P. This costs around £200 and comes with software which lets it send faxes as well as electronic mail. The software converts word-processed text into fax code and squirts it down the telephone line to any conventional office fax machine back home.

But that still left me without any hard copy of my own text, and on several occasions I found I needed this. So I started carrying the printer as well as computer and modem.

In the USA recently I found a simple way round the problem. I had written a report which I had to pass on to a business contact, but I had not brought my printer. So I phoned the hotel reception from my bedroom and asked for the hotel's fax number. I then used the Discovery modem to fax my report to the hotel office, with a note on the front addressing it to me.

Soon afterwards a messenger knocked on my hotel door carrying my fax. So I ended up with a hard copy print-out without ever using a printer.

Digital Copyright

Few people realise that since CD was launched, in 1983, the record and music industry has been missing out on a significant hidden benefit which was built into the format from day one.

When radio stations play records on the air, they must fill in copyright forms so that the artists and composers get the royalties due to them. The BBC pays up to 70 pounds in copyright fees on each record broadcast and each week staff spend 2,500 hours typing out 15,000 copyright forms.

Some TV stations and smaller radio stations write them in ink, with zeros indistinguishable from Os. The PPL and MCPS have to deal with over a thousand record companies (owning 3000 record labels). They have recently had to try and pay royalties on "Away in a Manager" and pieces of music identified only as "Overture", "The Rolling Stones track" and "The Who track".

The technology to automate copyright payment, by using inaudible identification codes buried in digital recordings, has been available for nearly ten years but never been used. The BBC has taken the intitiative and warned that if the technology is not used now, it will forever lie idle.

The CD standard, as laid down by Philips and Sony, defines eight channels in the digital bit stream, called subcodes, which carry information related to the music. The P and Q channels carry timing codes which control the CD player, telling it when musical selections begin and end. The Q channel can also carry copyright information. Digital tape formats can carry similar codes.

In 1986, after fifteen years discussion, the International Standards Organisation agreed a code format which is applicable to any digital recording medium. ISO 3901-1986 defines the International Standard Recording Code. Twelve alphanumeric characters can unambiguously identify a recording by date, name and company owner. A modified CD player in a broadcast studio will strip this code out of the bit stream and deliver it to a computer. The computer's internal clock will log when the recording was played and for how long.

The radio station will then give a copy of the log to all the copyright bodies (Phonographic Performance Ltd, the Performing Rights Society and Mechanical Copyright Protection Society), which then match the identifying number with their own database record to calculate what royalties the performers and composers should be paid.

It would all be so easy, accurate and fast. Everyone would gain. But most CDs now have a string of zeros where the code should be because record companies do not give the pressing plant an ISRC number to insert.

Without coded records, there has been no incentive for radio and TV stations to modify CD players and connect them to computers. Only one CD player, a Revox machine made by Studer, is already designed to strip out the code. It costs £1,800. So broadcaters continue to prepare copyright returns by hand.

Nimbus presses CDs for many companies and cannot remember ever being asked to include the code. Nor can Tape One, a finishing studio which prepares several hundred digital master tapes for pressing every month. Both say the cost of adding the code would be negligible, or nothing at all.

Says Tony Churcher, head of broadcasting administration at the Performing Rights Society, one of three copyright bodies involved in paying musical artists, "If we don't make a start now, we will never do it".

Overpowered!

I was in Cannes recently for the MIDEM music industry Conference and Festival. One day I heard the sound of deafeningly loud music from the street, stopping and starting every minute or so. It sounded like someone turning a mobile discotheque on and off.

The source turned out to be a small Renault car, with the entire back seat area made over to mount a batch of enormous loudspeakers. These churned out thunderous bass. But only while the car was moving and its alternator was generating enough power to drive the amplifier. Every time the car slowed down in traffic, the amplifier drew so much power from the battery, that the sound system tripped into silence and the engine stalled.

If the driver had turned down the wick a little he could have kept the engine and sound system running. But no. He was far happier to hear snatches of music in between re-starting the engine.

12V NiCad CHARGER

T. R. de VAUX-BALBIRNIE

Charge 12V battery packs from a 12V supply

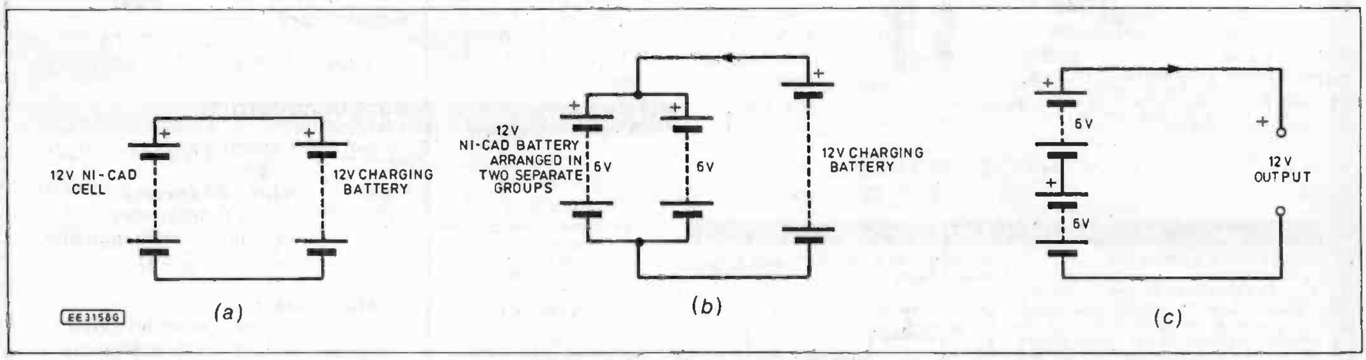
THIS CIRCUIT will charge a 12V nickel-cadmium battery pack from a car battery or other nominal 12V d.c. supply. This could have numerous uses where Ni-Cad batteries need to be charged and no mains supply is available.

Applications include models, video cameras, audio equipment, lights, boat and caravan back-up supplies, power tools, etc. Note that it is the ability of this circuit to charge 12V batteries from a 12V supply which is the point of the present design. A simpler circuit could be used to charge batteries having a lower nominal voltage.

It will charge "AAA", "AA", "C" and "D" size cells in approximately 24 hours and some in five hours as an option. The batteries and charging circuit are built into an aluminium box to make a self-contained unit.

This charger is really designed to charge a home-made battery pack made up from individual nickel-cadmium cells. It may be possible to modify an existing battery pack but the reader would need to make the necessary investigation. This is because it is necessary to "split" it into two separate 6V sections.

A special feature of this circuit is to reduce the current as charging proceeds. At the end point, the current is just a fraction – 25 per cent approximately – of the original value. This is good for the batteries and saves power when they are left on charge for long periods – or even continuously.



FDig. 1a. The charging battery cannot charge the NiCad cells because the two voltages are equal and opposite. No current therefore flows in the circuit.

Fig. 1b. The voltage across the two groups of cells is only 6V so the 12V charging battery can drive current through them.

Fig. 1c. The two groups of cells are now connected in series for discharging. 12V appears between the output terminals.

CHARGE/ DISCHARGE

A rotary-type charge/discharge switch and l.e.d charge indicator are mounted on one side of the case. A socket for connecting the input lead and a flying lead output are also provided. The input lead will have an appropriate connector – possibly a cigarette lighter type plug – on the end.

The maximum current which may be drawn from the unit is 3A which will be found sufficient for most purposes. Note that the case is connected to the negative terminal of the charging battery (and the negative output wire) so if used in a car, it is only suitable for "negative earth" systems. This is of little consequence since practically all cars in use today have this polarity.

PARALLEL CHARGING

When charging nickel-cadmium cells, a controlled current source is needed. This delivers the correct current for the type of cell being used.

Attempting to charge 12V batteries from a 12V supply using a conventional circuit, would be unsuccessful because the two similar voltages would be opposed and so unable to drive current through the cells – see Fig.1a. (Fig.1 shows simplified arrangements which would not make practical circuits). Even if the car battery were fully charged and had a terminal voltage greater than 13V, the excess voltage over that of the cells would be absorbed by losses (voltage dropout) of typically 2V in the charging circuit.

To overcome this problem, the charger arranges for the cells to be placed in two equal groups of 6V each. By means of two-way switching, these sets are connected in parallel (where the total terminal voltage is 6V) for charging and in series (where the total terminal voltage is 12V) for discharging – see Fig.1b and Fig.1c.

By using a separate controlled current circuit for each 6V section the correct charge rate is maintained for the type of cell being used. Taking into account the voltage dropout and the possibility of the car battery voltage falling below 11V, an excess voltage will still remain to drive current through the cells and so charge them.

Providing the supply battery is in good condition to begin with, the amount ofenergy needed to charge even high-capacity cells will cause only a small drain. If the batteries are to be charged repeatedly then it will need to be recharged every so often but if fitted to a car, normal running will do this.

CIRCUIT DESCRIPTION

The complete circuit for the 12V Ni-Cad Charger is shown in Fig.2. This is based on two identical integrated circuits, IC1 and IC2. These are combination voltage and current regulators each being responsible for charging one 6V half-set of cells B1 and B2 respectively.

Switch S1 is a 4-pole 3-position rotary switch. The poles and moving contacts (wipers) are labelled A, B and C, position D being unused. The fixed contacts are labelled 1, 2, 3 (for pole A), 4, 5,6 (for pole B) and so on.

CHARGE

With S1 set to Charge – that is, at either extreme position, a feed is established from supply battery, B3, positive terminal through fuse, FS2, and S1c contact 7 or 9. This is applied to pin 1 of IC1 and IC2 through diodes D4 and D5 respectively.

These diodes isolate the i.c. inputs. They also protect the circuit if B3 is connected with incorrect polarity since they would then be reverse biased and block current flow. At the same time, red l.e.d. Charge indicator, D3, operates through diode D5 and current-limiting resistor, R7.

Resistors, R1 and R2 set the output current flowing from pin 5 of each i.c. and are chosen to suit the particular cells being charged (see Tables 1 and 2). The value of R1/R2 shown in Fig. 2 is appropriate to standard charging of "AA" size batteries.

While in charge mode, S1a contact 2 is open and prevents current being drawn from the output – this could otherwise cause problems. Also, the two sections of the battery pack, B1 and B2 are connected through diodes, D1 and D2, to the appropriate i.c. output. These diodes isolate the regulator outputs and prevent current from the charged batteries possibly flowing back into the outputs when the supply is disconnected. S1b contact 4 or 6 completes the circuit to B1 by connecting the negative end to supply negative.

DISCHARGE

With S1 in the centre (Discharge) position, S1c contact 8 disconnects the positive supply feed battery. Diode D3 (Charge) then goes off. S1b contact 5 connects the negative terminal of battery B1 to the positive terminal of B2; the batteries now appear in series. S1a contact 2 establishes the output circuit and allows the combined total voltage (nominally 12V) to appear at the output via fuse, FS1.

Table 1: Standard Charging

Type of cell	Nominal Charge Current (mA)	Value of R1/R2 (ohms)	Fuse (FS2) Value (mA)
AAA	15	27	50
AA	45	10	125
C or D (1.2Ah commercial)	110	3.9	250
C (2.0Ah industrial)	180	2.7	400
D (4.0Ah industrial)	360	1.2	800

Table 2: Rapid Charging

Type of cell	Nominal Charge Current (mA)	Value of R1/R2 (ohms)	Fuse (FS2) Value (mA)
AAA	45	10	125
AA	140	3.3	400
C or D (1.2Ah commercial)	360	1.2	800

(Other types of battery not applicable)

Resistors R3/R5 (for IC1) and R4/R6 (for IC2) set each i.c. output to 7.8V approximately. Taking into account the voltage drop of approximately 0.7V across diodes D1/D2, there will be 7.1V available to charge the cells. This corresponds to 1.42V per cell and means that as charging proceeds, the voltage of the cells approaches that of the supply and the current falls.

The output fuse, FS1, will normally have a value of 3A. If a lower current is to be drawn, it could be reduced in value accordingly. The input fuse FS2 will have a value a little higher than the total maximum charging current being drawn – that is, rather more than twice the charging current for one set of cells (see Tables 1 and 2).

CONSTRUCTION

Readers wishing to use rapid charging should have available a multi-tester or milliammeter to check the charge rates. Nickel-cadmium cells will be damaged by overcharging.

Note that the specified case is correct for "AA" size cells. For "AAA" cells a smaller one could possibly be used but a larger box will be needed where "C" and "D" size cells are to be charged.

Construction of the 12V Ni-Cad Charger is based on a circuit panel made from a piece of 0.1 in. matrix stripboard, size 9 strips x 26 holes. The board component

COMPONENTS

Resistors
R1, R2 See Tables 1 and 2 1% or 5% (2 off)
R3, R4 1k5 (2 off)
R5, R6 820 (2 off)
R7 1k
All 0.25W or 0.6W 1% metal film except where stated.

See SHOP TALK Page

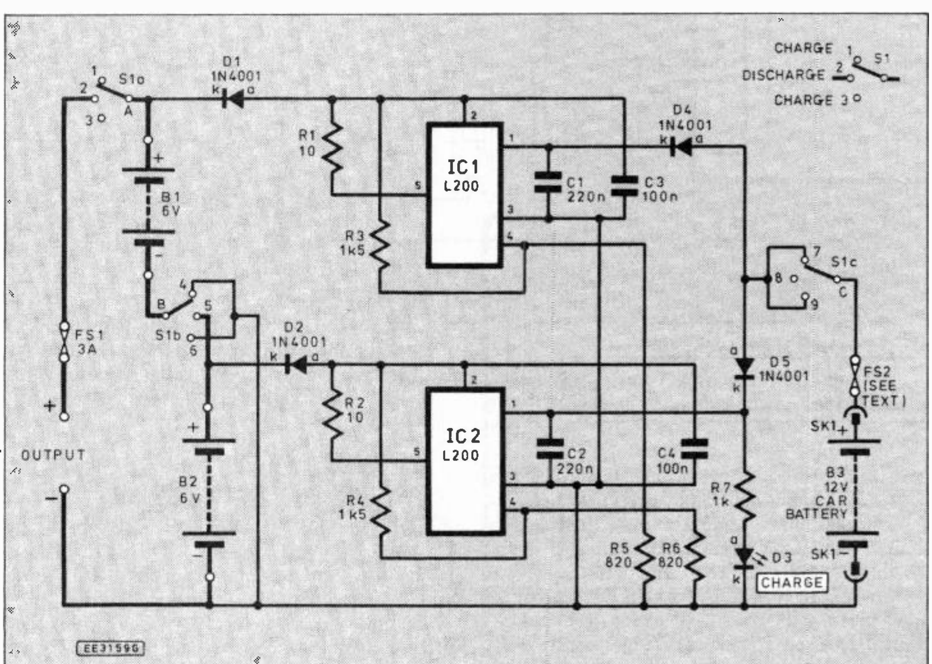
Capacitors
C1, C2 220n ceramic (2 off)
C3, C4 100n ceramic (2 off)

Semiconductors
D1, D2, D4, D5 1N4001 1A 50V rec. diode (4 off)
D3 Red l.e.d indicator
IC1, IC2 L200CV Adjustable voltage/current regulator, 2A max. (2 off)

Miscellanous
S1 4-pole 3-position rotary switch, break-before-make
FS1 20mm 3A quick-blow fuse and chassis fuseholder
FS2 20mm quick-blow fuse and chasis fuseholder, for value see Table 1/2
B1, B2 Holder for 10 cells (see text) and 10 nickel-cadmium cells to fit – see text
PL1/SK1 2.1mm power-in plug and matching chassis socket. Car cigarette lighter type plug or other connector for car battery
Stripboard 0.1in. matrix, size 9 strips x 26 holes; aluminium box, size 133mm x 102mm x 38mm (see text); strain relief bush or rubber grommet; multi-coloured stranded wire; connecting wire; solder; battery holder connector; small nylon fixings; 20mm aluminium squares (2 off for heatsinks).

Approx cost guidance only £10.50

Fig. 2. Complete circuit diagram for the 12V NiCad Charger.



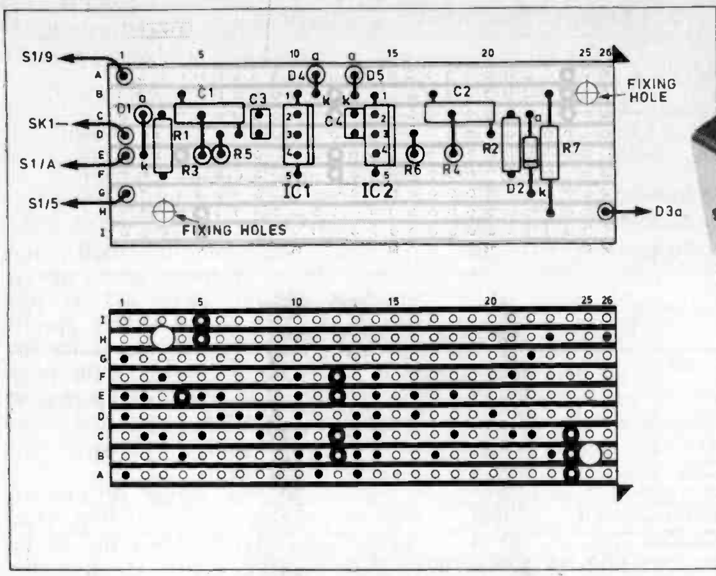


Fig. 3. Stripboard component layout and details of breaks required in the underside copper tracks.

The finished charger. Size of case depends on batteries used.

layout and details of breaks required in the underside copper tracks is shown in Fig.3.

Cut the stripboard to size, drill the two mounting holes and make all track breaks as indicated. Follow with the soldered on-board components taking care over the orientation of the four diodes. Mount IC1 and IC2 by gently straightening and spreading the pins to fit the 0.1in. stripboard matrix.

To select the correct value of R1 and R2 refer to Tables 1 and 2. If these resistors are mounted on short stalks (made from discarded resistor ends) as in the prototype unit, it will be easy to replace them with alternative values if ever the need arises. Solder 10cm pieces of light-duty stranded connecting wire to the copper strips *A, D, E* and *G* on the left-hand side and to strip *H* on the right-hand side as indicated.

Attach heatsinks to IC1 and IC2. These consist of pieces of thin sheet aluminium 20mm square approximately and bent as shown in the photograph. No mounting kit is needed – the heatsinks are attached direct to the i.c. bodies using small fixings.

BATTERY PACK

The battery pack is made from two sections containing five cells each. Holders for this number are not readily available but, for "AA" size at least, holders for 10 cells may be obtained.

For the prototype unit, it was an easy matter to cut the interconnecting wire at the mid-point and make soldered connections to the free ends. Alternatively, a holder for 4 cells and a holder for 1 cell could be used in each group.

Make a hole in the case to accommodate the strain relief bush or rubber grommet used for the output lead. Drill holes for the power input socket, l.e.d. indicator, switch, fuseholders, battery holder (depending on the type) and for circuit panel mounting.

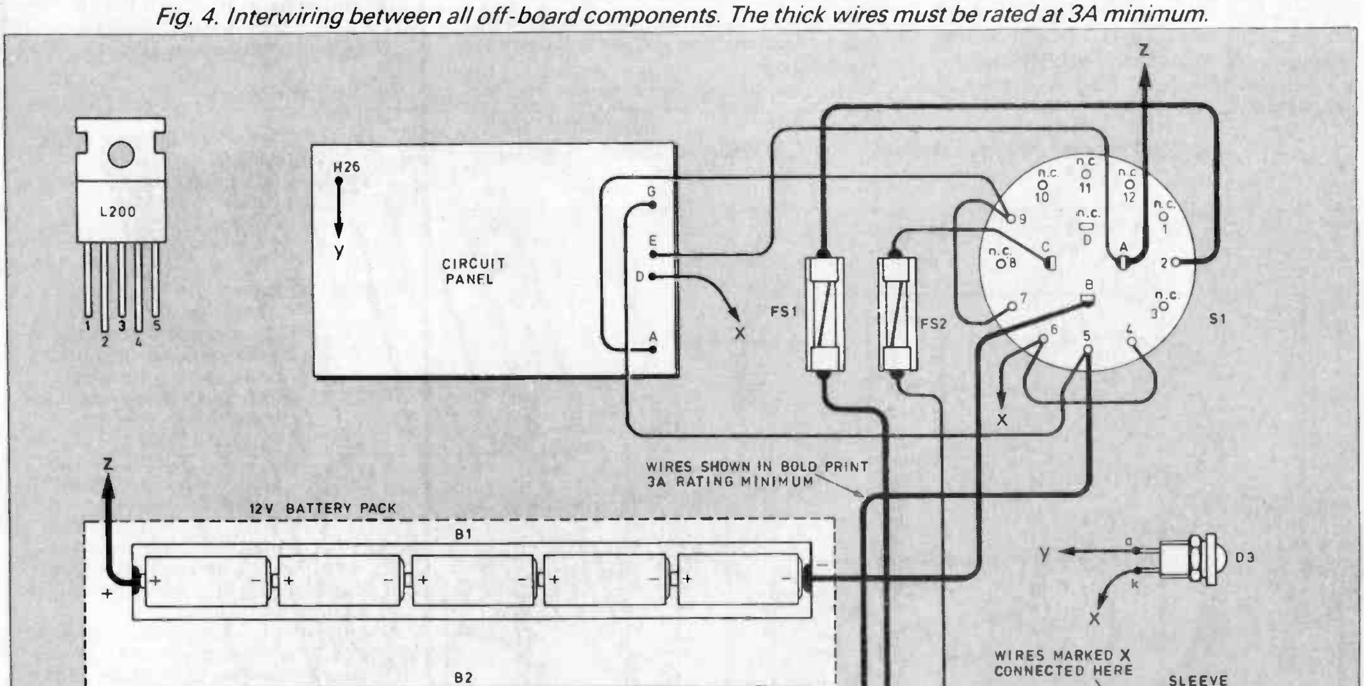
Refering to Fig.4, mount all internal components – but not the circuit panel – and complete the interwiring. Work carefully using different coloured wires; this will guard against errors which could be difficult to find later.

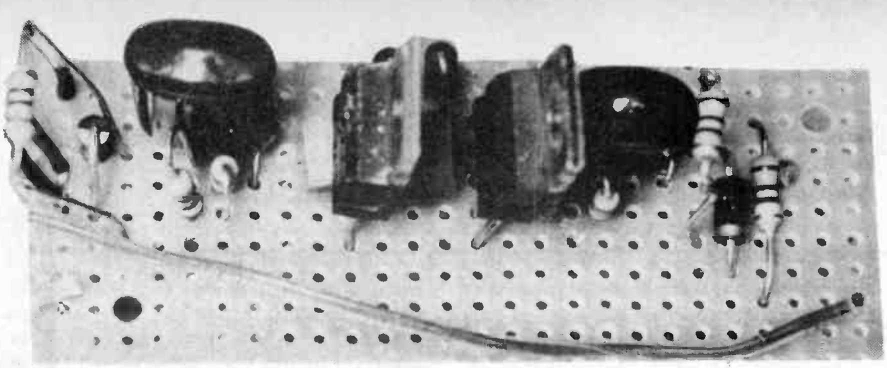
For clarity, some wires are letter-coded. Wiring shown in bold print should be of 3A rating minimum.

The negative terminal of SK1 is the meeting point for several wires denoted by the letter X and care must be taken over the quality of the soldered joint here. When soldering diode D3, use minimum heat from the soldering iron since this component is easily damaged. Also, take care over the polarity or it will not work.

Mount the circuit panel clear of the case to prevent short-circuits between the cop-

Fig. 4. Interwiring between all off-board components. The thick wires must be rated at 3A minimum.





The completed circuit board. Small 20mm square aluminium heatsinks should be bolted to the two i.c. tabs – see photograph below.

per strip side and the metalwork. In the prototype, a piece of cardboard was placed on the bottom of the box and the circuit panel separated from this using adhesive fixing pads.

Use nylon (non-conducting) fixings. This will prevent the possibility of a short circuit between strip *G* and the case. Note that all components are mounted on the base section of the box – this causes least strain on the numerous interconnecting wires.

With S1 switched to Charge, insert the batteries into their holders. The battery holders may be secured by using small fixings, adhesive fixing pads or a small bracket depending on the type. Take care that no battery holder connections can touch the case and cause a short-circuit. Insulate with cardboard if necessary.

If rapid charging is contemplated, it may be necessary to mount the battery holder with a 5mm clearance between itself and the base of the case so that holes may be drilled below to provide ventilation. In this case, do not secure the battery holder until tests have been made.

Drill a matrix of ventilation holes in the lid of the case corresponding to the position of IC1 and IC2 also above the battery holder if rapid charging is to be used. This is not necessary for charging "AAA" or standard charging of "AA" cells as was the case with the prototype.

Make the input and output leads. These consist of pieces of twin-stranded wire of 3A rating minimum with suitable connectors on the ends. The input lead will have a power-in plug on one end and perhaps a car cigarette lighter type plug on the other.

Measure the correct amount of output wire needed inside the case and fit it through the strain relief bush or rubber grommet. If using a rubber grommet, apply some strain relief – for example, tie a piece of string firmly around the wire on the inside. Make the internal connections and insert the fuses making sure that the fuseholders are correctly identified.

TESTING

Testing should be carried out with discharged batteries. If they are charged, connect a 12V lamp to the output, set S1 to Discharge and wait until the lamp goes out.

Now plug the input lead into the power-in socket and connect the other end to the car battery. Switch S1 to Charge and check that the l.e.d. indicator D3 lights.

Place the lid in position and leave the unit on charge for an hour checking the temperature of the cells and heatsinks periodically. Note that the heatsinks will become warm and at high charging currents they will become quite hot. If the temperature rise is excessive (too hot to touch), increase their size.

If the battery cells become more than just slightly warm, provide additional ventilation. If they are warm the current will fail to roll off at the end of the charging cycle as it should. This could also happen in a hot environment. Connect a 12V lamp to the output, switch S1 to Discharge and check that the charger has done its job.

Readers having access to a multi-tester (multimeter) may check the charging current in the following way. Using rapid charging, such checking is essential.

With the batteries discharged and with the supply battery disconnected, unsolder the positive connection from each section in turn. With the meter set to an appropriate current range connect the negative meter probe to the battery positive terminal and the positive one to the free wire. Reconnect the supply – the meter reading should not exceed the figure given in Table 1 or Table 2 for the type of cell being charged. Repeat the procedure with the other battery set.

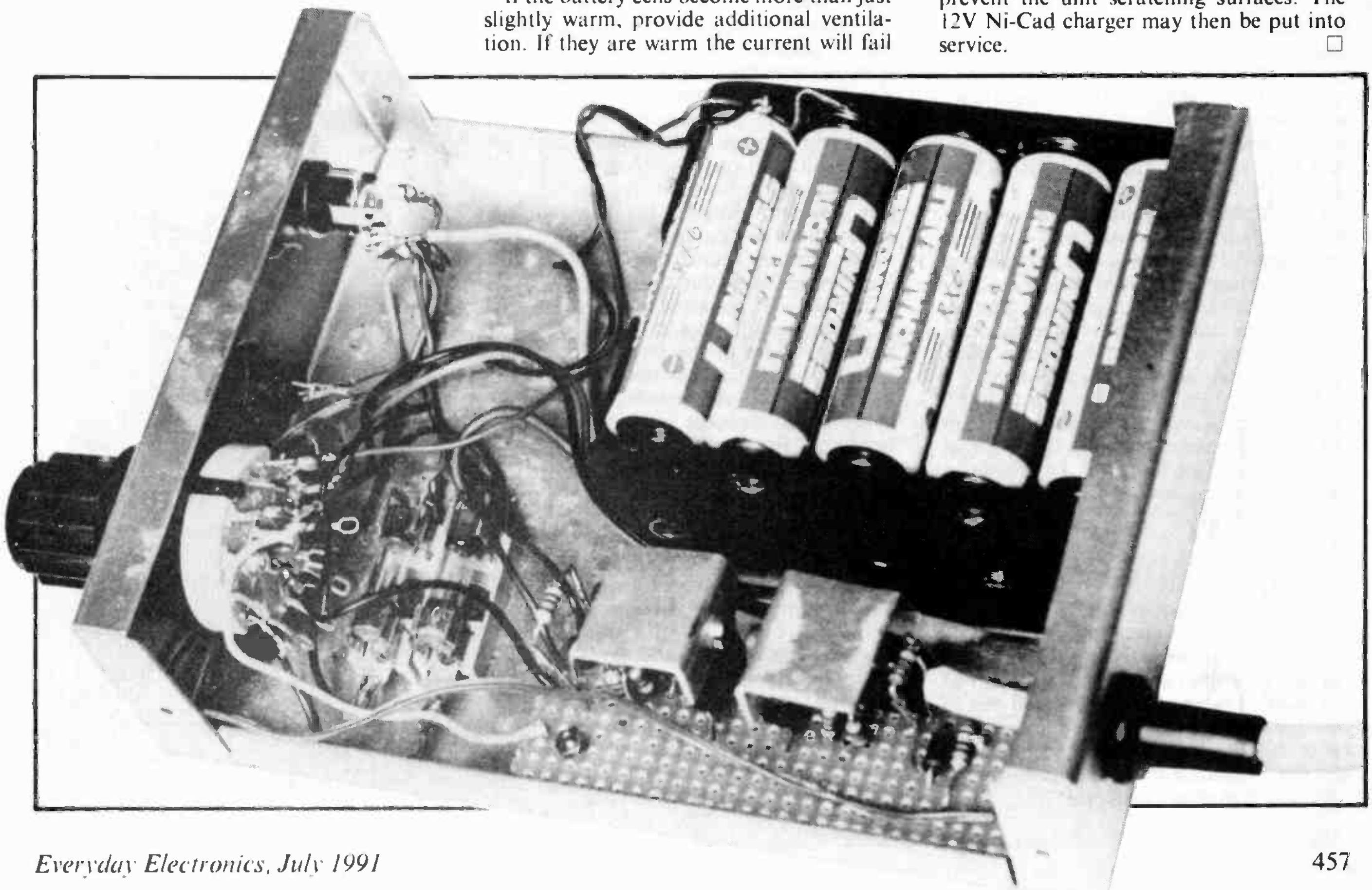
The charge rate should be similarly checked near the end point. With rapid charging, this must fall below the rate for standard charging (Table 1) within five hours and may then remain at this figure indefinitely. For example, fully discharged "AA" size cells may be charged at up to 140mA for five hours, after this time the current must not exceed 45mA.

If it falls below this figure in a shorter time, the charging time is simply increased. If it remains high for longer than 5 hours, and the cells are remaining cool, increase R5 and R6 slightly. Alternatively, simply remember to switch off promptly.

If all is well, re-solder the connections to the battery holders. There should be no need to alter the initial charging rates but they may be reduced by increasing the value of R1 and R2 and vice-versa.

Replace the lid of the box checking for trapped wires and short circuits, especially at S1 contacts. Check particularly that the self-tapping screws used to fix the two sections of the case together cannot cause a short-circuit to any part of the battery holder.

It only remains to attach plastic feet to prevent the unit scratching surfaces. The 12V Ni-Cad charger may then be put into service. □



ROBOT ROUNDUP

Nigel Clark

INNOVATION

Developing the new technologies is seen by many as the recipe for future prosperity in the UK. If we can take advantage of our natural ability at innovation, so the argument goes, then we have nothing to fear in 1992, with the single European market, from Japan or any developing country.

With many instances of British inventions which were developed aboard, the computer and the jet engine being two popular examples, it is thought that all we have to do is invent something and then ensure that we get the benefits to guarantee our future.

There is one major problem with this approach. Whereas there are many new products being invented only a few will prove to be successful and create or expand industries. Picking the winners from the losers is not easy. History is the only basis on which decisions can be taken but that, in terms of both existing products and a person's past ability at spotting winners, is a notoriously insecure foundation.

Sir Clive Sinclair is a good example. He created a market for home computers from almost nothing, with very little historical precedent on which to work. His judgement then let him down with his now infamous electric car.

However there is a growing belief that there is a much more fundamental obstacle in the way of a new technology-based future. And it is thought to be the result of something deep in our culture.

The British are said to be inventive, highly specialised and do not give proper recognition to practical abilities. This is manifested by the ability of British scientists to make great advances in a wide range of areas and find their efforts rewarded with status and awards. However the people who put these ideas to work in industry are given little recognition, thus encouraging people to go into research rather than industry.

At university engineers are put down by being called spannermen and having a reputation for heavy drinking and playing rugby. The future leaders of society are busy taking social sciences, history or English. Even within industry itself it is more often the accountants who reach the top positions rather than engineers or scientists.

These thoughts were brought to mind by two recent events, a colloquium on Advanced Robotic Initiatives in the UK at the Institution of Electrical Engineers in London and a fact finding mission to Japan looking at its advanced robotic technology.

COLLOQUIUM

Prof. John Gray, of the National Advanced Robotics Research Centre at Salford University, chaired the colloquium. He said that what concerned him was not the level of research being carried out in this country, although like any scientist he would always like there to be more, but the likelihood that the results would not be implemented properly.

He emphasised the cultural problems of getting people into what are seen as the less glamourous areas of industry. There is a large amount of work being done with enthusiasm on research under the Department of Trade and Industry's Advanced Robotics Initiative but he is not sure that this would result in new products and industries within this country.

He pointed to areas where change was necessary if the UK was to make the best use of the research being undertaken. He picked out the lack of cross disciplinary co-operation beginning at school and continuing into the professional bodies. The different bodies for different branches of engineering were given as an example of the way in which the disciplines have tended to stay apart.

There are some moves towards more co-operation with the amalgamation of some of the professional bodies, and universities beginning to offer interdisciplinary studies within engineering. However progress is slow and the tertiary education system is still dominated by traditional single discipline departments.

In a recent article in the IEE's *Computing and Control Engineering Journal* Prof. Gray outlined the depth of the problem faced in making use of robotics developments. There is a requirement, he wrote, "for personnel with broad interdisciplinary skills, encompassing nearly all the traditional engineering aspects as well as artificial intelligence and computer science."

JAPANESE EXPERIENCE

These problems compare with the experience of Japan. The visit to Japan was undertaken with the backing of the Department of Trade and Industry and the British Robot Association. It visited the '91 International Symposium on Advanced Robot Technologies and exhibition of research and findings being held in Tokyo this year and visited a number of Japanese companies.

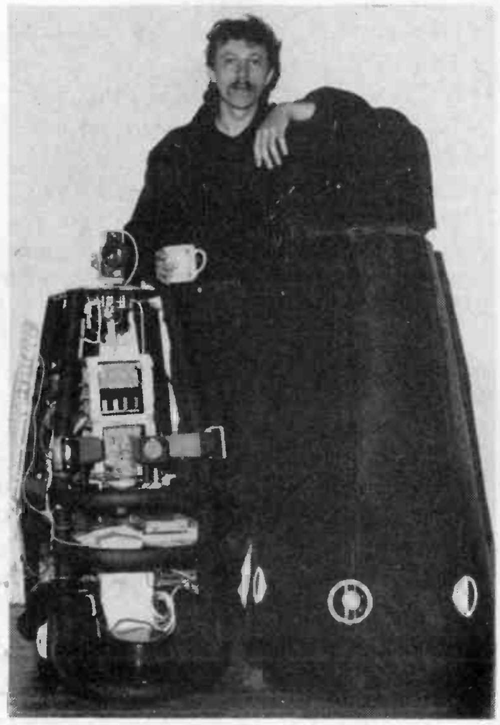
The visitors found that in a number of areas Japanese researchers were ahead of the UK. A spokesman for the DTI said that they were at the stage of building advanced prototypes in areas such as nuclear environments, security and fire fighting. Research is totally government funded in Japan, compared with an initial 100 per cent for feasibility studies in the UK, decreasing through 50 per cent for the prototype stage to nil for further development. However the major difference noted by others on the visit was not the funding and level of research but the way that research was conducted and what happened to the results.

It is felt that Japan is a country where making things is just as important as inventing them. And despite the fact that, of the nine products identified by the DTI Advanced Robot Initiative six have been taken up by industry, there seemed to be a greater co-operation between industry and research in Japan. The products identified by the DTI were in industries such as construction, underwater, medical and fire fighting.

In addition Japanese research is often more limited. Rather than aim immediately for the most sophisticated solution to a problem they find one solution and then seek to improve on that step by step. It is a similar approach to that discovered by the organisers of the Micro Mouse competition where the aim is to get an electronic mouse to the centre of a maze as quickly as possible. Unlike the UK contestants who were always searching for the most interesting way to solve the problem the Japanese took one design and concentrated on perfecting that. The success of this approach led to the rules being changed.

Many seem to recognise the problem of the gap between research and development into saleable products. The DTI says that it is taking action to try to bridge the gap by promoting co-operation between the academics and industry. However if industry does not have sufficient people who have the knowledge to spot the possibilities or who can be trained to make use of the resulting products then such links will prove of little use.

HILDA 2 and HILDA 3. These robots are the result of work being done by Technology Applications Group but will it lead to a saleable product?



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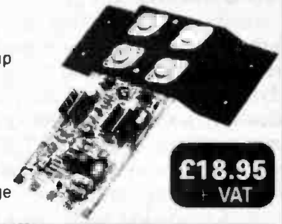

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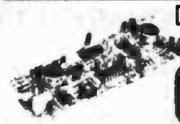

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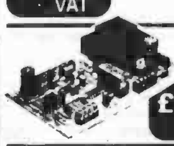

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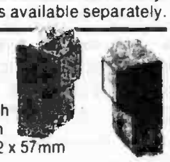

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The books listed have been selected by Everyday Electronics editorial staff as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full ordering details are given on the last book page. For another selection of books see next month's issue

TESTING, THEORY AND REFERENCE

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.
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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 extended 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

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 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).
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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.
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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.
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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 microelectronics 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.
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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.
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AUDIO AND MUSIC

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.

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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.

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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.

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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.

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CIRCUITS AND 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 project consists 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.

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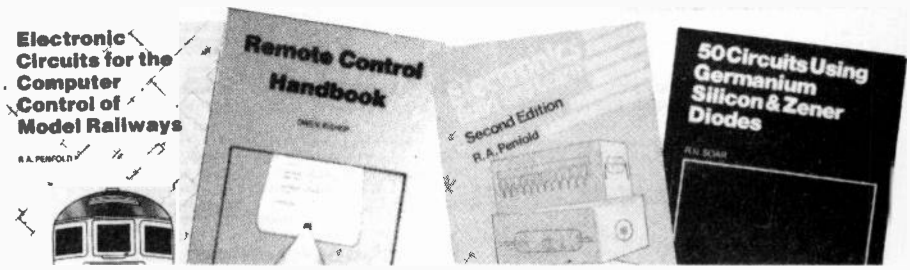

REMOTE CONTROL HANDBOOK
Owen Bishop

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 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.

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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. Whenever 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.

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BOOK 2 –
All projects use CMOS i.c.s. but the items on component identification etc., are not repeated from Book 1.

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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.

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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.

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HOW TO DESIGN ELECTRONIC PROJECTS
R. A. Penfold

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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.

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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

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.

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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.

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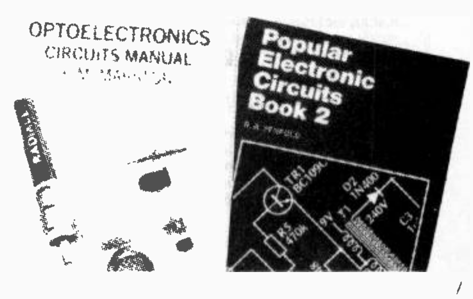

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R. A. Penfold
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This book describes in detail how to construct some simple and inexpensive but extremely useful, pieces of test equipment. Stripboard layouts are provided for all designs, together with wiring diagrams where appropriate, plus notes on construction and use.
The following designs are included:- AF Generator, Capacitance Meter, Test Bench Amplifier, AF Frequency Meter, Audio Millivoltmeter, Analogue Probe, High Resistance Voltmeter, CMOS Probe, Transistor Tester, TTL Probe. The designs are suitable for both newcomers and more experienced hobbyists.
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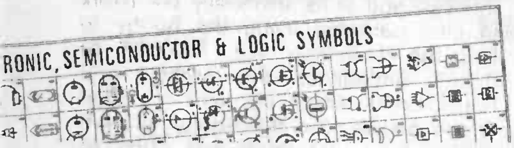
DATA AND COMPONENT IDENTIFICATION



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M. H. Banani B.Sc.(Eng.)
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Gordon J. King
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R. A. Penfold
Anyone can switch on a short wave receiver and play with the controls until they pick up something, but to find a particular station, country or type of broadcast and to receive it as clearly as possible requires a little more skill and knowledge. The object of this book is to help the reader to do just that, which in essence is the fascinating hobby of radio DXing.
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A TV-DXERS HANDBOOK
R. Bunney
Roger Bunney is probably one of the leading authorities in this country on the subject. Includes many units and devices which have been designed and used by active enthusiasts, and often, considerable ingenuity and thought have gone into the development of such units to overcome individual problems. A practical and authoritative reference to this unusual aspect of electronics.
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H. C. Wright
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The aim of the experimenter will be to make a measurement or confirm a principle, and this can be done with relatively fragile, short-life apparatus. Because of this, devices described in this book make liberal use of cardboard, cooking foil, plastic bottles, cat food tins, etc. These materials are, in general, cheap to obtain and easily worked with simple tools, encouraging the trial-and-error philosophy which leads to innovation and discovery.
Although primarily a practical book with text closely supported by diagrams, some formulae which can be used by straightforward substitution and some simple graphs have also been included.
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R. A. Penfold
Not only are PC and compatible computers very expandable, but before long most users actually wish to take advantage of that expandability and start upgrading their PC systems. Some aspects of PC upgrading can be a bit confusing, but this book provides advice and guidance on the popular forms of internal PC expansion, and should help to make things reasonably straightforward and painless. Little knowledge of computing is assumed. The only assumption is that you can operate, a standard PC of some kind (PC, PC XT, PC AT, or a 80386 based PC).
The subjects covered include: PC overview; Memory upgrades; Adding a hard disk drive; Adding a floppy disk drive; Display adaptors and monitors; Fitting a maths co-processor; Keyboards; Ports; Mice and digitisers; Maintenance (including preventative maintenance) and Repairs, and the increasingly popular subject of d.i.y. PCs.
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R. A & J. W. Penfold
Written for readers wanting to learn more about programming and how to make best use of the incredibly powerful model B's versatile features. Most aspects of the BBC Micro are covered, the omissions being where little could usefully be added to the information provided by the manufacturer's own manual.
144 pages Order code BP139 £1.95

AN INTRODUCTION TO 6502 MACHINE CODE
R. A. & J. W. Penfold
No previous knowledge of microprocessors or machine code is assumed. Topics covered are: assembly language and assemblers, the register set and memory, binary and hexadecimal numbering systems, addressing modes and the instruction set, and also mixing machine code with BASIC. Some simple programming examples are given for 6502-based home computers like the VIC-20, ORIC-1/Atmos, Electron, BBC and also the Commodore 64.
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The PRE-BASIC BOOK
F. A. Wilson, C.G.I.A., C.ENG., F.I.E.E., F.I.E.R.E., F.B.I.M.
Another book on BASIC but with a difference. This one does not skip through the whole of the subject and thereby leave many would-be programmers floundering but instead concentrates on introducing the technique by looking in depth at the most frequently used and more easily understood computer instructions. For all new and potential micro users.
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REPORTING AMATEUR RADIO

Tony Smith G4FAI

NOVICE LICENCE COURSE

As reported last month, RSGB courses in preparation for the new amateur radio Novice licence examination are now becoming available. They will cover the syllabus in approximately 30 hours, with extra time to learn the Morse code when required. Courses will comprise no more than four students and will have a strong practical emphasis.

Examples of some of the subjects covered by individual sessions, and how they are approached, are as follows:

Demonstrating the main controls of a receiver on the h.f. bands: Tuning through single sideband (SSB) signals, switching between upper and lower sidebands, band switching, function of audio frequency and radio frequency gain controls, frequency indication – analogue or digital, separation of bands into different sections for different modes, and demonstration of the different types of signal to be heard.

Soldering: Safety precautions, tinning, function of flux, need for correct size bits, appearance of good joints.

Components: Identification of different types, colour codes, periodic questioning during the course to confirm familiarity.

Multimeters: Setting for major modes of operation, difference between a.c. and d.c. voltage and current, importance of polarity, different scales on analogue instruments, importance of leaving the meter switched off when not in use.

WORKSHEETS

Linked with the individual sessions are worksheets which provide detailed information for students working with the instructor or revising at home. Apart from the above, these include a simple circuit/experiment to observe Ohm's law; codes and abbreviations used over the air; how to make a contact over the air; log-keeping and QSL cards; power of a circuit; propagation conditions on the amateur bands; alternating current; tuned circuits; receiver and transmitter block diagrams; harmonics; learning and using Morse code; aerials; EMC (electromagnetic compatibility), i.e., avoiding interference; power supplies; and more.

The course covers basic radio theory and practice in easily digestible "bites" each lasting about 30 minutes; and a great deal of work has gone into meeting the needs of the total beginner to the hobby. As part of Project YEAR (Youth into Electronics via Amateur Radio) the new licence is clearly aimed at the young, but candidates of *all* ages can become Novice operators and the course represents an excellent way of learning about the subject at "ground level". If any readers of EE enrol for one of the early courses I shall be delighted to receive and report their reactions to it.

STUDENT REQUIREMENTS

Students need to have the *Novice Licence Student's Notebook,* obtainable from the RSGB. A useful book of sample examination questions is also available. Also needed is an approved audio frequency amplifier kit, with other components, required to construct a basic radio receiver. Details will be provided by the instructor.

There is no course fee although the volunteer instructor may ask for assistance with modest incidental expenses. On successful completion of the course the RSGB will issue a Course Completion Slip, and an optional completion certificate will be available for £2.50.

Successful students may then apply to take the Novice Radio Amateurs Examination (Subject No. 773), to be held at local City & Guilds examination centres four times a year. The examination fee is £8.95, plus a centre examination fee. The C&G hope to publish results four weeks after each examination.

MORSE TEST

For those seeking the Novice A licence, which permits operation on selected h.f. frequencies (as opposed to the v.h.f. only B licence which does not require a knowledge of Morse code), the final hurdle is the RSGB 5w.p.m. Morse test which will become available in June or July this year. There are existing test centres in most counties, etc, where Novice tests will be held every two months, while candidates prepared to travel to adjacent areas will usually be able to arrange a test within a few weeks.

To help learners, the RSGB has a Morse code training tape, *Morse code – A Stage 1,* using a well-tried system which sends letters at 12w.p.m. while leaving longer than usual spaces between symbols and words to reduce the overall speed to five words per minute. Full details on all aspects of the Novice licence can be obtained from the Radio Society of Great Britain, Lambda House, Cranborne Road, Potters Bar EN6 3JE.

YOUNG AMATEUR OF THE YEAR

The DTI's Radio Communications Agency has announced its sponsorship for the *1991 Young Amateur of the Year Award* as part of its continuing support for Project YEAR. This is for the most outstanding achievement by an amateur radio enthusiast under the age of 18 during the period 1st August 1990 to 31st July 1991. The winner will get a cash prize of £250 and every entrant will receive a copy of the RSGB's amateur radio log book. The winner and runners up will be invited to spend a day at the Agency's Radio Monitoring Station at Baldock, Herts. Additional prizes will be donated by the radiocommunications industry.

Achievement in any field of amateur radio will be considered, such as an interest in d.i.y. construction; operating interests and skills, especially teamwork in club contests; using the hobby to help the community, e.g., RAYNET, St John's Ambulance, the disabled and housebound; encouragement of other young people into the hobby through presentations in schools and clubs; or involvement in amateur radio as part of a school project.

The closing date for applications is 31st July 1991. Candidates may enter directly or be nominated by an adult. Notes for entrants can be obtained from The Secretary of the RSGB, address as above.

AMATEUR RADIO AND THE GULF

As this is being written, the Gulf War has thankfully ended and stories are beginning to emerge of activities by radio amateurs which have assisted those affected by the hostilities. Soon after the Iraqi invasion, for instance, when news from Kuwait was minimal, a Russian amateur there sent a teletype (AMTOR) message, received by an Australian station, describing conditions under the occupation which received nationwide media coverage in Australia. American and Israeli amateurs sent and received messages on behalf of worried families after the Scud attacks on Israel, when telephone lines to Israel were hopelessly jammed by similar enquiries.

Radio amateurs in the American armed forces passed messages between serving personnel and their families at home and elsewhere, via US based stations, until a general radio silence was imposed at the commencement of hostilities. Many of these operations were on MARS frequencies, non-amateur frequencies permanently allocated for relaying messages, and phone-patching, between military personnel and their families worldwide. S.W.L. readers have no doubt heard the phone patching, i.e., connection of radio links into the public telephone system, which takes place regularly on the 20 metre amateur band.

Passing messages by radio amateurs on behalf of non-amateurs is permitted in some countries and not others, and international links are permitted only by formal agreement between the countries concerned. In the USA this facility is seen as a form of public service, and linking agreements exist with Australia, Israel and many other countries. In the UK, however, the radio regulations do not permit such "third party traffic" except in certain defined situations so, unlike their American colleagues, British forces in the Gulf were unable to send messages home via amateur radio.

MODULAR DISCO LIGHTING SYSTEM

Part Three: MASTERLINK SYNCHRONIZER MODULE

CHRIS BOWES

Light up your party or disco road show with these easy-build effects modules.

THIS MODULE is the first of the system control modules, which do not, in themselves, provide an output pattern to control a lighting display. The purpose of this module is to synchronise any of the other modules within the system, which have been switched to Masterlink control, so all of the modules so selected are driven in synchronism, see Fig. 1.

Essentially the Masterlink module contains the pulse generating and auxiliary function controls contained in most of the other modules The outputs from the Masterlink Module are buffered and made available at the connection sockets so that they can then be "bussed" to all of the more complex modules in the system.

CIRCUIT DESCRIPTION

The full circuit diagram for the Masterlink Module is shown in Fig. 2. The power to drive the module is obtained from the power input connections on the 7-pin DIN sockets SK1/SK2.

There are two such sockets, wired in parallel, on each Masterlink compatible module so that the Masterlink connections can be easily bussed through a stack of system control and/or effects modules, irrespective of the order in which they may be arranged. These sockets also serve to buss the external pulse line, which enables any of the pattern generating modules in the system to be operated by pulse outputs originating from any of the sound operated modules.

POWER SUPPLY

The positive power supplies from each of the connected modules are combined, through 1N4001 diodes installed in each of the Masterlink compatible modules. The positive power supply voltages appearing on pin 1 of the DIN sockets and the common 0 volt supplies appearing on pin 2 of the DIN sockets. The latter connections are commoned through the printed circuit board.

In order to avoid problems which might be caused by an inadvertent reversal of the power supply polarities for any reason, D1, another 1N4001 diode, is also included in the positive power supply rail. FS1 is a 100mA fuse which is included to protect the circuitry of the module in the event of a fault arising within this module.

Capacitor C1 is a tantalum type, which is used to decouple the logic circuits within the module. The red light emitting diode (l.e.d.) D4 and it's associated series resistor R1 is used to provide an indication that power is available to the module.

CLOCK CIRCUIT

Clock pulses to drive the system are obtained from three sources. The most usual source being the clock pulse generator which is made up of IC1, R3, VR1, R4 and C2. This operates in an identical manner to the generators in the rest of the modules.

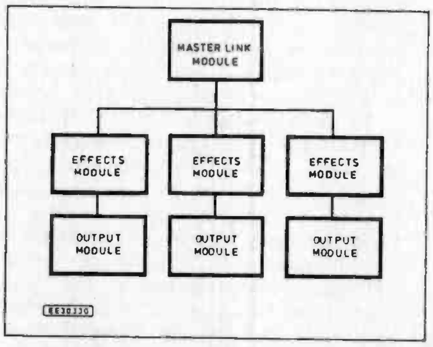


Fig. 1. Using Masterlink to synchronize any number of effects modules.

The 555 timer IC1 is configured in the astable mode and the frequency of the output pulse produced at pin 3, is governed by the values of R3, VR1, R4 and C2. As the output pulse from pin 3 is predominantly in the Logic 1 state this is connected to an inverter formed by IC2a, a two input NAND gate.

This ensures that the positive going pulses are of a relatively short duration. This precaution is necessary because the other pulses in the system are also positive going (switching from Logic 0 to Logic 1 when activating the counter) and any long duration Logic 1 state at the input to the counter will block any other pulse from activating the counter.

Switch S2 is included to select the pulses proceeding to the rest of the circuit between those produced by the internal clock pulse generator and pulses generated by external sound activated modules, the signals from which are commoned through the Masterlink connections appearing at SK1 pin 7. These pulses are fed via S2, diode D2 and resistor R7 to the base of transistor TR2.

ONE-SHOT CIRCUIT

The third source of clock pulses is the "One-Shot", push-to-changeover switch, S3. Any switch of this type will produce a number of high speed pulses when operated because of the bouncing effect of the switch contacts as they close.

In order to overcome this problem and to give a single shot output pulse for each operation of S3 it is connected to a debouncing circuit, formed by R5, R6, IC2b and IC2c. When switch S3 is operated it effectively shorts resistor R6 to 0V this changes the input state of pin 9 of IC2c. This produces a Logic 0 state at the output (pin 10).

The same switch action removes the short to ground of resistor R5 and allows the input to pin 13 of IC2b to rise to a Logic 1 state. The cross linking of IC2b and IC2c causes the output at Pin 11 to remain in the Logic 1 state until the states at pins 8 and 12 are reversed.

The one-shot pulse created at the output of IC2b is fed, via diode D3, to the junction with resistor R7. Diodes D2 and D3 form a simple OR gate which allows clock pulses from S3 to be added to those from the remainder of the circuit without causing interference.

When the base of TR2 is energised, by the presence of the Logic 1 state at the junction of D2, D3 with R7, the transistor conducts, causing current to flow through the pull-up resistor R8. This causes the state at this point to change from Logic 1 to Logic 0. This is inverted by IC2d and fed both to resistor R20 and transistor TR6, via another inverter (IC5b), and also to pin 13 of the Johnson counter IC3 and the indicator l.e.d. (D5), via its series resistor R9.

ONE-IN-FIVE CIRCUIT

The 4017 decade counter IC3 is used to provide a special output pulse, for use in certain modules, which occurs every fifth pulse of the Masterlink primary output pulse. Pin 14 of IC3 is held in the Logic 1 state by its pull up resistor, R10, and thus IC3 counts forward by one step for each negative going pulse fed to pin 13.

This required pulse is obtained from pin 10 (0_4) of the 4017, and the counter is reset to zero, with the unconnected output 0_0 being forced to Logic 1 by the connection of output 0_5 (pin 1) of the i.c. to the MR (reset) input (pin 15). When output 0_4 goes to the Logic 1 state the counter is reset to 0, counts up once more and hence produces the required pulse on every fifth count.

The output from output 0_4 is inverted via IC5a and fed through resistor R12 to the base of transistor TR3, which is used to provide a buffer output at pin 4 of the DIN sockets. As long as a Logic 1 output is available at the output of IC5a, TR3 is made to conduct and effectively shorts out resistor R13, causing a Logic 0 state to be present at the output pin 4 of the DIN sockets.

This state is the normal one but when the required output pulse is created as a Logic 1 state at pin 10 of IC3 it is inverted by IC5a causing a Logic 0 state to exist at the input of the buffer circuit comprising R12, TR3 and R13. TR3 ceases to conduct and current is no longer drawn through resistor R13 which causes the output at pin 4 of the DIN sockets (SK1/SK2) to rise to the Logic 1 state. Transistor TR3, in common with the other output transistors TR4, TR5 and TR6, forms a simple output buffer which

COMPONENTS

See SHOP TALK Page

Resistors

R1, R9, R11, R14, R15	1k (5 off)
R2	470
R3	5k6
R4	3k
R5, R6, R8, R10, R13, R17, R19, R21	10k (8 off)
R7, R12, R16, R18, R20	82k (5 off)

All 0.25W 5% carbon film

Potentiometer

VR1 250k rotary, lin.

Capacitors

C1	2μ2 tantalum, 25V
C2	47μ elect., 25V

Semiconductors

D1	1N4001 1A 50V rec. diode
D2, D3	1N4148 signal diode (2 off)
D4	Standard Red l.e.d.
D5-D8	Standard Green l.e.d.s (4 off)
TR1-TR6	ZTX300 *npn* silicon (6 off)
IC1	555 CMOS timer
IC2, IC5	4011 Quad 2-input NAND gate (2 off)
IC3	4017 Johnson counter
IC4	4520 Dual binary counter

Miscellaneous

S1, S2	S.P.D.T. min. toggle switch (2 off)
S3	S.P.D.T. pushbutton changeover switch
SK1, SK2	7-pin DIN chassis socket (2 off)
FS1	100mA 20mm fuse and p.c.b. fuse clips.

Aluminium instrument case (Maplin "Blue Case 233"), size 250mm x 150mm x 75mm; 8-pin d.i.l. socket; 14-pin d.i.l. socket (2 off); 16-pin d.i.l. socket (2 off); plastic knobs for VR1 and S3; p.c.b. stand-off pillars; connecting wire; solder pins; l.e.d. clips (5 sets); nuts and bolts for socket fittings; solder etc.

Printed circuit board available from *EE PCB Service*, code EE752.

Approx cost guidance only **£19** *plus case*

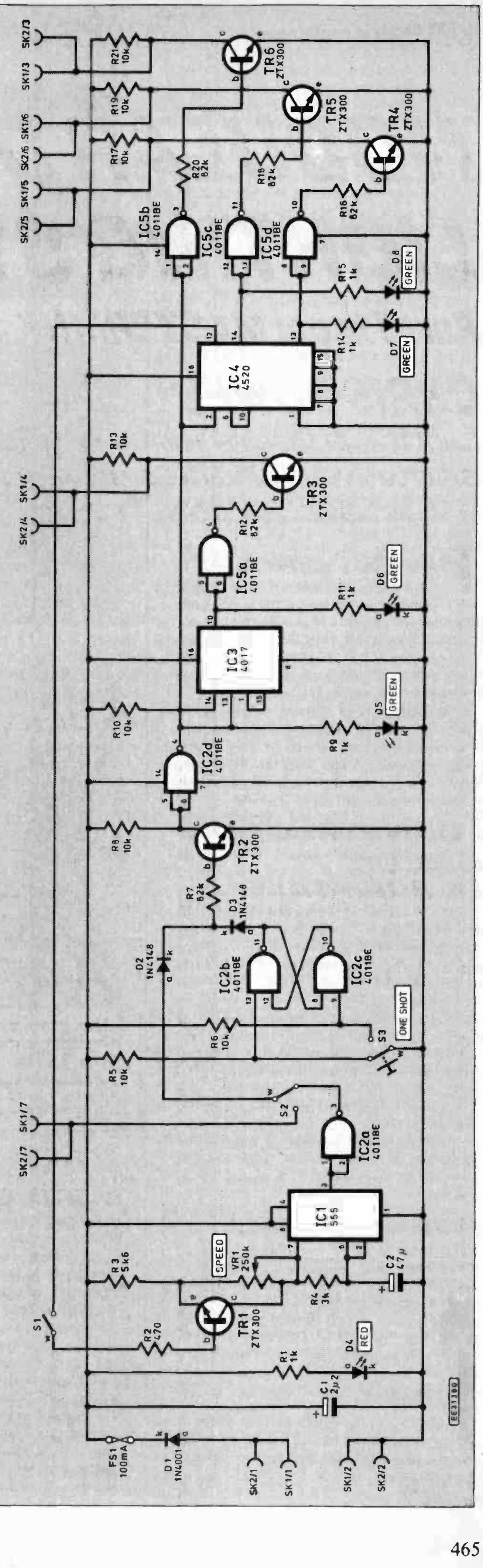


Fig. 2. Complete circuit diagram for the Masterlink Module. Note that a lead is taken directly from switch S2 to pin 7 of SK1.

enables a large number of modules to be driven by the Masterlink module.

A 4520 dual binary counter, IC4 is connected to form a 256 stage binary counter. The pulses generated by IC1 are fed to the $\overline{CP}_{1A}$ input (pin 2) of IC4 and, with the CP_{0A} input held at Logic 0, the counter advances by one step with every pulse.

Output 0_3 (pin 6) of the first half of the 4520 counter is connected to the Enable B $\overline{CP}_{1B}$ input (pin 10) of the other half of the counter, with it's Clock B (pin 9) input similarly being held at Logic 0. This counter thus advances at every sixteenth transition of the input pulse to the first half of IC4.

Outputs 0_2B and 0_3B of IC4 are taken both to their indicator circuits, comprising R14 and D7 and R15 and D8 respectively, and to the inverters IC5c and IC5d. The outputs of these two inverters are fed via resistors to the bases of transistors TR4 and TR5.

Together with the pull up resistors R17 and R19, these transistors form output buffers, in the same way as described earlier. The buffered outputs of all of the Masterlink signals are made available to all compatible modules via pins 3, 4, 5 and 6 of the DIN sockets SK1, SK2.

SPRINT CIRCUIT

Transistor TR1 and resistor R2 are used to provide a sprint or "Speed" facility. When output 0_1B (pin 12) of the second half of the 4520 counter (IC4) goes to the Logic 1 state this voltage is made available, via switch S1, through the base protection resistor (R2) and to the base of TR1.

When the base voltage of the transistor rises above the emitter voltage the transistor saturates and effectively shorts out the Speed control VR1. This causes the output pulses from IC1 to increase in frequency to that set by R3, R4 and C2 alone.

CONSTRUCTION

The Masterlink circuit is built on a single-sided printed circuit board (p.c.b.), the full size copper foil pattern and component layout of which is shown in Fig. 3. The foil pattern should be transferred to a suitable board which is then etched and drilled in the usual way. (A ready-tinned and drilled board is available from the *EE PCB Service*, code EE752).

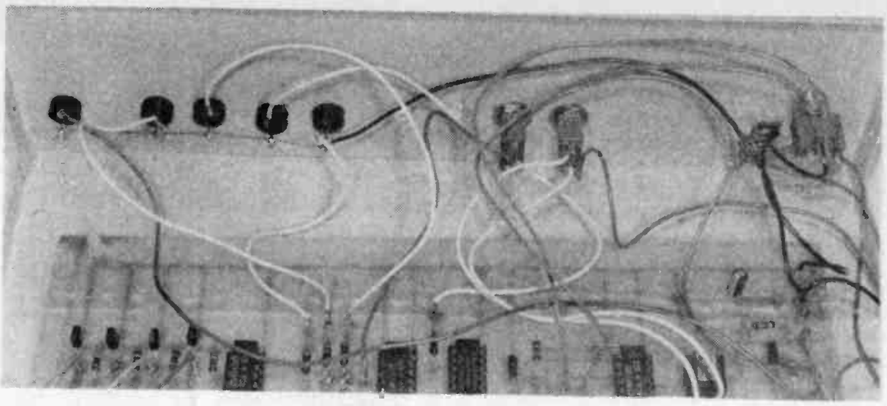
After drilling the board the components can be inserted into the board and soldered in place. Although this process can be carried out in any convenient order you will find that it is easier to perform this task if the components are inserted in ascending order of size.

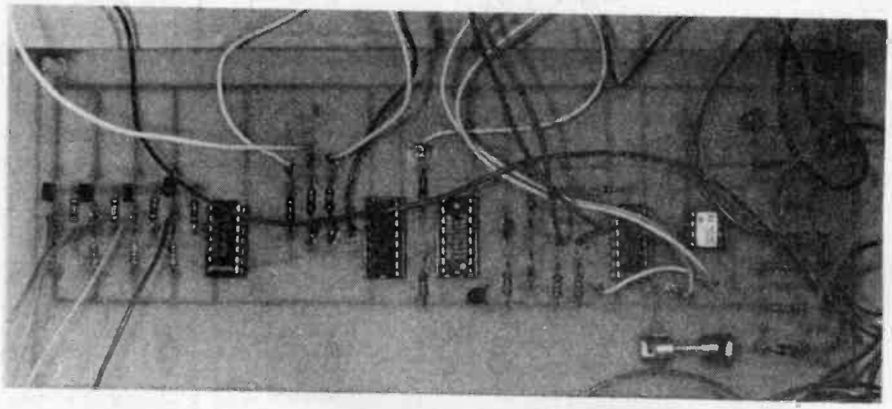
All the components of a particular size should be soldered into position before going onto a larger size of components. Care should be taken to ensure that all of the polarity sensitive components are connected into the circuit board with the correct polarity.

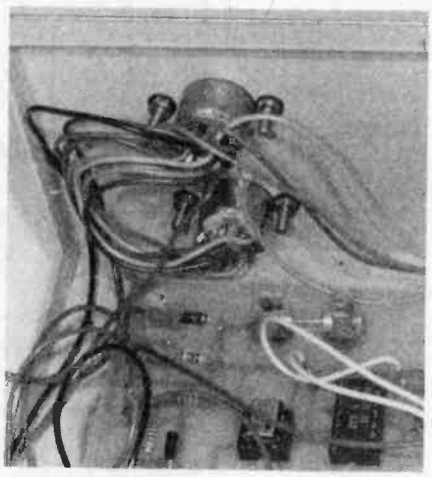
The i.c.s are best accommodated in sockets which are soldered in place along with the other components. The i.c.s should be inserted as the last task before testing out the unit. Care should also be taken with these components to ensure correct polarity.

CASE

All of the modules in this series have been designed to fit into the case detailed in the components list and you are advised to ensure that the case specified, or a metal one with at least the minimum of internal







(above) Wiring to front panel components, completed board and (left) interwiring to the rear DIN sockets.

space, is used since some of the modules are very tightly packed into the specified case.

Similarly the panel designs for all of the modules have been designed in a coordinated scheme so it is advisable to either follow the layouts given in the photographs or to design your own coordinated scheme. **Whichever case is used it is most important that they are properly "Earthed".**

WIRING-UP

Before commencing to install the case mounted components it is recommended that the case should be drilled and lettered. The p.c.b. is best not wired up to the case mounted components until all the components, except for the i.c.s, have been inserted and soldered.

The connections between the p.c.b. and the case mounted components are best made with flexible wires cut to a size which allows the board to remain connected to the control panel when removed for fault finding etc. 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 must be prepared by tinning before the cable is inserted into the appropriate holes on the board and then soldered into place.

TESTING

Once all the connections have been made the p.c.b. should firstly be carefully checked for broken tracks, solder blobs and incorrectly placed components before attempting to insert the i.c.s and test the unit. The i.c.s should then be inserted into the correct sockets, taking care to ensure that they are the correct way round.

In order to test the Masterlink module it will be necessary to connect it, via a five-pin DIN cable, to the Masterlink socket of a compatible module and connect that module to an Output Module. As soon as the Output Module is switched on l.e.d. D4 on the Masterlink module should glow and D5 to D8 should illuminate in a sequence such that D6 illuminates briefly after every fourth illumination of D5 whilst l.e.d.s D7 and D8 are illuminated in a binary pattern after a considerable number of illuminations of D5.

The Effects Module should be switched so that the Masterlink connection is activated (by setting the Masterlink switch to the down, or ON position) and the reverse and pattern controls should be switched to their AUTO positions. You should now see that the effects control functions now respond to that of the Masterlink.

IN USE

The Masterlink unit operates in the same way as the effects modules, in so far that the pulse and other functions are controlled by potentiometer VR1 and the Auto-Sprint circuitry which can be engaged via switch S1. The best method of connecting the unit into a stack of effects modules is to "daisy chain" the inputs up and down the stack by using five-pin DIN leads plugged into the Masterlink sockets.

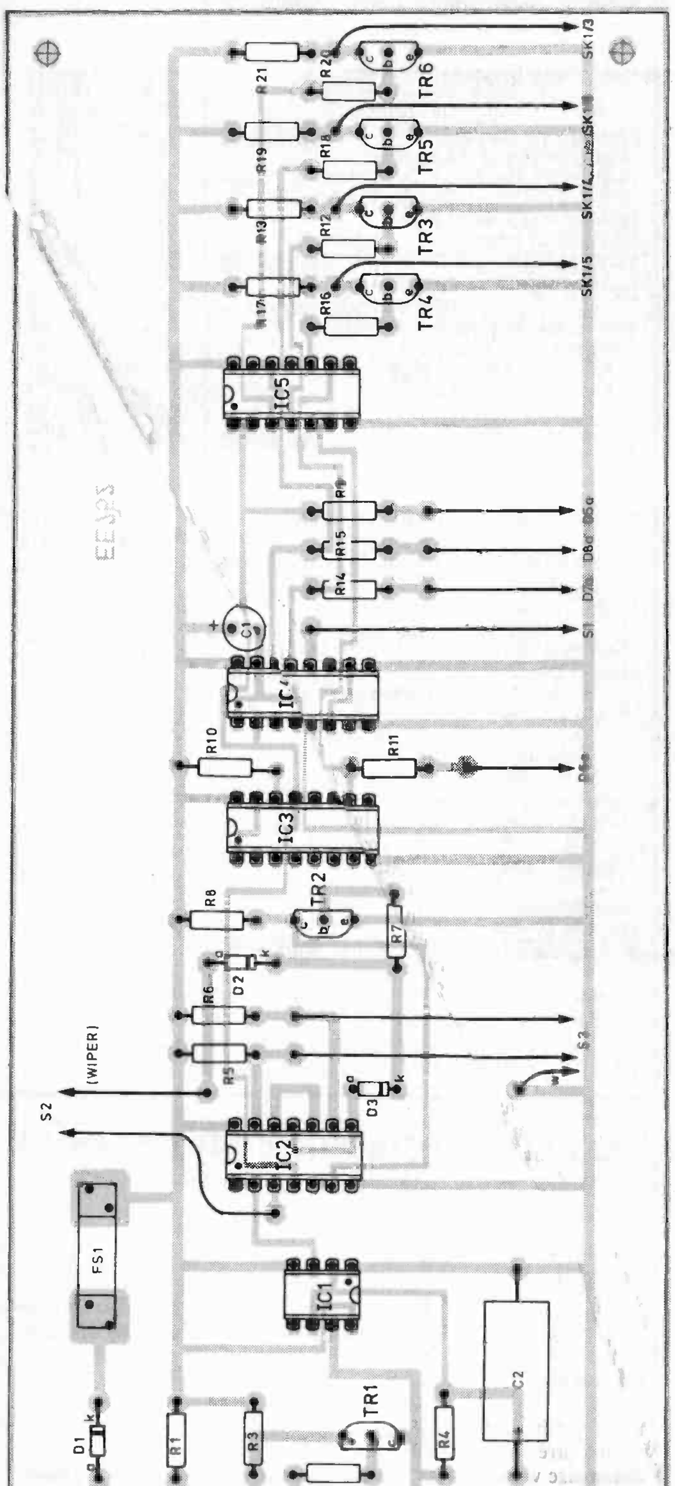
Each module, including the Masterlink module, is equipped with two DIN sockets so that they may be "daisy chained" by simply plugging each module into the next module up or down in the stack. It does not matter in which order any modules are stacked.

When the Masterlink module is in use any or all of the compatible module can be switched on to Masterlink control in which case they will be pulsed by the output pulses from the Masterlink module. The frequency of these pulses is selected by the setting of VR1, with the "sprint" facility being engaged by the operation of switch S1.

If the auto functions for direction and/or pattern are selected on any module where the Masterlink function has also been selected then control of that function will be passed to the outputs of the equivalent functions on the Masterlink modules. This means, that in use, all of the Masterlink compatible modules within the system can be made to pulse, change direction and change pattern at the same time.

They can, of course, be disconnected from the Masterlink module either by selecting a permanent function on the direction and pattern selectors or by turning the modules Masterlink switch to the off position. The Masterlink compatible modules are designed to be connected together in a stack by means of a simple seven-way cable which is terminated at each end in a cable mounting 7-pin DIN plug. These connectors are connected pin to pin for all of the pins.

Next Month: Random Pattern Module.



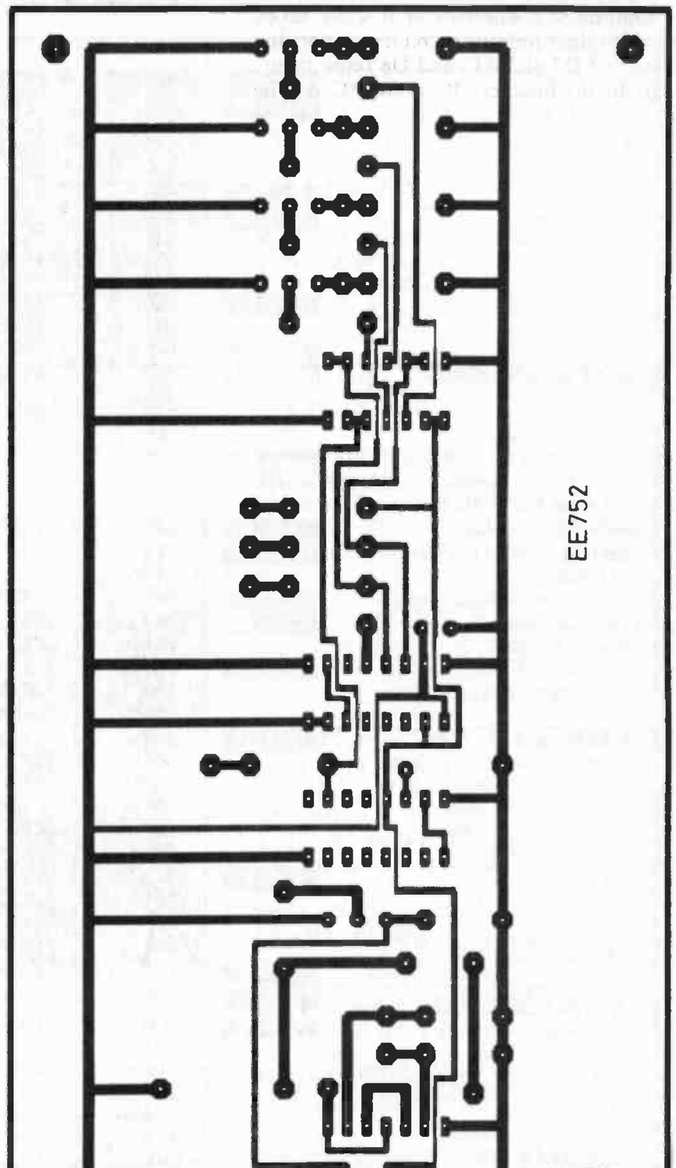


Fig. 3. Printed circuit board component layout and full size copper foil master pattern. A lead is also taken directly from one side of switch S2 to pin 7 of DIN socket SK1.

PCB SERVICE

Printed circuit boards for certain constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for overseas airmail. Remittances should be sent to **The PCB Service, *Everyday Electronics*, 6 Church Street, Wimborne, Dorset BH21 1JH.** Cheques should be crossed and made payable to *Everyday Electronics* **(Payment in £ sterling only).**

We do have some older boards in stock – please enquire.

NOTE: While 95% of our boards are now held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail. Please check price and availability in the latest issue. Boards can only be supplied on a payment with order basis.

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Tea Tune–Alarm Thermostat	AUG'88	609	£3.00
Time Switch		614	£4.84
Suntan Timer		610	£3.07
Car Alarm		615	£3.12
EPROM Eraser	OCT'88	620	£4.07
Doorbell Delay	NOV'88	616	£3.56
Infra-Red Object Counter Trans	£9.28 as a set	622	£4.61
Receiver		623	£3.23
Display		624	£3.05
Downbeat Metronome	DEC'88	629	£4.84
Phasor		631	£5.64
Continuity Tester	FEB'89	619	£2.67
Sound-to-Light Interface	MAR'89	637	£6.24
Midi Pedal		639	£7.00
Midi Merge		640	£3.00
Audio Lead Tester		641	£5.77
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Remote Interface (4 boards)		633	£4.59
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Spectrum EPROM Programmer	JUN'89	628	£7.87
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Xenon Beacon	SEP'89	650	£4.13
Power Supplies – Fixed Voltage		654	£4.08
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Power Supplies – 25V 700mA		656	£4.35
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EE Seismograph – Control		658	£4.08
Detector		659	£4.22
Lego/Logo & Spectrum		660	£6.49
Wash Pro	NOV'89	643	£3.83
Biofeedback Monitor – Front End		661	£4.52
Processor		662	£4.56
Logo/Lego & Spectrum Interface		664	£5.60
EEG Electrode Impedance Meter	DEC'89	665	£3.98
Biofeedback Signal Generator	JAN'90	666	£4.08
Quick Cap Tester	FEB'90	668	£3.92
Weather Station			
Anemometer – Freq./Volt Board		670	£3.94
Optional Display		669	£3.73
Wind Direction		673/674	£4.22
System Power Supply		675	£3.59
Prophet In-Car Ioniser		676	£3.18
EE Weather Station	MAR'90		
Display Driver		672 & 678	£4.22
Display and Sensor		671	£4.47
Fermostat Mk2		677	£4.28
Superhet Broadcast Receiver-Tuner/Amp		679/680	£4.22
Stereo Noise Generator	APR'90	681	£4.24
Digital Experimenter's Unit – Pulse Generator		682	£4.46
Power Supply		683	£3.66
Enlarger Timer		684	£4.28
EE Weather Station			
Rainfall/Sunlight Display		685	£4.27
Rainfall Sen and Sunlight Sen		686/687	£4.16
Amstrad Speech Synthesiser	MAY'90	689	£4.68
80 Metre Direct Conversion Radio	JUN'90	691	£4.95
Mains Appliance Remote Control			
Infra-Red Transmitter		692/693	£4.75
Mains Appliance Remote Control	JUL'90		
Encoder Board A		694	£6.61
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The Tester		696	£4.15

PROJECT TITLE		Order Code	Cost
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Main Board (double-sided) Display		699, 700	£10.95
Alarm Bell Time-Out		701	£4.10
Mains Appliance Remote Control Temperature Controller (p.c.b. only)		702	£5.20
Ghost Walker	OCT'90	703	£4.32
Frequency Meter		704	£5.25
Freq. Meter/Tachometer	NOV'90	705	£3.98
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R.F. section (726), Voltage Regulator (727) Audio Amplifier (728)		726/7/8	£3.06 per board
		all 3 together	£8.16
Pocket Tone Dialler	MAR'91	729	£4.36
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Simple Basic Alarm		731	£4.50
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Teach-In '91 Part 4 – Sinusoidal Oscillator		733	£4.39
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Waveform Generator (Teach-In '91 Project 4)		735	£4.72
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Teach-In '91 Part 5 – Digital Counter Module		738	£4.35
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Switched Power Output Module		739	£5.91
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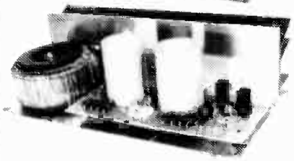

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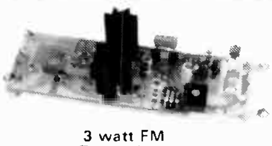

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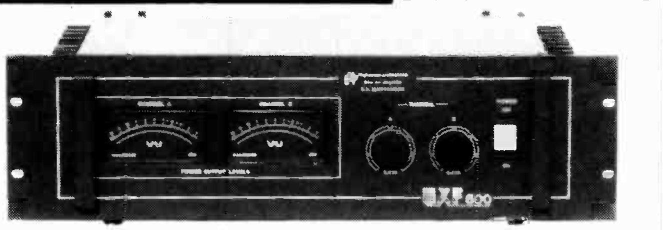

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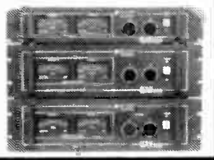

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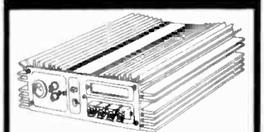

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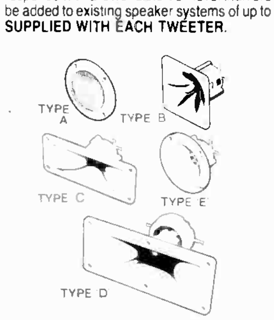
300 WATT £95.00 + £3.00 P&P EACH

PIEZO ELECTRIC TWEETERS-MOTOROLA

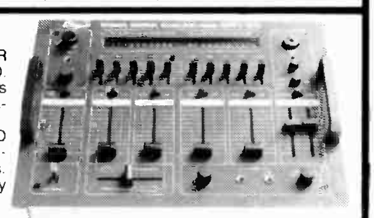
PIEZO ELECTRIC TWEETERS — MOTOROLA

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"×5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £6.99 each + 50p P&P.**
TYPE 'D' (KSN1025A) 2"×6" 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. 85×85mm. **Price £3.99 + 50p P&P.**

STEREO DISCO MIXER



STEREO DISCO MIXER with 2 × 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 360×280×90mm. Supply 220-240v.
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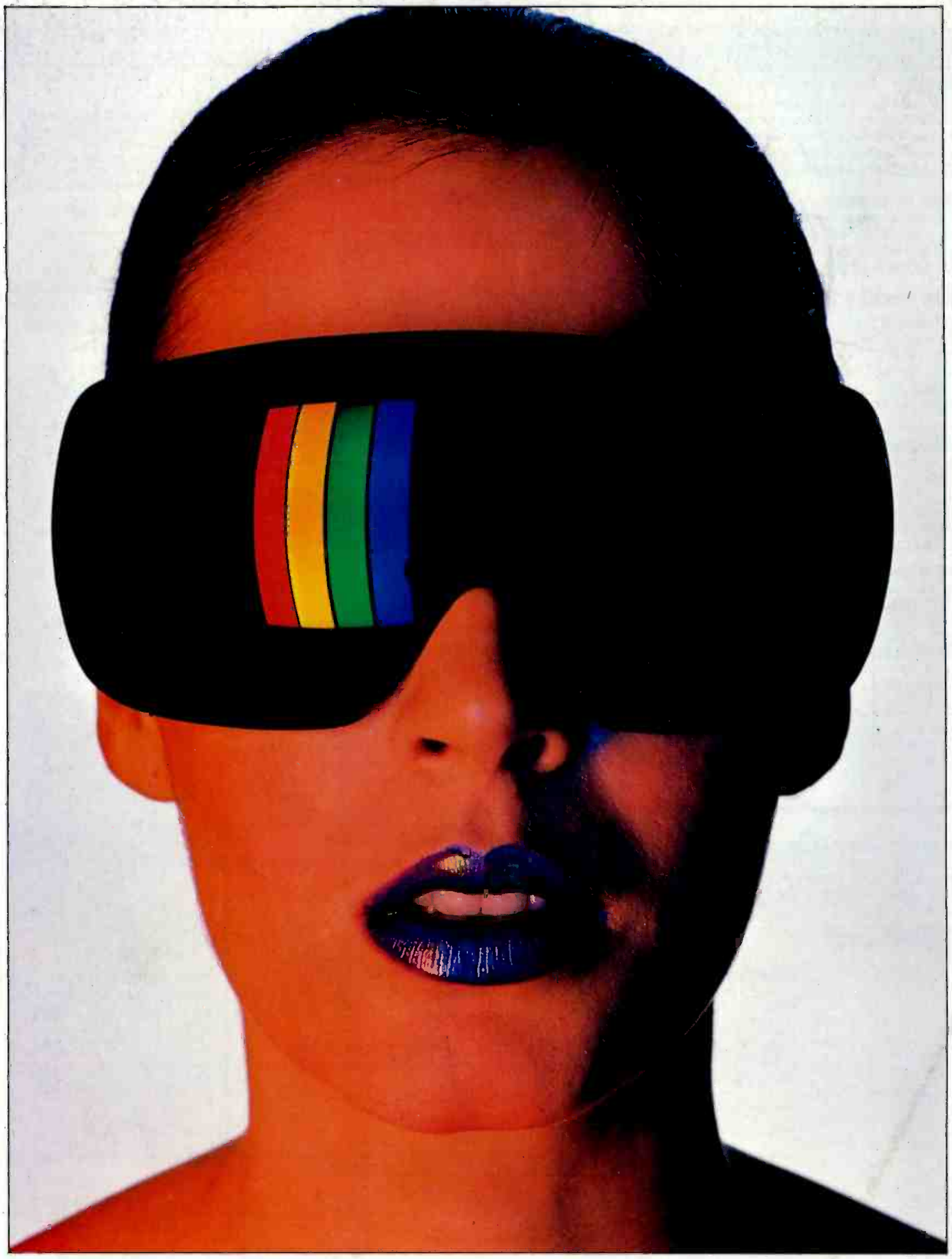

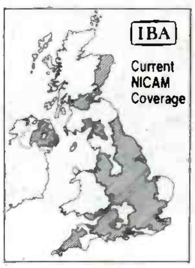

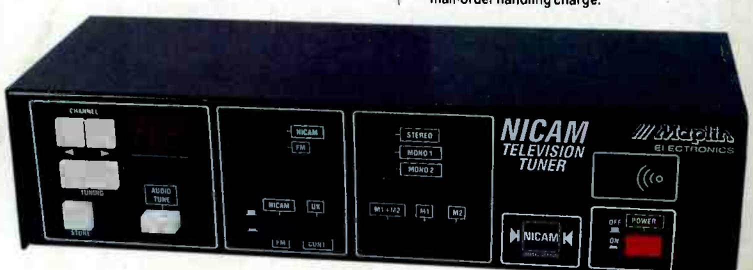

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