EVERYDAY ELECTRONICS

858

MARCH 1991

INCORPORATING ELECTRONICS MONTHLY

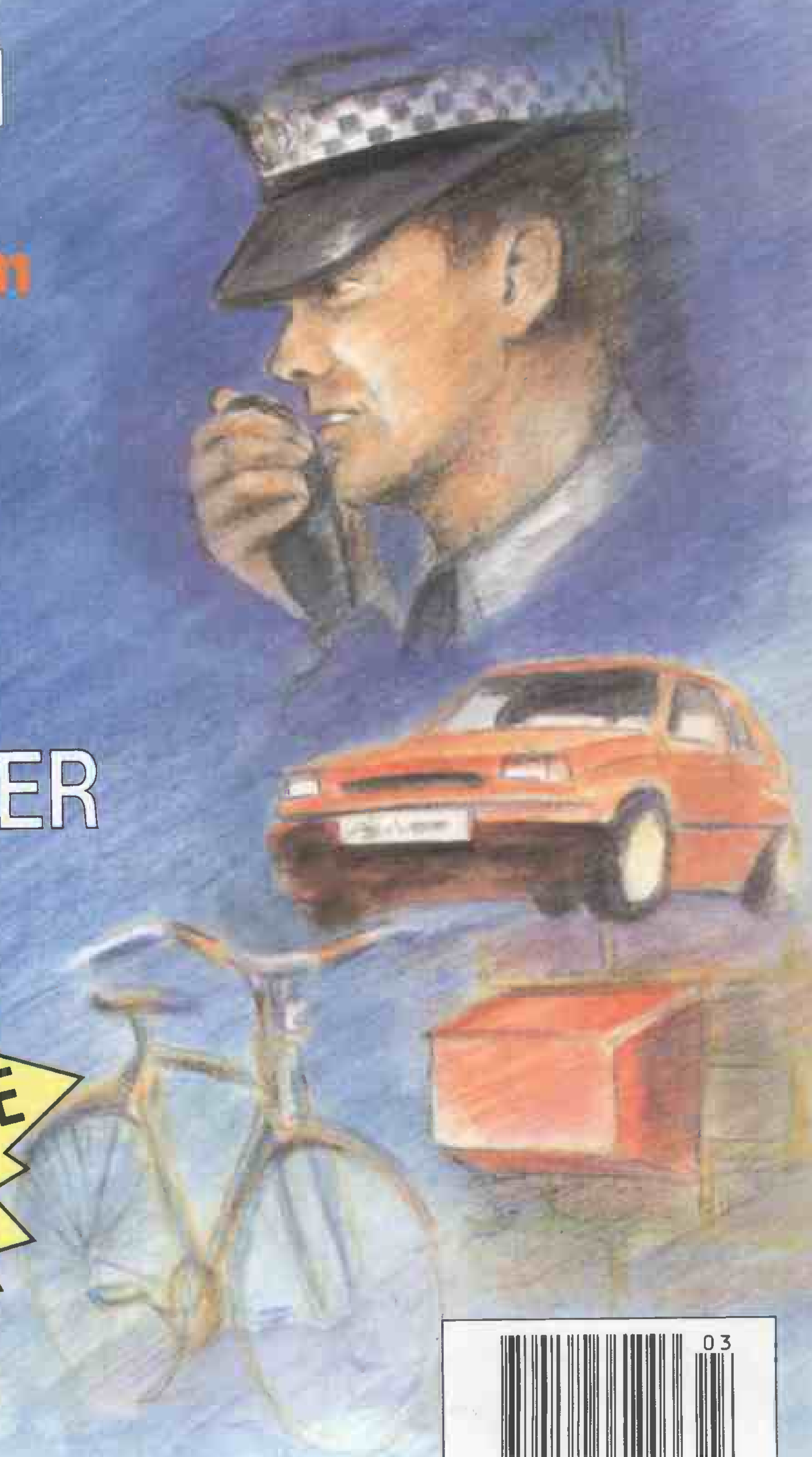
£1.50

EXTRA!

SIMPLE ALARM PROJECTS

Basic Alarm System
Personal Alarm
Car Code Lock
Vibration Alarm
Telephone Nuisance Alarm

BATTERY TO MAINS INVERTER



FREE INSIDE! MARCO 32 PAGE SPRING CATALOGUE SUPPLEMENT

03

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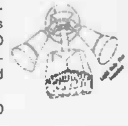
The No.1 Magazine for Electronics & Computer Projects

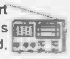
REAL POWER AMPLIFIER For your car, it has 150 watts output. Frequency response 20HZ to 20 KHZ and a signal to noise ratio better than 60db. Has builtin short circuit protection and adjustable input level to suit youe existing car stereo, so needs no pre-amp. Works into speakers ref 30P7 described below. A real bargain at only £57.00 Order ref 57P1.
REAL 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. We also have customer returned units with a builtin FM radio at £6.00 ref 6P34
2KV 500 WATT TRANSFORMERS. Suitable for high voltage experiments or as a spare for a microwave oven etc. 250v AC input. £10.00 ref 10P93
MICROWAVE CONTROL PANEL. Mains operated, with touch switches. Complete with 4 digit display, digital clock, and 2 relay outputs one for power and one for pulsed power (programmable). Ideal for all sorts of precision timer applications etc. £6.00 ref 6P18
FIBRE OPTIC CABLE. Stranded optical fibres sheathed in black PVC. Five metre length £7.00 ref 7P29
12V SOLAR CELL. 200mA output ideal for trickle charging etc. 300 mm square. Our price £15.00 ref 15P42

PASSIVE INFRA-RED MOTION SENSOR. Complete with daylight sensor, adjustable lights on timer (8 secs -15 mins), 50' range with a 90 deg coverage. Manual overide facility. Complete with wall brackets, bulb holders etc. Brand new and guaranteed. £25.00 ref 25P24.



Pack of two PAR38 bulbs for above unit £12.00 ref 12P43
VIDEO SENDER UNIT. Transmit both audio and video signals from either a video camera, video recorder or computer to any standard TV set within a 100' range! (tune TV to a spare channel). 12v DC op. £15.00 ref 15P39 Suitable mains adaptor £5.00 ref 5P191
FM TRANSMITTER housed in a standard working 13A adapter (bug is mains driven). £18.00 ref 18P10
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 15P42
10 BAND COMMUNICATIONS RECEIVER. 7 short bands, FM, AM and LW DX/local switch, tuning 'eye' mains or battery. Complete with shoulder strap and mains lead. £34.00 ref 34P1



WHISPER 2000 LISTENING AID. Enables you to hear sounds that would otherwise be inaudible! Complete with headphones. Cased. £5.00 ref 5P179.
CAR STEREO AND FM RADIO. Low cost stereo system giving 5 watts per channel. Signal to noise ratio better than 45db, wow and flutter less than .35%. Neg earth. £25.00 ref 25P21.
LOW COST WALKIE TALKIES. Pair of battery operated units with a range of about 150'. Our price £8.00 a pair ref 8P50

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

BUILD AN IBM COMPATIBLE PC !

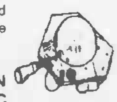
AT 12 meg turbo 286 mother board.	£115.00	pc1
1 meg memory for above board.	£55.00	pc2
4 meg memory for above board.	£214.00	pc3
AT keyboard	£49.00	pc4
AT power supply and pc case (complete)	£115.00	pc5
AT controller card with 2 x serial, 1 x parallel Floppy and hard controller + mono Display driver.	£74.00	pc6
1.2 meg 3 1/2" disc drive.	£74.00	pc7
1.44 meg 5 1/4" drive.	£66.00	pc8
Amber monitor 12".	£99.00	pc9
40 meg hard disc.	£270.00	pc10
100 meg hard disc.	£595.00	pc11

minimum system consisting of mother board, 1 meg of memory, case, power supply, 1.44 meg floppy, interfaces, and monitor is
£525.00 inc VAT (single drive mono 286) pc12
£795.00 inc VAT (40 meg + floppy + mono 286) pc13

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
TV SOUND DECODER. Nicely cased unit, mains powered 8 channel will drive a small speaker directly or could be fed into HI FI etc. Our price £12.00 ref 12P22
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. £8.00 each ref 8P26.
acorn data recorder ALF503. Made for BBC computer but suitable for others. Includes mains adapter, leads and book. £15.00 ref 15P43
VIDEO TAPES. Three hour superior quality tapes made under licence from the famous JVC company. Pack of 10 tapes £20.00 ref 20P20.
ELECTRONIC SPACESHIP. Sound and impact controlled, responds to claps and shouts and reverses when it hits anything. Kit with complete assembly instructions £10.00 ref 10P81.



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

SWITCHED MODE POWER SUPPLY (Boshert) +5 at 15A, +12 at 3A, -12 at 2A, +24 at 2A. 220 or 110v input. Brand new £20.00 ref 20P30.
SOLDER 22SWG resin cored solder on a 1/2kg reel. Top quality. £4.00 a reel ref 4P70.
600 WATT HEATERS. Ideal for air or liquid, will not corrode, lasts for years. coil type construction 3"x2" mounted on a 4" dia metal plate for easy fixing. £3.00 ea ref 3P78 or 4 for £10.00 ref 10P76.
TIME AND TEMPERATURE MODULE. A clock, digital thermometer (Celcius and Farenheit (0-160 deg F) programmable too hot and too cold alarms. Runs for at least a year on one AA battery. £9.00 ref 9P5.
Remote temperature probe for above unit £3.00 ref 3P60.
GEARBOX KITS. Ideal for 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.
QUALITY PANEL METERS. 50uA movement with 3 different scales that can be brought into view with a lever! £3.00 each ref 3P81.
CAR IONIZER KIT. Improve the air in your car! clears smoke and helps to reduce fatigue. Case required. £12.00 ref 12P8.
METAL DETECTOR. Fun light weight device for buried treasure! 33" long with tune and fine tune controls. £10.00 ref 10P101.

6V 10AH LEAD ACID sealed battery by yuasha ex equipment but in excellent condition now only 2 for £10.00 ref 10P95.
12 TO 220V INVERTER KIT. As supplied it will handle up to about 15 w at 220v but with a larger transformer it will handle 100 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. Complete with weight sensing electronics that would have varied the cooking time. Ideal for window displays etc £5.00 ref 5P165.
STC SWITCHED MODE POWER SUPPLY. 220v or 110v input giving 5v at 2A, +24v at 0.25A, +12v at 0.15A and +90v at 0.4A £12.00 ref 12P27.
CAMERA FLASH UNITS. Require a 3v DC supply to flash. £2.00 each ref 2P38 or 6 for £10.00 ref 10P101 (ideal multi-flash photography).
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).
MINATURE DOT MATRIX PRINTER assembly 24 column 5v (similar to RS type). £10.00 each ref 10P92.
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.

SURFACE MOUNT KIT. Makes a high gain snooping amplifier on a PCB less thanan an inch square!. £7.00 ref 7P15.
SURFACE MOUNT SOLDER. In easy to use tube. Ideal for above project £12.00 ref 12P18.
CB CONVERTORS. Converts a car radio into an AM CB receiver. Cased with circuit diagram. £4.00 ref 4P48.
FLOPPY DISCS. Pack of 15 3 1/2" DSDD £10.00 ref 10P88. Pack of 10 5 1/4" DSDD £5.00 ref 5P168.
SONIC CONTROLLED MOTOR. One click to start, two click to reverse direction, 3 click to stop! £3.00 each ref 3P137.
FRESNEL MAGNIFYING LENS. 83 x 52mm £1.00 ref BD827. lcd display. 4 1/2 digits supplied with connection data £3.00 ref 3P77 or 5 for £10.00 ref 10P78.
TRANSMITTER AND RECEIVER These units were designed for nurse call systems and transmit any one of 16 different codes. The transmitter is cased and designed to hang round the neck. £12.00 a pair ref 12P26.
ALARM TRANSMITTERS. No data avaliable but nicely made complex transmitters 9v operation. £4.00 each ref 4P81.
100M REEL OF WHITE BELL WIRE. figure 8 pattern ideal for Intercoms, door bells etc £3.00 a reel ref 3P107.
ULTRASONIC LIGHT. This battery operated unit is ideal for the shed etc as it detects movement and turns a light on for a preset time. (light included). Could be used as a sensor in an alarm system. £14.00 each ref 14P8.
CLAP LIGHT. This device turns on a lamp at a finger 'snap' etc. £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.
HI-FI SPEAKER. Full range 131mm diameter 8 ohm 60 watt 63-20 khz excellent reprduction. £12.00 ref 12P33.

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

12 " HIGH RESOLUTION MONITOR. AMBER SCREEN BEAUTIFULLY CASED NEEDS 12V AT 1A TTL INPUT (SEP SYNCS). £22.00 REF 22P2.

RADIO CONTROLLED CAR. Sigle channel R/c buggy with forward reverse and turn controls, off road tyres and suspension. £12.00 ref 12P40.
FERRARI TESTAROSSA. A true 2 channel radio controlled car with forward, reverse, 2 gears plus turbo. Working headlights. £22.00 ref 22P6.
SUPER FAST NICAD CHARGER. Charges 4 AA nicad's in less than 2 hours! Plugs into standard 13A socket. Complete with 4 AA nicad batteries £16.00 ref 16P8.
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.
QUICK FIX MAINS CONNECTOR. Ideal for the fast connection of mains equipment. Neon indicator and colour coded connectors. £7.00 ref 7P18.
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.
TOROIDAL TRANSFORMER. 24v 5A encapsulated 4" dia £5.00 ref 5P34.

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250 PORTLAND ROAD HOVE SUSSEX BN3 5QT DEPT EE
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EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

ABC

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The No 1 Magazine for Electronic & Computer Projects

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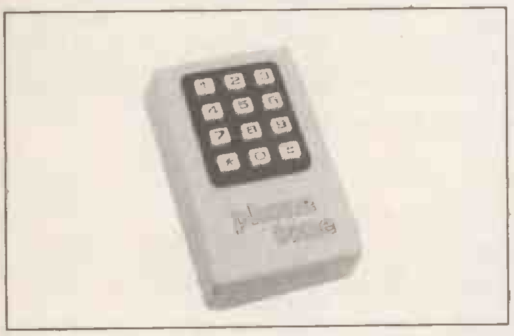
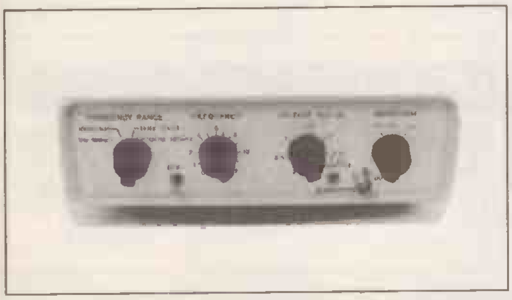
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .





Projects

Series

Features

FREE WITH THIS ISSUE

MARCO TRADING SPRING CATALOGUE SUPPLEMENT **between pages 180 & 181**

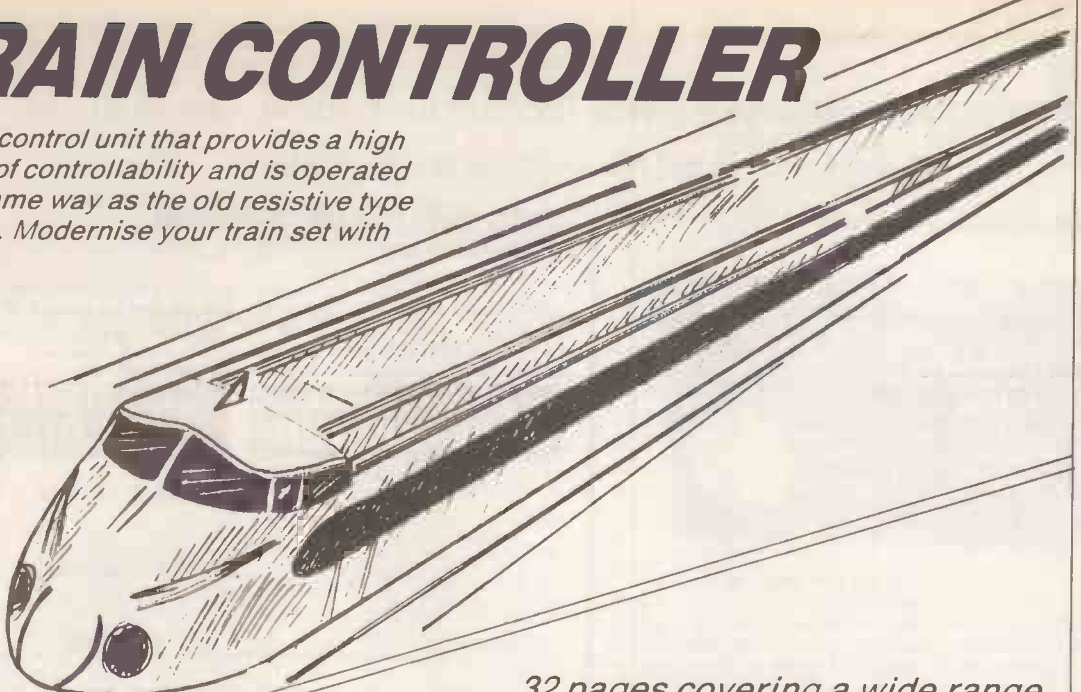
Our April '91 Issue will be published on Friday, 1 March 1991. See page 147 for details.

Readers Services • Editorial and Advertisement Departments 155

NEXT MONTH

TRAIN CONTROLLER

A pulse control unit that provides a high degree of controllability and is operated in the same way as the old resistive type controls. Modernise your train set with this unit.



32 pages covering a wide range of excellent products and their latest bargain list

FREE! GREENWELD CATALOGUE SUPPLEMENT

PLUS A FREE GIFT WITH EVERY ORDER

TREMOLO UNIT

A simple three transistor tremolo unit that will add a new dimension to electric guitars. Although simple the unit has a good performance with no "Tremolo Thump".

EVERYDAY ELECTRONICS

APRIL ISSUE ON SALE FRIDAY MARCH 1, 1991

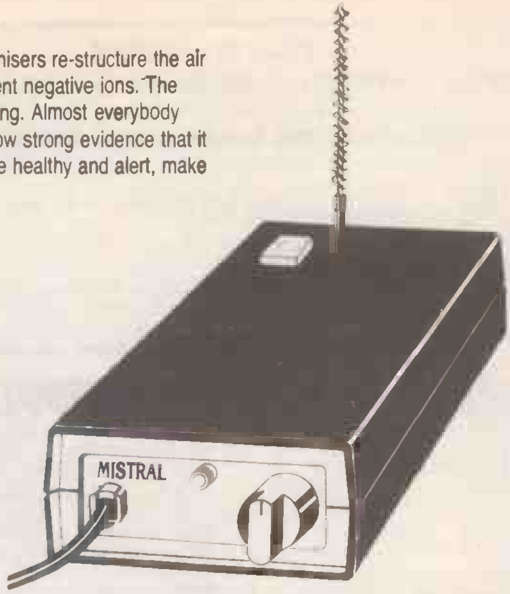
AIR IONISERS

By means of points raised to a very high voltage, ionisers re-structure the air you breathe, turning ordinary air molecules into potent negative ions. The effects of breathing in these ions can be quite startling. Almost everybody reports that it makes them feel good, and there is now strong evidence that it can also improve your concentration, make you more healthy and alert, make you sleep better, and even raise your IQ.

THE MISTRAL AIR IONISER ▷

The ultimate air ioniser. The Mistral has variable ion drive, built-in ion counter and enough power to drive five multi-point emitters with ease. Its nine main drive stages, five secondary drives and four booster stages give an immense 15 billion ions per minute output – enough to fill the largest room in a matter of seconds.

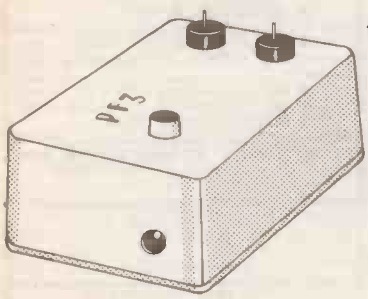
The parts set contains everything you need to build the Mistral: components, PCB, case, emitter and full instructions. If you're keen to increase the output still further, there's an optional eight-point internal emitter set to give extra ionising capability, and an almost silent piezo-electric ion fan to drive the ions away from the emitter and into the room.



MISTRAL IONISER PARTS SET **£32.66** ☐

INTERNAL EMITTER PARTS SET (optional) **£3.22** ☐

ION FAN (optional) **£11.27** ☐



◁ PROPHET PF3

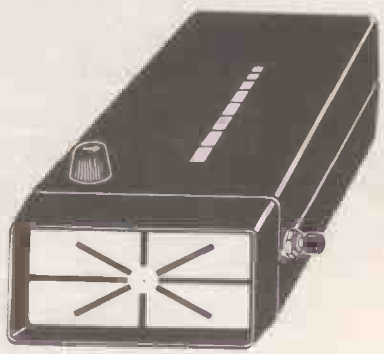
The Prophet performs its own special miracle on the dashboard of your car. First reports are most impressive: driving becomes a positive pleasure, easier to stay alert on long motorway journeys, a child cured of travel sickness. The ion effect is not to be underestimated. Don't forget the experiments either: there's the smoke trick, triffids, the living emitter, and more. The Prophet can be used anywhere with a supply of 9V to 12V DC, so don't restrict it to the car alone!

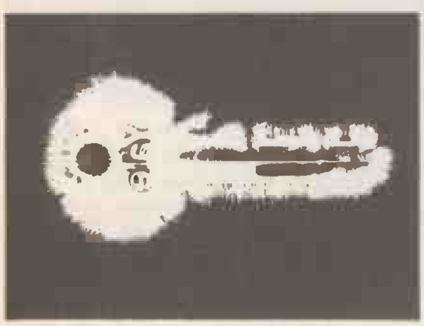
PROPHET PF3 PARTS SET **£21.39** ☐

THE Q-ION ▷

Check out the ion levels around your house. The Q-Ion will measure the output of any ioniser, test the air to see where the ions are concentrating, help you set up fans and position your ioniser for best effect, and generally tell you anything you want to know about ion levels in the air. The readout is in the form of a bar graph which moves up and down as the Q-Ion sniffs the air in different parts of the room. Readings up to 10^{10} ions per second, positive or negative.

Q-ION COMPLETE PARTS SET **£21.16** ☐





◁ KIRLIAN CAMERA

Bioplasmic fields, auras, or just plain corona discharge? No matter how you explain them, the effects are strange and spectacular. Can you really photograph the missing portion of a torn leaf? Can you really see energy radiating from your finger tips? Most researchers would answer 'yes' to both questions.

Our Kirlian photography set contains everything you need to turn the Mistral into a Kirlian camera, your bedroom or spare room into a darkroom, and to expose, develop and print Kirlian photographs (photographs made with high voltage electricity instead of light). The set includes exposure bed, safelight bulb, developing and fixing chemicals, trays, imaging paper and full instructions. A Mistral ioniser parts set is also required.

KIRLIAN CAMERA SET **£19.78** ☐

IONISER EXPERIMENTS

* The Vanishing Smoke Trick

Light up a cigarette and gently puff smoke into a glass jar until the air inside is a thick, grey smog. Carefully invert the jar over the ioniser so that the emitter is inside. Within seconds the smoke will vanish! This is one of the best demonstrations of an ioniser's air cleaning action and with a large jar the effect is quite dramatic.

* Triffids

Connect a length of wire from the ioniser emitter to the soil in the pot of a houseplant. One with sharp, pointy leaves is best. Hold your hand close to the plant and the leaves will reach out to touch you! In the dark you may see a faint blue glow around the leaf tips – this works better with some plants than with others, so try several different types. The plants don't object to this treatment at all, by the way, and often seem to thrive on it.

* The Electric Handshake

Wear rubber soled shoes. Touch the ioniser emitter for a few seconds until your body is thoroughly charged up. When your hair stands on end, that's just about enough. Then give everyone you meet a jolly electric handshake. Just think, you could lose all your friends in a single evening! (A meaner trick still is to charge up a glass of water or a pint of beer. Even your family won't speak to you after that!)

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All prices include VAT

UK orders: please add £1.15 postage and packing.

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HAMEG HM 203-7 OSCILLOSCOPE

New model just arrived. High quality reliable instrument made in W. Germany. Outstanding performance.
Full two year parts and labour warranty.
20MHz-2 channels 1mV sensitivity
Easy to operate and high performance

£338 +£50.70 VAT
Next Day Delivery £5.00

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 KIT PRICE **£19.44**

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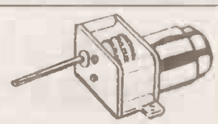

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Note – A simple multimeter is needed to fully follow this book. The M102 BZ is ideal. £13.98

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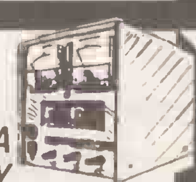

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EE MAY '86

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KIT REF 833 **£31.45**

EE EQUALISER

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KIT REF 707 **£17.37**

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.
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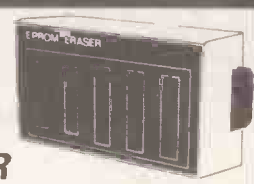
KIT REF 838



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EE OCT '88

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

KIT REF 790 **£27.90**

LIGHT RIDERS

EE OCT '86

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KIT REF 559 CHASER LIGHT	£15.25
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KIT REF 815 **£41.95**
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SUPERHET BROADCAST RECEIVER

EE MAR '90

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KIT REF 835

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INCORPORATING ELECTRONICS MONTHLY

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ENTHUSIASM

I have recently received the 98th Newsletter from the *British Amateur Electronics Club*, along with a letter from Herbert Howard (Chairman and Editor) inviting me to contribute an item for their 100th edition which will mark 25 years of the BAEC.

While we now carry a small advertisement for the club in our classified pages it may be that a number of readers are unaware of the BAEC or just what it is or does. The BAEC was originally formed as the St. Cyres Electronics Group back in 1966 – six of the original members are still members of the BAEC. Their aims are to promote and encourage all forms of electronics as a hobby and to this end they publish an interesting Newsletter on a quarterly basis.

Information on members' interests, abilities and equipment is available to other members so that they can help each other with any problems. A data-base of constructed projects and project data is also being set up for the information and assistance of members.

The BAEC has negotiated discounts with some component suppliers, has a library of books available and provides theory and project articles in their Newsletter. The Newsletter also often carries interesting notes and letters from members about their experiences in dealing with various component suppliers, etc.

GLOBAL

In short it's a non-profit making organisation run entirely by voluntary help which promotes our hobby and the good will between its members, wherever they are in the world – yes, it is open to members around the Globe. Their present U.K. membership costs £7 (£3.50 for under 16's) and this seems to me to be excellent value for money. If you are interested in getting further information then turn to our classified page for their address.

Mike Kenward

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Certain back issues of EVERYDAY ELECTRONICS are available price £1.70 (£2.20 overseas surface mail) – **£ sterling only please** – inclusive of postage and packing per copy. Enquiries with remittance, made payable to Everyday Electronics, should be sent to Post Sales Department, Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH. In the event of non-availability one article can be photostatted for the same price. *Normally sent within seven days but please allow 28 days for delivery.* **We have sold out of Feb, April, May, Aug, Sept, Nov. & Dec. 87, March, April, June, Oct, & Dec. 88, March & Aug. 89 & March 90.**

BINDERS

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

READERS' ENQUIRIES

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

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

COMPONENT SUPPLIES

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

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

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

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TRANSMITTERS/BUGS/TELEPHONE EQUIPMENT

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

Constructional Project

BATTERY TO MAINS INVERTER

MARK DANIELS

Drive your gas central heating or other 240V appliances during power cuts. Also useful for sailors, campers and caravanners

DURING the storms and severe gales of last winter it became apparent that despite all the efforts of the Electricity Supply Authorities many homes were without power for several days. This left people without lighting and heating (including gas central heating due to the refusal of the pump and timer to work without electricity).

The obvious alternative to mains electricity is an expensive petrol or diesel driven generator, which is beyond the means of many, the author included. If only moderate loads are required, to be supplied intermittently, then a d.c. to mains inverter running from one or more standard car batteries can be employed.

The following article describes a regulated inverter which runs from 12V d.c. and can supply up to 100 Watts at mains potential. If some loss of regulation can be tolerated then it will supply up to 150 Watts intermittently. Small portable power tools, such as drills will run at reduced power enabling them to be used where no mains electricity is available.

With the caravanning season arriving shortly, now is the time to build this inverter. Then you can take the food mixer and other useful kitchen appliances on holiday with you!

HOW IT WORKS

Inversion is sometimes described as the reverse process of rectification. As with rectification it involves the coupling of the d.c. circuit to the a.c. circuit using semiconductor switching devices which are closed for the appropriate periods of the a.c. waveform, enabling the a.c. to be developed. A transformer with a low voltage centre tapped "primary" is employed allowing the use of a push-pull configuration, which has the advantage of requiring only two switching transistors as shown in Fig. 1.

The bases of the two power transistors are driven from a square wave source such that the waveform at TR1 base is exactly out of phase with the signal at TR2 base. Thus, when transistor TR1 is switched on current flows from the positive supply rail to TR1 collector and into T1 "primary" (low voltage) winding at *A* via TR1 emitter, out of the winding at centre tap, *C.T.* and to battery negative.

This provides one half of the a.c. signal on T1 "primary". The other half is provided by transistor TR2 driving current in the opposite direction, through the other half of T1 "primary" at *B* when TR1 is switched off.

CIRCUIT DESCRIPTION

Note that the mains transformer T1 is used in "reverse" sequence in this circuit and the two windings are referred to in opposite terms to the normal practice:

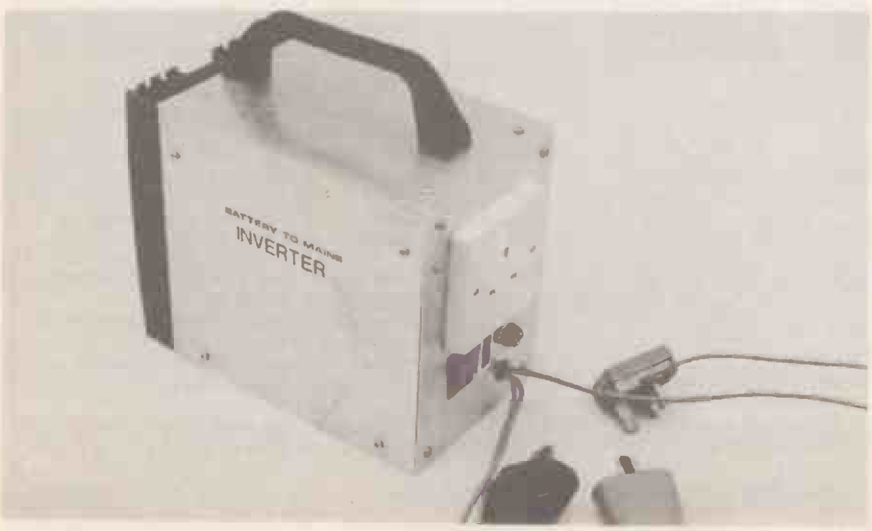
Secondary (low voltage) winding becomes *Primary*.

Primary winding becomes *Secondary*.

The full circuit diagram of the Battery To Mains Inverter is shown in Fig. 2. A purpose made CMOS timebase i.c. Is used to provide the complimentary 50Hz timing signals.

The CMOS timebase IC1 has an internal high frequency oscillator which is coupled directly to an external crystal X1. The crystal oscillates at 3.2768MHz and this frequency is divided by 2^{16} within the chip, producing complimentary 50Hz outputs.

Transistors TR2 and TR3 are used in the common emitter mode to provide both voltage and current gain. When MOSFET TR1 is fully turned on this allows virtually the full supply voltage to be available at



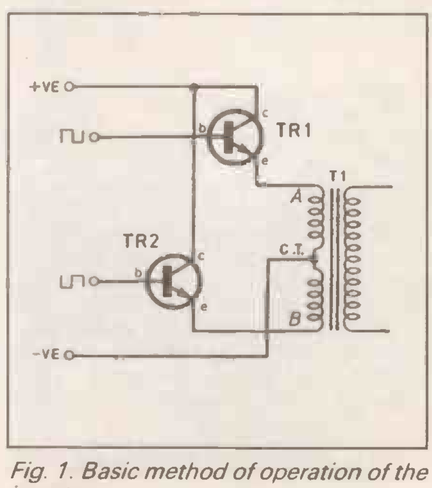


Fig. 1. Basic method of operation of the inverter.

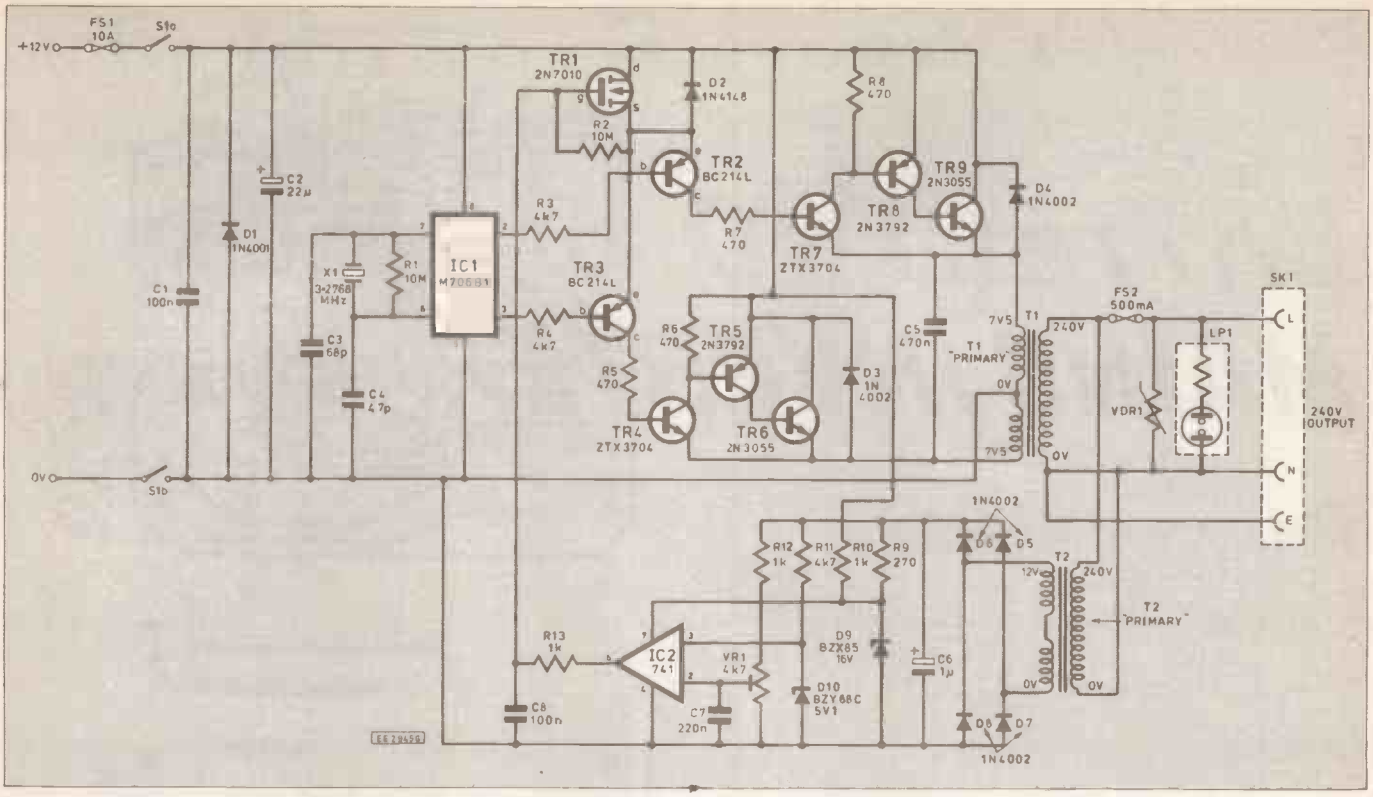


Fig. 2. Complete circuit diagram of the Battery To Mains Inverter.

TR4 and TR7 bases, as they are switched by IC1.

Transistors TR4 and TR5 are also connected in the common emitter mode, while TR6 is used as an emitter follower. Common emitter amplifiers normally offer a fairly high voltage gain. In this application, by use of a 100 per cent negative feedback loop between TR6 emitter and TR4 emitter, the voltage gain is reduced to unity.

Transistors TR7, TR8 and TR9 are arranged in exactly the same manner as above. TR6 and TR9 drive transformer T1 "primary" (low voltage side) with complimentary 50Hz square wave signals. This a.c. voltage is stepped up by T1 "secondary" to 240V (or 220V).

Diodes D3 and D4 absorb the high voltage spikes which are produced by virtue of the rapid switching of transformer T1 "primary".

Diode D1 protects IC1 from these high voltage spikes and can also give protection against the connections to the battery being reversed if a sufficiently large diode is used.

The prototype used a 25A stud rectifier, but five or six 1N5400 3A 50V diodes connected in parallel, as shown in Fig. 5, will do instead when a 10A fuse is fitted for FS1. If the unit is permanently connected to its own battery then a single 1N4001 may be used since it will not have to pass any large current.

The 240V (220V) output voltage of transformer T1 is monitored by transformer T2 and IC2. Transformer T2 is a small "stepdown" transformer producing 24V at its secondary for a 240V a.c. input. Its output is rectified and smoothed and a portion of this output appearing at preset VR1 wiper, is compared by IC2 with the stabilised voltage at D10 cathode (k).

The gate voltage of TR1 is adjusted by IC2 output, until the inputs of IC2 at pins 2 and 3 are equal. Preset potentiometer VR1 is adjusted so that this occurs when transformer T1 output is 240V.

CONSTRUCTION

Most of the components are mounted on

COMPONENTS

Resistors

R1	10M
R2	★10M
R3,R4	4k7 (2 off)
R5-R8	470 (4 off)
R9	★270
R10	★1k
R11	★4k7
R12	★1k
R13	★1k

See SHOP TALK Page

Potentiometer

VR1	★4k7 cermet preset

Capacitors

C1	100n polyester
C2	22µ tantalum, 25V
C3	68p ceramic
C4	47p ceramic
C5	470n monolithic ceramic
C6	★1µ tantalum, 35V
C7	★220n polyester
C8	★100n polyester

Semiconductors

D1	1N4001 1A 50V rec. (or 1N5400 (5/6 off)) see text
D2	1N4148 signal diode
D3,D4	1N4002 1A 100V rec. (2 off)
D5-D8	★1N4002 1A 100V rec (4 off)
D9	★BZX85 16V 1.3W Zener
D10	★BZY88C 5V1 400mW Zener
TR1	★2N7010
TR2,TR3	BC214L (2 off)
TR4	ZTX3704
TR5	2N3792
TR6	2N3055
TR7	ZTX3704
TR8	2N3792
TR9	2N3055
IC1	M706B1
IC2	★741

Miscellaneous

T1	† Mains transformer: 240V primary; 7.5V-0V-7.5V 100VA
T2	★ Mains transformer: 240V primary 12V-0V-12V 1.2VA secondary
FS1	10A fuse and holder
FS2	500mA fuse and holder
X1	3.2768MHz crystal
LP1	Mains neon with integral series resistor
VDR1	275V 75j; metal oxide varistor V275LA20A
SK1	13A socket outlet to BS1363
S1	16A double pole rocker switch

Printed circuit board available from the *EE PCB Service,* code 730; metal case, size 130mm x 200mm x 190mm; p.c.b. mounting screw-terminal blocks, 1 x 6-way (TB1), 1 x 2-way (TB2); 8-way 15A connector block (TB3); TO3 silicone rubber insulating kit (4 off); 1.5°C/W heatsink, drilled for four TO3 devices; p.c.b. mounting pillars; heavy duty connecting wire (see text); insulating sleeving; solder etc.

★ These components are not needed for an unregulated inverter.

† For unregulated inverter use 12V-0V-12V secondary.

Approx cost guidance only **£55** *plus case*

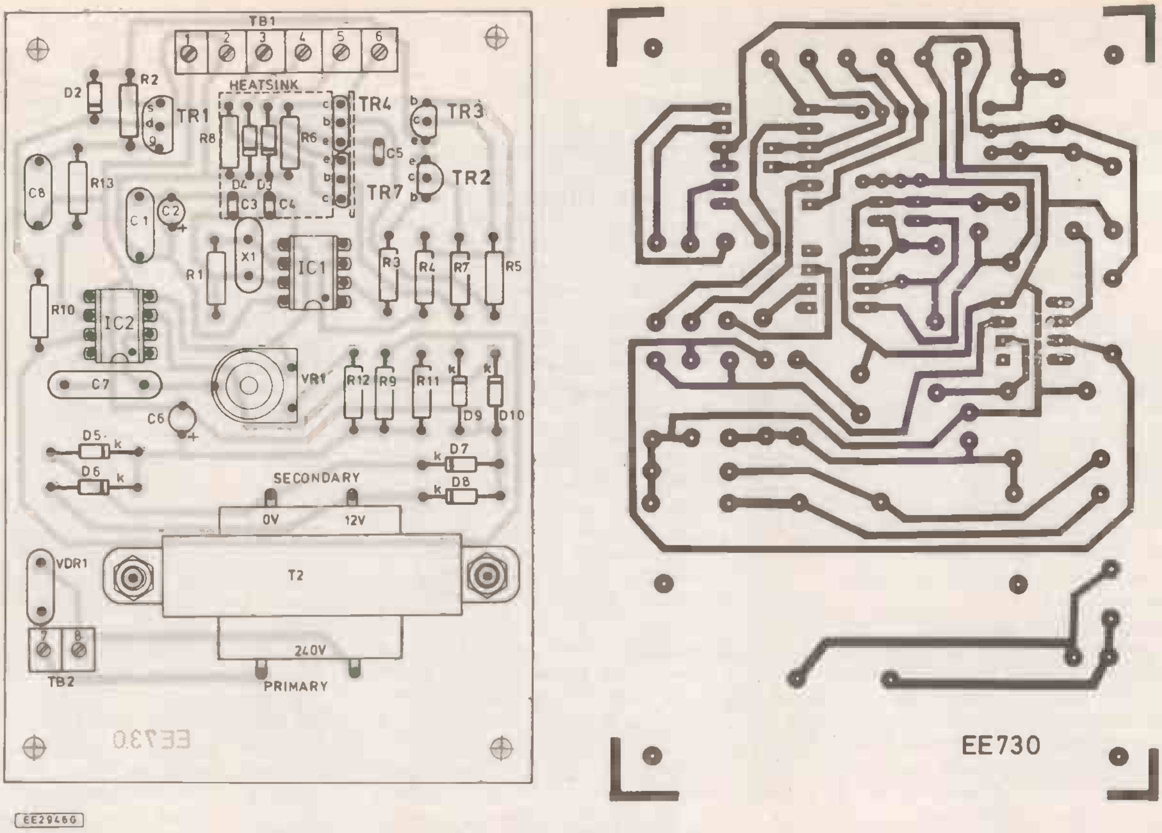


Fig. 3. P.C.B. layout and wiring.

a single-sided printed circuit board. This board is available from the *EE PCB Service*, code EE730. The full size copper foil pattern and component layout are shown in Fig. 3.

It is recommended that the components are fitted in the following order: i.c. sockets, wirelink (if fitted, see "Modifications"), resistors, capacitors, diodes, transistors and finally the crystal and MOSFET transistor. When fitting the MOSFET it is suggested that its pins be shorted together to protect it from damage by static electricity until after it is soldered in place.

Transistors TR4 and TR7 should be fitted with a small heatsink made from two small pieces of aluminium cut and bent as shown in Fig. 4 and bolted across the two transistors using a single 6BA bolt. A small amount of silicone grease should first be applied to both sides of the two transistors to aid heat transfer.

Take care when fitting IC1 as this is a CMOS type and can also be damaged by static.

The output voltage monitoring transformer T2 may now be fitted to the p.c.b. Its flexible leads should be shortened if necessary and the secondary centre tap lead cut off as this is not needed. T2 should be securely fastened to the p.c.b. using two M3 bolts and nuts as it is too

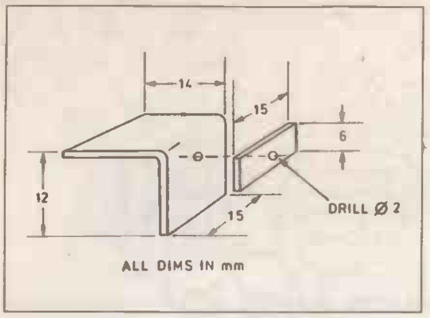


Fig. 4. Heatsink for TR4 and TR7.

heavy to be supported by its leads alone.

The four power transistors should be mounted on the heatsink using isolating kits. A solder tag should be placed under one of the mounting nuts on each transistor for the collector connection. The heatsink should be mounted on the outside of the case with the fins vertical to ensure adequate airflow. If the recommended washers are used for the transistors then no heatsink compound will be required.

An eight-way screw-terminal connector block can be mounted on or near the heatsink to facilitate the interwiring of the transistors, transformer and p.c.b. as shown in Fig. 5. Ensure that all wires carrying heavy current (i.e. transformer primary and input leads) are adequately rated. A minimum of 15A is suggested, preferably heavier.

Particular note should be taken of earthing. One side of T2 primary is connected to the chassis, which is ultimately connected to ground. The earthed side then becomes the neutral connection. An earth connection is achieved by fitting a heavy duty earth wire to the 0V connection on T1 and connecting this to the earth pin on a normal 13A plug. This plug is then inserted in a 13A mains socket, thus connecting the unit to the normal mains earth.

A one off case was made for the prototype but a commercial metal box will do just as well. The minimum sensible size is approx 200 x 190 x 130mm.

SETTING UP AND TESTING

Before testing, the p.c.b. should be checked for mistakes and for solder bridging tracks. All interwiring should be checked. Once everything is correct preset VR1 should be set to the centre position (most are supplied in this position but check anyway). The earth connection must be connected to a suitable earth *before* testing.

Connect the input leads to a 12V car battery (a mains power supply is NOT recommended because of the high initial surge current) and switch on. The transformer should now be buzzing quietly and the output on its secondary may now be measured and preset VR1 adjusted for 240V (or 220V if desired). Turning VR1 clockwise will increase voltage and anticlockwise lowers it.

For the next stage of testing a few light bulbs are required, ranging from 25W to 150W. Connect a 25W bulb and if possible measure the input current to the inverter which should be around 3A, the output voltage should remain at about 240V. The power transistors should not become warm with this load, if they do switch of and check all wiring.

Next connect a 100W bulb and check voltage and current again, the current should rise to between 10A and 13A but the voltage should remain well within 10 per cent of the no load voltage. Leave this load connected for about an hour, after which time the power transistors should be hot, but it should still be possible to touch them without getting your fingers burnt!

If a 150W bulb is available connect this and measure the voltage again which will probably be somewhat less than 240V. The prototype inverter would drive a 150W load quite happily for over an hour! The transformer became very warm during this test but caused no problems.

FAULT FINDING

An oscilloscope is desirable for fault finding on this circuit but is far from essential. A 64 ohm loudspeaker can be used for tracing the a.c. through the circuit and will produce a 50Hz buzz when correctly connected to one side of the battery and an output at one of the transistors or across T1 primary. ***The speaker must not be connected directly to IC1 outputs!*** For checking the regulator circuit a multimeter is essential.

If the output voltage is low and cannot be adjusted to give 240V with no load connected then it is probable that one side of T1 primary is not being driven. If this is the case the transistor driving the other half of the primary will probably be running very hot. If all new components are used in this circuit few problems should occur.

MODIFICATIONS

It is not possible here to give full details of all variations of this circuit, but some suggestions are given:

A larger transformer may be substituted for T1 to obtain higher output power. Transistors TR6 and TR9 may be retained for output powers of up to about 250W, but above this they will need replacing with higher current devices e.g. 2N3771, which will handle 30A each.

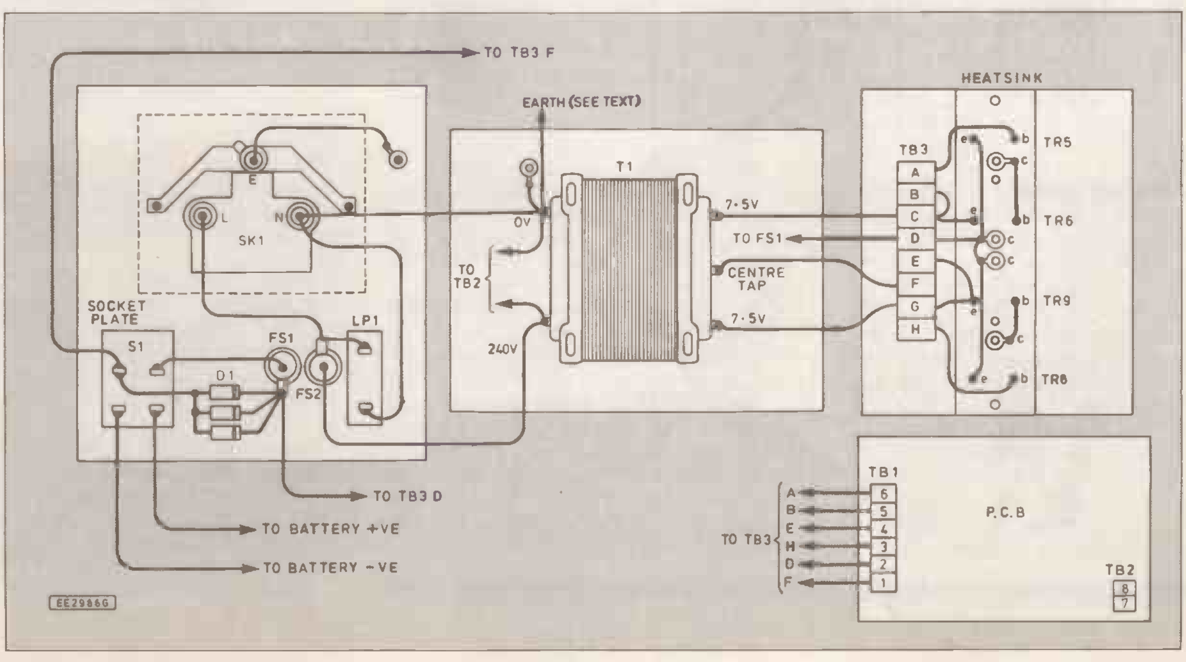
The circuit as it stands can be adjusted to give any voltage in the 200V-250V range. For 110V-120V output T1 and T2 will need replacing with transformers having 120V windings (many transformers have dual 120V primarys which can be connected in series or parallel to give 120V or 240V). The regulator will still function as before but the varistor and neon will need changing.

If an unregulated inverter is satisfactory for the constructors requirements then the components marked with an asterisk in the components list may be omitted. A wirelink will need to be inserted in place of TR1 source and drain connections. Also transformer T1 should be replaced with a 12V-0V-12V transformer. This should save several pounds.

Crystal X1 could be replaced with other crystals to give different output frequencies. A 4MHz crystal will give about 61Hz which should be suitable for running small induction motors (particularly of American origin) requiring 60Hz. The crystal should be of the parallel resonant type otherwise it will oscillate off frequency.

If it is intended to run a television set or audio equipment from this inverter a high current choke may be needed connected in series with T1 centre tap. About 5½ to 10½ turns of 16 s.w.g. enamelled copper wire on an RM10 (or similar) pot core should do. Without the choke you may get interference, although some televisions seem immune to this while others are badly affected. □

Fig. 5. Interwiring details for the inverter.



FOR YOUR ENTERTAINMENT

by Barry Fox

Matter of Standards

Do not worry if you feel confused about the multimedia market. So do a lot of other people.

Everyone agrees that multimedia could mean big business. It's a new way of publishing sound, pictures and text on a CD. But, as usual, there's a standards battle brewing.

Chip maker Intel developed an expensive system called DVI, for use with personal computers. Thorn EMI backs it in Britain. It's aimed at businesses.

Philips developed CD-I, with the backing of Matsushita (Panasonic/Technics), Sony and US chip maker Motorola. Although it is being launched first for industrial use, CD-I is aimed at the domestic market. With add-on controls, CD-I players can play CD-ROM discs, like encyclopedias, as already available to professional users.

But Panasonic is now planning a DVI player as well!

Meanwhile, Computer company Commodore is hoping to get into the shops a year ahead of Philips. Comodore will sell a system called CDTV, which actually stands for Commodore Dynamic Total Vision. CDTV is based on the Amiga home computer and games system, and is wholly *in*compatible with either DVI or CD-I or CD-ROM.

We can forget DVI for domestic use. So what we have is another VHS-versus-Beta battle between CDTV and CD-I.

Although in mid October Philips said professional CD-I players (costing around £1000) were available "now", this is just another example of Philips making daft promises. Orders were being taken last year for players due for delivery in February '91.

Philips pledges to start selling domestic players in the US and Japan late in 1991, and in Europe the following year, at $1000 dollars i.e. around £500 or £600. From Day One these will be able to play Full Motion Video, an hour of pretty good quality video from a single CD.

Commodore first announced CDTV in June but gave few details. Reports of an October launch were denied (*ERT* October 18th). At the multimedia conference held at the Barbican in mid-October, Jim Mackonichie, multimedia consultant to Commodore International, made a last-minute appearance with a shopping bag containing what he claimed to be a "fully operational, production model" CDTV player.

It looks like a a large CD audio player, and Mackonochie said the player will be test marketed in the UK and California at the end of November, at a UK price of £699. If the test market is successful, Commodore will launch worldwide, with a wider selection of programme discs, in spring 1991.

The CDTV player will play conventional audio CDs through a hi fi. When connected to a TV set is will also play CD+G discs. These are audio discs which have graphics designs, text, like song lyrics, and still pictures of the musicians, buried in the music data stream. So far there are only a few such discs available and they are not very exciting. CD+ is a pretty primitive system.

A CDTV player will also play Amiga games that have been transferred to CDTV disc format. There will be educational discs too, e.g. on family health and the works of Shakespeare.

But a CDTV player will not play any of the CD-ROM discs already published for the computer industry. Most important, a CDTV player will not play CD-I discs. Neither will it be able to display Full Motion Video. There is no promise of upgrading to FMV either. Realistically it won't be possible.

Commodore is staking everything, probably even corporate survival, on getting CDTV into the market ahead of CD-I. To succeed CDTV must be seen as much more than a very expensive games computer. So far it looks like just that, with the added ability to play audio CDs.

Makonichie refused to demonstrate the CDTV player which he took to the conference. "I prefer to keep my powder dry; I don't believe in vapourware" he explained.

Personal Judgement

Sony's *Walkman* personal stereo is ten years old. Sony never filed patents, believing the concept to be an innovation but not an invention.

Since then several inventors have claimed royalties both from Sony and other Japanese manufacturers. Panasonic received a bill for a million pounds from one hopeful. "It was ignored", says Panasonic.

Italian inventor Andreas Pavel has for many years been telling the press that Sony's Walkman infringes patents he filed in March 1977. In 1988 he threatened to sue Sony but backed down when told how much it would cost. But Pavel kept his British Patent (1 601 447) in force by paying annual renewal fees, and is thus now free to sue in Britain's new low cost Patents Count Court.

Sony expects to be the first company to fight a case in the new court, sometime this year. A close look at the patent explains why Sony remains confident.

The legal claims in Pavel's British patent specify "in combination" a stereo amplifier and battery power source attached to "a belt for personal wear". As Sony points out, Walkmen come with an optional carrying strap or belt clip, but never a belt.

If the case goes to Court, the PCC will have to decide whether Pavel's idea was novel and whether the belt restriction rules out his claim for compensation.

We all know how judges like to create the impression that they know nothing of the real world, with questions like who is Gazza. Andreas Pavel can be confident that the judge in the Patents County Court will be asking him questions like "what is a Walkman" and "who is Mr Sony".

The judge at the new court is Peter Ford. Hi fi buffs with long memories of the audio industry will remember that in the sixties Ford used to write excellent articles in the hi fi press, often on the history of recording. His pieces on tape history were later used as a short cut source reference by other writers with fewer principles.

If anyone can decide whether Pavel is owed royalties, Peter Ford surely can.

No-one's Perfect

I bought a copy of the WordPerfect wordprocessing program and as a result of registering as a user now receive a newsletter entitled *Perfect User*.

The first issue puffed WP's standard features, including a "Spell Checker" which automatically ensures the correct spelling for all words processed. What a pity, I wrote at the time, that just a cursory glance at one page of WordPerfect's newsletter revealed at least four spelling errors, "imnages", "similare to", "Wordperfects features" and "designe to offer".

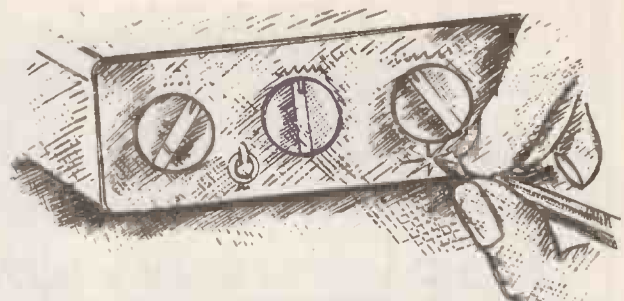
Now I have been sent another issue, which puffs more features of WP which are supposed to make printed text look perfect.

Perfect User begins with a "Ooops!" and continues: "I would like to apologise for the typing error made in our last *Perfect User*, it was infact (sic) issue number 1 and not number 7 as printed. So I therefore welcome you to issue number 2".

Issue 2 then tells of other WP aids to spelling, grammar and office efficiency. A casual glance reveals a split infinitive ("to easily make"), an awkward spelling, ("paper back edition") and a very curious piece of hyphenation (Dra-w Perfect).

I now just can't wait for Issue 3.

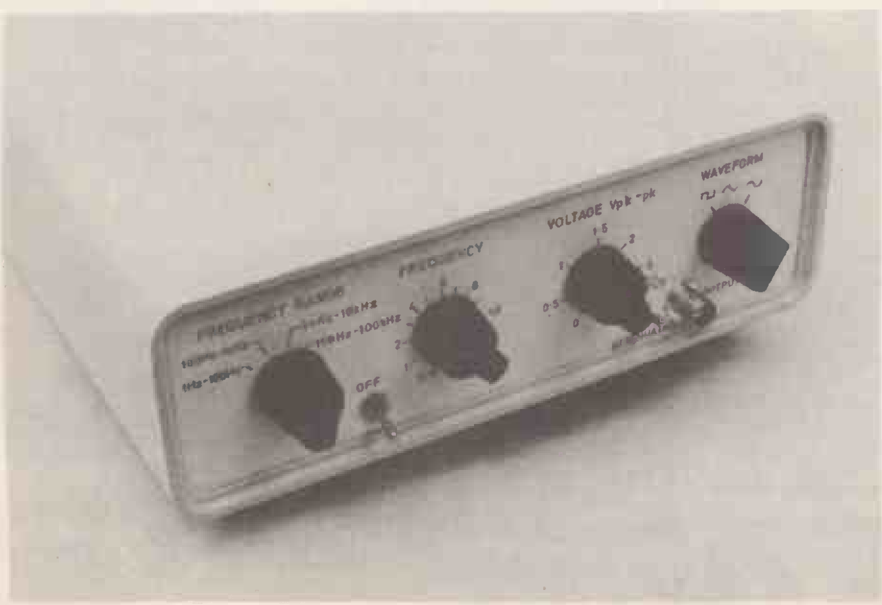
WAVEFORM GENERATOR



MIKE TOOLEY BA

The fourth constructional project which is a companion to our Design Your Circuits series takes the form of a simple yet versatile Waveform Generator which provides sine, square and triangle wave outputs from 1Hz to 100kHz in four switched frequency ranges.

As with all of the practical constructional projects in this series, a number of modifications are suggested so that the more intrepid constructor can customise the unit to his or her own particular requirements.



A SOURCE of signals is invaluable when testing and carrying out performance measurements on a huge variety of electronic circuits. Our Waveform Generator has been designed as a general purpose signal source covering the frequency range which extends from 1Hz to 100kHz and thus encompasses the entire audio frequency range with a generous overlap at each end!

The Waveform Generator may be switched to provide sine, triangle or square wave outputs with an amplitude which can be varied from a few millivolts to 3V peak to peak.

CIRCUIT DESCRIPTION

The complete circuit of the Waveform Generator is shown in Fig. 1. IC1 is an ICL8038CC waveform generator, the output frequency of which is determined by the value of timing capacitor (C1 to C4) and the d.c. voltage level appearing at pin-8. VR1, VR2 and VR3 form a potential divider across the ±9V supply rails; VR2 provides a continuously variable adjustment of the output frequency whilst VR1 and VR2 are respectively used to set the minimum and maximum output frequencies produced.

Since the sinusoidal output of the 8038 (available at pin-2) is synthesised from the output of an internal square wave generator, VR4 and VR5 are provided in order to minimise the distortion which is inherent in this process.

The frequency range (in decades) is selected by means of S1 and timing capacitors C1 to C4 (which should preferably be reasonably close tolerance high stability types). S2 is used to select the required output waveform whilst resistors R3 and R7 are present to ensure that all three waveforms have identical pk-pk output voltage levels.

IC2 is a unity gain buffer amplifier which minimises the loading on the outputs from IC1 and also ensures a very low value of output impedance. R9 and R10 act as a voltage divider (÷ 100) in order to provide the "attenuated" output which is used for testing sensitive low-level circuits and small-signal amplifiers.

The circuit operates from positive and negative supply rails of nominally 9V. This supply may be derived from dry batteries or from a suitable mains adapter (the unit will operate successfully from any regulated d.c. supply capable of delivering an output in the range ±9V to ±12V).

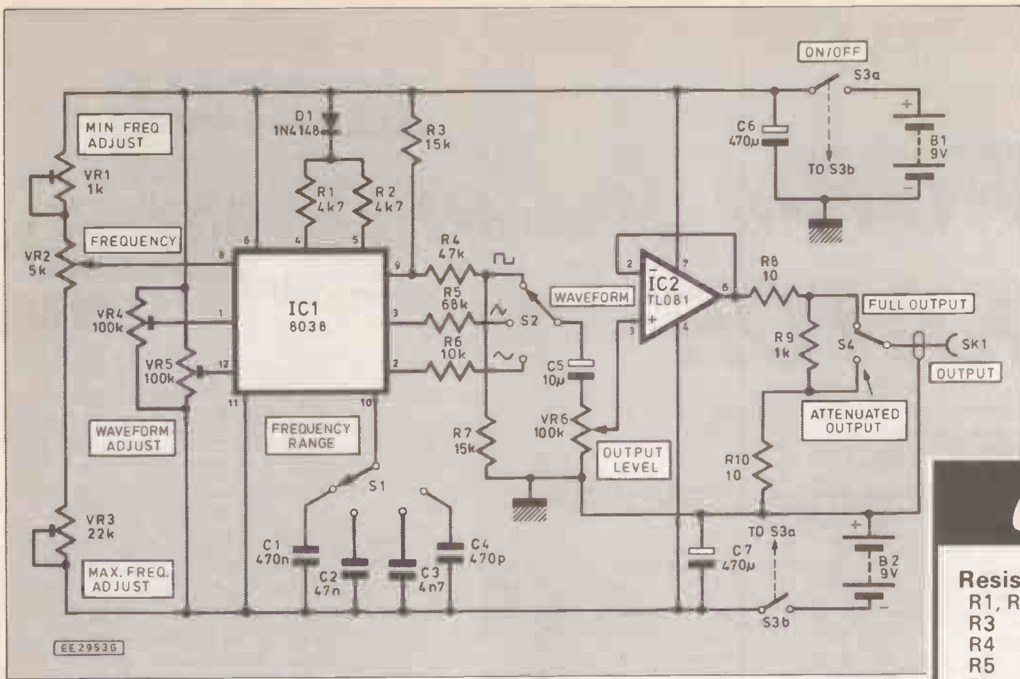


Fig. 1. Complete circuit of the Waveform Generator.

CONSTRUCTION

Construction of the Waveform Generator is very straightforward and the vast majority of the components are assembled on a single-sided printed circuit board measuring approximately 95 x 60mm. The layout of the printed circuit board is shown in Fig. 2.

Components should be assembled on the printed circuit board in the following sequence; p.c.b. headers, d.i.l. sockets, link (using tinned copper wire of 24 or 26 s.w.g.), resistors, capacitors, and diode. As with all of our projects, it is vitally important to ensure that all of the components are correctly located. Furthermore, in the

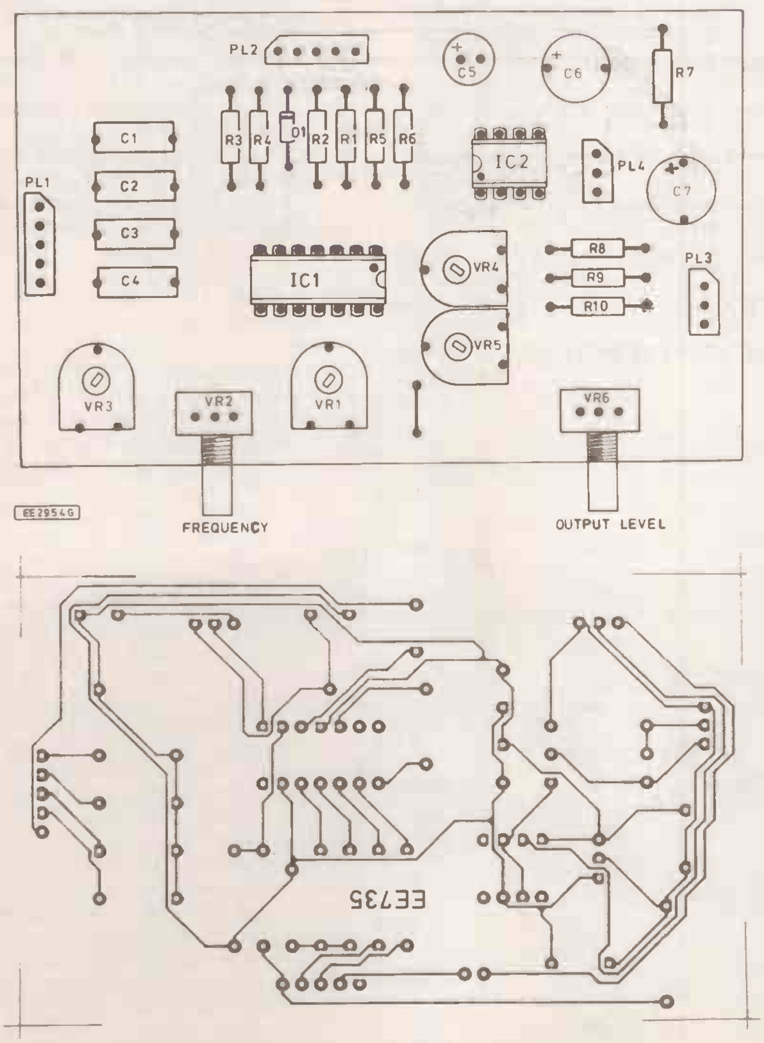


Fig. 2. P.C.B. layout and construction.

COMPONENTS

Resistors

R1, R2	4k7 (2 off)
R3	15k
R4	47k
R5	68k
R6	10k
R7	15k
R8, R10	10 (2 off)
R9	1k

All 0.25W 5%

See SHOP TALK Page

Potentiometers

VR1	1k min. horizontal preset
VR2	5k lin. p.c.b. mounting
VR3	22k min. horizontal preset
VR4, VR5	100k min. horizontal preset (2 off)
VR6	100k lin. p.c.b. mounting

Capacitors

C1	470n polyester
C2	47n polyester
C3	4n7 polystyrene
C4	470p polystyrene
C5	10µ radial elect. 16V
C6	470µ radial elect. 35V
C7	470µ radial elect. 35V

Semiconductors

D1	1N4148
IC1	ICL 8038CC
IC2	TL081

Miscellaneous

S1	1P 4W rotary switch (1P 12W component with rotation stop suitably adjusted)
S2	1P 3W rotary switch (1P 12W component with rotation stop suitably adjusted)
S3	DPDT miniature toggle switch
S4	SPDT miniature toggle switch
PL1,PL2	5-way straight p.c.b. header (0.1inch pitch), 2 off
PL3,PL4	3-way straight p.c.b. header (0.1 inch pitch), 2 off
SK1	Chassis mounting BNC socket

Printed circuit board available from the *EE PCB Service*, order code EE735; plastic p.c.b. fixing pillars with self-tapping No. 6 fixing screws (2 required); snap-fit battery connectors (2 required); 14-pin low-profile d.i.l. socket; 8-pin low-profile d.i.l. socket ABS enclosure, approx 220 x 230 x 70mm – see text.

Approx cost guidance only **£20** *plus case*

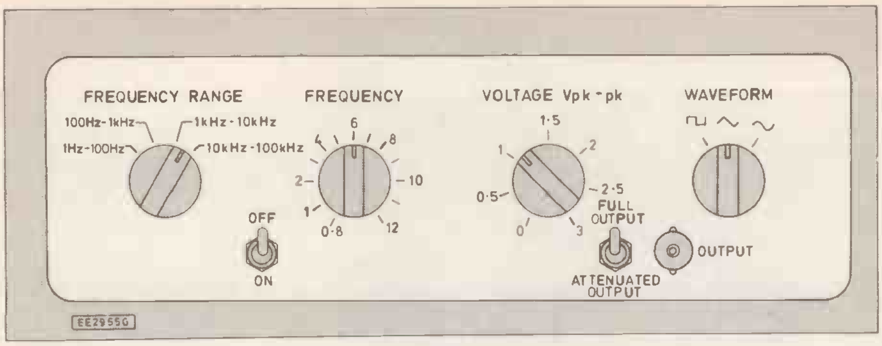


Fig. 3. Recommended front panel layout.

The internal wiring of the waveform generator is shown in Fig. 4.

case of the polarised components (such as electrolytic capacitors, diode and the two i.c.s) it is absolutely essential to ensure that each component is correctly orientated.

When construction of the printed circuit board has been completed (and before inserting IC1 and IC2 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 board has been completed, IC1 and IC2 should be inserted into their respective 14-pin and 8-pin sockets (taking care to observe the correct orientation).

CASE

The Waveform Generator should be housed in an ABS enclosure with aluminium front and rear panels. The enclosure used for the prototype instrument measured approximately 220 x 230 x 70mm however the precise dimensions of the enclosure are unimportant, provided adequate room is made available on the front panel for the various controls, switches and output connector and the enclosure is large enough to accommodate two 9V batteries (or an a.c. mains power supply unit).

The front panel should be carefully marked out before drilling and cutting takes place. As usual, there is nothing particularly critical about the layout of the unit and constructors may wish to experiment with the location of the front panel controls, input/output connectors and l.e.d. indicator. Fig. 3 shows the front panel layout and markings used on the prototype.

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

Battery holders (for two 9V batteries or an equivalent number of AA size cells) can be manufactured from simple L-shaped aluminium brackets secured to the base and/or rear of the case.

INTERCONNECTIONS

Connections to the printed circuit board are made using four 0.1 inch pitch printed circuit board headers. Two five-way and two three-way headers are used to provide the various off-board connections. PL1 (a five-way header) is used for connection to the frequency range switch (S1) whilst PL2 (the second five-way header) provides a connection for the waveform selection switch (S2). A three-way header (PL3) provides a means of connecting the output connector (SK1) and attenuator switch (S4). Finally, PL4 (a second three-way header) provides supply connections to the two batteries via the d.p.d.t. on/off switch, S3.

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 and rear panels. The following colour coding is recommended:

PL1

Pin	Colour	Connection to:
1	Brown	S1 selector
2	Red	S1 position 1 (1Hz to 100Hz)
3	Orange	S1 position 2 (100Hz to 1kHz)
4	Yellow	S1 position 3 (1kHz to 10kHz)
5	Green	S1 position 4 (10kHz to 100kHz)

PL2

Pin	Colour	Connection to:
1	Brown	S2 position 1 (square)
2	Red	S2 position 2 (triangle)
3	Orange	S2 position 3 (sine)
4	Yellow	S2 selector
5	none	not used

PL3

Pin	Colour	Connection to:
1	Brown	S4 (full output)
2	Red	S4 (attenuated output)
3	Orange	SK1 ground

PL4

Pin	Colour	Connection to:
1	Brown	S3a (+9V)
2	Red	Common
3	Orange	S3b (–9V)

TESTING AND ADJUSTMENT

Before testing the Waveform Generator, it is important to carefully check the wiring of the p.c.b. and front panel mounted components. The two 9V supplies should then be connected and a milliammeter inserted to measure the supply current in each of the supply rails. Switch the unit on and measure the supply current. This should be in the range 10mA to 20mA. If this is not the case, disconnect the supply and carefully check the wiring and p.c.b.

In order to adjust the four pre-set potentiometers, two items of additional test equipment will be required; a digital frequency meter and an oscilloscope (where the former instrument is unavailable, an oscilloscope may be used to determine the output frequency of the generator by reference to an accurately calibrated timebase scale). Both these items of test equipment should be connected to SK1 in order to display the output (frequency and waveform, respectively) of the generator.

To commence the adjustment procedure, the waveform generator should be set as follows:

1. VR6 fully clockwise (marked "3")
2. S1 switched to range 2 ("100Hz to 1kHz")
3. S3 switched to the "on" position
4. S4 switched to the "full-output" position
5. VR1 and VR3 set to the fully anticlockwise position; VR4 and VR5 set to the mid-position.

The following sequence of adjustments should then be made:

6. Switch S2 to position 1 ("square") and set VR2 to the fully anticlockwise position (marked "0.8"). Adjust VR1 for an output frequency of exactly 80Hz (or a periodic time of 12.5ms if using an oscilloscope to

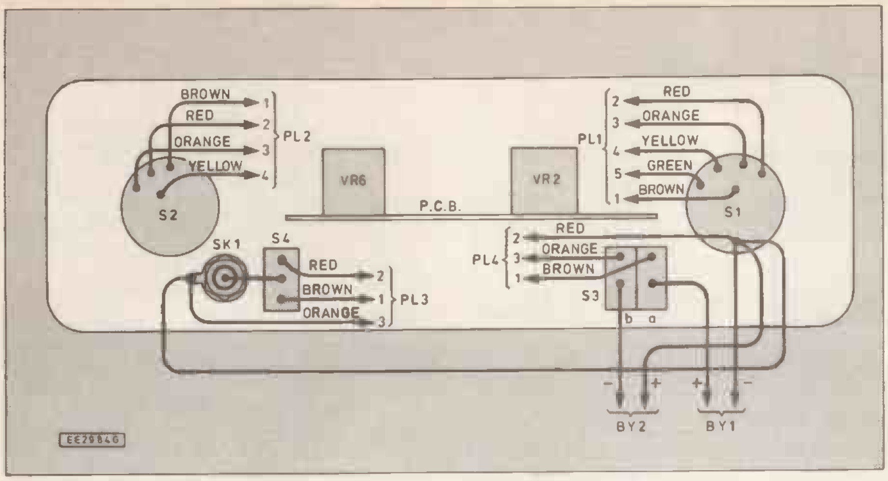
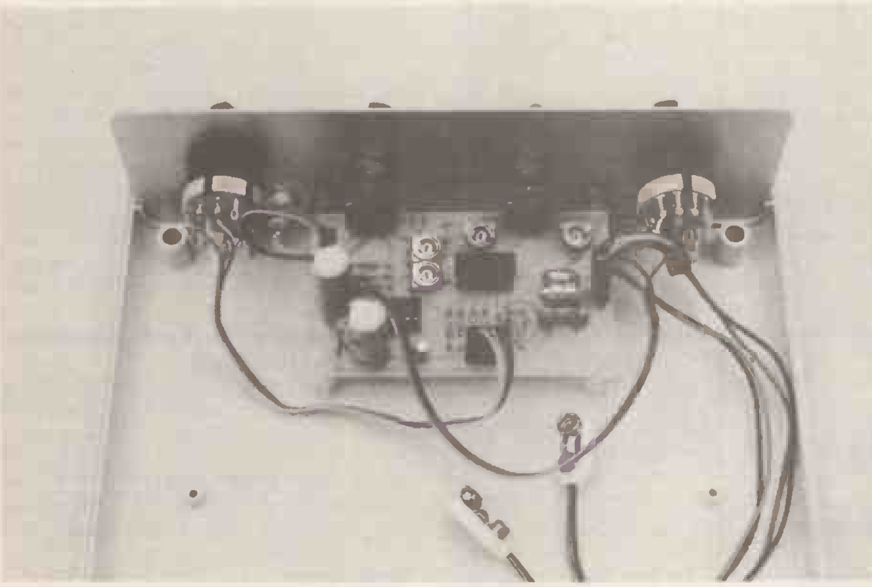


Fig. 4. Internal wiring of the waveform generator.



carry out the frequency measurement).

7. Set VR2 to the fully clockwise position (marked "12"). and adjust VR3 for an output frequency of exactly 1.2kHz (or a periodic time of 0.833ms if using an an oscilloscope to carry out the frequency measurement).
8. Repeat steps 6 and 7 several times in order to ensure that the frequency limits on range 2 are 80Hz (minimum) and 1.2kHz (maximum).
9. Switch S2 to position 3 ("sine") and VR2 to the fully anti-clockwise position (marked "0.8"). Adjust the oscilloscope to display the portion of the waveform either side of the positive peak. Carefully adjust VR4 to produce the smoothest, most sinusoidal, waveform.
10. With S2 and VR2 set as for step 9, adjust the oscilloscope to display the portion of the waveform either side of the negative peak. Carefully adjust VR5 to produce the smoothest, most sinusoidal, waveform.
11. Repeat steps 9 and 10 (as necessary).

This completes the adjustment of the Waveform Generator. The instrument is now ready for use!

MODIFICATIONS

A number of useful modifications may be made to enhance the performance of the Waveform Generator. 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.

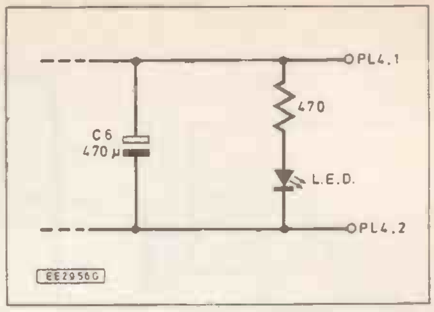


Fig. 5. Adding an l.e.d. indicator.

Extra frequency ranges

One or more extra frequency ranges can be added by means of one, or more, additional positions on S1 and further timing capacitors of appropriate value. A 4µ7 electrolytic timing capacitor will, for example, provide an additional frequency range extending from 0.1Hz to 1Hz. It is important to note that there is little point in extending the frequency range upwards above 100kHz as the sine and triangle output waveforms progressively deteriorate in quality above 30kHz, or so.

L.E.D. supply indicator

An l.e.d. can easily be added to the basic waveform generator to indicate the presence of the supply. A circuit for this is shown in Fig. 5.

Mains operation

The Waveform Generator can be very easily adapted for mains operation. A suitable mains supply is the Dual Output Power Supply module which appeared in Part One of the series. The module should be fitted with 9V regulators (7809 and 7919 for IC1 and IC2, respectively) and used in conjunction with a transformer having two secondaries rated at 9V, 0.25A (or greater). Fig. 6 shows the necessary circuit modifications.

Specification

Waveforms:	Sine, square and triangle
Total harmonic distortion (sine wave output):	2% (typical)
Rise time (square wave output):	100ns (typical)
Output voltage:	Adjustable to 3V peak to peak (full-output) Adjustable to 30mV peak to peak (attenuated output)
Output impedance:	10 ohm (approx)
Output frequency:	Adjustable from 1Hz to 100kHz in four decade ranges (i.e. 1Hz to 100Hz, 100Hz to 1kHz, 1kHz to 10kHz, and 10kHz to 100kHz)
Supply voltage:	2 x 9V (PP6 or PP7 batteries recommended)
Supply current:	16mA (typical)

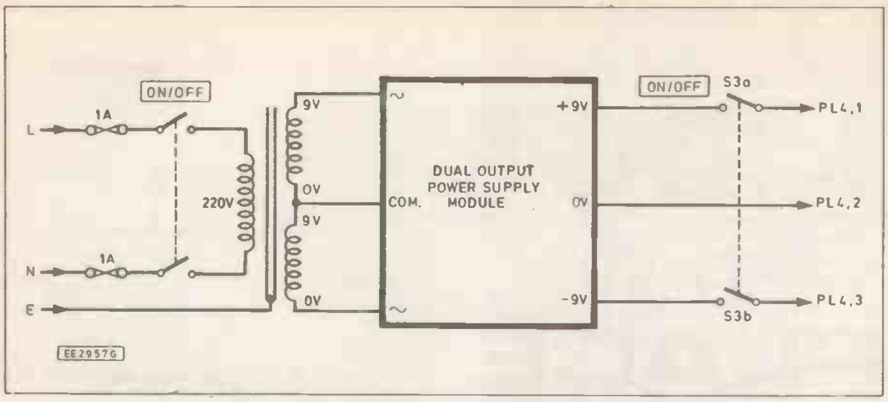


Fig. 6. Modifications for mains operation.

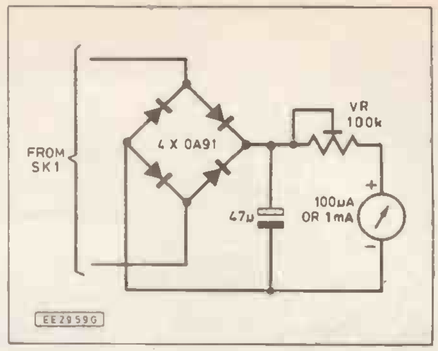


Fig. 8. Output level meter.

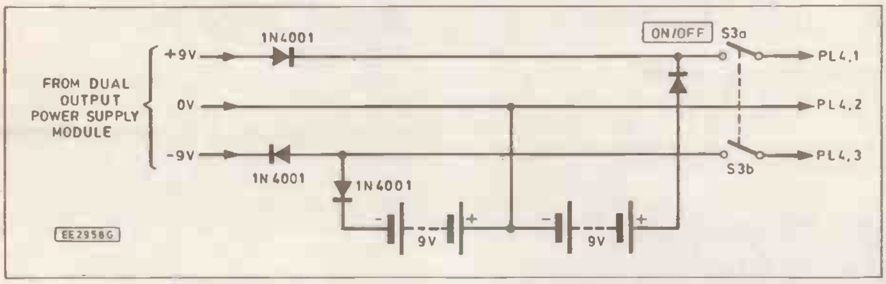


Fig. 7. Modifications for dual mains/battery operation.

Mains/battery operation

As with last month's *Bench Amplifier*, our Waveform Generator can be readily adapted for dual mains/battery operation with automatic changeover to battery operation in the event of supply failure or disconnection of the mains. Fig. 7 shows the necessary changes to the circuit.

Output level meter

Lastly, Fig. 8 shows how a level meter can be incorporated to provide an indication of the output voltage level produced by the Waveform Generator. The variable resistor, VR, may be adjusted to determine the sensitivity of the arrangement (a 5k component is recommended for a 1mA meter movement whilst a 50k preset should be used for a meter having full-scale deflection of 100μA, or less). The meter scale should be calibrated against a known a.c. voltmeter connected to the output terminals on sine wave. □

SHOP TALK

with David Barrington

Battery To Mains Inverter

There are quite a few points to be raised regarding components for the *Battery To Mains Inverter* and we shall take them in the order they appear in the "Comp List". Also it is vital that extreme care is exercised when testing or working on the unit and correct fuses are used. It might be wise to use heavy duty wire for all interwiring.

The BZX8516V Zener diode may prove elusive to locate but the more common BZX61C16 can be substituted. The cheaper 2N7011 transistor will work in place of the 2N7010 but is a lower voltage version.

The only source for the ZTX3704 we have found is **JPG Electronics** *(☎ 0246 211202)*, no substitues appear to exist and the outline package (E-line) is important for the heatsink arrangement. The only stockists listing the 2N3792 are **Farnell** *(☎ 0532 636311)* and JPG Electronics.

The 50Hz timebase i.c. M706BI is a RS component (code 304-835) and was purchased through **Electromail** *(☎ 0536 204555)*, their mail order arm. The device is designed to be used with an external 3.2768MHz crystal. The crystal is to be found in quite a number of catalogues under "timing crystals" sections.

The designer informs us that the mains transformer T1 used in his model was originally purchsed from Electromail. However, is is suggested that an alternative would be to use a **Maplin** transformer kit (YJ63T).

This kit has a ready wound 240V primary winding. It only requires 66 turns of 18s.w.g. (1.2mm) enamelled copper wire, tapped at 33 turns for a centre tap, to provide the secondary. A 9V-0V-9V sec. winding works well, but output voltage drops off quicker with increasing load.

Pocket Tone Dialler

There are one or two components which are "special" to the *Pocket Tone Dialler* and may prove difficult to locate locally.

The MV5087 Dual Tone Multi-Frequency (DTMF) generator i.c. was purchased from **STC Electronic Services** (☎ **0279 62677**), code 065394A.

We have only been able to locate two sources for the quartz crystal and these are STC Electronic Services (code 017977F) and **Maplin**, code UJ03D.

The printed circuit board for the tone dialler is obtainable from the *EE PCB Service*, code EE729 (see page 210).

Car Code Lock

As far as we can ascertain, the combination lock i.c. type MLS7225, handheld "custom" case and the 12V 280 ohm coil (contacts 250V 16A) relay used in the *Car Code Lock* are only available from **Magenta**. Other relays may be used provided they are capable of handling the work loads. This will mean that they will have to be mounted separately and leads taken to the relay board.

A full kit of parts (£19.44), including a pre-drilled keypad case and printed circuit boards, is available from **Magenta Electronics, Dept EE, 135 Hunter Street, Burton on Trent, Staffs, DE14 2ST** *(☎ 0283 65435)*. Add a further £2 for postage and packing.

The two small printed circuit boards are available as a pair from the *EE PCB Service*, code EE732a/b (see page 210).

Waveform Generator

The waveform generator chip ICL 8038 and the f.e.t. op. amp TL081 called for in the *Waveform Generator*, this month's *Teach-In '91* project, are currently listed by **Cirkit** *(☎ 0992 444111)* and **Cricklewood** *(☎ 081 452 0161)*. The choice of case is left to the individual constructor.

Basic Alarm

We cannot foresee any component buying problems for readers undertaking the *Basic Alarm*, the first of our special alarm projects. Most component suppliers should carry stocks of the "high power" buzzer.

The use of a pressure mat sensor with this circuit should not cause any supply problems as quite a number of our advertisers carry stocks. Alarm specialists such as ***Suma Designs, Autona*** and ***TK Electronics*** should be able to help.

Personal Alarm

The only item that needs consideration by constructors of the *Personal Alarm* is the warning alarm siren. The sound output should be loud enough to attract attention, frighten-off would be attackers and operate from about 6V to 12V.

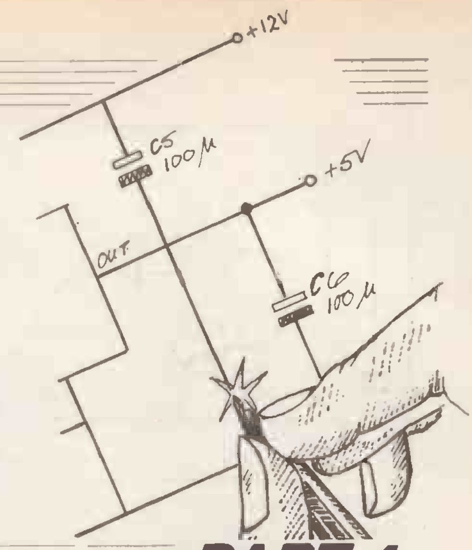
The siren used in the prototype model was obtained from **Maplin** (code JK42V) and is a piezoelectric type giving 110dB at 1m, when powered by 12V.

Vibration Alarm

The specified mercury loaded vibration switch used in the *Vibration Alarm* appears to be only available from **Maplin**, code UK57M (Vibration Switch). The rest of the components are all standard lines.

Telephone Wailer

Most of our advertisers carry a suitable miniature 64 ohm speech coil loudspeaker (an 8 ohm is not suitable) for the *Telephone Wailer* project. The only real criterion is that it should be able to fit inside the small handheld (Verobox 401) control box.



DESIGN YOU OWN CIRCUITS

Oscillators

MIKE TOOLEY BA

PART 4

This ten part series aims to dispell some of the mystique associated with the design of electronic circuits. This fourth part deals with oscillators. Our design problem is based on a signal injector whilst our companion project deals with the construction of a versatile Waveform Generator.

Introduction

THUS FAR in our series on *Design Your Own Circuits*, we have dealt at some length with two major topics; power supplies and amplifiers. This month we shall move on to another important topic, oscillators.

When designing high-gain amplifiers it is often necessary to take steps in order to avoid the risk of oscillation caused by unwanted feedback. Furthermore, since an amplifier is not generally required to provide any signals other than those associated with the input, the reason for such a precaution should be fairly obvious!

With an oscillator, the story is rather different as the basic requirement is for a circuit which will produce an output without any input (other than, perhaps, that of a synchronising signal). An oscillator must, therefore, be based on an amplifier with feedback introduced in such a manner as to ensure that oscillation is sustained rather than suppressed.

A typical oscillator specification might run along the following lines:

Output waveform:	Sine wave
Output frequency:	400Hz ±2%
Long term frequency stability:	±40Hz
Output amplitude:	1V pk-pk into 600ohm
Long term amplitude stability:	±100mV
Minimum recommended load impedance:	100ohm
Supply voltage:	+9V at 10mA

It is important to note that the specification includes several parameters which may, or may not, be important depending upon an individual application. An oscilloscope calibrator, for example, will normally require that the waveform is a square wave (rather than a sine wave) and that the amplitude and frequency are accurately defined. In the case of a simple calling tone generator for use with an intercom, on the other hand, we may not be concerned with the shape of the waveform nor the precise frequency (subject to the generated signal being somewhere near the centre of the audible frequency range).

The most commonly generated waveforms are *square* (or rectangular pulse), *triangle*, *sawtooth* and *sinusoidal* (i.e. sine wave). An oscillator circuit is usually required to faithfully produce one (or more) of these waveforms.

Just as low values of distortion are important with amplifiers, distortion is often an important consideration in the design of an oscillator. An oscillator designed to produce a sine wave may, for example, be used to test a high quality amplifier. In such an application, it is essential that the distortion present within the signal produced by the oscillator is several orders of magnitude less than the distortion introduced by the amplifier on test (otherwise it will not be possible to accurately quantify the level of distortion produced by the amplifier).

Criteria for Oscillation

Essentialy, an oscillator consist of little more than an amplifier which has positive feedback applied such that its output stage is fed back to its input in a sense which causes reinforcement of the input rather than cancellation. In practice, and since it is usually essential that the frequency of oscillation is accurately defined and that the output amplitude is stabilised (e.g. to ensure that the waveform produced is free from distortion), an oscillator will generally contain the following elements:

1. A source of gain (such as one, or more, transistors or an integrated circuit) which must be sufficient to exceed the losses within the positive feedback path.
2. A means of determining the frequency of oscillation which may take one of several forms, either:
   (i) a C-R timing (or "relaxation") circuit
   or (ii) a C-R phase shift network
   or (iii) an L-C tuned circuit (or tuned transformer) arrangement.
   or (iv) a quartz crystal (or ceramic resonator).
3. A means of stabilising the output waveform (in terms of amplitude and/or frequency).

The overall phase shift present within an oscillator circuit should be 360 degrees so that the output signal arrives back in-phase with the input. Readers may recall from Part Two that a single-stage transistor amplifier operating in common emitter mode provides only 180 degrees of phase shift hence, when using only a single transistor in an oscillator configuration, an additional 180 degrees of phase shift must be provided. In some practical relaxation oscillator arrangements, this additional phase shift is provided by means of a transformer whereas, in phase-shift oscillators, the extra 180 degrees of phase shift is provided within the phase-shift network itself.

PRACTICAL OSCILLATOR CIRCUITS

Having introduced some of the basic concepts of oscillators, we shall now develop some practical circuits which satisfy the criteria outlined previously.

Blocking Oscillators

One of the simplest forms of oscillator, often referred to as a "blocking oscillator", is shown in Fig. 4.1. This circuit employs a single-stage transistor amplifier (operating in common emitter mode) together with a simple *C-R* timing network. The trans-

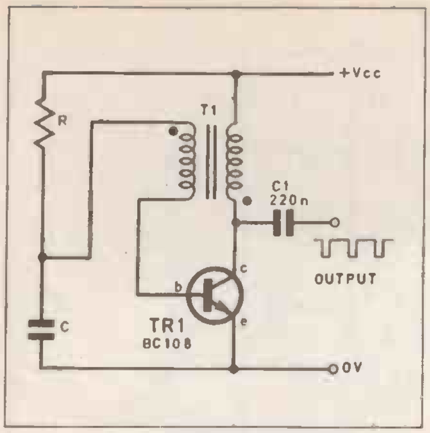


Fig. 4.1 Simple blocking oscillator circuit

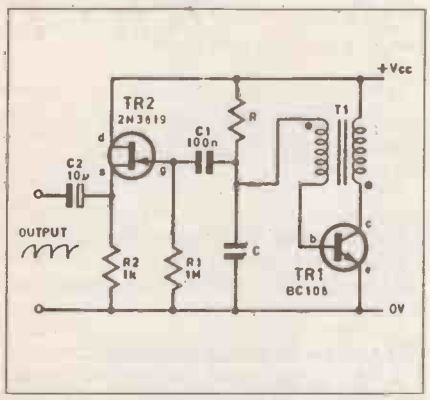


Fig. 4.2 Blocking oscillator with buffered sawtooth output

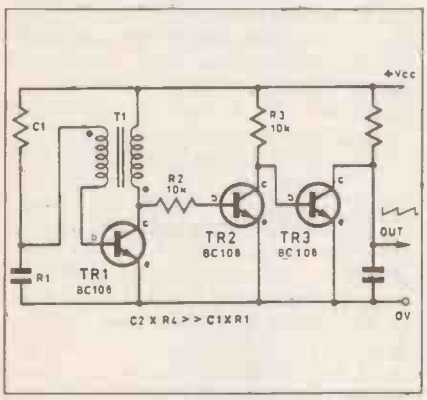


Fig. 4.3 Additional transistor switches required to produce an accurate ramp waveform from a blocking oscillator

former T1 is used to provide feedback and the additional 180 degrees of phase shift necessary to sustain oscillation.

The output waveform can be derived either from the collector (in which case the output will comprise a negative going pulse train) or from the timing capacitor (in which case the output waveform will resemble a sawtooth). It is important to note that, where the output is derived from the timing capacitor, a high impedance buffer amplifier is essential (see Fig. 4.2). Alternatively, a more accurate triangular waveform can be produced by means of a two further transistors (operated as saturated switches), the second stage of which operates in conjunction with a C-R circuit of much longer time constant (see Fig. 4.3).

The operating frequency of the circuit shown in Fig. 4.1 is given by:

$$f = \frac{K}{CR}$$

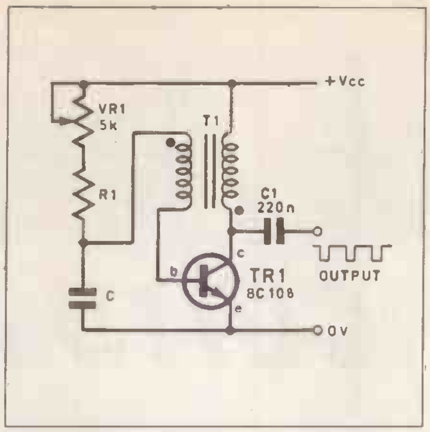


Fig. 4.4 Simple method of varying the frequency of a blocking oscillator

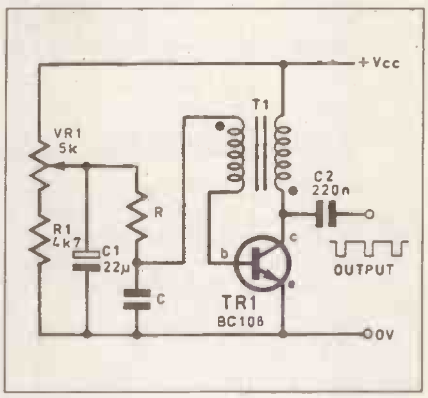


Fig. 4.5 Improved method of varying the frequency of a blocking oscillator

where f is the frequency (in Hertz), C is the capacitance (in Farads), R is the resistance (in ohm), and K is a constant which depends upon other factors (such as the transformer turns ratio and supply voltage).

A typical value for K (when using a small 4:1 ratio interstage coupling transformer, 9V d.c. supply, and BC108 transistor) is approximately 7. Hence, the following values of capacitor produce the following approximate output frequencies:

Timing capacitor, C	Output frequency, f
22nF	15kHz
47nF	7kHz
100nF	3.2kHz
220nF	1.5kHz
470nF	700Hz
1µF	320Hz

Where it is necessary to vary the output frequency, this can be achieved in two ways, either by varying the timing resistor (R) as shown in Fig. 4.4, or by applying a separate (variable) d.c. voltage supply to the base circuit, as shown in Fig. 4.5.

When a sinusoidal (rather than rectangular pulse or sawtooth) output is required, the circuit of Fig. 4.4 can be coerced to produce a sine wave at the collector by connecting a capacitor of appropriate value across the transformer primary (i.e. between the collector and the positive supply rail). Note, however, that such an arrangement can generally only provide a rather inferior sine wave and hence one of the later circuits (based on phase shift techniques) will usually be preferable.

Whilst blocking oscillators are very simple and do have uses in many non-critical applications, they are unfortunately somewhat unpredictable. The output frequency is often very dependent upon the

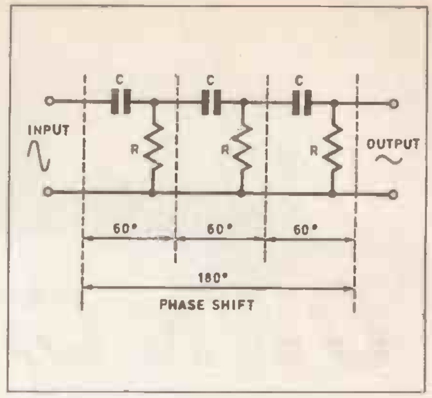


Fig. 4.6 Three-stage ladder phase-shift network

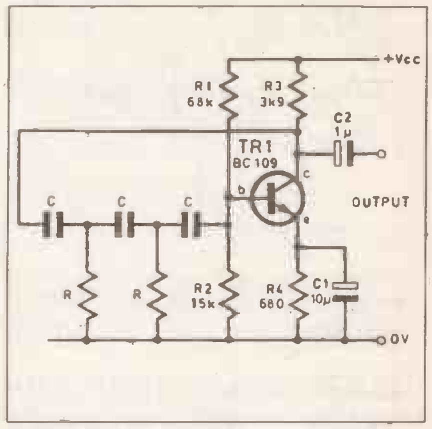


Fig. 4.7 Basic ladder network oscillator

supply voltage (and hence the supply voltage will generally require regulation) and the frequency of oscillation (and collector output waveform) will be dependent upon the transformer (turns ratio, coupling, etc). The circuit is thus not recommended for general applications or for when a sinusoidal output is required.

Ladder Network Phase-shift Oscillator

A single C-R circuit can provide a phase shift of up to 90 degrees. Three such circuits, arranged in cascade, can thus readily provide a phase shift of 180 degrees (in which case each C-R element will be responsible for providing a phase shift of 60 degrees).

Such an arrangement is shown in Fig. 4.6 and gives rise to the three-stage ladder network oscillator shown in Fig. 4.7. In this circuit, transistor TR1 operates as a common-emitter amplifier (phase shift = 180 degrees) whilst the ladder network provides the additional 180 degrees necessary to provide positive feedback.

The frequency of oscillation of such an arrangement is given by:

$$f = \frac{0.065}{CR}$$

where f is the frequency (in Hertz), C is the capacitance (in Farads), and R is the resistance (in ohms).

One notable disadvantage of the ladder network oscillator is associated with the losses within the ladder network. The attenuation associated with the three C-R stages amounts to just less than 30, hence, to ensure oscillation, the transistor amplifier stage must exhibit a voltage gain of at least 30.

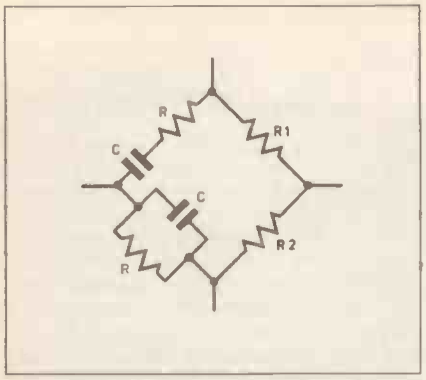


Fig. 4.8 Wien bridge network

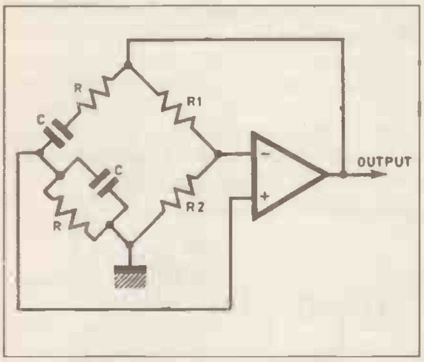


Fig. 4.9 Basic arrangement of a Wien bridge oscillator

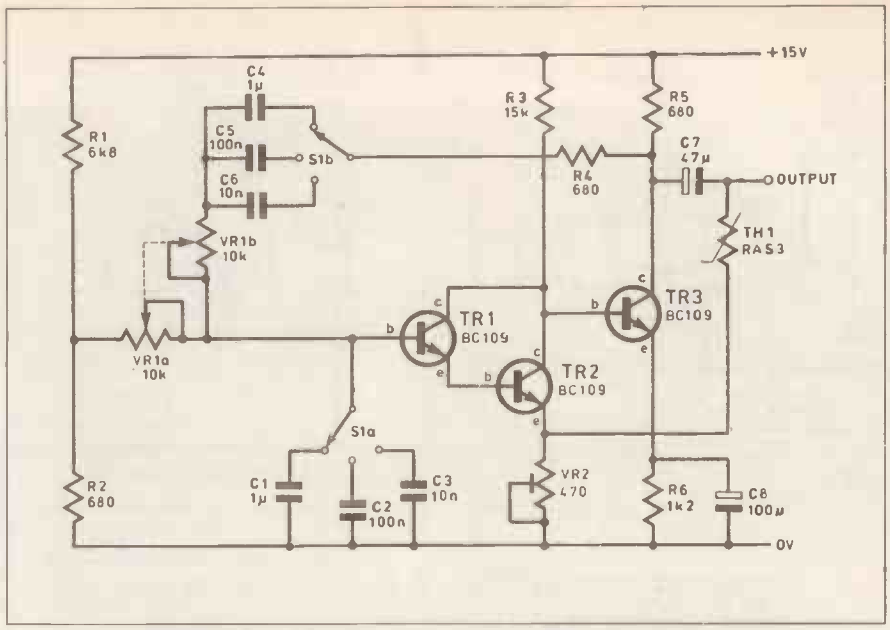


Fig. 4.10 Sine wave signal generator based on a Wien bridge oscillator

A second disadvantage of the ladder network oscillator only becomes apparent when it is necessary to vary the output frequency. In such cases, it is necessary to change *three* component values simultaneously. Since triple ganged variable resistors are rare (and expensive!) this usually rules out such an arrangement for use as a variable frequency signal source.

Question 1: A three-stage ladder network oscillator is to provide an output of 1kHz. If the value of *R* is 10k, determine the required value of C and the frequency error if the nearest preferred value is used.

Wien Bridge Oscillator

The Wien bridge (Fig. 4.8) provides an alternative to the use of a ladder network (Fig. 4.6) and offers the following significant advantages:

1. Only two components need to be varied in order to make the frequency adjustable over a wide range.

and 2. The Wien bridge exhibits minimal attenuation (approx. 3) and thus the circuit will operate happily in conjunction with a low-gain amplifier.

The basic arrangement of a Wien bridge oscillator is shown in Fig. 4.9. The bridge circuit comprises a series branch (*C* and *R* in series) and a parallel branch (*C* and *R* in parallel). The bridge circuit produces zero phase-shift (and oscillation is produced) at a frequency given by:

$$f = \frac{0.159}{CR}$$

where f is the frequency (in Hertz), C is the capacitance (in Farads), and R is the resistance (in ohms).

Sine Wave Signal Generator

A practical sine wave signal generator circuit based on a Wien bridge is shown in Fig. 4.10. This circuit deserves further comment as it employs a number of techniques which readers may wish to incorporate into their own working designs.

Transistors TR1 and TR2 form a compound Darlington transistor amplifier stage which provides a high current gain and high input impedance. A second amplifier stage (TR3 and associated components) provides further gain and ensures that the overall phase shift (between the base of TR1 and collector of TR3) of the amplifier is 360 degrees.

Since the combined voltage gain of TR1/TR2 and TR3 is very much larger than the minimum required to sustain oscillation, a large amount of negative feedback is applied. The overall stage gain (determined by the amount of negative feedback applied) is determined by the ratio of the resistance of TH1 (an RA53 thermistor) and the setting of the pre-set resistor, VR2.

The thermistor TH1 is provided in order to ensure that the output amplitude is stabilised; the resistance of TH1 decreases as the amplitude of the output signal increases, thus reducing the overall stage gain and consequently also reducing the output signal amplitude. In practice, VR1 is adjusted so that there is sufficient gain for oscillation to commence but, at the same time, ensuring that the output signal is a reasonably pure sine wave.

The Wien bridge itself is realised from the following components:

(a) Parallel branch (C1/C2/C3 and VR1a in series with R1 and R2 effectively in parallel).

(b) Series branch (C4/C5/C6 and VR1b in series with R4).

Resistors R4 and R2 determine the maximum frequency of oscillation on each of the range settings determined by switch S1. Note that decade frequency ranges (of nominally 15Hz to 250Hz, 150Hz to 2.5kHz, and 1.5kHz to 25kHz) are obtained by switching decade values of capacitor (C1/C4, C2/C5 and C3/C6).

Question 2: A Wien bridge oscillator is to be variable over the nominal frequency range 200Hz to 2kHz by means of a dual gang variable resistor of 10kilohms. Determine the required value of capacitor and the value of fixed resistor that must be placed in series with the variable resistor in order to establish the highest frequency of operation.

Twin-T Oscillator

Whilst the Wien bridge oscillator is useful in many applications, there are occasions when a more simple oscillator circuit is required which may only need frequency adjustment over a relatively narrow range using a single component. The twin-T network (Fig. 4.11) and oscillator (Fig. 4.12) provides an answer to this particular requirement.

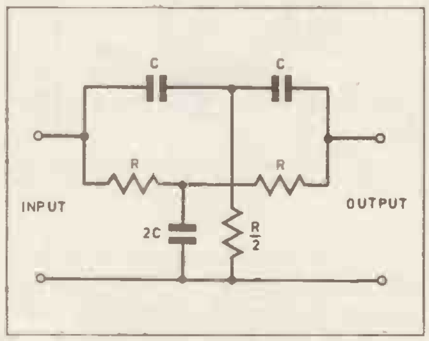


Fig. 4.11 Twin-T network

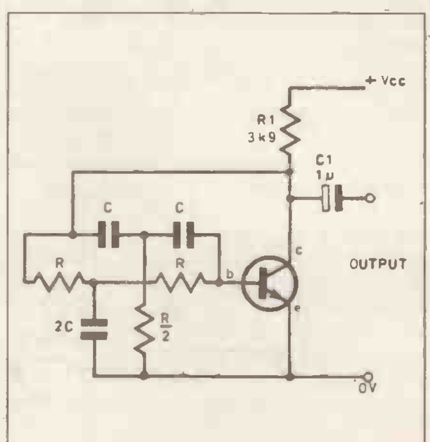


Fig. 4.12 Basic twin-T oscillator

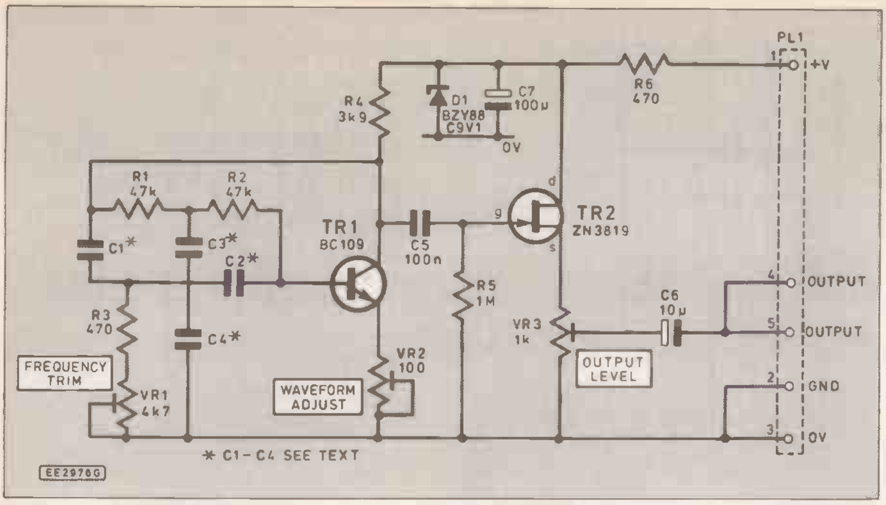


Fig. 4.13 Circuit diagram of the Sinusoidal Oscillator Module

The frequency of oscillation of the circuit shown in Fig. 4.12 is given approximately by:

$$f = \frac{0.159}{CR}$$

where f is the frequency (in Hertz), C is the capacitance (in Farads), and R is the resistance (in ohms).

Sinusoidal Oscillator Module

With a few additional components, the basic twin-T oscillator shown in Fig. 4.12 can be used as the basis of a versatile signal source capable of generating a very pure sine wave output. Fig. 4.13 shows a low-distortion Sinusoidal Oscillator Module based on the twin-T oscillator arrangement. The output signal produced by the module is highly stable (in terms of both amplitude and frequency) and both the frequency and amplitude are adjustable by means of pre-set components.

Transistor TR1 and associated components form the twin-T oscillator whilst TR2 acts as a high input impedance buffer stage in order to minimise the effects of loading at the output on oscillator frequency and output signal amplitude. A simple Zener diode shunt regulator (R6 and D1) minimise the effects of supply voltage changes on output frequency and amplitude.

The output frequency of the Sinusoidal Oscillator Module is determined by four capacitors, C1 to C4, which are identical in value. The relationship between the capacitor values and output frequency is given in the following table (VR1 provides an adjustment range of approximately ±40 per cent from the nominal centre frequency):

C1-C4	Centre frequency (approx)
2n2	7kHz
4n7	3.4kHz
10n	1.6kHz
22n	700Hz
47n	340Hz
100n	160Hz

The printed circuit board component layout and full size copper foil master pattern for the Sinusoidal Oscillator Module are shown in Fig. 4.14. This board is available from the *EE PCB Service*, code EE733.

Note that preset VR2 should be adjusted for minimum distortion in the output waveform whilst VR1 is adjusted to provide the desired output frequency (adjustable over a range of approximately 2:1). It will usually be necessary to adjust VR1 and VR2 several times as there

Sinusoidal oscillator module specifications

Output waveform:	Sine wave
Distortion:	Less than 0.1% THD (typical)
Output frequency:	Adjustable over the frequency range 50Hz to 50kHz (depending upon component values)
Long term frequency stability:	±2% (typical)
Output amplitude:	Adjustable to 1.5V peak-to-peak (max) into 5kohm
Long term amplitude stability:	±50mV
Minimum recommended load impedance:	600ohm
Supply voltage:	+12V to +15V at 10mA (typical)

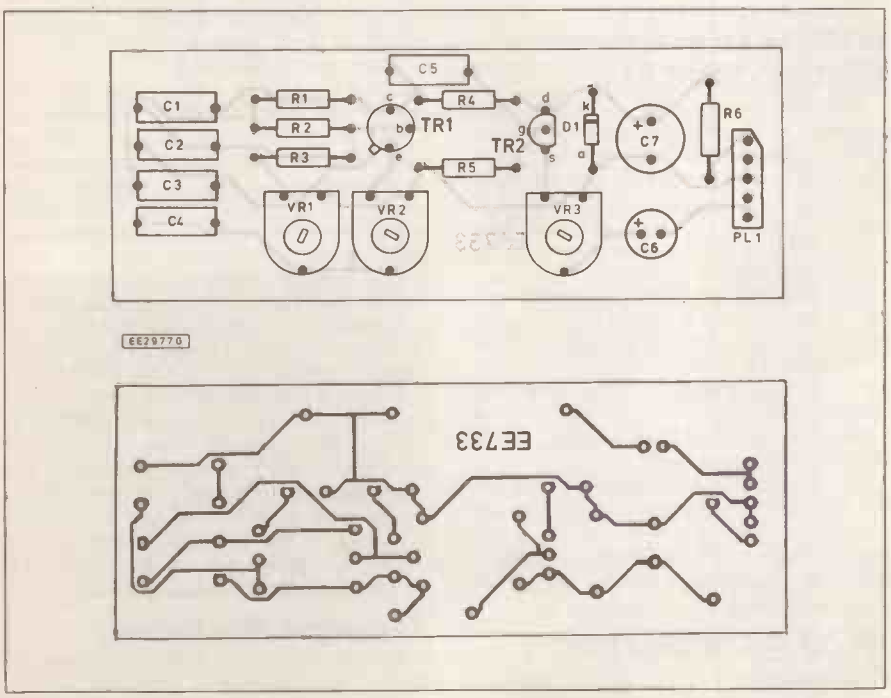


Fig. 4.14 Component layout and full size copper foil master patern for the Sinusoidal Oscillator Module

COMPONENTS

Resistors

R1	47k	
R2	47k	
R3	470	
R4	3k9	
R5	1M	
R6	470	

All 0.25W 5% carbon types.

See SHOP TALK Page

Potentiometers

VR1	4k7 min. horizontal mounting skeleton preset
VR2	100 min. horizontal mounting skeleton preset
VR3	1k min. horizontal mounting skeleton preset

Capacitors

C1, C2, C3, C4	see text
C5	100n polyester
C6	10µ radial elect. 16V
C7	100µ radial elect. 16V

Semiconductors

D1	BZY88C9V1 500mW Zener, 9.1V
TR1	BC109 *npn* silicon
TR2	2N3819 *n*-channel f.e.t.

Miscellaneous

PL1 5-way 0.1 in pitch, straight p.c.b. header; Printed circuit board available from *EE PCB Service*, code EE733; plastic case to choice; connecting wire; solder etc.

Approx cost guidance only **£8** *plus case*

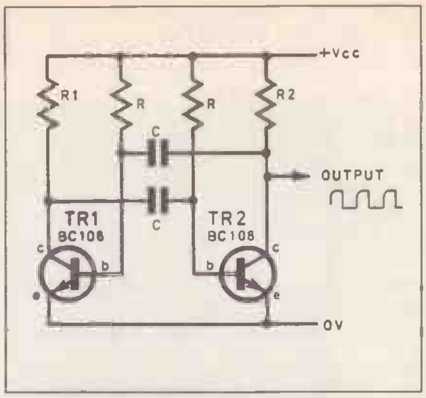


Fig. 4.15 Astable multivibrator

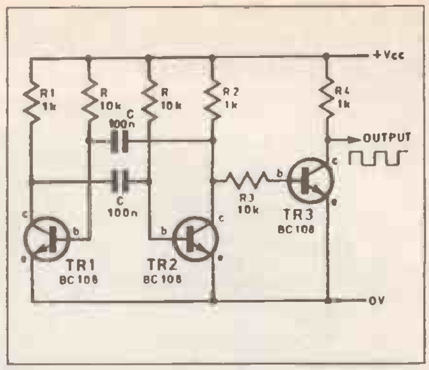


Fig. 4.17 Astable multivibrator with improved square wave output.

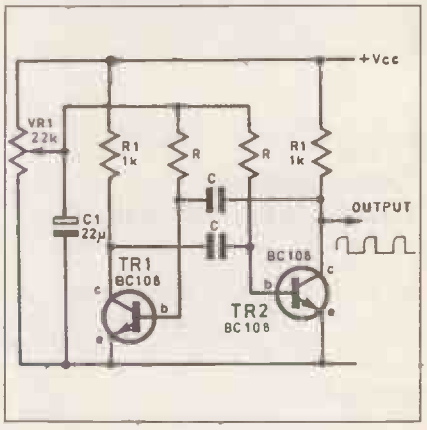


Fig. 4.16 Variable frequency astable multivibrator

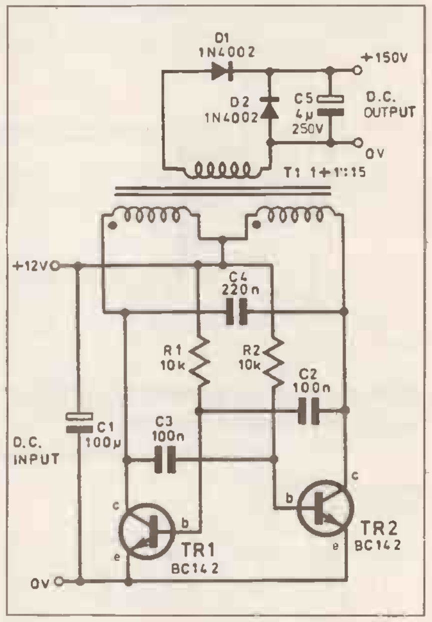


Fig. 4.18 Power astable multivibrator used in a simple d.c. to d.c. converter

will normally be some interaction between them. The output level (of up to 1.5V pk-pk) is adjusted by means of preset potentiometer VR3.

Square Wave Oscillators

The simplest form of square wave oscillator (and one which most readers will doubtless already be familiar with) is the astable multivibrator (Fig. 4.15). This circuit provides a reasonably square output signal (derived from either one of the collectors) or a ramp waveform (dervice from either one of the bases).

The circuit is capable of operation over a wide frequency range (from a few Hz to over 100kHz) by appropriate choice of values and the operating frequency is given by:

$$f = \frac{0.725}{CR}$$

where f is the frequency (in Hertz), C is the capacitance (in Farads), and R is the resistance (in ohms).

The astable multivibrator is remarkably uncritical of component values and does not require that the transistors be high gain types. Indeed, almost any type of transistor can be employed (even power transistors). The output frequency can be made adjustable very easily by means of a variable d.c. supply to the bases, as shown in Fig. 4.16 which provides an output over the range 135Hz to 4kHz.

The rise time of the output waveform of the simple multivibrator shown in Fig. 4.15 can be improved by means of an additional transistor stage operating as a saturated switch, as shown in Fig. 4.17. This circuit produces a near-perfect square wave of 50 per cent duty cycle at approximately 700Hz and can be used as a general source of pulses or as a calibrator.

How an astable multivibrator can be used to form the basis of a simple d.c. to d.c. converter is shown in Fig. 4.18. The circuit provides an output of up to 10mA at 150V d.c. from a 12V d.c. supply and operates at an efficiency of about 70 per cent.

8038 Waveform Generator I.C.

The 8038 waveform generator i.c. provides a cost-effective solution to the need for simultaneous generation of sine, square and triangle wave signals. The 8038 is housed in a 14-pin d.i.l. package and requires only a handful of additional components in order to realise a complete "function generator".

The 8038 requires a dual rail power supply of between ±5V and ±15V and can provide outputs over the range 0.001Hz to 100kHz. The internal oscillator is voltage controlled and the output frequency is determined by the d.c. voltage applied to pin 8 and the value of a single timing capacitor connected to pin 10.

The duty cycle of the output waveform can be adjusted (by means of the relative voltages applied to pin 4 and pin 5) as can the shape of the synthesised sine wave produced (by means of the d.c. potentials at pin 1 and pin 12).

8038 Oscillator Module

The circuit diagram Fig. 4.19 shows how the 8038 can be used to form the basis of a practical waveform generator which provides simultaneous square, triangle and sinusoidal outputs. With the value of capacitor C1 as specified (47n) the output frequency is adjustable (by means of VR1) over the range 200Hz to 2kHz.

Alternative values of 470n and 4n7 can be used to provide ranges from 20Hz to 200Hz and 2kHz to 20kHz, respectively. Other values may be used in order to extend the range to frequencies of as low as 0.01Hz or as high as 100kHz (with reduced performance). The circuit requires a dual supply of nominally ±9V however a ±12V supply may also be used.

The printed circuit board component layout and full size copper foil master pattern for the 8038 Oscillator Module is shown in Fig. 4.20. This board is available from the *EE PCB Service*, code EE734

Preset VR1 should be adjusted to produce the desired output frequency whilst VR2 and VR3 are adjusted to produce the "best" sine wave output. This adjustment will require the use of an oscilloscope connected to pin 3 of PL1. However, if such an instrument is not available, the two pre-set potentiometers should simply be set to mid-position.

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

8038 waveform generator module specifications

Output waveforms:	Sine, triangle or square
Distortion (sine wave output):	Less than 2% THD typical
Output frequency:	Adjustable from 0.1Hz to 20kHz (depending upon timing capacitor used)
Long term frequency stability:	±5% (typical)
Output amplitude:	1V peak-to-peak into 50kohm
Long term amplitude stability:	±100mV
Minimum recommended load impedance:	10kohm
Supply voltage:	±9V at 10mA

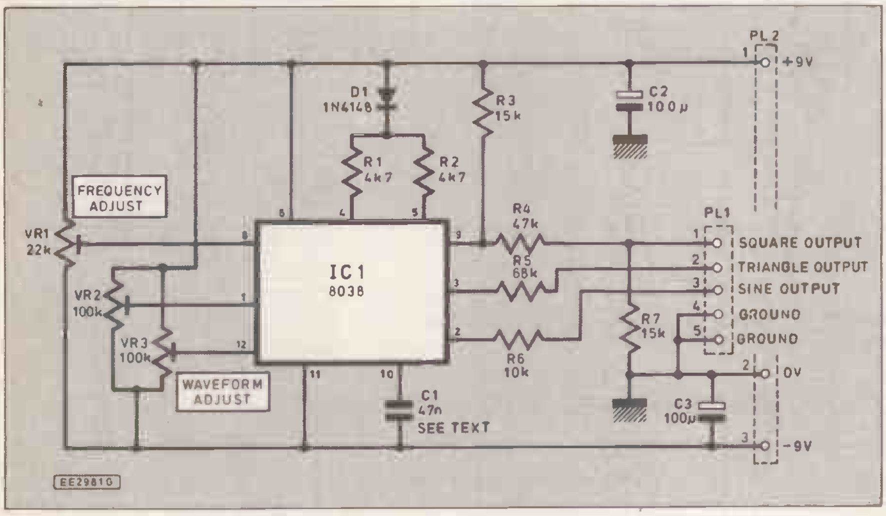


Fig. 4.19 Circuit diagram of the 8038 Oscillator Module

COMPONENTS

Resistors
R1 47k
R2 15k
R3 470
R4 68K
R5 10K
R6 15K
All 0.25W 5% carbon types.

See SHOP TALK Page

Potentiometers
VR1 22k min. horizontal mounting skeleton preset
VR2,VR3 100 min. horizontal mounting skeleton preset (2 off)

Capacitors
C1 see text
C2, C3 100μ radial elect. 35V (2 off)

Semiconductors
D1 1N4148 signal diode
IC1 ICL8038CC waveform generator

Miscellaneous
PL1 5-way 0.1 in pitch, straight p.c.b. header
PL2 3-way 0.1 in pitch, straight p.c.b. header
Printed circuit board available from *EE PCB Service*, code EE734; 14-pin low-profile i.c. socket; small plastic case to choice; connecting wire; solder etc.

Approx cost guidance only **£11** *plus case*

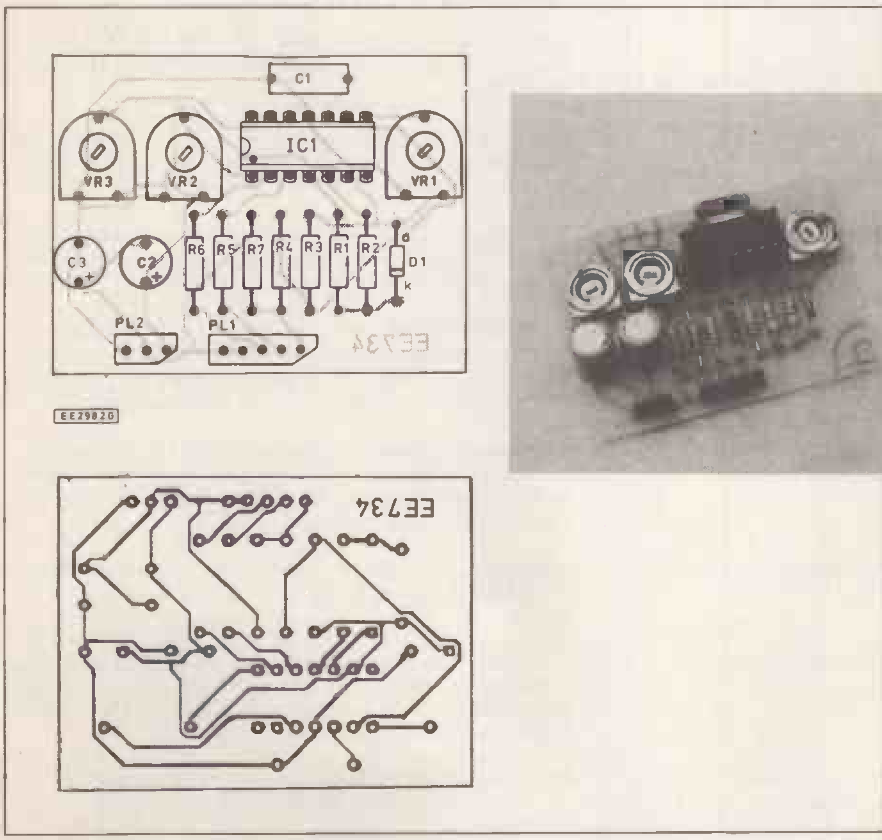


Fig. 4.20 Component layout and full size copper foil master pattern for the 8038 Oscillator Module

"homework". The exercise may be tackled purely "on paper" or may be used as the basis of a complete constructional project.

This month's problem arises from the need for a means of generating a wideband signal which may be used to test a wide variety of electronic apparatus:

A signal injector is to be designed according to the following target specification:

Fundamental output frequency:	*1kHz ± 10%*
Output voltage:	*1V pk-pk*
Power supply:	*9V (PP3)*

Design a suitable signal injector circuit suitable for mounting in a handheld instrument case and based on low-cost, low-tolerance discrete components.

Answer to last month's Design Problem

A low-cost guitar amplifier is to be designed according to the following target specification:

Output power:	*30W*
Frequency response:	*20Hz to 20kHz at −3dB (or better)*
Input impedance:	*50kilohm*
Output load impedance:	*8 ohms*
Voltage gain:	*50 (minimum)*

Design a suitable power amplifier circuit based on 2N3055/PNP3055 complementary output transistors.

One solution to last month's design problem is shown in Fig. 4.21. The rationale behind this circuit arrangement is as follows:

(a) The minimum supply voltage required to produce an output of 30W using the simple complementary symmetrical power amplifier arrangement (Fig. 3.10) is approximately 45V (calculated from $P = V_{CC}^2/8R_L$).
(b) The improved bias supply arrangement used in Fig. 3.11 (High Quality Power Amplifier Module) has been "borrowed" in order to provide improved temperature protection.
(c) The simple f.e.t. input stage (Fig. 2.9) has been added in order to obtain the specified input impedance. The supply to the input stage has been regulated by means of the Zener diode, D1 (see Fig. 1.8).

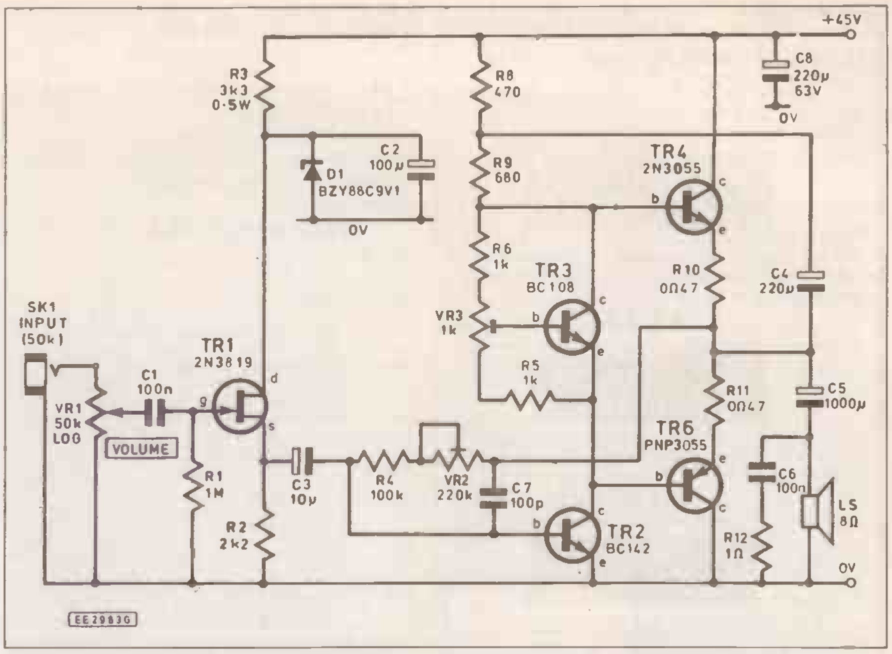


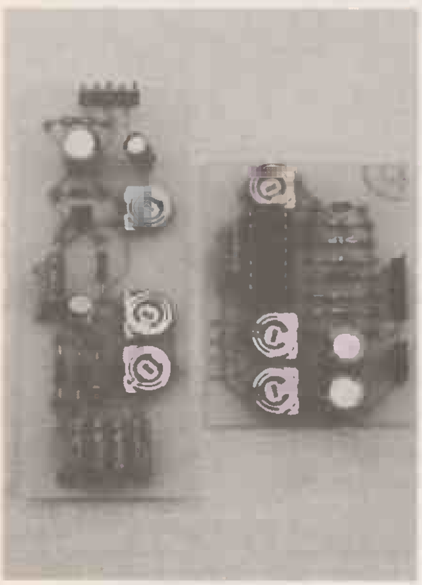
Fig. 4.21 Low cost guitar amplifier circuit diagram. (Answer to last month's Design Problem).

Next month: Next month's instalment deals with logic circuits. Our design problem involves an intruder alarm whilst our accompanying constructional project features an Electronic Dice.

Answers to Questions in Part Four

Question 1: The required value of capacitance is 6n5. The nearest preferred value is 6n8 and this will produce an output frequency of 956Hz resulting in an error of 44Hz (4.4%).

Question 2: Calculated capacitance (f = 200Hz and R = 10k) is 79n5. Nearest larger preferred value = 100n. Assuming that the actual highest frequency shall be 2.2kHz (to allow some overlap at the end of the control range), the necessary value of fixed resistor is 722 ohm (nearest preferred value = 680 ohm). The actual frequency range (at the extreme ends of the control) will then be from 150Hz to 2.3kHz (approximately).



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.

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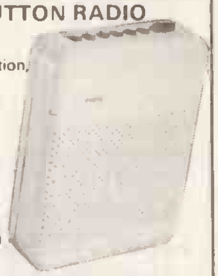

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Constructional Project

SIMPLE ALARM PROJECTS

BASIC ALARM

MAX HORSEY

With reports continually hitting the National headlines that "*criminal activities are on the increase and we must be even more vigilant*", we present a selection of inexpensive, easy to build alarms for a wide range of applications. These projects should help to deter the mugger - burglar - thief - and nuisance phone caller

● *Basic Alarm* ● *Vibration Alarm* ● *Telephone Wailer* ● *Car Code Lock* ● *Personal Alarm* ●

This Basic Alarm circuit was designed following requests for the simplest, least expensive circuit, which could perform the following functions:

1. Operate with any type of switch, or wire loop
2. Drive a small buzzer, or loud siren as required
3. Latch on when triggered, until the power supply is disconnected

SOLUTIONS

1. RELAY: A relay can be made to perform these functions, but is more expensive than the circuit described. Also the relay coil requires a significant current, and in some applications will quickly run down a battery.

2. TRANSISTOR CIRCUIT: A latching circuit can be designed using two or more transistors, but the cost will be greater than solution 4.

3. CMOS LOGIC CIRCUIT: A CMOS gate requires very little current, and can easily be made to latch. This makes it ideal for alarm systems.

However, the output current is limited, and transistors will still be needed to drive a siren. The total cost is therefore much greater.

4. THYRISTOR: A thyristor works in a similar way to a transistor, except that once switched on, it latches until the current flowing through it is interrupted.

The common C106 thyristor costs less than half the price of a relay, yet conducts up to 4 amps. It will also withstand a reverse voltage of 100V or more, making it hard to destroy! The thyristor option was therefore chosen for this project.

THYRISTORS

Thyristors are sometimes called "silicon controlled rectifiers". They behave in a circuit like a diode (a diode is a device which conducts in only one direction), except that a third connection, called a "gate" is used to switch on the device (Fig. 1).

A small current flowing into the gate is able to switch on a very much larger current from the anode to the cathode. Once a thyristor begins to conduct it remains "switched on" even if the current into the gate stops flowing. In other words, the thyristor is latched on.

The thyristor is "unlatched" by interrupting the flow of current, for example by disconnecting the power supply.

Note: When buying a thyristor there will probably be a letter after the code "C106". This last letter normally indicates the maximum voltage that the thyristor will withstand. For example a C106D thyristor will withstand up to 400V. If there is any choice, buy the least expensive, since you will only be using 9V or 12V.

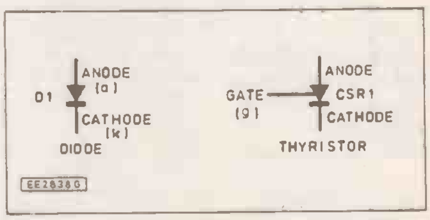


Fig. 1. Comparison of a diode circuit symbol with a thyristor. The gate switches the "diode" on.

ALARM SWITCHES

Alarm switches fall into two main groups: normally open types, and normally closed types. This is a very important difference and needs to be clearly understood.

This alarm circuit will work with either type of switch, but it will not operate with both types at the same time. You can use several normally open switches at the same time, or several normally closed switches, but you cannot have a mixture of both types in this particular circuit.

Note that if you use normally open switches, the circuit will use no current unless the siren is sounding. When using normally closed switches, a small current will flow whenever the alarm is set, even if the siren is not sounding. Therefore, if you are using a battery, and want the maximum battery life, use normally open switches.

The electrical contacts of the normally open switch are disconnected from each other until the switch is operated, at which time the contacts make, see Fig. 2a. With normally closed switches the contacts are touching each other until the switch is operated, at which time the contacts separate, or break, see Fig. 2b.

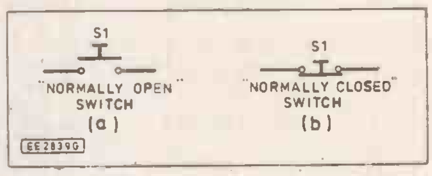


Fig. 2. Circuit representation of (a) normally open and (b) normally closed switches.

ALARM SWITCHES

A good quality catalogue will list a wide variety of switches, and the following are types often used in alarm circuits.

TOGGLE SWITCH: A simple on/off switch which may be used to set or turn off the alarm. If this switch is too accessible the intruder will also be able to switch off the alarm!

KEY SWITCH: Operated by a key, like the ignition switch in a car. Very useful as the main alarm operating switch, to enable only the key holder to switch off the alarm after it has been triggered.

ALARM TRIGGER SWITCHES

The following switches may be used to trigger an alarm circuit. Note carefully whether they are normally open (make) types, or normally closed (break) types. Some switches may be used as either type, and the instructions in the catalogue, or supplied with the switch should be followed.

UNDER CARPET PRESSURE MAT SWITCH: (normally open) When the intruder steps on the mat, the contacts close together or make.

REED SWITCH AND MAGNET: (normally closed, in use) This type of switch is often used to detect doors or windows being opened. The magnet is fitted to the door or window, so that when shut, the magnet is next to the reed switch which is mounted on the frame. The effect of the magnet is to cause the reed switch contacts to close. When the intruder enters, the magnet moves away from the reed switch, causing the contacts to open or break.

LOOP OF WIRE: (normally closed) A simple but effective method of securing equipment. You may have seen this in hi-fi shops, where loops of wire are passed through the handles of tape recorders etc. The loop of wire acts like a closed switch. If the loop is disconnected or cut, the alarm is triggered.

Another application is for a bicycle alarm, where the wire is passed through the spokes of the wheel. WARNING: Use thin wire which will break easily (and set off the alarm) if the bicycle is moved, rather than damage the spokes of the wheel!

WINDOW FOIL: (normally closed) Similar to the last type, except that specially made self-adhesive foil is secured near the edge of the glass, so that if the window is broken, the foil will break.

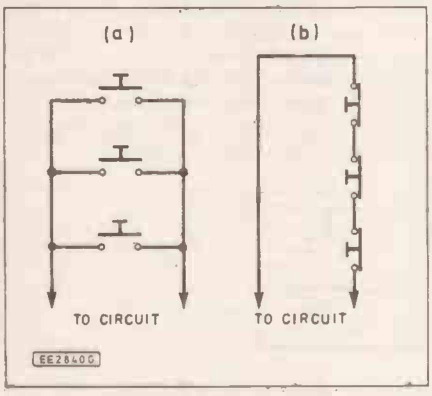


Fig. 3. Normally open switches (a) connected in parallel and (b) several normally closed switches in series.

TILT SWITCH: (normally open or normally closed) Here the switch opens or closes according to its position. Two switches carefully mounted on, say a video recorder, can be used to detect the machine being lifted.

VIBRATION SWITCH: (normally open) Very useful for protecting equipment which might be left in any position, such as a bicycle. When the switch is moved, its contacts close (make) for a moment.

GLASS BREAK DETECTOR: (normally open or normally closed) When fixed to a window, the contacts will open or close (break or make) when the glass is broken by an intruder.

PASSIVE INFRA-RED DETECTOR: (normally open or normally closed) This is more than just a switch, and would place the alarm system in a completely different price bracket! It is only mentioned since it has become so popular in professional house alarm systems. The device sits in a corner of the room, and is triggered by the movement of any warm object, such as a person. It is not triggered by the movement of a cold object (such as an insect), or by the warmth from a stationary object such as a radiator. The output is normally via a pair of relay contacts, which can be used as a normally open or normally closed switch.

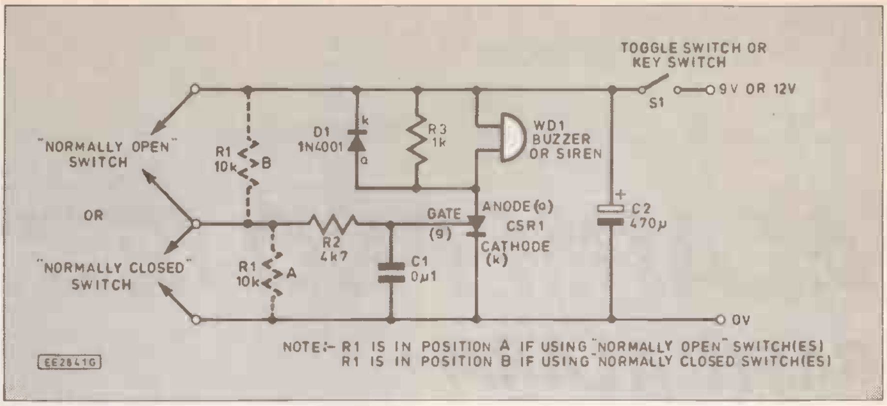


Fig. 4. Complete circuit diagram for the simple Basic Alarm.

USING SEVERAL SWITCHES

Several normally open switches can be connected in parallel to your circuit, as shown in Fig. 3. Several normally closed switches can be connected in series. As previously stated, you cannot mix these two types in this project.

THE CIRCUIT

The full circuit diagram for the simple Basic Alarm is shown in Fig. 4.

We have all experienced the problem caused by alarms being falsely triggered. Some care must therefore be taken to ensure that no stray electrical signals can reach the thyristor gate. Such signals are caused by electrical equipment being switched on or off, or by induced voltages caused by mains equipment. The wires between your circuit and the trigger switch can act like an aerial, picking up unwanted electrical signals.

Capacitor C1 (Fig. 4) removes any alternating current which may be induced into the circuit, and resistor R2 assists by partially isolating the long connecting wires between the trigger switch and the circuit.

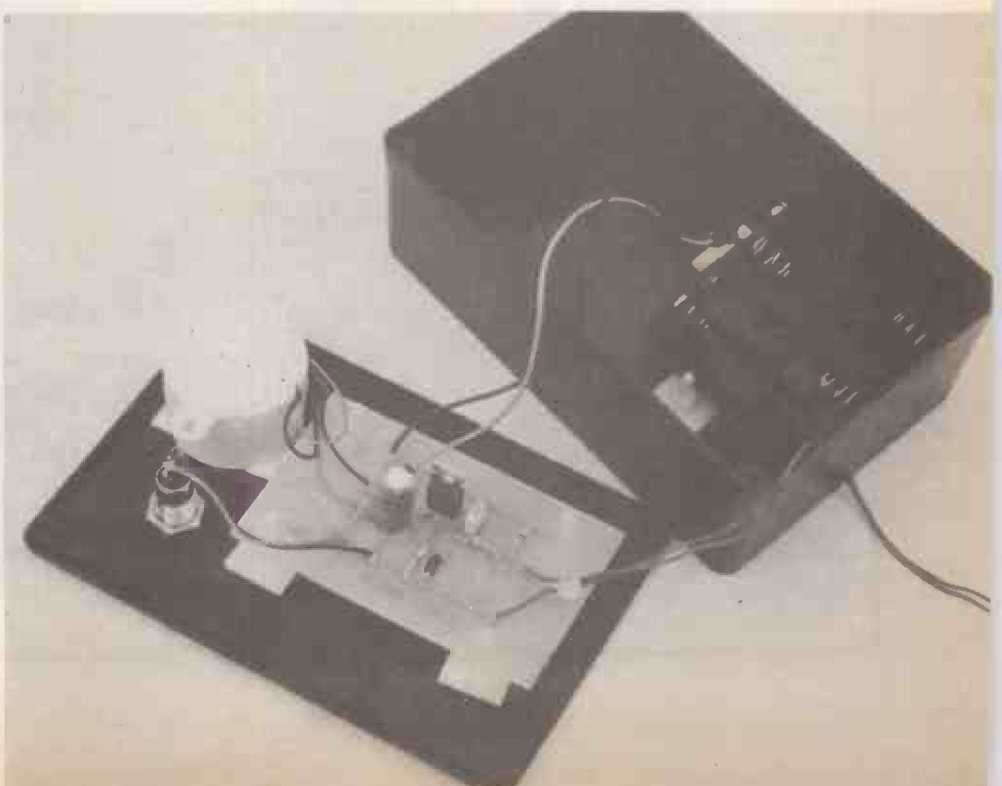
NORMALLY OPEN TRIGGER

Resistor R1 in position "A" ensures that the input is at 0V when the trigger switch is open. When the trigger switch is closed by – for example – an intruder stepping on a pressure mat, current flows from the positive supply, via the trigger switch, through R2 and into the thyristor gate. Resistor R2 keeps the flow of current down to about 2mA.

The current flowing into the thyristor gate turns on the thyristor, and current flows via the siren and through the thyristor to 0V. The thyristor is now latched on, and even if the gate voltage returns to 0V, the siren will remain working unless the current flowing through the buzzer is interrupted.

Many buzzers and sirens do not conduct a continuous flow of current, and in some cases this would allow the thyristor to switch off. Resistor R3 is therefore included to provide a continuous path for the current, so preventing the thyristor from accidentally unlatching. Some types of buzzer also produce high voltages when operating, and diode D1 is provided to remove any harmful voltage spikes.

Capacitor C2 decouples the circuit. In other words it helps to maintain a steady voltage across the circuit, especially when the buzzer or siren switches on.



NORMALLY CLOSED TRIGGER

Assuming that the normally closed switch is connected, the voltage at the junction between R1 (in position B) and R2 is 0V. There is now a continuous flow of current from positive, through R1, and via the trigger switch to 0V. This current is very small at about 1mA, but if the alarm is powered by a battery, it would be wise to use a larger type than a PP3.

If the trigger switch is operated (opened), the voltage at the junction of R1 and R2 rises, causing a current to flow through R2 and trigger the thyristor. Once triggered, the thyristor remains latched as explained above.

CONSTRUCTION

The Basic Alarm circuit is built on a small p.c.b. which is available from the *EE PCB Service*. Begin by soldering in the smallest components, such as the three resistors (Fig. 5). Note that R1 must be fitted in position "A" if using normally open switches, or in position "B" if using normally closed switches. Resistors may be fitted facing either way, but ensure that the correct values are used. Diode D1 must be fitted the correct way round, as must capacitor C2. Capacitor C1 may be fitted either way round.

Next solder in the thyristor, ensuring that it faces the correct way. The thyristor code is printed on its upper side. Finally add the connecting wires.

TESTING

If using normally open switches, keep the trigger switch wires leading from the circuit apart. If using normally closed switches, join the two switch trigger wires together temporarily.

Connect a 9V or 12V power supply and switch on S1. The buzzer or siren should not sound. Now touch the trigger switch wires together if using normally open switches, or separate the trigger switch wires if using normally closed switches.

The buzzer or siren should sound, and should continue to sound regardless of what you do to the trigger switch connections.

FAULT FINDING

If the buzzer does not work, use a piece of wire to join the thyristor's anode and cathode together. If the buzzer still fails to work, check it is connected the correct way round, and that the power supply is functioning. If the buzzer did work (when the thyristor's anode and cathode were joined with wire), check that the thyristor is connected the correct way round, and

COMPONENTS

See SHOP TALK Page

Resistors

R1	10k (see text)
R2	4k7
R3	1k

All ¼W carbon

Capacitors

C1	0µ1
C2	470µ radial elect. 16V

Semiconductors

CSR1	thyristor type C106 (see text)
D1	diode type 1N4001

Miscellaneous

WD1	9V or 12V buzzer or siren
S1	key switch (or toggle switch)

Alarm trigger switch (see text); p.c.b. available from the *EE PCB Service*, order code EE731; case; battery box; PP3 battery clip.

Approx cost guidance only **£13**

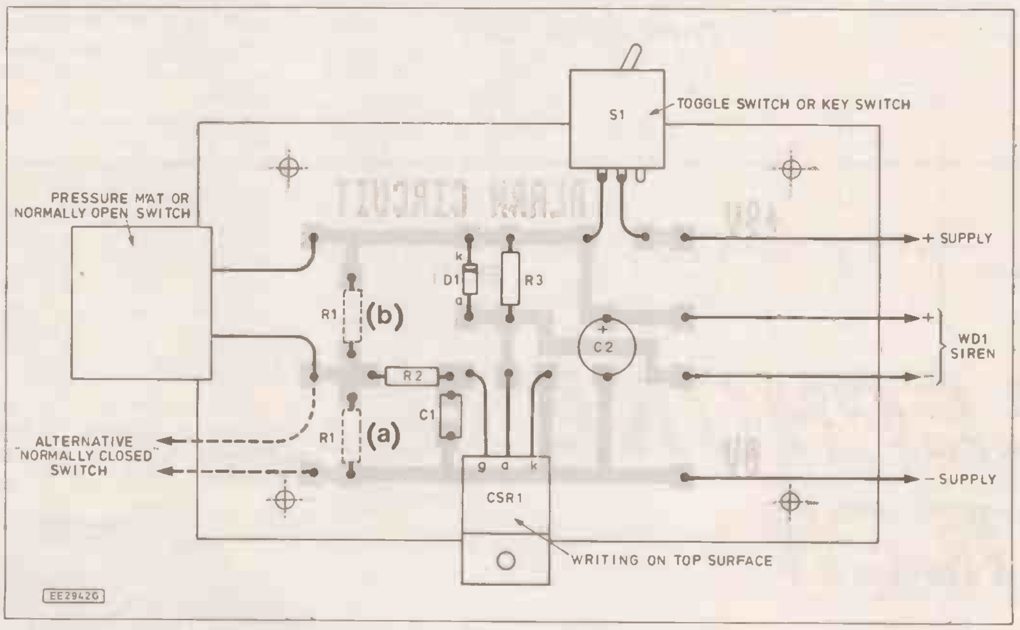
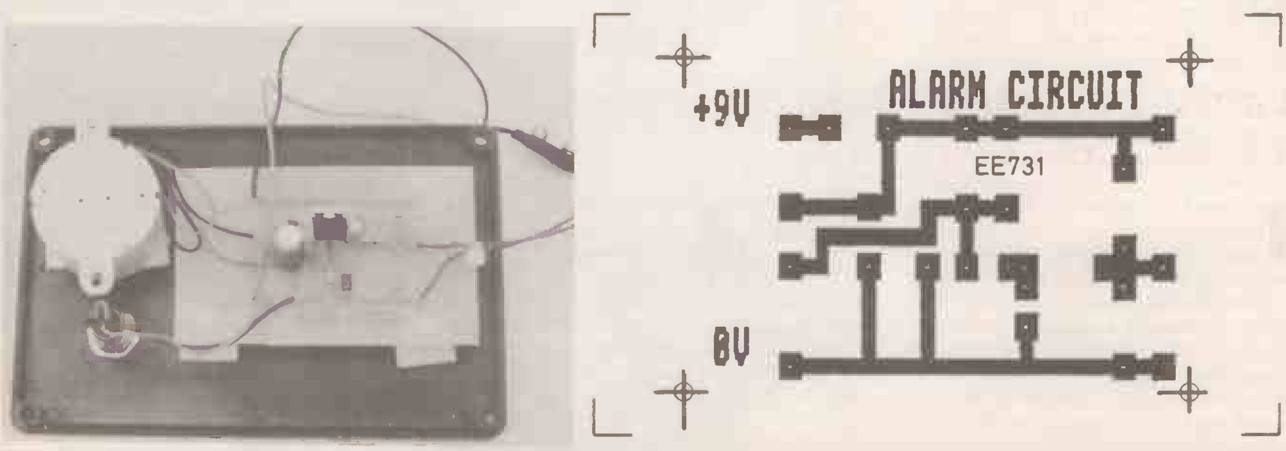


Fig. 5. Printed circuit board component layout, full size copper foil master pattern and photograph of completed board.



that the resistors R1 and R2 are fitted correctly.

If the circuit fails to latch correctly, check the value of R3. If the problem continues, try connecting a capacitor of 100μF or more across the anode/cathode of the thyristor, or across the siren or buzzer.

SETTING UP

The circuit may be powered by a small PP3 battery, particularly if normally open switches are used. However many sirens require 12V, and a battery holder of eight 1.5V cells is a better option.

In normal use the batteries should last many months, particularly if normally open switches are used. If the alarm is triggered, the batteries should run down within a reasonable period in order to avoid causing annoyance to neighbours, particularly if you are away on holiday.

The alarm may also be powered from a mains converter supplying 9V or 12V, but check that the converter is capable of supplying enough current to drive the chosen siren. Also remember that the intruder may be able to easily switch off the supply, that the alarm will fail during a power cut, and if falsely triggered will cause great annoyance to neighbours since it will continue to sound until switched off. For all these reasons, mains derived power supplies are not recommended for this circuit.

Select a case which can easily house the circuit and chosen battery. Drill a hole for the key switch, and a hole for the wires connecting the trigger switch(es), and possibly the buzzer or siren, if mounted elsewhere. In the prototype the p.c.b., siren and key switch were mounted in the lid of the case, Fig. 6. The case may then by mounted on the wall, and the lid screwed in position afterwards.

The circuit board may be mounted using self adhesive p.c.b. supports. These are fitted to the p.c.b. through small holes, and then stuck inside the case. Once installed, if the project is not to be moved about, the battery or battery box may be rested on the lower surface of the case. If the alarm is used on a bicycle or other movable object, more care must be taken to secure the battery box in position.

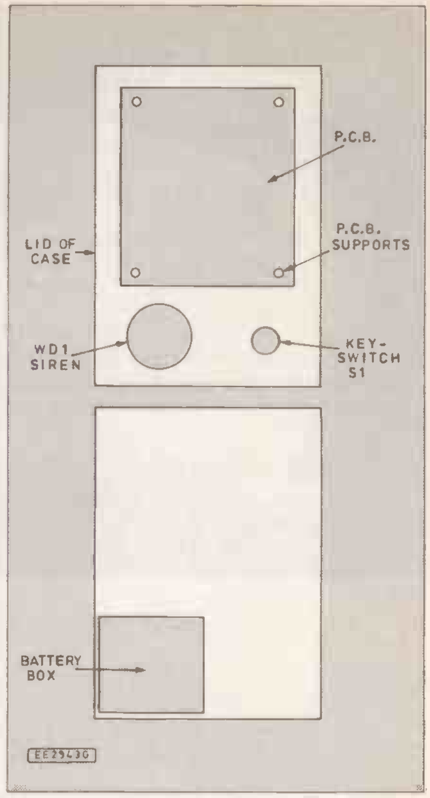
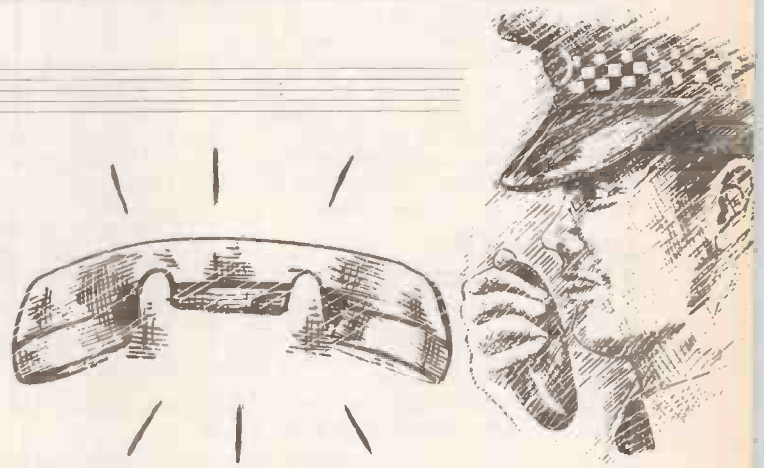


Fig. 6. Suggested layout of components on the rear of the lid and position of battery box.

Once tested and working, the alarm project should provide many years of reliable service, and will be a useful introduction to alarm systems. □

Constructional Project

TELEPHONE WAILER



T. R. de VAUX BALBIRNIE

A low-cost device to keep nuisance callers at bay.

NUISANCE and obscene telephone calls can be worrying. They are even worse for the elderly or those living on their own. The best advice is to hang up and inform British Telecom and the police. However, a little extra action of your own could stop the calls very quickly. The nuisance caller takes delight in his ability to unnerve people. It follows that it is best not to listen but to assume control of the situation yourself.

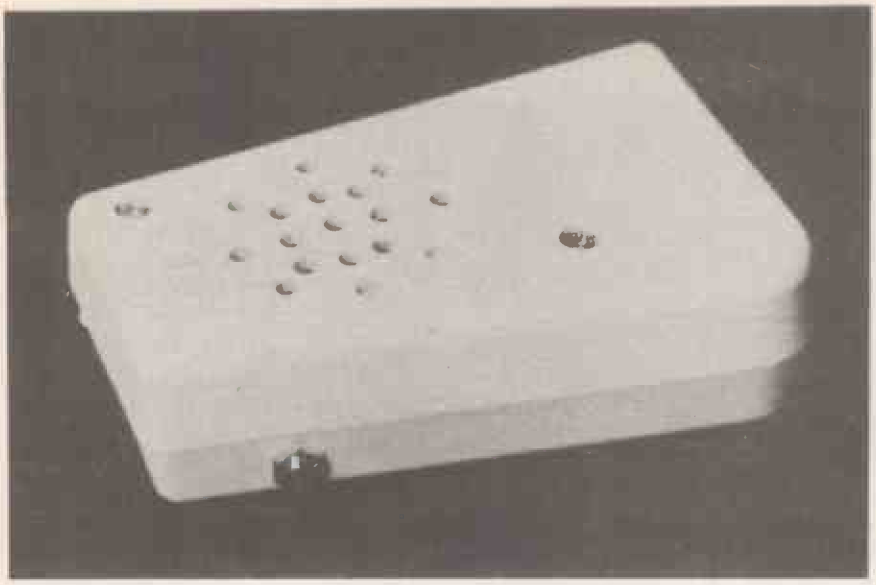
The Telephone Wailer produces a high-pitched pulsating whistle. The moment you know your call is of the nuisance type, you remove the handset from your ear, hold the device close to the microphone and press a button. A shrill tone will be heard at the other end of the telephone line. After a few seconds you hang up leaving the caller shocked and confused. Knowing that he is getting nowhere he will probably drop you as a target for his future attention.

Tests on the prototype have been made using various modern telephones, including the cordless type, as well as older ones having a traditional carbon-granule microphone. The sound is fairly loud but not excessively so – the idea is to shock and confuse rather than to deafen the caller.

No doubt, the Telephone Wailer could be used for other purposes and may be loud enough for small-scale security applications.

CONFIGURATION

The circuit is built in a very small hand-held plastic case with the push-



The completed Telephone Wailer housed in a handheld case.

button switch on the side and a matrix of holes for the sound to pass through. Due to the small physical size of the device, a miniature 6V silver oxide battery is specified. Unfortunately this is rather expensive and some readers will wish to use a PP3 9V battery.

The 9V battery will need a larger box but otherwise the circuit will work without modification and the results will be slightly louder. In occasional use, the battery will last almost as long as its shelf life since the circuit draws no current while switched off and only 20mA approximately while actually sounding.

Tests show that the best frequency to use is around 2kHz. Frequencies below this are ineffective and do not sound particularly penetrating. In this circuit the sound is provided by a miniature loudspeaker and the frequency may be fine tuned to best effect. The rate at which the tone is pulsed can also be adjusted between limits of two and ten per second approximately.

CIRCUIT DESCRIPTION

The complete circuit for the Telephone Wailer is shown in Fig. 1. IC1 is a dual integrated circuit timer with each section IC1a and IC1b connected as an astable multivibrator. This means that a continuous train of pulses appear at the appropriate output (pins 5 and 9 respectively) as long as the supply is connected (S1 on) and the appropriate reset input (pins 4 and 10) is kept high (positive supply voltage).

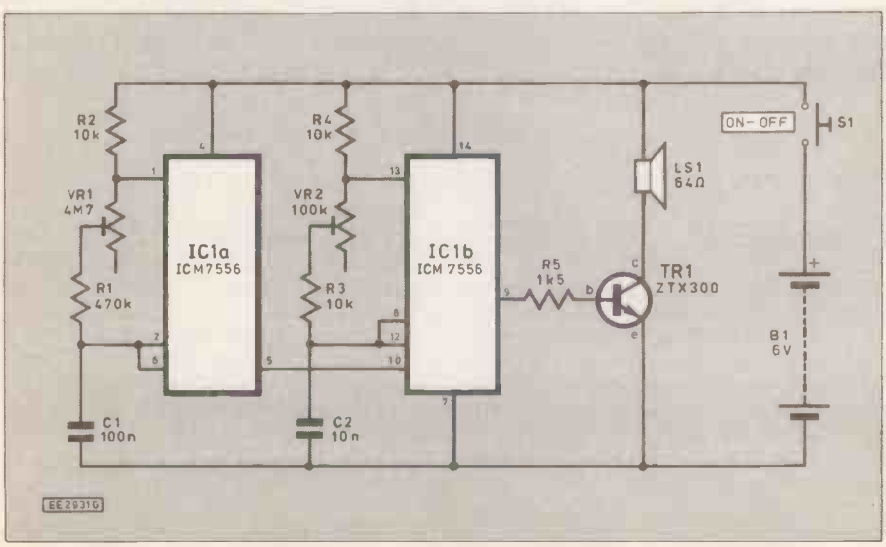
The reset input for IC1a, pin 4, is kept high as long as a supply is connected so pin 5 delivers pulses continuously. IC1b, operates at a high (audio) frequency and is responsible for the audible tone. The first section, IC1a, operates at a much lower frequency and sets the pulse repetition frequency.

Consider IC1b. The frequency of the signal appearing at the output, pin 9, depends on the values of fixed resistors R3 and R4 together with preset, VR2 and capacitor, C2. With the values specified, the frequency can be altered between limits of 400Hz and 4kHz approximately according to VR2 adjustment.

Section IC1a operates in the same way as IC1b but with different component values to alter the frequency. Here, the frequency depends on the values of R1, R2, preset VR1 and capacitor, C1. The frequency produced at IC1a output pin 5, may be varied between limits of 2Hz and 10Hz approximately, according to VR1 adjustment. This output signal is applied direct to IC1b reset input – pin 10 – and this has the effect of disabling IC1b with each low transition. This produces a pulsating high frequency tone from IC1b pin 9.

The output from IC1b is applied to transistor TR1 base through current-limiting resistor, R5. The signal is amplified and used to operate miniature loudspeaker, LS1, in the collector circuit. At the setting-up stage, presets VR1 and VR2 are adjusted for best effect. Note that this circuit produces a square-wave output and in this application this gives a result similar to that of a sine-wave.

Fig. 1. Full circuit diagram for the Telephone Wailer. The miniature loudspeaker must be a high impedance (64 ohm) type.



CONSTRUCTION

Please note that the miniature loudspeaker used in this circuit must have a high impedance – 60 to 70 ohms approximately. An 8 ohm speaker is unsuitable and must not be used.

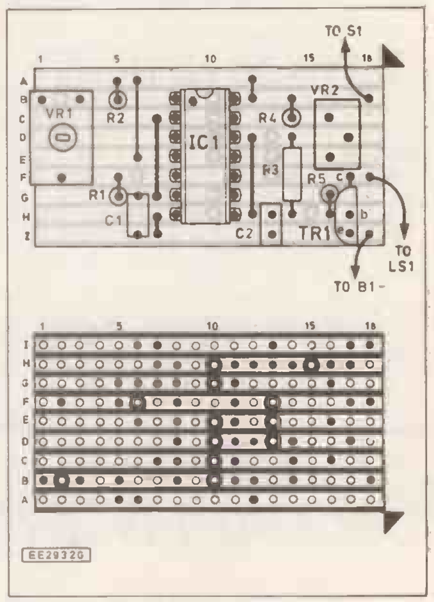


Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks..

Construction of the Telephone Wailer is based on a circuit panel made from a piece of 0.1 inch matrix stripboard size 9 strips × 18 holes. Full top and underside details for preparing this are shown in Fig. 2.

Cut the stripboard to size and make all track breaks and inter-strip links. Note that the copper strip linking IC1 pins 5 and 10 must be left intact. Solder all on-board components into position but do not insert IC1 into its socket yet. Solder 8cm pieces of light-duty stranded connecting wire to copper strips *B*, *F* and *I* along the right-hand edge of the circuit panel. Make a careful check for errors – particularly for any copper tracks which may have become accidentally "bridged" with solder and tracks not completely broken where they should be.

Prepare the case by drilling a hole in the side for S1 and a matrix of holes 3mm in diameter in the top for the sound to pass through (see photograph). It is worthwhile marking out the positions of these holes carefully since the final appearance depends largely on this. Mount the loudspeaker in position using a few slivers of adhesive fixing pad around the rim. Mount S1 then, referring to Fig. 3, complete all wiring.

Secure the circuit panel using two adhesive fixing pads. Make sure that no short-circuits are caused between the circuit panel and loudspeaker when the two halves of the case are placed together. Adjust VR1 and VR2 to approximately mid-track position. Insert IC1 into its socket with the correct orientation and *without touching the pins*. This is necessary since IC1 is a CMOS device which could be damaged by static charge existing on the body.

BATTERY CONNECTION

The specified battery must not have wires soldered to its ends. Connections were made in the prototype unit by removing a few millimeters of insulation from the ends of the battery connecting wires, doubling them over and tinning with solder. They were then held in position using a short elastic band.

Take care over the polarity of the battery and make certain short-circuits are not caused between these connections and the metal case. Secure the battery in the position shown (see photograph) using an adhesive fixing pad.

TESTING

Press S1 and note the effect. The loudspeaker should produce a bleeping sound. Adjust VR2 to give a high-pitched whistle – clockwise rotation of the sliding contact as viewed from the top edge of the circuit panel increases the frequency. At certain points the sound will be particularly penetrating. Note however, that a frequency set too high may seem suitable but will not be reproduced by the telephone.

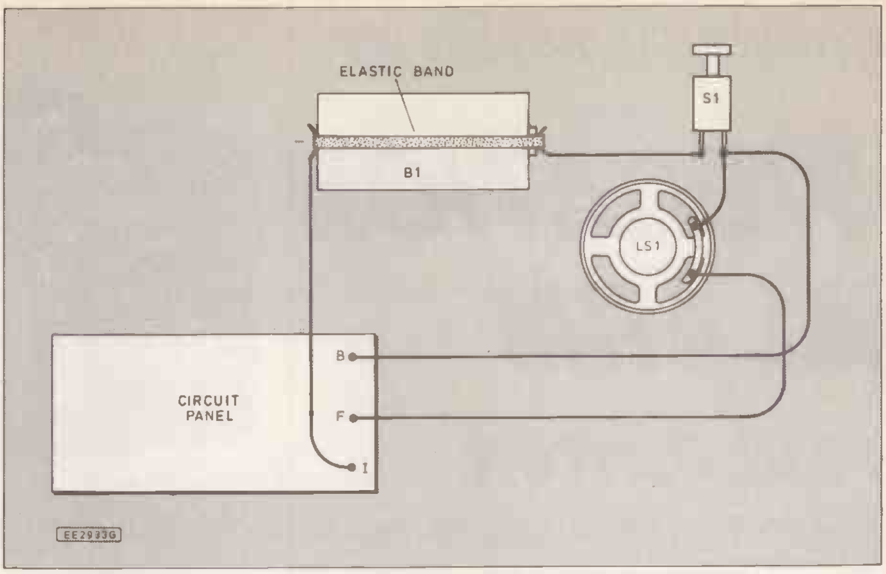
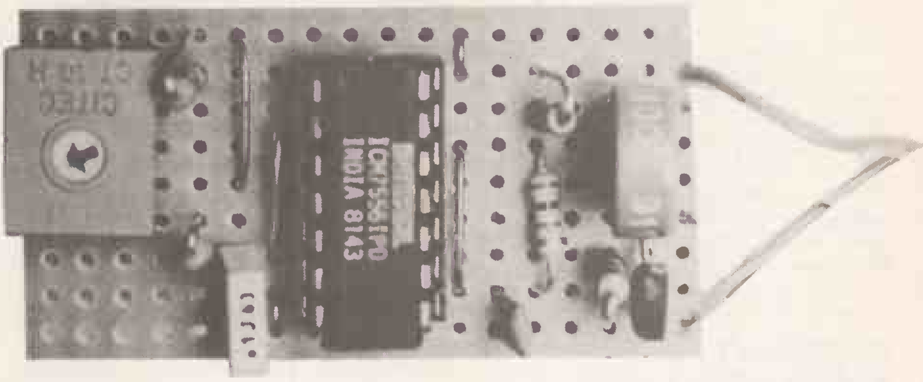


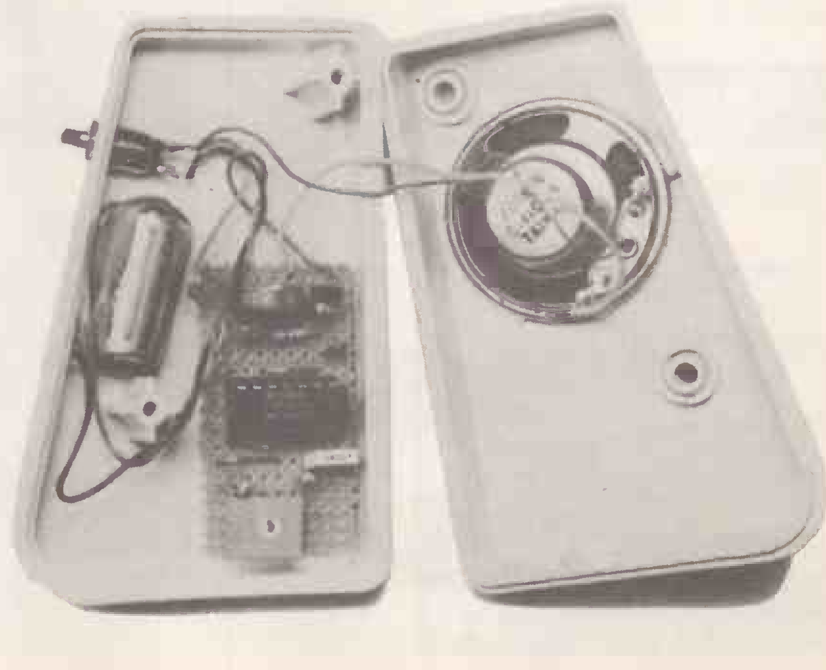
Fig. 3. Interwiring from the circuit board to the battery, loudspeaker and switch. The completed circuit board is shown below.



Adjust VR1 to pulse the tone at the desired rate – anticlockwise rotation increases the frequency. In tests, a pulse frequency of approximately three per second was found to be particularly effective but readers may wish to experiment on this point. Note that it is normal for the first pulse to be slightly longer than subsequent ones.

It only remains to try out the Telephone Wailer using a friend on a distant telephone. Please remember to issue a warning of what you are about to do. You will then be able to make final adjustments. □

The completed unit showing positioning of the battery and miniature loudspeaker.



COMPONENTS

See SHOP TALK Page

Resistors

R1	470k
R2 to R4	10k (3 off)
R5	1k5

All 0.25W 5% carbon

Potentiometer

VR1	4M7 min horizontal preset
VR2	100k min vertical preset

Capacitors

C1	100n ceramic
C2	10n ceramic

Semiconductors

TR1	ZTX300 *npn* silicon
IC1	ICM7556 dual CMOS timer

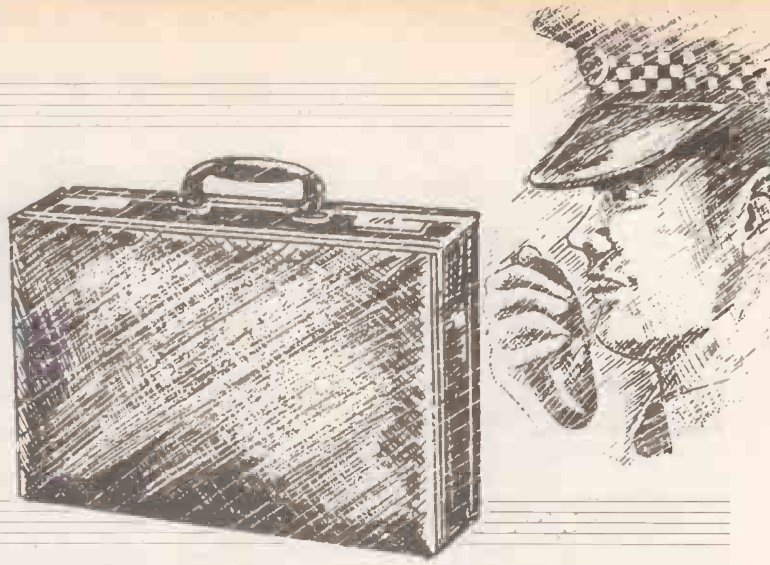
Miscellaneous

S1	sub-miniature push-to-make switch
LS1	miniature loudspeaker 38mm dia, 64 ohms impedance
B1	6V silver oxide battery type 4SR44 12.6mm dia x 25.2mm (see text)

Stripboard 0.1 in. matrix size 9 strips x 18 holes; 16-pin d.i.l. integrated circuit socket; hand-held plastic box size 94mm x 61mm x 27mm (Verobox 401); stranded wire; solder; adhesive fixing pads; elastic band.

Approx cost guidance only **£5**

Constructional Project



VIBRATION ALARM

PAUL BENTON

Ideal for guarding the medicine cabinet from inquisitive fingers

A SIMPLE vibration alarm which gives an audible output, for a predetermined period, whenever the unit is tilted from any angle has many varied and possible applications. It may be used to deter people who make a habit of picking things up to have a nose, whenever ones back is turned for a second. It may be attached to medicine cupboard doors, drawers, placed inconspicuously inside a padded envelope etc.

It has caused hours of endless fun for children of all ages, being used to play "burglar" or "carry the bomb"! With a slight modification, the simple Vibration Alarm can be installed as an anti-tamper device for cars or motorcycles. Despite its simplicity, it is a fun/useful device.

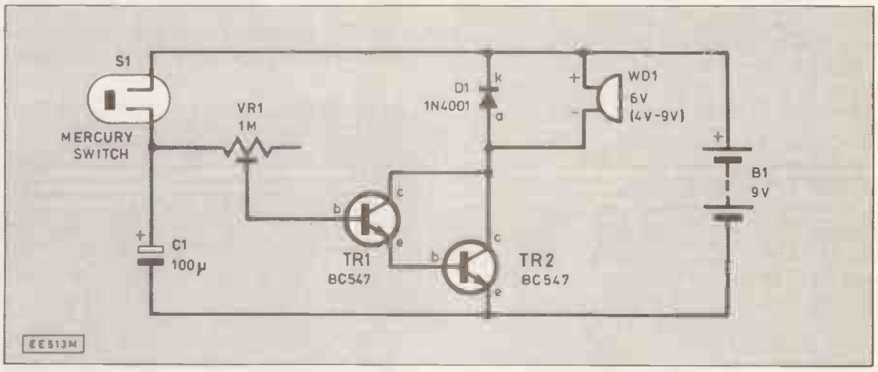


Fig. 1. Complete circuit diagram for the simple Vibration Alarm.

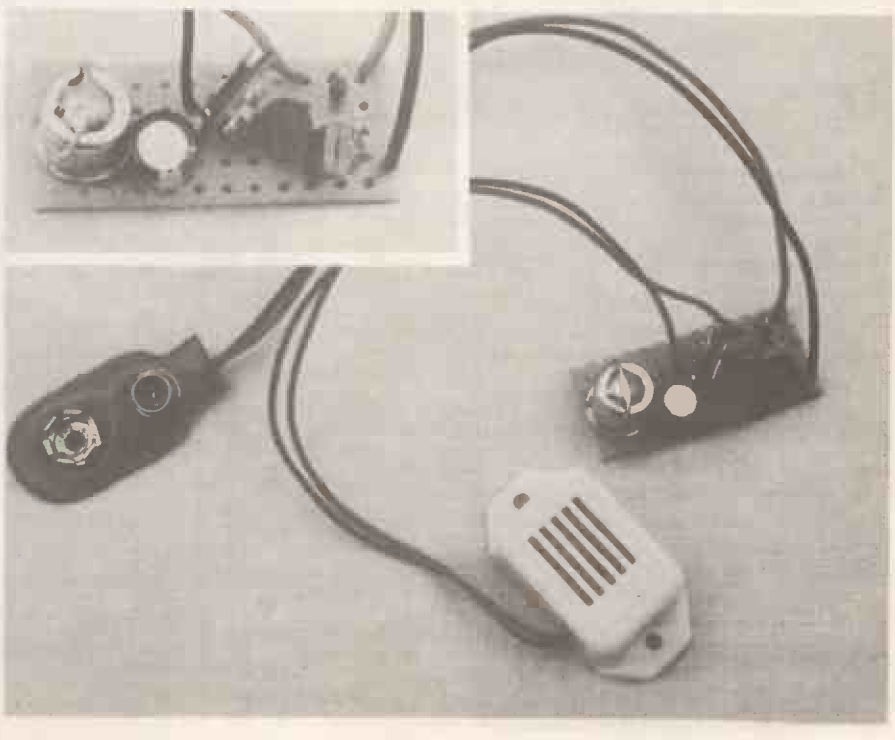
CIRCUIT DESCRIPTION

The complete circuit diagram for the simple Vibration Alarm is shown in Fig. 1. When the alarm is moved, the vibration switch S1 momentarily closes, thereby instantly charging up the electrolytic capacitor C1 to near enough the supply voltage. If the movement ceases, the storage capacitor will straight away discharge, through the preset potentiometer VR1, and turn on the Darlington pair transistors TR1 and TR2. Current will flow through the warning device WD1, sounding the alarm.

When the capacitor has sufficiently discharged, the Darlington pair will have insufficient input to remain on, and so the warning device will be switched off. If movement of the board continues, the capacitor will be constantly kept "topped up", and so the device will operate until movement ceases, and the capacitor is discharged.

With careful adjustment of the preset VR1, the alarm may operate from just a few seconds with it set at almost short circuit, and up to several minutes if VR1 is set at maximum resistance. In fact, the prototype had it's battery pulled off after two minutes of operation because the noise was intolerable!!

A diode D1 has been incorporated in the circuit to go across the output of the switch, for although not required when using the suggested buzzer, if another device, relay, etc, is substituted, then there



COMPONENTS

See SHOP TALK Page

Potentiometer
VR1 1M vertical preset, lin.

Capacitor
C1 100µ radial elect. 10V

Semiconductors
D1 1N4001 1A 50V rec.
TR1,TR2 BC547 *npn* silicon (2 off)

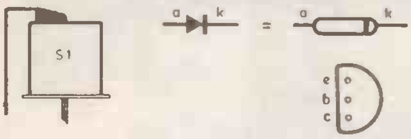
Miscellaneous
Stripboard, 0.1 in. matrix size 5 strips x 12 holes; plastic case (optional); mercury vibration switch; buzzer (WD1), 4V-9V; 9V battery (PP3) and connector; connecting wire; solder etc.

Approx cost guidance only **£5**

may be an e.m.f. generated that could damage either or both transistors! If however it can be assumed that a non-inductive load is to be utilised, then the diode may be omitted.

CONSTRUCTION

The Vibration Alarm is simple enough to be built, with exception of the buzzer and battery, on a small piece of stripboard, size 5 strips x 12 holes. The component layout and details of breaks required in the underside copper track is shown in Fig. 2.



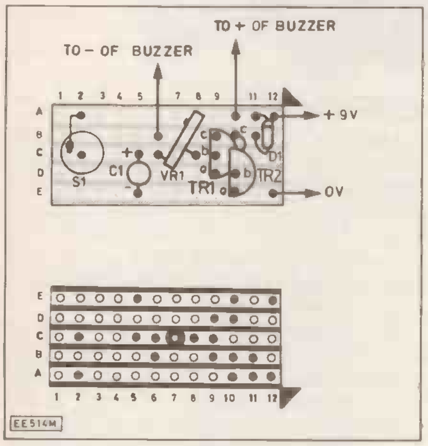


Fig. 2. Stripboard component layout and connection details for the mercury switch, diode and transistor.

Only two of the "legs" of the preset VR1 are used. The spare leg is removed, before inserting the component.

Observe the correct polarity of the electrolytic capacitor C1 and also of the diode D1 if fitted. The specified buzzer also has positive (red) and negative (black) leads.

No problem was experienced when soldering a connection wire to the body of the mercury vibration switch S1 using a 15 watt soldering iron. However, it is recommended that the part to be soldered is first given a quick once-over with fine grade abrasive paper etc, so that soldering can be as quick as possible to prevent damaging the device.

To save soldering a lead to the body of S1, a Terry-clip could be used and a solder tag placed under the clip fixing. This would save any overheating or possible "dry joint" problems and it is much easier to solder a lead to the solder tag.

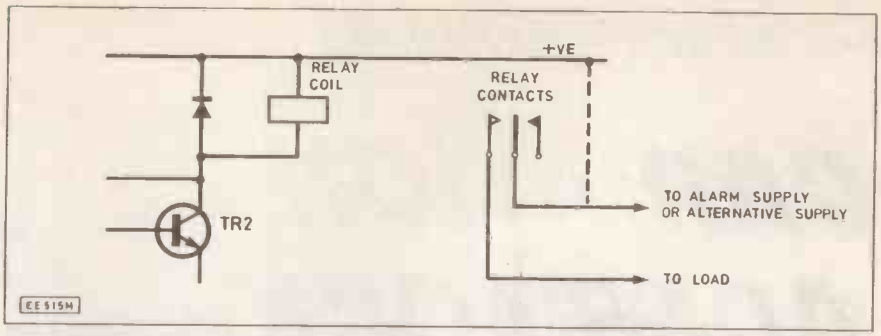


Fig. 3. Replacing the warning buzzer with a relay to handle greater loads.

USE

Once assembled correctly, adjust preset VR1 for *nearly* zero resistance, and connect the battery B1. A slight tap or disturbance of the board should trigger the unit, and the buzzer should continue for a few seconds. If the preset is adjusted for more resistance, the buzzer should operate for a longer period.

If it is desired to use the unit to operate bigger loads, for example a motor cycle horn etc, then a relay of sufficient rating may be connected in place of the buzzer, see Fig. 3.

Be careful not to exceed the maximum collector current of the BC547, which is only 100mA, or else upgrade TR2 to a more sturdy type. If the device is to be used with a 12V supply, it may be necessary to use a relay with a 9V coil to ensure efficient latching. □

CAR CODE LOCK

MARK STUART

Confuse the car thief with this versatile combination lock and immobilize your vehicle when left unattended. Cannot be "hard-wired" to start vehicle.

THIS project will find many applications where a combination lock security system is required. One application for which it is especially suited is in the protection of motor vehicles, where its addition to the existing ignition key-operated lock will make a big improvement in security and will protect a vehicle even if the keys have been stolen.

The lock can be armed either by entering the correct four digit combination, or automatically by switching off the ignition. To disarm the lock the correct combination must be entered within a short time after switching on the ignition. An incorrectly entered code locks out the keypad for 10 seconds before another try is allowed so that getting the correct combination by trial and error is tedious and unlikely.

DESIGN

Care has been taken in the design to make sure that the lock does not interfere with normal running, and that it is not necessary to re-enter the combination when, for example, the engine has stalled on a roundabout.

The use of a separate relay board which operates only when a special a.c. signal is received from the lock circuit ensures that the keypad cannot be removed and "hard-wired".

The "output" from the lock is a set of changeover relay contacts rated at 250V and 16A which should be plenty for most applications. The relay is mounted on a small board which should be concealed under the dashboard after it has been wired into the appropriate circuit. The ignition circuit is the most obvious of these but does raise safety problems in the event of component failure.

It is far preferable to connect it into the starter solenoid circuit so that the vehicle will not stop if the circuit fails whilst in the fast lane. Modern vehicles may well offer other circuits which can immobilise them in other ways.

CIRCUIT

The circuit diagram of the lock is shown in Fig 1 and the relay unit circuit in Fig. 2. The lock functions are carried out by IC1 which is a dedicated combination lock i.c. Four of the twelve keypad switches are connected to the input pins 11, 12, 13, and 14 of IC1 and must be pressed in that order to be a correct code.

The keypad terminals can be wired in any order to these pins to select the desired combination. The circuit does not allow the use of the same number twice, and so the number of possible combinations is 10 x 9 x 8 x 7 or 5040 for a keypad with 10 keys. All 12 keys on the keypad specified may be included if required giving 12 x 11 x 10 x 9 or 11880 possible numbers. The unused numbers must be connected to pin 10 of IC1 so that any incorrect code is recognised immediately.

A time limit to enter the combination is set by the value of C1 which gives approximately eight seconds for 1μF. If this time expires before four digits have been entered the sequence is rejected and must be re-entered.

An incorrect code sequence of any sort is immediately recognised by the i.c. which produces a 15 microsecond pulse on pin 5. IC2a and IC2b form an unusual monos-

Fig. 1. Circuit diagram for the "lock" or combination stage of the Car Code Lock.

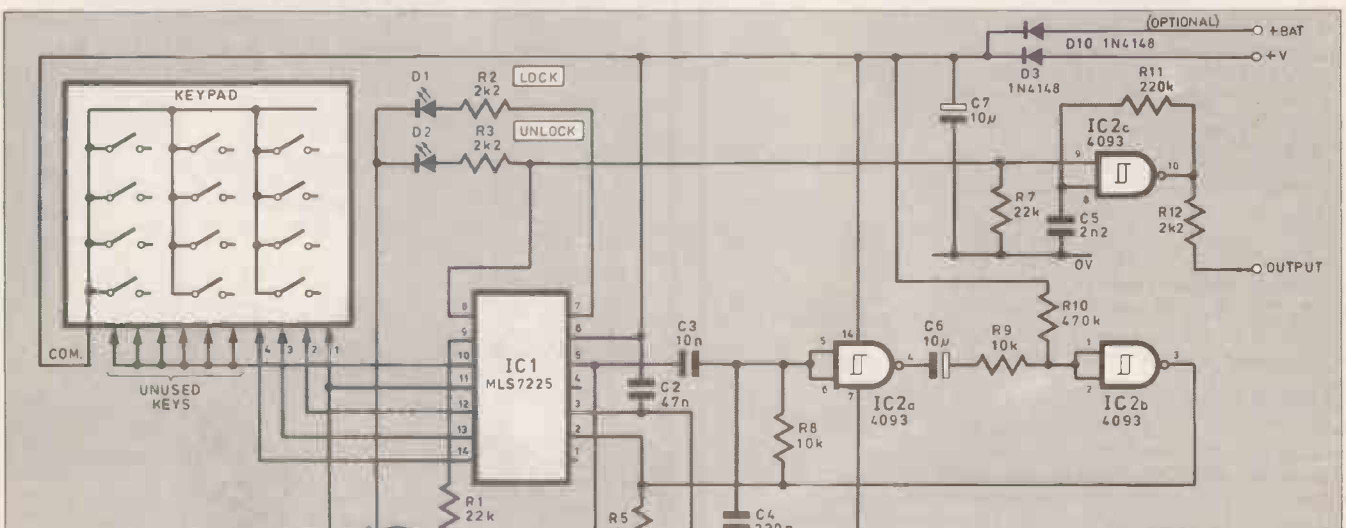


table circuit which stretches this pulse so that the voltage on pin 2 of IC1 is held high for approximately 10 seconds. This resets the sequence detector and prevents any new key presses from being registered until the time is up. Resistor R10 and capacitor C6 set this time, which is a compromise between preventing trial and error attempts, and allowing genuine mistakes to be corrected quickly.

At 10 seconds a very lucky thief needing at least 1000 attempts will take almost three hours, providing each entry is started at exactly the right time and completed within the allowed eight seconds. Since the thief has no knowledge or indication of the time constraints, the chances are that numbers will be keyed in at random intervals and even correct sequences will not work.

PULSE STRETCHER

The pulse stretcher is designed around two NAND gates which are wired as inverters by connecting their inputs together. In this mode the output is always the opposite of the input state. Initially the inputs to IC2a are held at 0V (low). As IC2a is an inverter, its output is at 12V (high). The inputs of IC2b are held high by R10 and so its output is low and holds the inputs of IC2a low via R8. The circuit sits in this state until the arrival of a positive pulse from IC1. When this happens the output of IC2a goes low and pulls the inputs of IC2b low via C6. The output of IC2b therefore goes high, driving the inputs of IC2a high via R8, so that it remains high even after the initial pulse.

The circuit latches into this state but cannot remain there because the positive end of C6 begins to move positive as it charges via R10. Eventually (after the chosen delay of 10 seconds) the inputs of IC2b have risen until it is again high, and its output switches from high to low. This drives the inputs of IC2a low causing its output in turn to go high and the circuit resumes its initial state.

Capacitor C4 ensures that the circuit enters the correct state immediately after switch-on and resistor R5 is included to pull down pin 2 of IC1 if the delay circuit is not used.

INDICATOR LAMPS

There are three other outputs from IC1. Pin 7 goes high when the circuit is in the locked condition, pin 8 goes high in the unlocked condition, and pin 9 pulses high after a correct sequence has been entered and remains high until the eight second time delay ends. These outputs can be used to drive l.e.d. indicators if required or may be left open circuit.

In the prototype the Lock and Unlock outputs each drive an l.e.d. via transistor TR1 which is switched by the momentary output from pin 9 of IC1. This arrangement gives a short pulse on the appropriate l.e.d. to indicate that the lock has been enabled or disabled.

If a permanent indication is required a wire link can be fitted from TR1 emitter to TR1 collector. Another possibility is to disconnect the Unlock l.e.d. and link out TR1 so that the only indication is a continuous red light when the alarm is set, avoiding the possibility of a continuous green lamp indicating to everyone that the alarm is left disarmed.

ANTI-TAMPER CIRCUIT

The Unlock output is used to drive the control relay via a simple but effective anti-tamper system. If the relay were to be driven by a direct d.c. signal from the lock board it would be possible to cut the wires and permanently energise the relay by making a few simple connections. To avoid this an a.c. signal is generated and used to drive the relay via a circuit which is unresponsive to d.c.

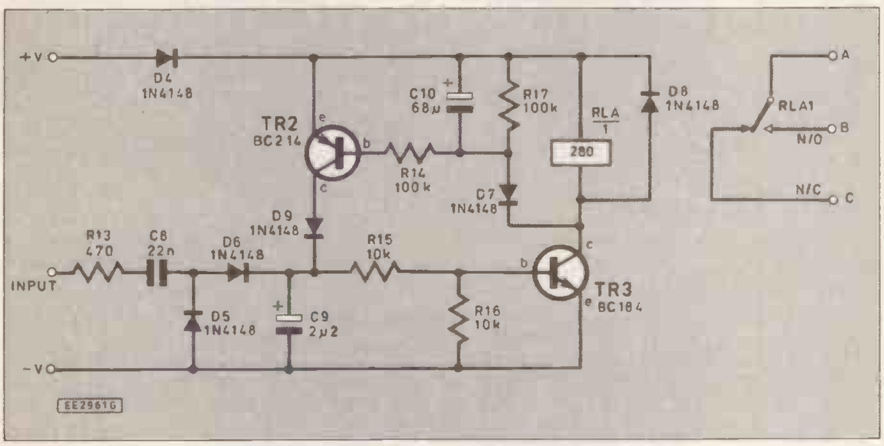


Fig. 2. Relay driver stage of the Car Code Lock.

The first part of this circuit is IC2c which operates as a standard Schmitt trigger oscillator, generating a square wave of approximately 1kHz as capacitor C5 charges and discharges via resistor R11. This oscillator is turned on when the unlock output of IC1 is high. The output of IC2c passes via protection resistor R12 to the relay unit input.

RELAY DRIVER CIRCUIT

The relay driver circuit diagram is shown in Fig. 2. The incoming a.c. signal from the lock circuit is coupled via R13 and C8, to diodes D5 and D6. These diodes rectify the incoming signal and the resulting output charges capacitor C9.

When a signal of the correct frequency and voltage is present the voltage on C9 is sufficient to turn on TR3 via R15 and R16. This operates the relay and turns on the latching transistor TR2 via D7 and R14.

When TR2 turns on it provides base current to TR3 via D9 so that the input signal is no longer required and the circuit latches with the relay operated. In this state the lock is unlocked and the vehicle can be started and driven.

If the lock code is entered whilst the vehicle is running the relay circuit takes no notice and the relay remains operated. The lock circuit remembers however and it ceases to produce the a.c. signal. If the power to the relay circuit is removed by, for example, turning off the ignition, the relay will release. Capacitor C10 will remain charged however as it can only discharge slowly via R17 and R14, so that if power is re-applied TR2 is turned on and the relay latches on even if the a.c. signal is not being sent from the lock.

This "convenience delay" is necessary to deal with situations such as engine stalls where it is necessary to turn off the ignition before a restart can be attempted. The time set by C10, R17 and R14 is approximately 20 seconds. This time delay is re-started each time the ignition is turned on and so the total time available for re-starting is indefinite, provided attempts are made at no more than 20 second intervals.

POWER

The lock circuit automatically assumes the locked state whenever power is disconnected. It can be wired either to be powered

permanently or powered only when the ignition switch is on. Each method has its merits. In the first case the lock can be left in its unlocked state when the vehicle is parked in a safe place or when a stranger, parking attendant or garage mechanic needs to drive. The second method ensures that the lock is set automatically each time the vehicle is left and so offers a higher level of security.

With either method, if the vehicle battery is to be removed it will be necessary to enter the combination before the vehicle can be re-started. To avoid this problem many garages now apply a temporary supply to the vehicle via the cigar lighter socket (it also saves problems with code locked radios).

Alternatively a PP3 battery can be fitted to the lock circuit to provide backup for several weeks. The case used for the lock has a compartment for a battery, and a 1N4148 diode needs to be fitted in series with the battery lead (a space has been left on the board labelled D10) so that reverse current does not flow when the vehicle battery is reconnected.

COMPONENTS

Resistors

R1, R7	22k (2 off)	
R2, R3, R6 R12	2k2 (4 off)	
R4, R14 R17	100k (3 off)	
R5	47k	
R8, R9 R15, R16	10k (4 off)	
R10	470k	
R11	220k	
R13	470	

All ¼W carbon

See SHOP TALK Page

Capacitors

C1	1µ sub. min. radial elec. 16V
C2	47n ceramic 50V
C3	10n ceramic 50V
C4	220p ceramic 50V
C5	2n2 ceramic 50V
C6, C7	10µ sub. min. radial elect. 16V (2 off)
C8	22n ceramic 50V
C9	2µ2 radial elect. 10V
C10	68µ radial elect. 16V

Semiconductors

D1	miniature red l.e.d.
D2	miniature green l.e.d.
D3-D9	1N4148 diode (7 off)
TR1,TR3	BC184 *npn* (see text) (2 off)
TR2	BC214 *pnp* silicon
IC1	MLS7225 combination lock
IC2	4093 quad 2-input NAND Schmitt trigger

Miscellaneous

RLA1	12V single pole relay with 250V 16A contacts

Keypad, 12-way 1-pole normally open type; lock case, approx 60mm x 100mm x 26mm (see text); printed circuit board for lock and relay circuits available from *EE PCB Service*, order code EE732a/b; 14-pin d.i.l. socket (2 off); 10-pin and 14-pin straight pin headers; 1/0.5 and 16/0.2 connecting wire; PP3 battery clip and battery (see text).

Approx cost guidance only **£22**

CONSTRUCTION

Both the lock board and the relay board are available from the *EE PCB Service* as a pair, code EE732a/b. The layout of components on the lock board and the p.c.b. track pattern are shown in Fig. 3.

Fit the smaller components to the board first. The diodes D3 and D10 (if fitted) must have the bands indicating the cathode end fitted as shown. Fit sockets for IC1 and IC2 noting that the two i.c.s are opposite ways round.

The electrolytic capacitors C1, C6, and C7 have their negative leads indicated by a band and negative signs marked on the plastic sleeve. TR1 must be fitted with the flat side of the case as shown, and must be of the correct type. A BC184L will not work as it has a different pin out from the standard BC184 specified. All of the other components can be fitted either way round.

A 10-way pin header should be fitted last for the off board connections. The only ones used here are the four key sequence pins, the positive pin, and the false key pin, all of which connect to the keypad. The other pins allow the lock to be used in different applications.

The lock and unlock indicator l.e.d.s are fitted to the track side of the board. They must be spaced from the board by approximately 6mm if the specified case is used. The exact positions can be found by trial and error after final assembly. A 14-way pin header should also be fitted to the keypad so that the pins can pass through the lock board and connected with wire links to the 10-way pin header.

If desired the keypad can be mounted away from the board and fitted with ribbon cable connections. In this case it may be better to make the wire connections straight to the board without using the pin headers.

The case supplied with the Magenta kit has been drilled with holes for the l.e.d.s and a close fitting rectangular cut-out for the keypad. Alternative cases may be used and the cut out for the keypad made using an Abrafile or similar tool and smoothed with a file. With care this method can produce excellent results.

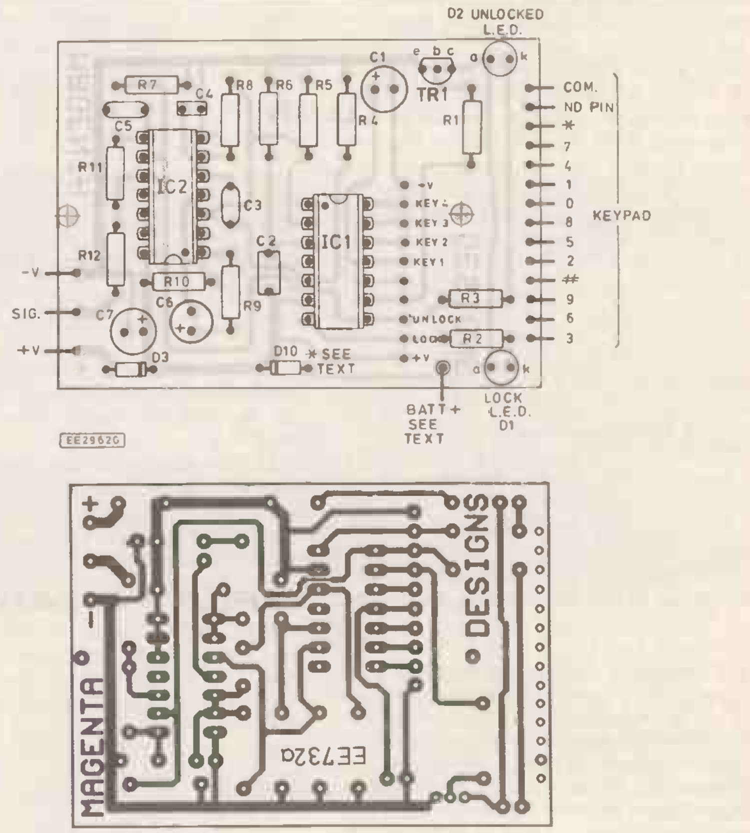
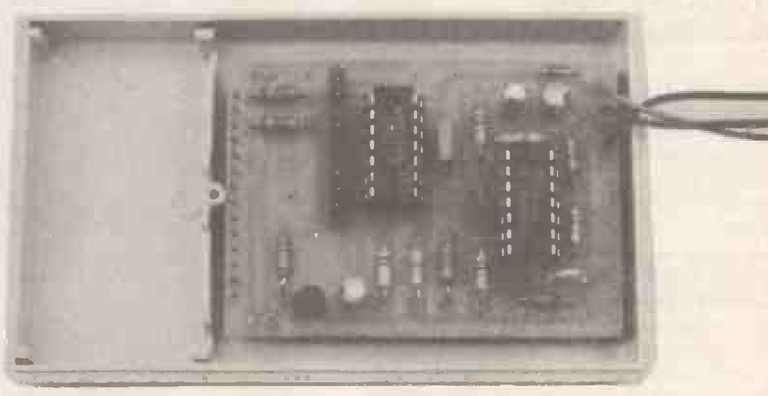


Fig. 3. Printed circuit board component layout and full size copper foil master pattern for the lock board. The finished board is shown below.



RELAY BOARD

The relay board layout is shown in Fig. 4. Take care to identify the polarity of the diodes and capacitors C9 and C10. The transistors are different types and cannot be interchanged.

Fit the relay only after all the other components have been checked and soldered in position. It is possible to use different types of relay if wires are taken from the board to the coil connections. It is not necessary to make any connections between the relay contacts and the board. If an alternative relay is used its coil resistance must be above 150 ohms.

The relay board will fit into a standard small plastic box or can be protected with large size sleeving. If a box is used slots can be cut at one end to take the connecting wires. It is not necessary to fix the board inside the case, but if necessary sticky pads can be used.

TESTING

When assembly is complete the boards should be thoroughly checked for short circuits, dry joints and incorrectly fitted components. The lock board can be tested on its own.

First fit three leads for power and output and link the keypad temporarily to the board using wire links. Fig. 3 shows the keypad connections. Link the common pin from the keypad to the positive pin of the 10 way pin header. The four keypad pins should be linked to the chosen code pins of the keypad. Do not connect the False key pin yet.

Fit IC1 and IC2 in the correct places and the correct way round. Power the board from a small 9 or 12 volt battery (not a car battery) via a 47 ohm limiting resistor and enter the chosen code. If the code is entered quickly enough the green l.e.d. should light momentarily. Enter the code again and the red l.e.d. should light momentarily.

If this does not happen it is a good idea to link out TR1 emitter and collector to permanently enable the l.e.d.s. The correct code should now switch between the lock and unlock l.e.d.s.

If there are still problems, double check the wiring of the keypad and make sure that the correct sequence is being entered. Check also that C1 and the l.e.d.s are the right way round and that the red l.e.d lights following the connection of power.

If all is well so far with TR1 in circuit the l.e.d.s will indicate the time available to enter the code. Note that if the code is entered quickly the l.e.d.s stay on for slightly longer. This is because the momentary time delay starts from the moment that the first key of the code is pressed. If a longer time is required C1 can be increased in value.

INCORRECT SEQUENCE

When an incorrect sequence is entered the circuit should be disabled by the pulse stretcher circuit around IC2a and IC2b. The output of this circuit can be read with a multimeter connected to pin 2 of IC1. Normally this pin will be held at 0V, but should switch to a high voltage following the operation of one of the sequence keys in the wrong order.

Note that as only the four sequence keys have been connected so far the other keys will not produce any response. Problems here should direct attention to the components around IC2a and IC2b, especially the resistor and capacitor values and the polarity of C6.

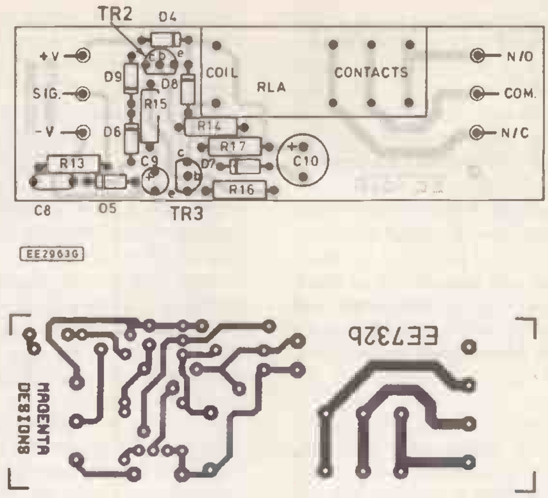


Fig. 4. Printed circuit board component layout and full size copper foil master for the relay board. The completed board is shown below.

When this part is working correctly the unused keys of the keypad can be connected together and linked to the False Keys pin. Any incorrect key being pressed should now produce a voltage on pin 2 of IC1 locking out further tries until the pulse stretcher time has expired.

A.C. OUTPUT

Only the a.c. output remains to be checked. A signal of approximately 1kHz should be present at the output of IC1c whenever the lock is unlocked. A small loudspeaker or a crystal earpiece connected to the output should make this signal audible.

If the signal is absent check the input to pin 9 of IC2c which should be high when unlocked and zero when locked. Also check C5 and all of the associated resistors for the correct values.

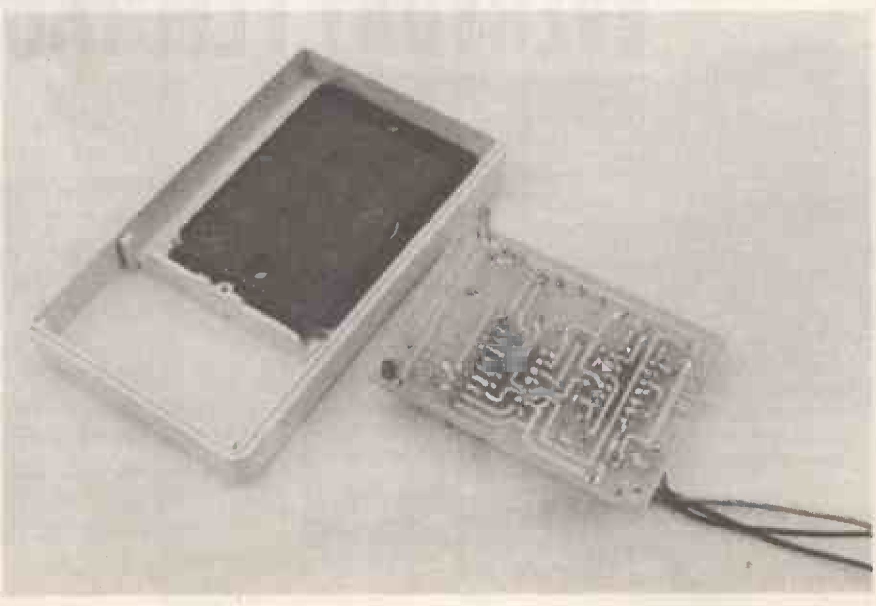
RELAY BOARD

Once the lock board is functioning correctly the relay board should be connected and checked. The current limiting resistor used in earlier tests should be disconnected or replaced with 10 ohms as the relay requires more current than a 47 ohm can allow without a serious voltage drop. Make sure that an output is present from the lock board by setting it to the unlocked state, and if all is well the relay should click as it is operated. Lock the lock and the relay should remain operated.

Disconnect the positive supply and the relay will release and will operate again as soon as power is re-connected, even with the lock locked. Remove power for 30 seconds and the relay should now remain released when power is re-applied. This is because C10 has had time to discharge fully and so TR2 is not turned on each time power is re-applied.

The exact time delay can be established by trial and error, but remember that each time power is re-applied before the time has expired, C10 is re-charged and the time restarts. The time set should be between 20 and 30 seconds and will depend on the voltage being used for the test. If any of these tests fail, check all of the components, particularly the diodes and transistors.

If the circuit fails to latch but the relay operates correctly the fault lies around TR2. If the relay will not operate at all, then TR3, D5, and D6 are probably at fault. A multimeter connected across C9



should indicate 2V or more when the unlock signal is present.

FINAL ASSEMBLY

Once everything is working the keypad should be disconnected and fitted temporarily into position in the case cut-out so that the pins point to the inside of the case. Three lengths of 7/0.2 wire of suitable length should be fitted to the lock board and a 3mm hole drilled in the rear of the case so that these can be routed inconspicuously.

The lock board can now be fitted track side down over the pins and the position of the two l.e.d.s adjusted so that they align correctly in their holes. It is necessary to bend the l.e.d. wires to pass around the keypad base.

Once this is done, fix the keypad with a flexible adhesive (so that it can be removed if necessary for replacement) and fit the lock board in position. A sticky pad between the keypad and board will retain the board in position but is not really necessary as the pins from the keypad should hold the two together adequately.

The links between the keypad and the lock board can now be made using 1/0.5 insulated wire. The combination can be set up as required and altered in future by changing the links if necessary.

INSTALLATION

The specified case has a slide off retaining clip which can be screwed into position in the vehicle and the lock case slid into place. Alternatively the case can be mounted inside a glovebox or similar convenient place. It must be clearly visible though so that the combination can be entered easily in the time allowed.

More ambitious constructors could mount the keypad flush in a spare equipment panel and make a very neat job. The final decision depends on the vehicle and the constructor.

It would also be possible to fit a three way connector so that the lock could be removed completely from the vehicle. This would provide a very high level of security but could be inconvenient.

Positioning the relay board is less complicated as it can be fitted anywhere that the necessary wires are to hand. The board can be fitted loosely into a small plastic case to protect it and provide insulation. The simplest and most effective connection arrangement is to wire the normally open relay contacts in series with the supply to the ignition circuit from the ignition lock.

All connections are made easily using press fit connectors. The negative power connection to the relay board is connected to the vehicle body, at a suitable nearby fixing point, and the positive supply connects to the ignition power circuit so that the board is powered only when the ignition switch is turned on. The same two points can be used to power the lock board, or alternatively a local negative connection to the vehicle body can be made, and the positive power lead connected to a continuous supply.

The decision whether to power the board via the ignition circuit or directly depends on the mode of operation and has been discussed earlier. An alternative method giving additional security is to power the lock via a secret switch. The switch need not be hidden as its function will be totally confusing to a possible thief. A changeover switch could also be fitted which would allow direct or ignition switched power to be applied to the lock board.

IN USE

With the lock connected into the ignition circuit, operation is automatic. The lock sets itself 20 seconds after leaving the vehicle and requires the correct combination to be entered after turning the ignition on before the vehicle can be started.

If a wrong code is entered, count to ten and try again. The green l.e.d. will blink on when the correct code is entered. If TR1 has been linked out the l.e.d.s will give continuous indication of the lock state.

A permanently powered lock board will require the correct code to be entered to set the lock before leaving the vehicle. Unlocking is identical in either mode.

SAFETY

Once the lock is unlocked the components on the relay board are the only ones in circuit. A fault in any of these or in the connections to the ignition circuit could result in the vehicle engine stopping. Take care with construction and thoroughly test and inspect the board before final installation.

If the risk of a breakdown of this type is unacceptable, the lock can be wired into the starter solenoid circuit. In this case the lock is fail-safe and will simply prevent the engine from starting in the first place.

This is certainly the author's recommended method of installation and should be used if possible. It is slightly less secure as it does not prevent bump starting, but is still a major improvement in the vehicle security.

FUSES

The recommended wire for the positive connections to the lock and relay boards is 16/0.2 flexible insulated. This must be protected by in-line fuses of no greater than 5A rating to prevent the wire from overheating in the case of short circuits. These safety matters must be given due consideration and a proper installation will be safe and reliable.

ALTERNATIVE USES

Motor vehicle protection is just one area of application for a lock of this type. The basic requirements of a low current 9 to 12 volt supply are all the lock needs to be fitted in a wide variety of applications.

The specified relay can be used to switch mains voltage circuits at up to 3kW power rating and so can prevent unauthorised operation of many types of equipment. Computers, video recorders, security lighting, machine tools, heaters, and many types of equipment which could be dangerous in the wrong hands may all be given additional security by this type of lock.

When using mains applications an Earth connection to the relay board and lock board negative supplies is ESSENTIAL to protect the user in the event of a fault.

As discussed before the lock is as reliable as most other electronic equipment, but some types of component failure could result in a false lock or unlock state. This means that the circuit must not be used as the only means of protection where its failure could cause danger. It should only be used as additional security, or where failure would only result in inconvenience. □

PERSONAL ALARM

T. R. de VAUX-BALBIRNIE

A compact multi-purpose alarm

THE CIRCUIT described here serves as a personal attack alarm (anti-mugging device), elderly person's alarm (to summon help) and property alarm. As an attack or elderly person's alarm, it may be triggered by pressing a button or by dropping it on the ground. This would happen if the person fell over.

As a property alarm, it uses a wire loop connected to the unit by two plugs. The alarm will sound if either plug is pulled out.

With a long loop, the wire may pass through handles of valuable objects to trigger if a plug is removed or if the wire is cut or broken. It may thus protect doors and windows as well as articles such as cameras on the beach.

It is a simple matter to omit any of the triggering options not required. A two-position switch selects either PERSONAL or PROPERTY mode as required.

KEY OPERATION

The circuit is armed by switching on using a key-operated switch. If this is done before leaving the car, hotel, etc. there will be no need to carry the key on the person. Once triggered, the alarm sounds for a preset time from a few seconds to more than four minutes or until cancelled manually.

As a property alarm, it will sound continuously if the wire loop is broken or a plug pulled out. There is a secrecy element built into the cancelling procedure to prevent an unauthorised person from silencing the device prematurely.

Dropping the unit onto a hard surface such as concrete will cause damage to the case. Depending on the way in which it falls, there may also be some damage to the switches. It would be possible to protect the edges and corners of the case with thick material to prevent this happening. This was not done in the prototype, however. Shock-proofing the circuit panel and audible waring device prevents internal damage.

A loud sound output was considered necessary so a fairly large audible warning device had to be used in the design. The prototype alarm was built in an aluminium box size 102mm × 64mm × 51mm which is still small enough to be held in the hand. Some readers may wish to reduce the size by using a smaller audible warning device but checks should be made to ensure that it is loud enough for the purpose.

The specified warning device has a rated output of 110dB at 1m when operated from a 12V supply although a 9V PP3 battery was used in the prototype. Readers wishing to use a 12V supply would need to use a larger box but this is hardly worthwhile in terms of the small additional sound output.

A lithium PP3 battery is recommended for long life. However, an alkaline one could be used to save cost.

The standby current requirement depends to some extent on the operating time adjustment. This is because the timing capacitor passes a certain leakage current. The average standby current will be 100μA approximately so even if the unit is switched on for extended periods the battery will last for a long time. While actually sounding, the unit requires 100mA approximately.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Personal Alarm is shown in Fig. 1. This is based on a monostable centred on a CMOS timer, IC1.

With the key-operated switch, S7, (STANDBY) switched on and with all other switches disregarded for the moment, the circuit receives power from battery B1. IC1 trigger input (pin 2) is kept high (battery positive voltage) via pull-up resistors, R2 and R3 connected in series and under these conditions the output (pin 3) remains low (negative supply voltage) and there is no further effect.

Making pin 2 low actuates IC1 and pin 3 goes high for a time depending on the values of fixed resistor, R6, preset VR1 and capacitor, C1. It then reverts back to low.

While high, the output directs base current to transistor, TR1, through current-limiting resistor R7. This, in turn, operates the audible warning device, WD1, in its collector circuit.

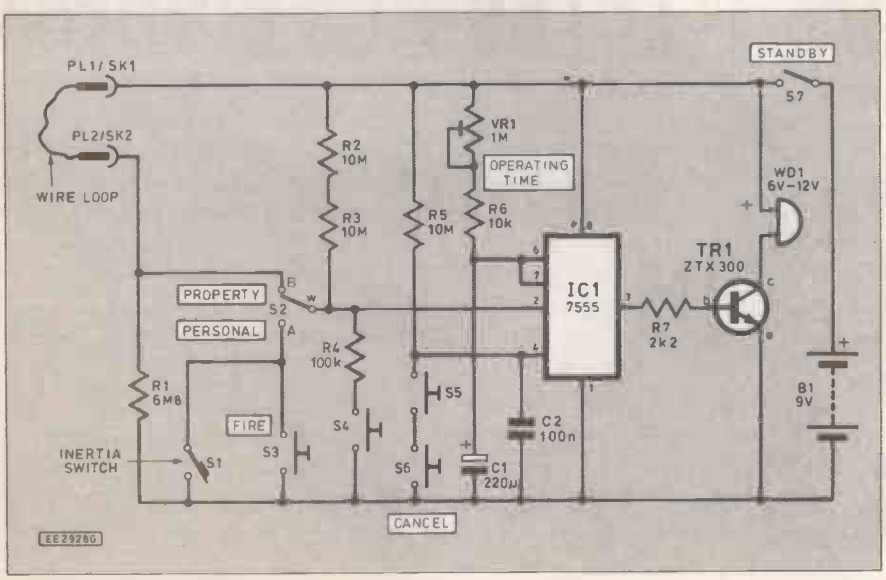
TRIGGERING

The two-position slide switch S2 allows for either Personal (position A) or Property (position B) mode. While in position A, triggering may be effected by either push-to-make switch, S3 (FIRE) or by the normally open contacts of "inertia" micro-switch S1 – these contacts "make" momentarily when the unit falls to the ground.

When S2 is in position B (PROPERTY), IC1 pin 2 is kept high through the wire loop connected between plug and socket arrangement PL1/SK1 and PL2/SK2. Breaking the loop by cutting the wire or removing a plug will cause the alarm to sound since pin 2 is then made low via resistor R1.

With S2 in position B, and with the loop broken, a potential divider is formed be-

Fig. 1. Complete circuit diagram for the Personal Alarm.



tween resistors R2 and R3 in the upper section and R1 in the lower one. The voltage at IC1 trigger input, pin 2, will then be less than one-third that of the supply and this allows triggering to occur.

The continuous current drain through resistors R2, R3 and R1 is minimised by using large values for these resistors. The reason why two resistors are used for R2 and R3 is that 10 megohm is the largest easily-obtained value. A *single* 20 megohm resistor could replace R2 *and* R3 if one is available.

The alarm may be cancelled in the absence of the key by making IC1 reset input, pin 4, low momentarily. This is done by pressing sub-miniature push-to-make switches S5 and S6 *together*. Mounted between these switches is a further push-to-make switch, S4. This when pressed triggers the alarm by making pin 2 low. Someone attempting to silence the alarm is likely to try pressing any button which comes to hand and is unlikely to succeed.

Resistor, R4 limits the current flowing from the battery in the event of switch S4 being operated when there is a continuous loop and switch S2 is in position B. Without this, a short-circuit would occur. On switching on, capacitor C2 makes IC1 reset input, pin 4, low momentarily and prevents self-triggering.

CONSTRUCTION

The design of the Personal Alarm is based on a main circuit panel made from 0.1in. matrix stripboard, size 8 strips × 16 holes. The component layout and details of cuts required in the underside copper tracks is shown in Fig. 2.

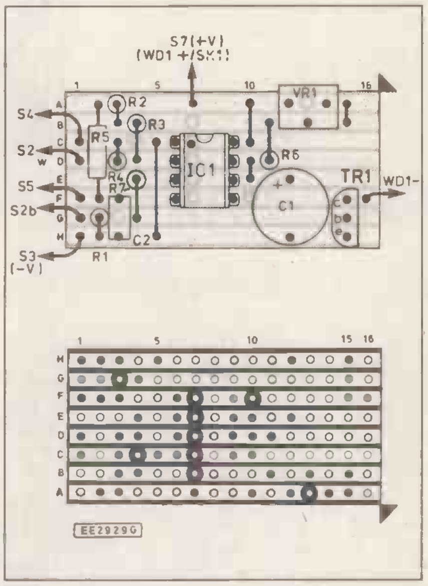
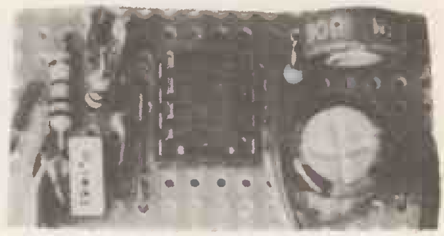


Fig. 2. Component layout and details of breaks required in the underside copper strips.

Begin construction by making all track breaks and inter-strip links as indicated. Follow with the soldered on-board components, taking care over the orientation of capacitor C1. Insert IC1 into its socket with the correct orientation and adjust preset VR1 sliding contact fully clockwise (as viewed from the top edge of the circuit panel) to provide the shortest timing period.

Check the circuit board carefully for errors then solder 15cm pieces of light-duty stranded connecting wire to copper strips *C*, *D*, *F*, *G* and *H* along the left-hand side and to strip *A* (*A*7) near the centre. Use of different colours will help to keep wiring neat and avoid errors. Shorten the connecting wires of the audible warning device to a length of 8cm and connect the negative one to strip *F* on the right-hand side.

Drill holes in the box for all switches noting that S4 occupies a position between S5 and S6. Drill holes for SK1 and SK2 also the matrix of holes for the sound to pass through. For maximum sound output one large diameter hole could be made at WD1 position. Refer to Fig. 3 and mount all components except switch S1, the circuit panel and siren WD1 in the case.



The completed circuit board showing the CMOS timer i.c. mounted in a socket.

INERTIA SWITCH

The inertia switch, S1, consists of a lever-arm microswitch with its lever suitably loaded with a small mass. In the prototype unit, this load consisted of a single 0BA brass nut secured by bending the tip of the lever (the end 4mm) downwards and soldering it into position.

Before attaching the nut permanently, it should be wedged into position using matchstick ends or something similar to test the arrangement. Normal shaking

COMPONENTS

Resistors
R1 6M8
R2, R3, R5 10M (3 off)
R4 100k
R6 10k
R7 2k2
All 0.25W 5% carbon

See SHOP TALK Page

Potentiometer
VR1 1M sub-min preset, vertical

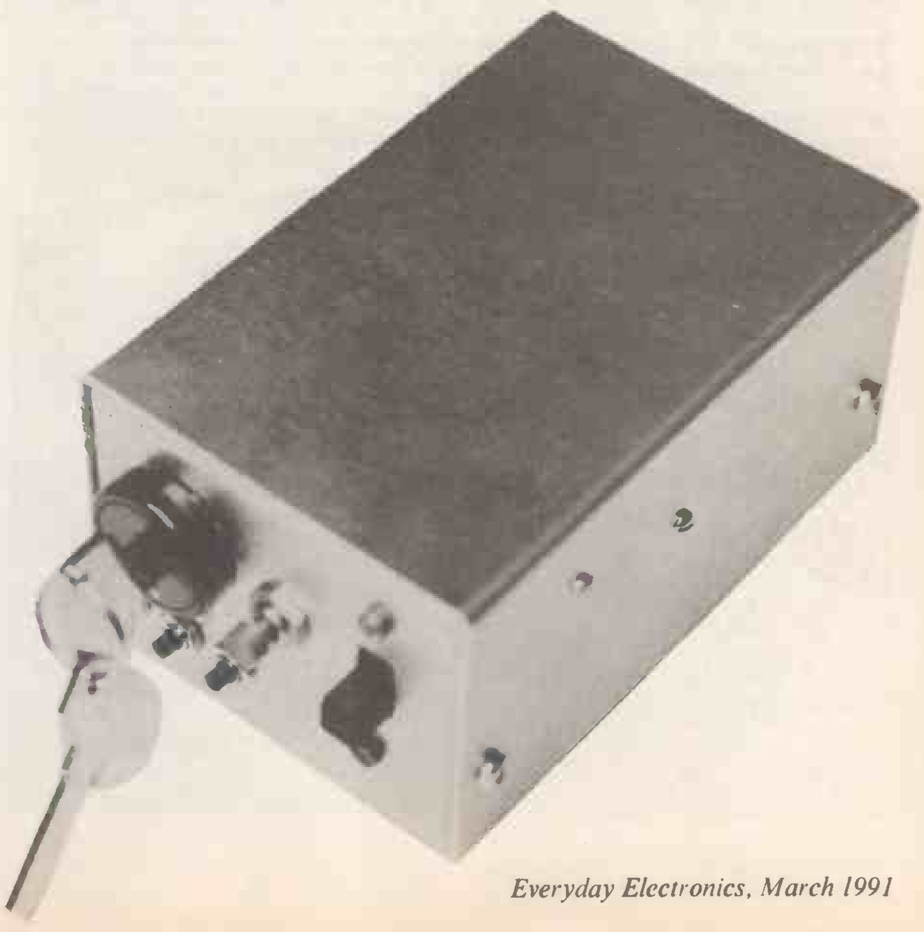
Capacitors
C1 220µ radial elect. 16V
C2 100n ceramic

Semiconductors
TR1 ZTX300 *npn* silicon
IC1 ICM7555 low power CMOS timer

Miscellaneous
WD1 Miniature piezoelectric siren 150mA rating at 12V. Operating range 6V-12V d.c. Output 110dB at 1m. Size 43mm x 39mm x 59mm overall
S1 Lever-arm microswitch
S2 Miniature s.p.d.t. slide switch
S3 Standard size push-to-make switch, with red button
S4, S5, S6 Sub-miniature push-to-make switches (3 off)
S7 Key-operated s.p.s.t. switch
SK1/SK2 2mm sockets (2 off)
PL1/PL2 2mm plugs (4 off)

Stripboard, 0.1in matrix 8 strips x 16 holes; aluminium case, size 102mm x 64mm x 51mm; 9V lithium battery (PP3) and connector, see text; 8 pin d.i.l. socket; self-adhesive pads (approx. 20 off); stranded wire; 0BA nut for S1 "inertia switch" lever; small fixing; solder etc.

Approx cost guidance only **£21**



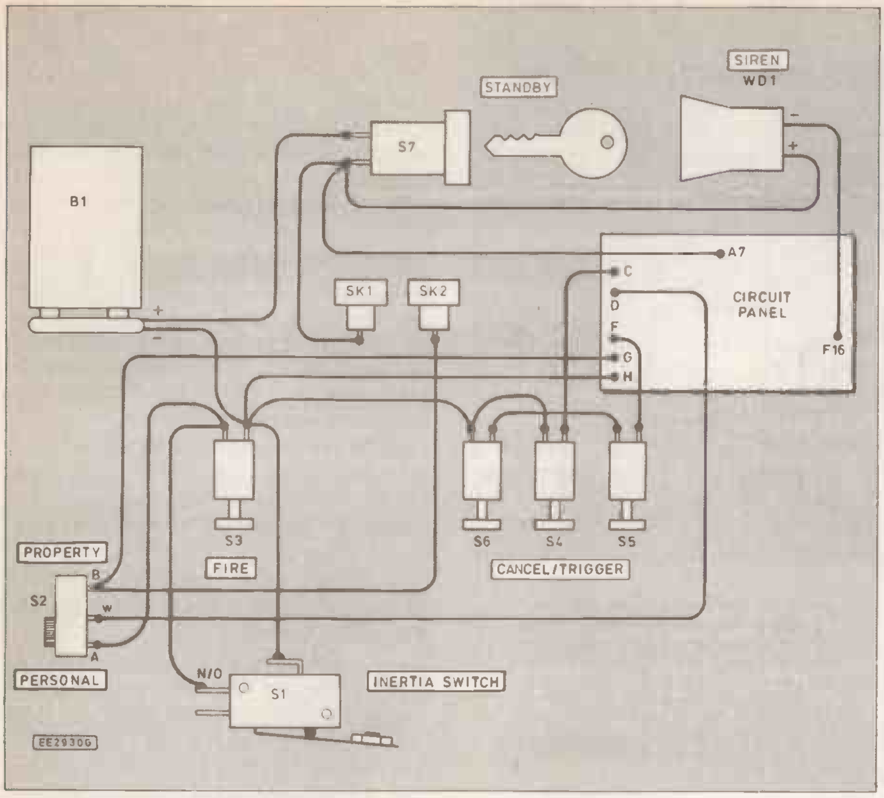


Fig. 3. Interwiring to all the switches and circuit board.

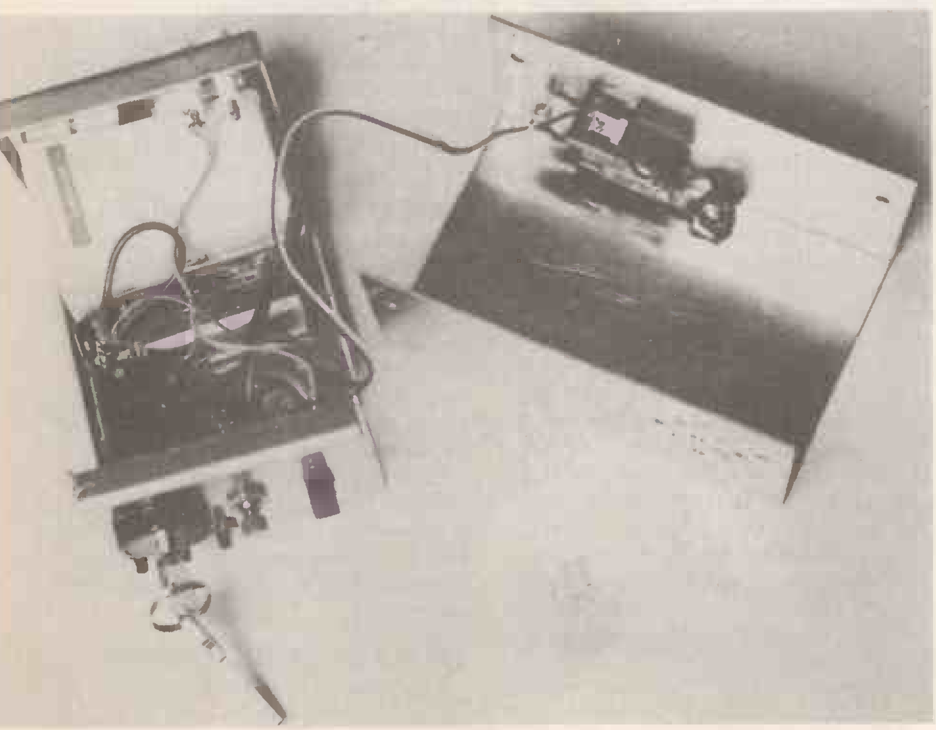
should not operate the switch but with violent movement it should be heard to click. The strength of the microswitch spring seems to vary greatly from one manufacturer to another so be prepared to make adjustments here.

Mount switch S1 noting that this is the only component attached to the lid section of the box. The position of this switch will need to be marked out carefully since there is not much space for it.

When in position, the nut, on the end of the microswitch lever, should overhang the small end of the audible warning device and must be free to move. When the unit falls to the ground, the shock will cause the switch to operate for an instant and trigger IC1. Connect the "make" (normally-open) switch contacts to S3 using 10cm pieces of light-duty stranded wire, see Fig. 3.

Mount the circuit panel on self-adhesive fixing pads – use three pads made up to double thickness – that is, six altogether. This secures it firmly and ensures that the connections on the copper strip side remain clear of the metalwork. Take care to avoid short circuits between components on the circuit board and switches S4/S5/S6.

The tight packing of components inside the specified metal case. The only component mounted inside the lid section of the case is S1



Remove the two fixings which hold the audible warning device bracket and discard it. Secure the device on two sides using further adhesive fixing pads. Use multiple thickness where the contour reduces – you will need about 12 pads altogether for this. For best results, clean the areas of contact carefully and press the part firmly into position.

Refer to Fig. 3 and complete all internal wiring shortening the wires as necessary. Switch off S7, secure the battery using two more fixing pads and connect it up.

Using adhesive pads is simple, effective and gives the necessary shockproofing when the unit falls to the ground. Readers wishing to use other methods of attachment must be satisfied on this last point.

Fit the lid of the case checking carefully to avoid trapped wires and anything which might interfere with the action of S1. Watch particularly WD1 wires at the point where they leave the device.

TESTING

Readers are warned that the specified audible warning device is very loud. It is suggested that for testing purposes, the end is taped over to reduce the sound output.

Whenever S7 is switched off it is necessary to wait a few seconds for capacitor C2 to discharge before switching it on again. This prevents self-triggering.

Interconnect PL1 and PL2 using a short piece of light-duty stranded wire and plug them into SK1 and SK2. Set S2 to PROPERTY then switch S7 (STANDBY) on. Remove and re-insert one of the plugs. The alarm should sound for a few seconds then stop. Note that it will sound continuously until the circuit is re-made.

Set S2 to PERSONAL and press the red button, S3 (FIRE). The alarm should again sound. Test the inertia switch by dropping the unit from a height of 1m on to a carpeted floor (to prevent damage to the case) – again the alarm should sound.

If it is found that the alarm triggers when the unit is being carried or when shaken gently, then the mass of the inertia switch, S1, lever should be reduced. If it fails to trigger when dropped, increase the mass.

Remember that, in use, the alarm will have to trigger if dropped on to a soft surface, such as long grass, as well as a hard one. When the correct loading has been established, solder the mass permanently into position.

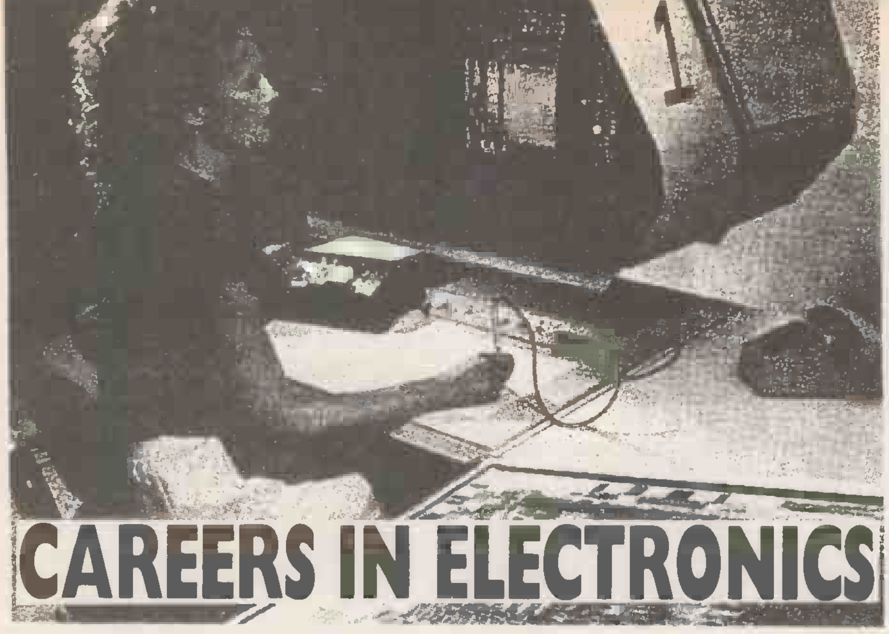
Check the reset action by triggering the alarm then pressing switches S5 and S6 together. Check also that switch S4 triggers the system.

WIRE LOOPS

Use light-duty stranded wire for the loops. It is suggested that two are made – one short using 5cm or wire and a longer one – perhaps, 40cm. Loops may be any reasonable length.

For the protection of property with handles and straps such as cameras, the long loop is used. For this to be effective, the alarm unit should be attached to some other larger item. To protect doors, windows, etc. the short loop is required and attached using adhesive tape or string so that when disturbed a plug is pulled out.

It only remains to adjust preset VR1 for the required operating time and to put the unit into service. The Personal Alarm will then give reassurance wherever you go. ☐



CAREERS IN ELECTRONICS

By James Robertson

WHAT starts out as a hobby for some people ends up becoming a profession. The danger with that, I heard someone say, is that one has killed off one's hobby, meaning that having worked at electronics all day, most people do not want to go home and dabble in it some more.

This is not true for everyone. Some people work on the administrative side of electronics and are glad to go home and get some hands-on experience. Others, although working on the hardware side, put their skills to a different aspect at home, designing music keyboards, remote controls for model planes, train modelling, etc.

WHICH QUALIFICATION?

There are a vast number of qualifications you can obtain, ranging from City and Guilds Certificates to degrees at various Universities. The BTEC (Business and Technical Education Council) National Certificate and Higher National Certificate are popular. There are also various diploma courses run by polytechnics and establishments of evening education.

Polytechnics and colleges of further education also prepare students for external examinations leading to T.Eng (Technician Engineer) and C.Eng (Chartered Engineer) from the Council of Engineering Institutes (CEI).

The type of course you embark on will depend on a number of factors:

a) The qualifications already achieved, "GCSE" or "A" levels etc.

b) Whether you have the stamina to undertake a degree course.

c) The field of electronics you are interested in.

d) The availability of courses in the neighbourhood.

e) Whether you are prepared to travel further afield and live away from home in order to complete a course not available nearer home.

The best starting point for enquiries is at your local library, careers office or college within the area. Most libraries will carry a copy of *British Qualifications*, a comprehensive guide to educational, technical, professional and academic qualifications in Britain.

FULL TIME COLLEGE OR APPRENTICESHIP?

Whether to pursue a full-time or part-time course will depend on your feelings and your personal circumstances. For instance if you are already employed and supporting a family, but wish to pursue an electronics course, either to improve your qualifications or change your field of employment, then you have little choice but to continue working and attend evening classes, or the Open University, or a correspondence course.

Solitary studies like the Open University or correspondence courses are always harder since it is difficult to seek immediate assistance with theoretical work. Also with practical work you have to rely on your own ingenuity and be aware of safety guidelines when handling electrical equipment. Nevertheless, many useful qualifications have been gained by late starters and mature students.

But what of the young student fresh out of school? Apprenticeship or university course? If an apprenticeship is available it offers the prospect of immediate employment whereas a college course merely offers the possibility of future employment when you will also be competing with graduates for jobs.

To some extent the choice will depend on what "GCSE" or "A" level grades you have obtained and whether you have the stomach for a three year slog at college. If you have good "A" levels and can face full-time studies it is a good idea to obtain a degree, since virtually all employers now expect a degree for the higher engineering posts. A degree from a reputable university will also enable you to join professional institutes and obtain jobs abroad.

However paper qualifications in themselves do not make a good engineer or manager as we shall see later. There are some people with few or no formal qualifications who have a natural ability with electronic circuitry.

Nevertheless an apprenticeship plus part-time studies have drawbacks; your time and energy are shared between work and study. Often the financial independence is a temptation to go out in the evenings instead of staying in and studying.

For those who cannot bear the thought of full time studies, an apprenticeship is the obvious way towards achieving qualifications. Some employers prefer sandwich courses involving six months at work and six months at college, others prefer day release of one or two days per week.

FIELDS OF WORK

Fields of work can be classed as disciplines within electronics as well as job categories. Some of the disciplines are: Computer hardware; Computer software; Radio; Television; Telecommunications; Microwave; Test Equipment; Medical Electronics; Defence Electronics; Avionics; Industrial Electronics.

No doubt there are some disciplines not listed above and new ones will evolve in the future. Some of the above may be specialised and stand in their own right, like radio or industrial electronics involving robotics and telemetry. Others like telecommunications and defence electronics have evolved to encompass a multitude of disciplines to include computing, radio communications, infra red detection, weapons guidance systems, detection and ranging, etc. In spite of this, most employees will usually spend a lifetime specialising in only one of these fields.

COMPUTERS

With the increasing numbers of computers used in the office, the home, and as part of industrial and communications equipment, there is a need for engineers to design these as well as service them. On the software side there is always a demand for good software development both for business and computers as well as for leisure (computer games, amusement arcades).

Almost every large business organisation, like banks, run several local area networks (LANS) which require software support and LAN maintenance. These LANs are small networks restricted to a building or even a department.

RADIO AND TELEVISION

Modern society expects a wide range of "leisure electronics items" as can be gauged by sales of radio, hi-fi, television sets, compact disc players, video recorders, satellite receivers, etc. Engineers and technicians are required not only to design and manufacture these but also to maintain them, including transmission equipment used by the broadcasting authorities.

Radio of course is not restricted to entertainment. Communication by radio, in spite of atmospheric interference, is big business. Both fixed point as well as mobile and cellular radio have increasing demands placed upon them.

TELECOMMUNICATIONS

Along with leisure, another trait of modern society is to be in touch at all times whether at home, in the office or on the move. People still tend to associate only the telephone with telecommunications, whereas the field includes communication of not only speech but data, television and facsimile. The medium, of transmission includes cable, radio and satellite.

Engineers are employed to manufacture, plan, install, commission and maintain telecommunications equipment.

TEST EQUIPMENT

With the growth in all types of sophisticated electronic equipment, there is a requirement for stringent testing. Gone are the days when the serviceman's kitbag consisted of a voltmeter and screwdriver. Today, expensive oscilloscopes are commonplace on most workbenches. Also, programmable analysers are available for carrying out full diagnostics on particular types of equipment e.g. digital telephone exchanges.

A good appreciation of the latest measurement techniques is a must for anyone intending to work in this field.

MEDICAL ELECTRONICS

No expense has been spared in the research and development of equipment for patient care, from body scanners to blood glucose monitors for diabetics. Ten years ago a blood glucose monitor cost about £300. Today a blood glucose monitor with memory costs £30 and is therefore within reach of the public.

Some aspects of medical electronics share a common interest with industrial electronics, e.g. the development of transducers. For instance the blood monitor requires a transducer to record the glucose level in the blood and then translate this into numbers which the patient can read. Similarly, industrial processes require the temperature and pressure of liquids and gases to be measured.

Perhaps medical electronics is one field of electronics where the engineer is not fully in charge, but has to understand what it is that the medical team is trying to achieve, however job satisfaction is obviously high.

DEFENCE ELECTRONICS

Every western country is actively developing sophisticated weapons and defence systems. Not only are engineers required to develop these but highly skilled operators are employed to use them and keep them in working order. In addition the countries that buy the systems require training and maintenance back up. The ethics of weapons manufacture and sales will not be dealt with here, but should obviously be considered by anyone contemplating working in this field.

The major fields of defence electronics are:

i) Early warning systems e.g. radar
ii) Detection e.g. infra red
iii) Ranging using radar and computers
iv) Weapons guidance using computers
v) Last but not least, a highly reliable and flexible communications network, including battlefield communications.

AVIONICS

With the growth in air travel for business as well as leisure there is always a demand for engineers to service the numerous airports and aircraft. Such aircraft carry not only the standard radio and radar but computers for automatic flight path plotting. Not to mention all the other auxiliary equipment like landing gear, entertainment, etc.

On the ground, air traffic control is becoming more sophisticated in order to cope with the huge demand for airspace, particularly during the holiday period.

INDUSTRIAL ELECTRONICS

Industrial electronics started with transducers so that remote monitoring of processes could take place. Using digital logic to open and close hoppers as well as remote monitoring, the processes were automated saving time and money. Also, dangerous processes could be monitored from a distance. This means that employees do not have to stand near hot, caustic or radioactive materials.

Robotics has led to a widespread application in assembling and spraying cars, taking away much of the tedium from human workers who had to carry out such boring tasks as stamping out sheet metal for eight hours a day. Engineers are required to design and service industrial circuits including control panels.

JOB CATEGORIES

This is a brief roundup of some of the fields of electronics. Let us examine some of the job categories:

Manufacturing; Planning; Installation; Commissioning; Maintenance; Sales; Lecturing; Designing.

MANUFACTURING

Manufacturing could include anything from manufacturing components or printed circuit boards (p.c.bs) to complete pieces of equipment e.g. radio, television, telecommunications equipment etc.

In factories manufacturing complete pieces of equipment, it is usual to break down the equipment into modules and manufacture these separately. When the modules come off the assembly line they are passed to groups of testers and troubleshooters.

For instance television sets are manufactured as modules, a set may consist of between two and seven individual modules. Technicians are employed to troubleshoot the modules, if any tests show up a fault. The various modules are then assembled to produce the final unit and adjustments of convergence, etc are made.

PLANNING

Firms with large communications networks require planners. For instance telecommunications network providers need to know where to place their exchanges for maximum switching capability, microwave towers for minimum interference and sizes of terrestrial cables to handle traffic growth.

They also need to know customer requirements for telex, data, facsimile, television, etc. The international medium of transmission is either satellite or submarine cable. A good educational background and an interest in planning is required.

Large firms like banks have a similar network on a smaller scale linking their branches for telephone and data transmission. Such networks are called private networks and run on line capacity leased from the main network providers.

Other networks rapidly springing up everywhere from a multitude of suppliers are the radio mobile, cellular and paging networks. All these require careful planning and field surveys to prevent mutual interference.

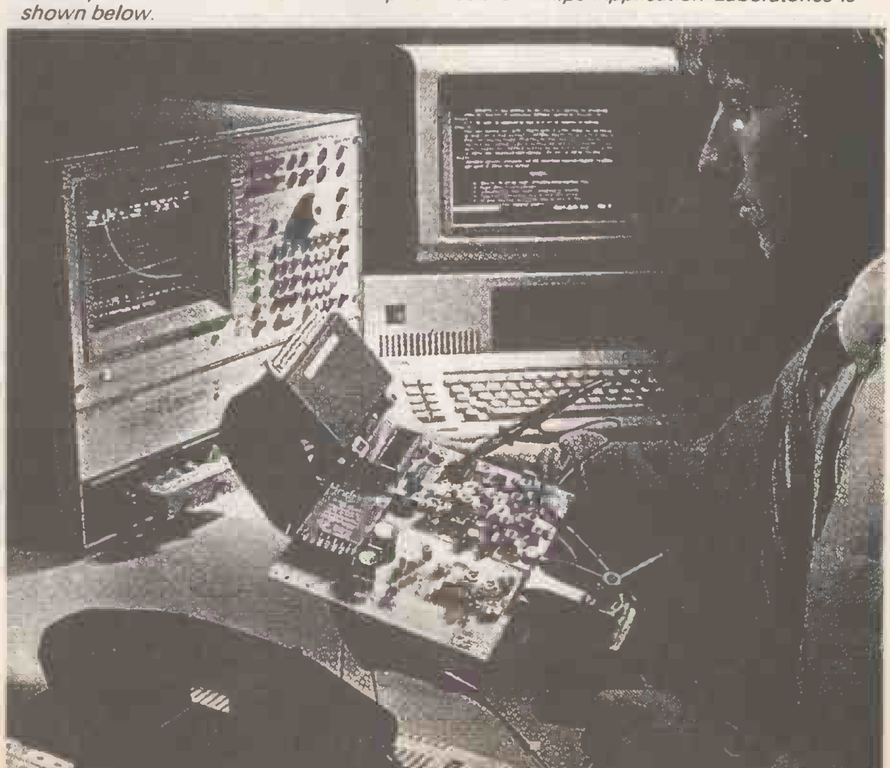
INSTALLATION

Wiremen (and wirewomen?) are usually employed to bolt racks of equipment to the floor and cable them up to flexibility racks. There is a wide range of installation work from installing exchanges, transmission equipment etc, to local area networks in offices and hospitals.

COMMISSIONING

Once the equipment is installed it needs

Heading photograph shows a CAD system in use at Philips IC Centre in California. Development work on a cordless telephone at the Philips Application Laboratories is shown below.



to be commissioned. Here people with years of experience on the particular type of equipment are valuable in recognising recurring problems or to tackle new problems.

Telephone exchanges, submarine cables, satellite links, microwave links, etc, are all commissioned by people experienced in testing those particular pieces of equipment.

MAINTENANCE

Maintenance technicians have always been required and this is likely to be the growth industry of the future. As circuitry has become complex so have the maintenance technicians specialised in one type of equipment. For instance technicians who used to service both radio and television now specialise in radio and audio equipment separately from those that service television receivers and video recorders.

Similarly technicians specialise in servicing computers, telecommunications equipment, medical equipment, defence electronics, avionics circuits, industrial robotics etc.

SALES

Just as the electronics field is as broad as it is long, so have the sales staff to be specialised. Not so much specialised in how the equipment works as in what it is capable of and the differences between similar types of equipment.

Someone selling military hardware is unlikely to know much about medical equipment. And someone selling computers is not likely to be hawking avionic equipment, even though automatic landing systems may well incorporate computers.

Salespersons can earn a great deal of money for their firms and are held in high regard judging by the amounts of commission they earn. Although an ability to sell is more important than a detailed knowledge of how the equipment operates, most successful salespersons have a fairly detailed knowledge of the equipment. It is not unusual for technicians servicing equipment to discover they would be better at selling.

LECTURING

Lecturing or assisting in laboratories at numerous universities, polytechnics and evening classes is another large area of employment. These worthy people tend to accumulate knowledge in several different areas of electronics either due to force of circumstances e.g. shortage of staff or a desire to change fields after working in one field for several years.

However the specialist tends to stay in the same field, particularly where it is necessary to impart knowledge to advanced students.

DESIGNING

Design and development laboratories and research establishments employ the cream of the crop. You have to be gifted to push back the frontiers of knowledge. That is not to say there is no room for lesser mortals. Engineers are required to build and test the ideas of the experts.

PAY SCALES

Only a rough guide can be given to pay scales. Much will depend on age, qualifications, experience, field of work, type of firm etc.

Present pay scales for apprentices range from £5,000 p.a. to £10,000 p.a. and for new graduates from £10,000 to about £20,000 p.a. Thereafter with experience you can increase this to around £35,000. After that one is really leaving engineering and going into senior management.

Once again the above are only rough estimates since salespersons can earn £35,000 with commission, plus company car. However to achieve such rewards you have to be dedicated to the clients, work long hours, and be on call.

Lecturing jobs are not well paid and this reflects the pay in the teaching profession generally.

Judging by the advertisements in electronics magazines enticing people to go to Texas, the best paid jobs seem to be in microwave engineering and computer software offering $40,000 to $60,000. They are, of course, attracting only the very best in those fields.

There are also many opportunities to go to Africa and the Middle East on tours of duty from one to three years, either to do the job or train local staff. Such tours carry generous expatriate terms of tax free salaries, bonuses at the end of service, regular leave periods with free air travel etc.

SOUGHT AFTER EMPLOYEES

Most firms ask for good interpersonal skills and ability to work under pressure. This shows that paper qualifications are not the only requirement. Ability to work under pressure shows that an employee is not only able to do the work but also able to meet deadlines.

Good interpersonal skills are vital to those meeting customers or those who have to liaise with other departments in a big firm. Someone who is business minded or can motivate staff is just as valuable to the firm as the paper qualifications he brings and these are essential ingredients when seeking promotion.

Such skills may not be as important when working individually, servicing equipment or designing circuits. However, even here there is a need to meet customers as a service agent or to give a presentation to get sponsorship for a research project etc.

So an ability to get on well as part of a team or lead a team is just as important as professional qualifications.

CURRICULUM VITAE

Your curriculum vitae (CV) should be typed with good margins and bold headings. Standard formats for writing CVs are available from books in the library. The format usually begins with personal details of name, address, date of birth, etc. Other sections would be: Education, Work experience, and Hobbies.

For this reason CVs should not be written as job descriptions. For instance if the post is for selling radios, you should not merely state where you sold radios previously but show how any problems were overcome, improvements made, staff reorganised, sales figures improved etc. If you are applying for your first job then it will be necessary to go back to college or school life, leisure activities and part time jobs to find examples which would prove your abilities.

WHAT AFTER?

When you accept your first job it may come as a bit of a shock that after learning to design circuits right through college, there is unlikely to be any design work to do at first..

This is to be expected, just as a doctor learns surgery at medical college but settles down into something very mundane, like looking at sore throats, in general practice.

Also you may not get quite the job you wanted in the first place. For instance you may get a job in radio instead of television. However this is a good time to gain experience while looking around for something else. Also you will be moving away from textbooks and into the real world. For instance the design of the radios may assume less importance and you may have to learn more about spectrum management and licensing conditions etc.

That is not to say you should lose touch with technical developments. Quite the contrary. Any field of electronics is making such rapid strides that you cannot afford to loose touch.

One of the best ways of keeping in touch is by reading journals and publications both within the firm and outside. Another useful point of exchange of views and information is membership of professional institutes. There are numerous institutes for technicians and engineers and some big firms even have their own institutes, clubs etc.

FUTURE PROSPECTS

There is no doubt that the future of electronics is bright and the quiet but effective revolution taking place around us is the technology revolution. That was one of the main reasons why the Government deregulated the telephone network, so that competition would improve both the product as well as the quality of service.

The sales of most electronic goods is expected to increase. Perhaps the ones which will increase the most are computers, radio telephones and entertainment equipment. Other systems like defence, aviation and medicine will have a greater penetration of technology, as will industrial robotics.

All this will mean that more engineers will be required to design, plan, manufacture and install. But most of all, service engineers will be required. Even in a throw away society it will be necessary to fault down to at least panel level before something can be thrown away.

Other items like cars and washing machines have had a low penetration of electronic circuitry but this is being redressed with some very clever fuel management systems in cars and electronic programmes in washing machines etc. The future of electronics then is quite bright. □

ACTUALLY DOING IT!

by Robert Penfold

IN LAST month's *Actually Doing It* article we considered the tools that are essential (or virtually so) when constructing electronic projects. This month we will consider tools that are in the highly useful category, rather than an essential part of project building.

The number of potentially useful tools for this type of thing must be extremely large, and we will consequently only consider those that are likely to be used a fair amount in general project construction work.

PUNCH-UP

A common problem when building projects is having to make large cutouts in cases, chassis, etc. As pointed out last month, this type of cutting can be undertaken with the aid of a miniature file. This enables holes of any shape to be produced, and even quite large cutouts can be made. However, it is not a particularly fast way of tackling the job. It requires a lot of slow and careful filing to make even moderate sized cutouts.

For round holes that are too large to be drilled (i.e. more than about 10 to 12 millimetres in diameter), a chassis punch is probably the best tool. To be strictly accurate, chassis punches are not restricted to round holes. A few types for producing square and rectangular holes are produced, but you are unlikely to use these.

A chassis punch works in the manner shown in Fig.1. First a guide hole for the bolt must be drilled. Then the chassis punch assembly is fitted in place, and the threaded cutting blade is tightened by hand.

Next the Allen key is used to tighten the blade further, which forces it into the panel, and eventually right through it. The chassis punch assembly then comes away from the panel, leaving the required hole. The blade must be unscrewed so that the washer-like piece of metal removed from the panel can be removed from the screw, leaving the device ready for the next hole.

Although you might think that this rather crude method would produce a somewhat mangled panel with a very rough hole, in most cases it actually produces very neat results. In fact it mostly seems to produce higher quality results than any of the alternative methods. Bear in mind though, that most chassis punches are only intended for use on aluminium panels, or thin steel types.

If you use a punch on a panel that is too thick and (or) too hard, it is quite likely that it will jam in place before it breaks right through the panel. Removing it could be a difficult job which might not leave the case in serviceable condition.

I have always found these punches to be perfectly satisfactory with plastic cases made from one of the softer types of plastic. With some of the harder plastics there would be a high risk of the punch tending to crack or even shatter the case.

GOT IT TAPERED

Although chassis punches are excellent tools, they are relatively expensive. Even so, it is well worthwhile investing in a small set of good quality punches if finances will permit this. A typical set would include 16, 18, 20, 25, and 30 millimetre diameter types. This obviously leaves plenty of gaps, and you will often wish to produce holes of sizes that fall within these gaps.

The standard solution is to make a hole slightly smaller than that required, and to then enlarge it to the correct diameter using a tool called a "reamer." Some sets of chassis punches are supplied complete with a matching reamer, but they are also available separately.

A reamer is a conically shaped tool having a number of cutting blades running the full length of the cone. At the fat end of the device there is some form of handle or a bar, so that it can be inserted into a hole in a panel and rotated with considerable force if necessary. Rotating the tool results in the blades cutting into the edge of the hole, steadily enlarging it in the process.

Reamers tend to produce slightly rough result, with raised "lips" to the finished hole. However, these are easily filed away. Reamers are very useful indeed, as they permit round holes of practically any size to be produced reasonably easily. They tend to work best with aluminium and most plastic cases – not steel types.

A QUICK NIBBLE

Large irregular shaped cutouts can be quite awkward to produce. A coping saw or fretsaw fitted with a metal cutting blade is much quicker and more precise than using a miniature file. You need to be quite skilful with one of these saws in order to get it absolutely right first time though. Whether using a file or a saw, it is probably best to cut just inside the line marking the perimeter of the cutout. Then use a file to enlarge it to precisely the right size and shape.

Probably the quickest and easiest way of making cutouts of this type is to use a tool called a "nibbler" (sometimes rather quaintly called a "hand nibbler"). These vary somewhat in design, but they are mostly scissor type tools which punch out a small rectangle of the case or panel each time they are operated.

Using one of these tools you can therefore literally nibble into the edge of a panel. Cutouts within a panel (rather than at one edge) can be made by first drilling a suitable hole in the panel, so as to make an edge within the panel that can be nibbled into.

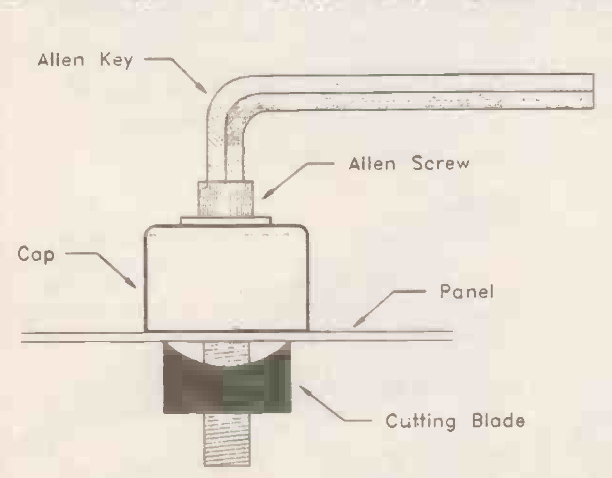
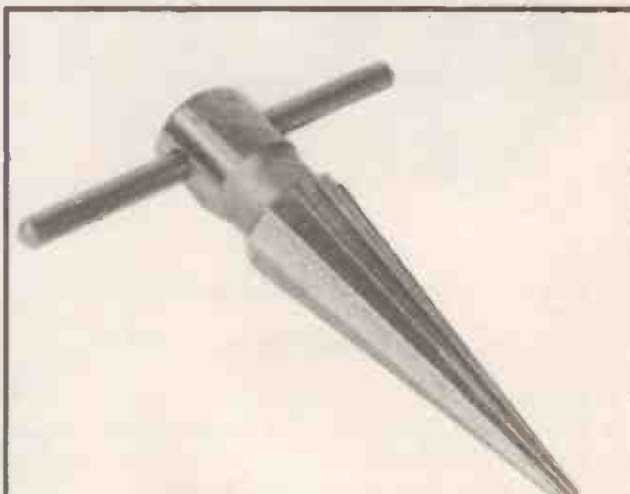


Fig. 1. Chassis punches are excellent for producing holes of around 12 to 40mm diameter.



A reamer can be used to enlarge holes to the required size.

Where they are suitable, tools of this type probably represent the quickest and easiest way of making cutouts. You can cut through aluminium and thin sheet steel at a surprisingly fast rate.

They do have their limitations though. One of these is simply that it is not possible to make cutouts having genuinely curved edges. This is simply because the nibbler cuts in a series of short straight lines. However, you can get something approximating to a curved edge, which can be tidied up later using a round or half round file.

The main limitation is that they are not suitable for small cutouts. This is not a major drawback since small cutouts can be handled quite well using a miniature file. It is large cutouts that are usually the most difficult, and where nibblers are at their best. Bearing in mind the reasonably low cost, these tools make an extremely worthwhile addition to the toolbox.

MINI DRILLS

In many of the larger electronic component catalogues you will find miniature electric drills listed, together with matching power supply units, drill stands, etc. These drills are not of great use for general project work, but are invaluable if you get into producing your own printed circuit boards.

The average d.i.y. printed circuit board has one hundred or more holes of about 0.8 to 1.5 millimetres in diameter, which must be positioned with great accuracy. A full-size electric drill tends to be rather large and cumbersome for this type of thing (although fitting one in a proper stand partially alleviates this problem).

Very small drill bits of about one millimetre in diameter are not recommended for use in hand drills. They tend to be very slow going even when drilling through quite thin material, and are almost invariably very short lived (about 5 holes per drill!).

If you are going to undertake more than a small amount of do-it-yourself printed circuit board construction, then one of these drills, complete with a matching stand and power supply, could reasonably be regarded as essential. Otherwise, there is probably no point in buying one.

GETTING TO GRIPS

The use of G-clamps is something that will not be needed very often, but they are sometimes the only solutions to difficult situations. They can be used to hold cases and panels in place while they are drilled and filed, or perhaps to hold things together while glue sets.

It is worth investing in a few of these when funds permit, but note that for electronic project construction it is only the small to medium size clamps that you will need (i.e. capacities of up to about 50 millimetres). The larger types, which are much used in carpentry, boat building etc., will be expensive and of little use in the current context.

GETTING IN TRIM

If you are interested in radio construction it is likely that you will need to do a fair amount of core adjustment on various types of radio frequency transformer.

In order to undertake this type of thing a proper set of trimming tools is required. It is tempting to simply use a small screwdriver, but this is a mistake.

The first problem is that the metal screwdriver will tend to alter the inductance of the coil. The setting of the core may be correct while the screwdriver is in place, but as the blade is removed, the inductance of the coil will be shifted away from the correct value. Proper trimming tools are made of materials that avoid this effect.

The second problem is that of the wedge shaped screwdriver blade tending to crack the brittle cores. This can easily result in the cores becoming jammed in place, probably rendering the coil useless. If you are going to undertake construction of more than the occasional project that includes radio frequency transformers, a set of trimming tools should be regarded as essential.

DESOLDERING

Desoldering is an important part of project construction that is often overlooked. Ideally you should always get things right first time, but in reality at least occasional mistakes will be made and have to be corrected. Also, from time to time a faulty component will need to be removed from a circuit board and replaced.

Components having two or three leads are not usually too difficult to remove. You can simply apply the bit of the iron to each joint in turn, pulling each lead free of the board as you go. Multi-lead and multi-pin components, particularly d.i.l. integrated circuits are a different matter. You have to pull all the pins or leads free simultaneously.

Prevention is better than cure, and it is advisable to be especially careful to fit integrated circuits the right way round in the first place. It is also advisable to use holders wherever possible. You then merely need to unplug the device and refit it the right way round.

If the device to be removed is known to be a "dud", the simplest approach is to use wire clippers to cut through all the pins. The body of the component will then fall away, permitting the pins to be easily desoldered one at a time.

If the device must be removed intact, then some desoldering equipment will be needed. With the solder completely removed from every joint, the component should easily pull free from the board.

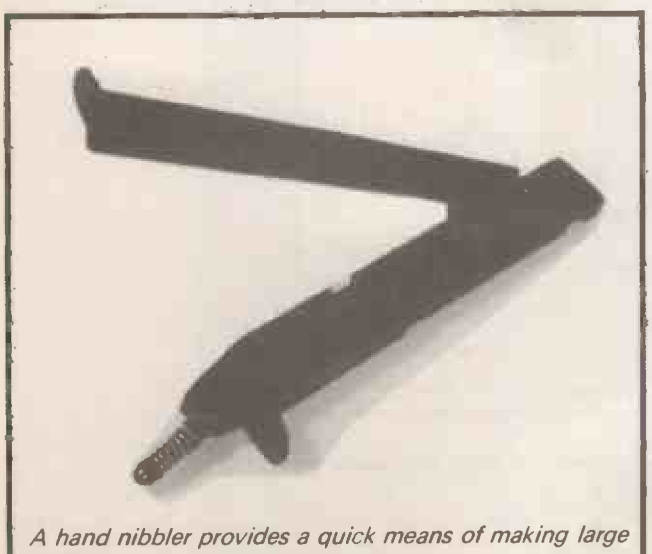
A cheap method for occasional desoldering is to use the special braid that is available. This is a sort of copper string that is impregnated with flux. If the braid and a soldering iron are applied to a joint, the braid will soak up the solder, hopefully leaving a nicely desoldered pin or leadout.

This method usually works quite well provided the iron and braid are removed together. The main problem is that heat tends to travel up the braid quite fast, leaving you with hot fingers unless everything is carried out fairly swiftly.

DESOLDERING TOOLS

The alternative method is to use some form of suction style desoldering tool. The simplest tool of this type is a simple rubber bulb and nozzle device. The bulb is squeezed in order to remove most of the air, and the nozzle is then placed against the molten solder. Next the bulb is rapidly released, causing the molten solder to be sucked into the bulb. These devices are quite cheap, but in my experience it is difficult to release the bulb with suitable rapidity while keeping the nozzle accurately in place.

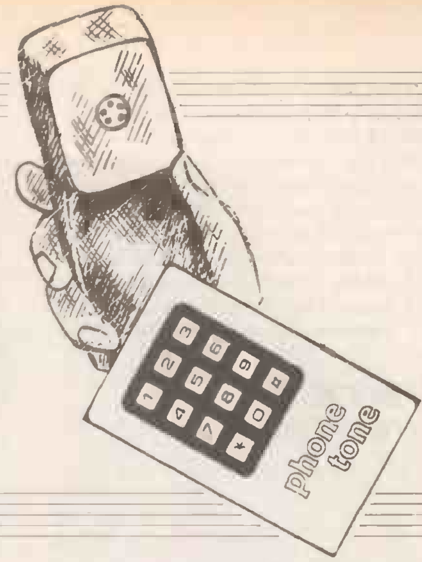
There is a more sophisticated form of suction tool, and these have a spring-loaded piston mechanism. You depress a plunger to cock the device, place the nozzle next to the molten solder, and then press a button to trigger the unit. These devices cost only a few pounds each, and are usually very effective. This is a tool that is more than a little useful to have in the electronics workshop.



A hand nibbler provides a quick means of making large cutouts.

The piston-type of desoldering tool.

Constructional Project



POCKET TONE DIALLER

CHRIS WALKER

A Dual Tone Multi-Frequency dialler to speed up dialling and send control tones

MANY modern telephones feature a numbered keypad which produces delightful bleeps as the buttons are pressed. These musical tones signal the number being "dialled" to the telephone exchange. *Tone dialling* is faster then the older *loop-disconnect* or *pulse dialling* method which originated with the mechanical rotary dial telephones.

The tone signalling system used is called "*Dual Tone Multi-Frequency*", or DTMF for short. In addition to improved dialling speed, DTMF tones can be used to access the ever increasing number of facilities on offer by telephone-related companies.

Customers can, for example, check the balance of their bank or credit card account by calling a computerised enquiry service and then keying in their personal details on the DTMF keypad. Also, most new telephone answering machines can be instructed to replay recorded messages down the 'phone line by calling-in and sending a sequence of DTMF tones from any other telephone.

The *Mains Appliance Remote Control (MARC) Phone-In* article in last month's *Everyday Electronics* makes use of these tones to enable the householder to phone home and switch on lights and central heating etc. just in case he should find himself unexpectedly caught away from the house.

Many private and public phones still in use, however, use pulse dialling. In order to exploit the full potential of DTMF tones with such instruments, it is necessary to use a separate tone generator which is held close to the telephone mouthpiece. The tones are picked-up by the mouthpiece and sent along the line in the normal way.

This article describes the construction of the "Pocket Tone Dialler" a pocket-sized audible DTMF tone generator.

FREQUENCIES

Each row of keys on the telephone keypad is assigned a different "Low-Group" tone frequency, as listed in Table 1. Similarly, each column has a unique "High-Group" frequency.

When a button is pressed, the high-group and low-group frequencies appropriate to that particular button are mixed together to form the composite DTMF tone. For example, pressing key 5 generates two tones of frequency 770Hz and 1336Hz.

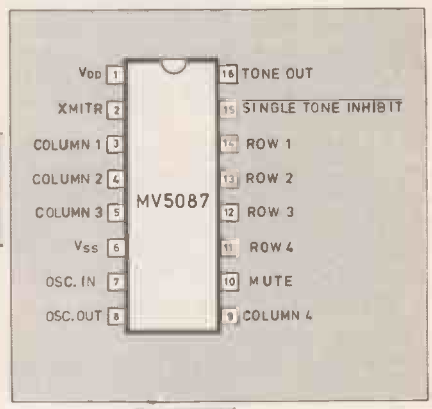
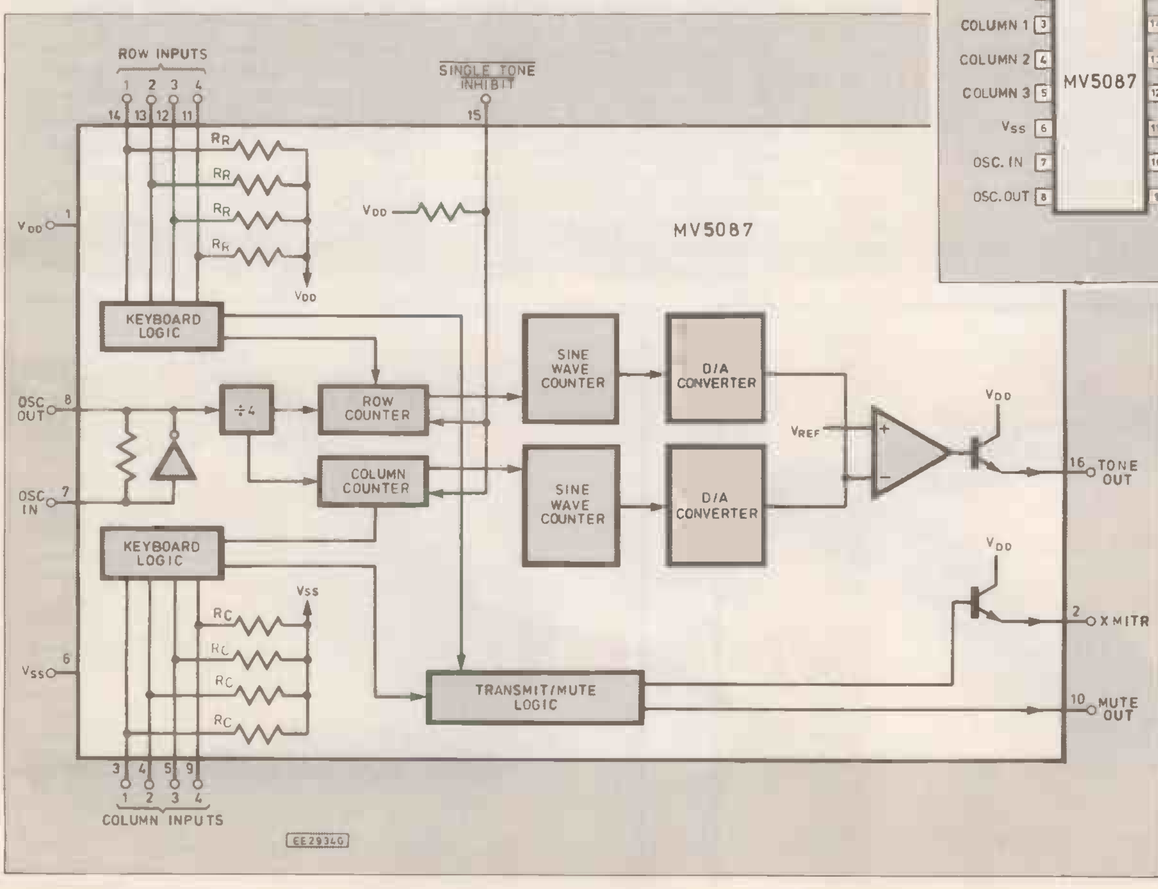


Fig. 1. Functional diagram and, inset, pinout details for the DTMF tone generator integrated circuit.



Each key, therefore, has its own characteristic pair of tones which are separated by the DTMF receiver at the signal's destination. The receiver then only has to identify these two frequencies in order to recognise which digit is being transmitted.

The actual frequencies used were chosen because of the low probability of finding such combinations of frequencies in the human voice. This reduces the risk of ordinary speech being mistaken for DTMF tones.

SYSTEM FUNCTION

The Pocket Tone Dialler is centred around the MV5087 integrated circuit. This advanced device performs all the functions required for DTMF tone generation.

A functional diagram of this chip is shown in Fig. 1 along with the d.i.l. pinout. The *XMITR* and *MUTE* outputs are not used, along with the *Single Tone Inhibit* input.

The *ROW* and *COLUMN* inputs connect to a telephone style keypad wired in a 4-by-3 matrix. When a button is pressed the chip proceeds to generate two digitised sine waves which correspond to the high and low group frequencies for that particular key.

The timing signal for the entire system is derived from a 3.579545 quartz crystal connected between pins 7 and 8. Two digital-to-analogue converters change the digitised waveforms into "stepped" or "staircase" sine waves which are then mixed together and presented at the output, pin 16.

Since the output has been generated by the addition of two digitised approximate sine waves, it too will be a stepped waveform similar to that shown in Fig. 2a.

FILTERING

If the tone generator was being used in a telephone which involved direct connection to the telephone network, it would be necessary to process the output through a low-pass filter to remove the high frequency components which are present in a stepped waveform. The result would be similar to that shown in Fig. 2b.

However, because the Pocket Tone Dialler is only *acoustically* coupled to a telephone, such filtering is not necessary. One reason for this is that the loudspeaker used to generate the tones has a limited frequency response and will tend to suppress the high frequency components in the output.

The microphone in the telephone mouthpiece will have a similar frequency response. In addition, the telephone unit itself contains frequency limiting filters which will help remove the harmonics before they leave the telephone.

CIRCUIT DESCRIPTION

The full circuit diagram for the Pocket DTMF Tone Dialler generator is shown in Fig. 3. The keypad consists of twelve s.p.s.t. switches (S1 to S12) wired in a matrix fashion. This item is purchased as a single unit, the conductive-rubber type contacts found in cheaper keypads are perfectly adequate.

The tone output from pin 16 of IC1 is buffered by transistor TR1, wired as an emitter-follower. Current is coupled via d.c. blocking capacitor C1 into the coil of loudspeaker LS1.

Table. 1: DTMF Frequency Allocation

Frequency in Hz	1209	1336	1477
697	1	2	3
770	4	5	6
852	7	8	9
941	*	0	#

High Group

↑
Low Group

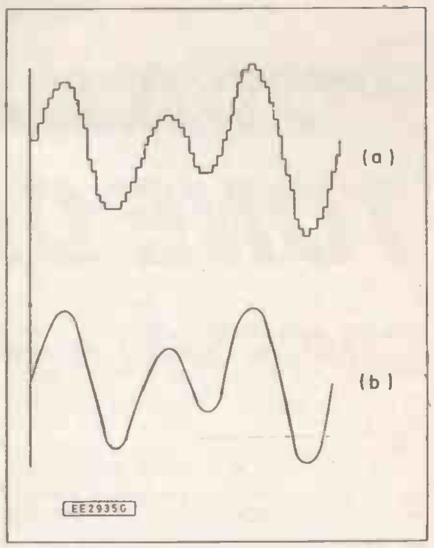
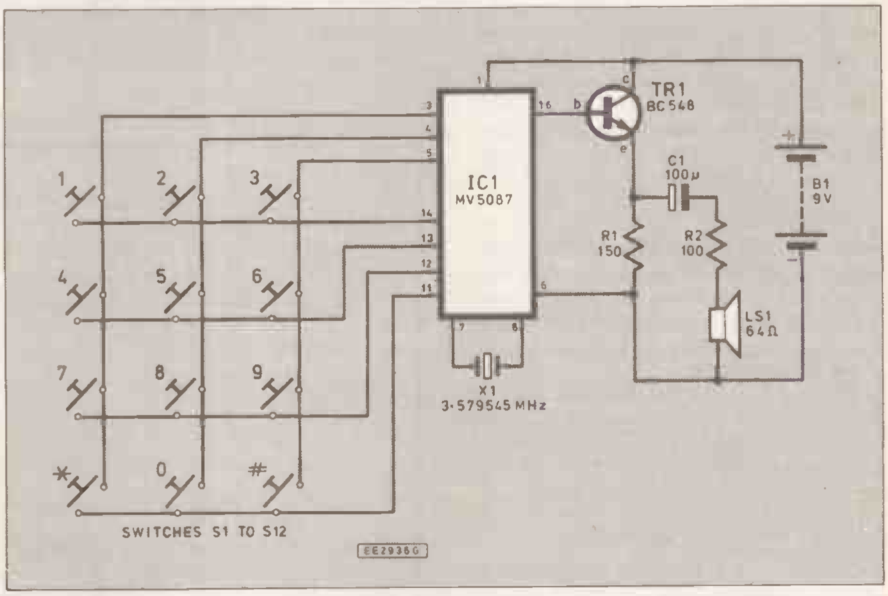


Fig. 2 (right). Digitally generated sine waves.

Fig. 3 (below). Complete circuit diagram for the Pocket Tone Dialler.



Resistor R2 is present to dissipate some excess output power to reduce the volume emitted from LS1. This results in a volume which allows the "tone dialler" to be held directly over the mouthpiece of the telephone whilst tones are generated.

The exact volume produced depends, amongst other factors, on the conditions under which the loudspeaker is mounted. The value of resistor R2 may be changed slightly to compensate for this, if necessary, although most DTMF systems are very tolerant of wide variations in signal level.

No ON/OFF switch is provided as the

standby current for the circuit is under 1μA. It is easy to insert a switch in one of the battery leads from B1 if constructors think that there may be a risk of the keys being accidentally pressed in a pocket or handbag.

CONSTRUCTION

A small printed circuit board (p.c.b.) is used to simplify construction. This board is available from the *EE PCB Service*, code EE729. The layout of components on this board and the full size track pattern are given in Fig.4.

The p.c.b. was designed to fit over the magnet of the loudspeaker, making efficient use of space within the case. It is, obviously, important to insulate the underside of the board to prevent short-circuits on the metal loudspeaker frame; a piece of card is used for this purpose in the prototype.

It is recommended that a 16-pin d.i.l. socket is used for IC1, rather than soldering the device directly to the board. The i.c. should *not* be inserted into this socket until the very end of construction.

Due to lack of space, it may be necessary to lie the quartz crystal, X1, flat on the board. Try not to overheat the crystal when soldering.

It will be found more convenient to solder the flying leads from the keypad, loudspeaker and battery onto terminal pins in the p.c.b. rather than directly to the copper pads.

The entire circuit can be housed in any small case. The prototype uses a hand-held ABS box measuring 110mm x 68mm x 33mm, complete with a PP3 battery compartment which forms a neat enclosure.

TESTING

If your local exchange has been updated to accept DTMF dialling then you can hold the Pocket DTMF Tone Dialler over the telephone mouthpiece and use it to dial a number. If you have not used tone dialling before then you may be surprised to find out just how fast the system is.

COMPONENTS

Resistors
R1 150
R2 100
Both 0.6W metal film

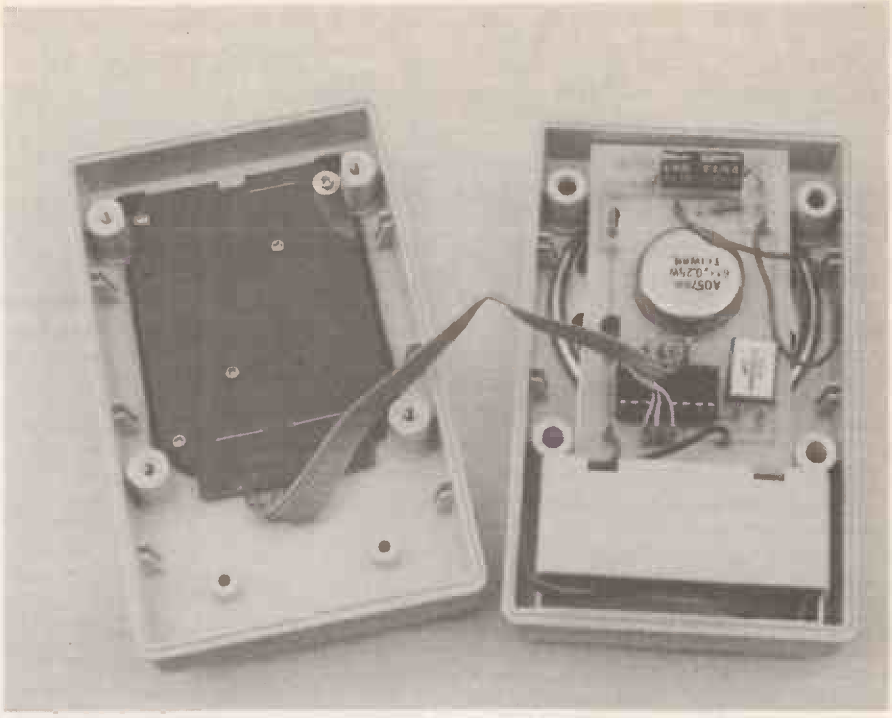
See SHOP TALK Page

Capacitor
C1 100μ elect, 35V

Semiconductors
TR1 BC548 *npn* silicon, general purpose
IC1 MV5087 DTMF generator

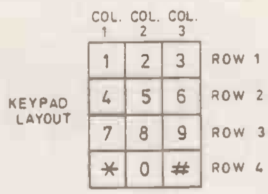
Miscellaneous
X1 3.579545MHz quartz crystal
S1 to S12 12-key telephone style matrix keypad
LS1 64 ohm speaker approx. 57mm diameter
B1 PP3 9V battery
Printed circuit board, available from *EE PCB Service*, code EE729; plastic case, 110mm x 68mm x 33mm; 16-pin d.i.l. socket; terminal pins; battery clip; connecting wire etc.

Approx cost guidance only **£12**



This project was originally designed for use with the MARC *Phone-In* mentioned at the start of this article. This system has proved to be very reliable and extremely useful; it brings peace of mind to know that your empty house looks occupied if you should be caught away from home.

The designer's unit has taken up residence in the glove-box in the car so that it is always ready for use at public pay-phones. □



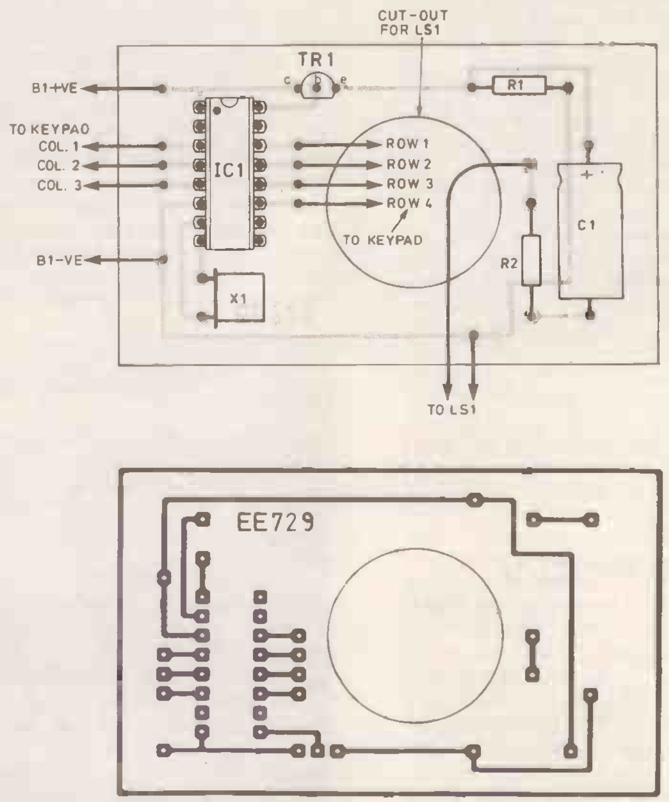


Fig. 4. Printed circuit board component layout and full size copper foil master pattern.

REPORTING AMATEUR RADIO

Tony Smith G4FAI

ANNUAL REPORT

The annual report of the DTI's Radiocommunications Agency for the year 1989-90 describes the Agency's main activities as:

a) regulating the use of radio equipment, in particular by licensing its use, investigating interference and enforcing relevant legislation;
b) participating in international fora dealing with radio spectrum management matters;
c) seeking to ensure that all United Kingdom users, manufacturers and installers of radio equipment comply with relevant European Community measures and with the relevant provisions of international agreements to which the UK is a party . . . ;
d) developing policy for, and planning and regulating use of, the radio frequency spectrum, the GSO and other earth orbits by all non-government users of radio equipment in the UK except where otherwise agreed;
e) monitoring the radio frequency spectrum as an aid to its management, enforcement, and ensuring freedom from harmful interference;
f) maintaining an appropriate programme for R&D.

In the space available it is only possible to mention a few items, but the 43 page report goes into detail on all these activities which, in one way or another, have some impact on amateur radio.

In the year under review the Radio Investigation Service continued in its efforts to enable authorised radio users to operate without undue interference. Its stated priorities are to tackle interference which could endanger lives, and to help those whose business operations are disrupted as a result of interference. Only after these are dealt with, says the Report, can the RIS deal with other complaints. During the year, 302 successful convictions were obtained and 400 warning letters sent. The greatest number of convictions were for unlicensed broadcasters on radio, with 138; CB AM 73; CB FM 56, while amateur radio was at the bottom of the list with just 3.

There were 349 requests received from householders, who paid the standard fee of £21, for visits to diagnose the cause of broadcast reception difficulties, and 3,138 reports of possible illegal transmitters and other interference sources were also received.

The Report reveals just how much money accrues to the government in return for licences issued. At 31st March, 1990, a total of 230,946 individual licences produced nearly £16M with another £5M coming from Telecom, Mercury, the BBC and the IBA. CB had the largest number of individual licences, 80,477, worth £990,000; Amateur Radio was the next largest, with 59,625, producing £726,000, while Private Mobile Radio with 23,115 licences, produced just over £11M, a paradoxical and thought-provoking statistic! The report is available, free of charge, from The Librarian, Radiocommunications Agency, Room 605A, Waterloo Bridge House, Waterloo Rd, London SE1 8UA.

EXAMINATION FEES

The Radio Society of Great Britain has increased the cost of the 12 w.p.m. amateur morse test, which it administers for the DTI, to £13.00. Starting in 1991 the RSGB will also be responsible for the new Novice 5 w.p.m. Morse test.

The new Novice Licence Examination will be administered by The City & Guilds of London Institute, and the exam fee will be £8.95. The first examination will probably be held in the late Spring of 1991.

WHERE WILL THE NEXT HAM COME FROM?

An interesting letter from Sheldon Harvey, Secretary of the Association of North American Radio Clubs, appears in the November 1990 issue of the Canadian Amateur Radio Magazine (*TCA*). He is circulating an article under the title *Where Will The Next Ham Come From?* to the 18 SWL clubs in his Association, referring to the problem the amateur radio community has in recruiting new members.

"Everybody," he says, "wants things right away these days. They want to go into a store and pick it up on the spot . . . With a pastime, they want to start right away. That is something you cannot do with amateur radio, with courses, licenses, etc, that can take three to nine months or even longer.

"I look at this as an outsider and say, 'Let's turn the clock back a bit and see what got people interested in ham radio through shortwave listening.' My theory is that we have come full circle and that now the feeding ground for amateur radio can again be shortwave listening; and until the bridge is made between these two groups, the number of amateur operators will continue to decline.

"By amateur radio operators promoting shortwave listening as well as amateur radio, you will naturally draw people into both hobbies. Shortwave listening is something you can start immediately."

SHORTWAVES IN SCHOOLS

This is an interesting proposition. Shortwave listening used to be the traditional way into amateur radio but few newcomers seem to take that route today. It went out of fashion when amateurs changed from a.m. to single sideband telephony which was not resolvable on the then average shortwave broadcast receiver. Nowadays there are a good number of general coverage receivers capable of resolving SSB so Sheldon Harvey may well have a point.

Current initiatives such as the RSGB's Project YEAR (Youth into Electronics via Amateur Radio) are aimed at young people still at school, but these have an exclusive amateur radio emphasis and are not concerned with shortwave listening as a specific activity. Assuming that SWLing really is a means of generating interest in amateur radio, an American schools programme devised by Myles Mustoe, a teacher who is also a shortwave listener, offers some intriguing alternative possibilities.

Concerned about the results of National Geographical Society surveys of high school students around the world, which found a poor level of knowledge of world geography and current events, he founded IMAST, the International Monitoring Association of Students and Teachers. This promotes a system of learning in schools using shortwave radio as a learning tool, linking SWLing with geography, history, languages, communications, current events, etc.

GUIDANCE FOR TEACHERS

He also wrote a guidebook, *Shortwave goes to School – a Teacher's Guide to Using Shortwave Radio in the Classroom,* giving guidance and instruction on implementing his system. This includes an Introduction to shortwave radio; Shortwave radio's classroom potential; Developing a shortwave learning centre; and activity cards.

There are 44 suggested activities, such as Comparing shortwave news with your newspaper; Identifying foreign languages; The country of the week; Discovering music, World place names; Corresponding with shortwave stations, and so on. The activities are intended to develop the skills of students and to interest them in learning about the world, its people, places and events. At the same time they are taught about radio itself and the technical aspects of the medium.

The system has apparently been adopted by many schools throughout the USA, although Sheldon Harvey reports in his *Listening to the World* column in *TCA* that his own efforts to interest schools in Canada in the system have been less successful. It has, however, been part of the curriculum of one School Board in Ottawa for over a year, commencing in their schools at grade six level, and "is progressing very well".

In a limited way I can, myself, vouch for the value of international broadcasts in the classroom. Some long time ago, when in the RAF, I attended French classes, in what was then Malaya, and every week as part of the course we listened on shortwaves to Radio Siagon's "French by Radio". We had printed material to accompany the lessons, and these broadcasts from French Indo-China (now Vietnam) were undoubtedly the highlight of the week.

PROJECT DEVELOPMENT FOR GCSE

In this, the third of a six-part series, a GCSE assessor looks at the development work involved in building a project.

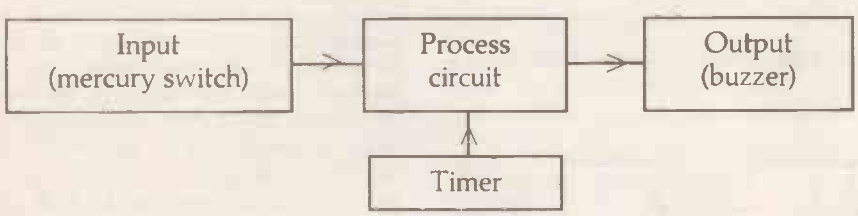
SUMMARIZING from last month, you have decided on the need for a project involving some personal interest. You have examined several ways of making it and have done some basic tests on the circuits. In the light of these tests, you have eliminated all but one way.

You have written a specification and have made sure that your chosen design lends itself to evaluation on at least three points involving measurements. This is all written up in your diary.

Note that, as yet, you have only thought about outline circuits. You have been getting some advice as to whether any proposed circuit would be within your capability and within the resources of the school.

Devising a circuit

Now is the time to start thinking about the actual circuit needed. Consider our fictitious Elderly Person's Alarm introduced last month. Begin by drawing a block diagram in your diary like this:



Development work

Don't be too hasty in placing an order for components with an outside supplier. If the school has a mercury tilt-switch, so much the better. If not, don't bother ordering one for the time being – you can simulate its action by simply touching two wires together! This goes for other switches too. It is better to reach the stage where you know in detail what you will require and order everything at once. Of course, you cannot be sure how the mercury switch will behave in practice so you can't delay too long before obtaining one.

A further point is that a small bulb can be used in place of the buzzer as a temporary measure. This is kinder on the ears, especially where other students are using audible devices!

Work on a breadboard so that components may be changed as required. The best type of breadboard is one with a small number of holes well spaced out. Some are too fiddly for simple project development.

It is better to use a battery for the supply rather than a mains-operated one – there will be less of a problem in the event of an accidental short-circuit. If you do use a mains-operated power supply, make sure that the output is fitted with a low-value fuse, 500mA will probably be sufficient.

From your own thoughts, by asking your teacher and by researching books and magazines, you devise a circuit using a bipolar 555 timer as a monostable, a single transistor to amplify the output current and an audible warning device. The monostable circuit will probably be standard and just a copy of part of a published design.

The input device will be the mercury switch and the output transducer the audible warning device. The transistor section will be a standard "transistor as a switch" circuit, again, obtained from a book or a magazine.

You decide (wisely) that the viability of a pulse tone section will be thought about later when the basic circuit sections are working. You also decide to get the monostable working using an l.e.d. in the output before adding the transistor stage and buzzer. This technique enables you to check individual sections as you go along. In this way you can isolate any fault and pinpoint the section it is in.

An entry in your diary will look something like this:

Date: 24th January, 1991

Title: Elderly Person's Alarm.

Object of today's work: Preliminary investigation to see if this basic monostable circuit is sound (see Fig. 1).

What I did: This circuit, using a 555 timer as a monostable, was tried as a basis for the alarm. When the mercury tilt-switch contacts "make", current flows from battery, B1, to the rest of the circuit. Capacitor C1 and resistor R1 determine the time during which IC1 is on (pin 3 high). While IC1 output is on, the l.e.d. (representing the audible warning device), D1, will be on. After a time, the monostable switches off and with it the l.e.d.

What happened: I found that the circuit did not trigger reliably – sometimes it worked sometimes it didn't. I referred to 555 timer data sheets and discovered that the i.c. needs to be triggered by a low pulse to the trigger input, pin 2. Before next session I intend to find out how the 555 timer can be triggered at the instant of switching on.

I also found that the operating time was much too short – about three seconds. To correct this, I will try varying the values of C1 and R1. This will also be investigated next time.

Evaluation of today's work: Circuit is basically sound but the timing is too short and triggering unreliable.

Things to try next time: Increase operating time. Improve triggering.

Before the next practical session you would then look up the 555 timer in more detail. You will need to look at books and have further talks with your supervisor. Your next diary entry might look something like this.

Date: 28th January, 1991

Object of today's work: To achieve a longer operating time and, perhaps, to improve triggering.

What I did: Firstly, I increased the value of capacitor C1 keeping resistor R1 constant and tabulated the times obtained. I

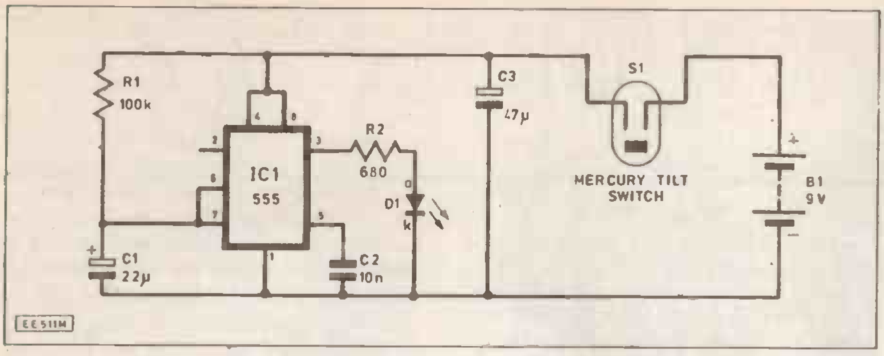


Fig. 1. Preliminary investigation to see if the basic monostable circuit for an Elderly Person's Alarm is sound.

then increased the value of R1 keeping C1 constant and did similarly. Each time, I triggered IC1 with the battery left connected, by touching a wire from the trigger input, pin 2, to the low (0V) line.

(R1 = 100k)			(C1 = 22μ)	
C1 μ	Time (s)		R1 (k)	Time (s)
22	3		100	3
47	5		470	12
100	11		1000	28
470	54		2200	64
1000	120		4700	136

I can obtain the time required by using a high value for capacitor C1. However, it then becomes large and bulky. It would be better to use a large value for resistor R1 and a small one for C1. The specified time of one minute will be achieved using R1 = 2M2 and C1 = 22μ.

In the final version I shall probably use a preset variable resistor for R1 so that the timing can be adjusted.

I had no time to improve the triggering.

Looking in textbooks, asking around and thinking about the problem further, you discover that only a very short low pulse is needed for IC1 to be triggered. This could be achieved by connecting a small value capacitor and a resistor in the manner shown below. On switching the circuit on, the voltage across C2 and hence at the trigger input will be zero. This triggers the i.c., capacitor C2 then charges and the voltage across it rises – the trigger pulse is then removed.

Date: 30th January, 1991

Object of today's work: to try the improved triggering circuit below (Fig. 2):

And so on. The following entry will show the adding of the transistor output stage and trials using the buzzer itself. Your diary will soon begin to look like a working document and show a gradual progression from humble beginnings to a final operating circuit. Note that your knowledge of electronics need only be basic. It is far more important to recognize problems and seek ways of putting them right.

Referring to books, magazines, data sheets and talking to people is all part of your expected research. It is not something to be "covered up" but to be freely acknowledged.

I will now relate the sad tale of a student who was severely colour-blind. He used all kinds of ways of identifying colour-coded resistors to avoid asking his teacher or anyone else for help. When the problem was eventually noted, it turned out that he thought that he would lose credit by asking his teacher for assistance with the colours!

Colour-blindness is fairly common and even those with normal vision sometimes find difficulty distinguishing between yellow and orange, red and brown and so on – especially on very small resistors. There is a difference between asking for general assistance and suggestions to help you to proceed and showing dependence on your teacher to solve problems for you.

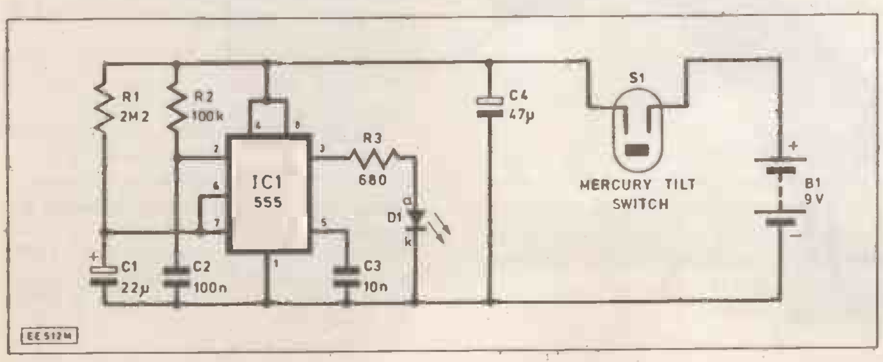
Change of direction

At this stage, you should resist any temptation to change direction. So long as your circuit is developing steadily there is no reason why you should want to. I have seen students time and time again scrapping all their previous work because they have thought of something "better" – or changed their hobby! Only if you think you are coming to a dead end should you consider large-scale changes now.

By the way, if for some reason you do need to start again don't scrap all your diary notes. They are part of the complete story and should be supplied at the end with everything else together with an explanation of why you decided to make the change.

Remember, if the examining board required an outline plan beforehand, you would need to re-submit any new project specification for approval once again and this would hold you up. Any changes which do not affect the outline specification do not, of course, need approval.

Fig. 2. Improving the "alarm" circuit by changing the values of R1/C1 and adding a resistor and capacitor to the i.c. trigger pin 2.



Group effort

Making the same circuit as someone else is asking for trouble and must be avoided. Circuits having the same specification may, of course, be built by two students but they should not use the same circuit and must have a fundamentally different approach.

Similarly, students may not work together (although you can discuss you circuit with a fellow student or anyone else) – only individual work is allowed. Your teacher needs to see exactly how you as an individual cope with problems and solve them as they occur. Such assessment is impossible if two or more students are working together.

Initiative

To illustrate practical problem-solving, I remember a student who devised a circuit in two sections – a door alarm with delay. The idea was that when the door was opened, a magnetically-operated reed switch would trigger the circuit. However, the alarm would not sound until there had been a short delay. This was to allow time for the user to disarm the system by pressing a hidden switch. The student duly developed the circuit – firstly the alarm section then the timer.

Both sections worked perfectly as individual circuits on the breadboard. The problem was that when the two parts were connected together and operated from the same battery, the circuit as a whole would not work.

His eventual solution was to isolate the two sections using a relay and a separate battery for each. There was then no electrical connection between the two. This would be frowned on by a professional designer but not by his teacher or by me. This candidate was using his initiative and achieved the specification albeit in a rather crude way. At times your little electromagnetic friend (the relay) can get you out of trouble!

That's all for this month. Next time we shall look at further trials on the working Elderly Person's Alarm while still on a breadboard and its realization into soldered-up form.

ROBOT ROUNDUP
Nigel Clark

ALFRED THE RESILIENT

Some robots refuse to die. While there have been a number which have come and gone, despite in many cases, very good engineering, there are others which might suffer temporary hiccups in supply but keep coming back. The Armdriod is a good example and Alfred is developing similar powers of resilience.

Alfred was originally designed by Alan Green and Dave Doughty and they set up Robot City Technology in Milton Keynes to develop it. That company ran into difficulties and Green and Doughty moved onto Research Development Associates taking Alfred with them.

Last year RDA ceased producing Alfred and it has now been taken up by Hadenhill Systems of Bedford. The position of Green and Doughty with Hadenhill was not known at the time of going to press.

Everyday Electronics has a soft spot for the little robot arm with five axes plus gripper as plans for an early version were printed in the magazine a few years ago (now unobtainable). Now it can lift a maximum of 110gms with a maximum reach of 330mm. It is powered by d.c. motors with toothed belt transmission. There is software for the BBCs, Archimedes and Amiga and even the Psion Organiser will accept Logo packages

COMEBACK

Another arm making a comeback in this country is the Scorbot ER III, the Israeli-built device which used to be imported by Syke Automation. It is now being sold by Boxford, a tool distributor based in Halifax. The range being offered has been expanded to include the ER V and ER VII.

Boxford decided to distribute the Scorbot after looking for a robot arm to complete its flexible manufacturing system. It was thought that the ER V best suited its requirements and now forms part of the system with CNC lathe and milling machines.

All the Scorbot's have five axes and a gripper and are powered by d.c. motors with optical encoder control and toothed belt transmission. The grippers have two fingers and sensors which enable them to measure the size of the object they are carrying.

The maximum reach is 610mm and they can lift up to 1kg. The waist moves through 310 degrees, the shoulder through 165 degrees, elbow 260 degrees, wrist pitch 260 degrees and the wrist roll is unlimited.

The on-board controller can accept instructions from a teach pendant which can be used to operate the Scorbot directly or to write and edit programs off-line which can then be tested on the robot.

The robots' own software, Scorbase, is available in five different levels which run on IBM or IBM-compatible micros. Programs written on the pendant can be down loaded to be stored on disk.

The highest level of the software is intended to emulate a variety of industrial robotic functions including defining a position in terms of XYZ co-ordinates, absolute or relative, and the control of a complete manufacturing work cell. Utilities allow programs written in other languages such as Basic, C and Pascal, to be run.

WORK CELL

As well as the pendant there are a number of accessories to enhance the use of the robots. A work cell can be built up with a rotary table, conveyor and gravity feeder.

Scorbot can be mounted on a sliding base 120cms long and the gripper can be replaced by one of a group of four pneumatic end effectors which can be used for lifting objects, spray painting and material dispensing. There is also an adaptor for picking up round objects.

The controller can deal with up to eight motors simultaneously allowing equipment using two extra motors to be controlled at the same time.

The company also supplies what it calls an experimental table, which is designed to demonstrate the use of inputs and outputs from the system. A photo-electric sensor is available to provide some input. There is also a vision system.

All this comes for a range of prices starting at about £2,000 for the ER III by itself and going up to almost £22,000 for the flexible manufacturing system. In between there is a wide range of prices depending on the complexity of the work tasks that the robot is capable of performing.

For example the ER III system, including controller and software up to level three is almost £3,000. The ER V system including controller, software to level five, user manual and advanced terminal software costs in the region of £5,000.

ARTICULATED GRYPHON

Meanwhile Cybernetic Applications is maintaining its position as one of the few companies still creating new robot arms. The latest is an articulated arm with five axes plus gripper. Known as Gryphon it appears to be a sturdier version of the same company's Mentor having a reach of 600m against Mentor's 420mm and the same lifting capacity of 1kg.

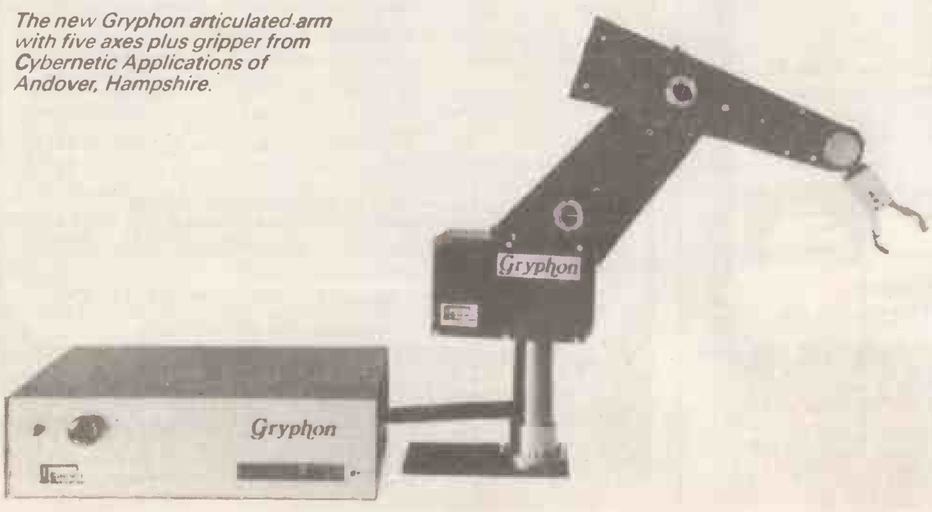
However, Cybernetic says that the similarity is only in appearance. The drive is provided by stepper motors instead of d.c. servos and the electronic control of the system is of a higher order providing a repeatability of 0.5mm against Mentor's 2mm.

The new design is the result of Irish educational establishments announcing that they intended to buy robot arms and issuing specifications of the device they would require. As none of the existing Cybernetic range of five arms fitted the bill a new one was created. Unfortunately the Irish have delayed placing orders for arms but the new device has still been put on the market.

As with the others in the range Gryphon operates under the Walli system, can be controlled by its on-board processor or connected to an IBM PC and works in network with other Cybernetic machines. If working under its on-board processor instructions can be entered by teach pendant as well as a simulator, a small model of the arm, the movements of which are replicated by the larger machine.

All this comes for a basic price of about £4,000 with extra for the simulator and the control pendant.

Cybernetic has also been upgrading its Walli operating system so that instructions can be accepted in any language which will then be translated into executable code for carrying out work commands. This expands the number of devices which can be added to the Cybernetic network, particularly vision systems.



The new Gryphon articulated arm with five axes plus gripper from Cybernetic Applications of Andover, Hampshire.

DIRECT BOOK SERVICE

The books listed have been selected as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full ordering details are given on the last book page.

MORE BOOKS NEXT MONTH—MORE BOOKS NEXT MONTH

AUDIO & MUSIC

SYNTHESIZERS FOR MUSICIANS
R. A. Penfold
Modern synthesizers are extremely complex, but they mostly work on principles that are not too difficult to understand. If you want to go beyond using the factory presets or the random poking of buttons, this is the book for you.

It covers the principles of modern synthesis—linear arithmetic as used by Roland, phase distortion (Casio), Yamaha's frequency modulation, and sampling—and then describes how the instruments are adjusted to produce various types of sound—strings, brass, percussion, etc. The theoretical side of synthesis is treated in an easy to understand way—the technical information being restricted to what you need to know to use your instrument effectively.
168 pages **Order code PC105** **£6.95**

AUDIO
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Analysis of the sound wave and an explanation of acoustical quantities prepare the way. These are followed by a study of the mechanism of hearing and examination of the various sounds we hear. A look at room acoustics with a subsequent chapter on microphones and loudspeakers then sets the scene for the main chapter on audio systems—amplifiers, oscillators, disc and magnetic recording and electronic music.
320 pages **Order code BP111** **£3.95**

INTRODUCTION TO DIGITAL AUDIO
Ian Sinclair
Digital recording methods have existed for many years and have become familiar to the professional recording engineer, but the compact disc (CD) was the first device to bring digital audio methods into the home. The next step is the appearance of digital audio tape (DAT) equipment.
All this development has involved methods and circuits that are totally alien to the technician or keen amateur who has previously worked with audio circuits. The principles and practices of digital audio owe little or nothing to the traditional linear circuits of the past, and are much more comprehensible to today's computer engineer than the older generation of audio engineers.
This book is intended to bridge the gap of understanding for the technician and enthusiast. The principles and methods are explained, but the mathematical background and theory is avoided, other than to state the end product
128 pages **Order code PC102** **£5.95**

MAKE MONEY FROM HOME RECORDING
Clive Brooks
Now that you've spent a fortune on all that recording gear, MIDI and all, wouldn't it be nice to get some of it back? Well here's the book to show you how.

It's packed with money making ideas, any one of which will recoup the price of the book many times over. Whether you have a fully fledged recording studio at home, or just a couple of stereo cassette recorders and a microphone, you'll be able to put the ideas in this book into practice and make money.
105 pages **Order code PC104** **£5.95**

TESTING & TEST GEAR

ELECTRONIC TEST EQUIPMENT HANDBOOK NEW
Steve Money
The principles of operation of the various types of test instrument are explained in simple terms with a minimum of mathematical analysis. The book covers analogue and digital meters, bridges, oscilloscopes, signal generators, counters, timers and frequency measurement. The practical uses of the instruments are also examined.

Everything from Audio oscillators, through R, C & L measurements (and a whole lot more) to Waveform Generators and testing Zeners. A truly comprehensive book for the hobbyist, student, technician and engineer.
206 pages **Order code PC109** **£8.95**

HOW TO TEST ALMOST EVERYTHING ELECTRONIC—2nd EDITION
Jack Darr and Delton T. Horn
Describes electronic tests and measurements—how to make them with all kinds of test equipment, and how to interpret the results. New sections in this edition include logic probes, frequency counters, capacitance meters, and more. (An American book.)
190 pages **Order code T2925** **£9.05**

GETTING THE MOST FROM YOUR MULTIMETER
R.A. Penfold
This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.
In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.
96 pages **Order code BP239** **£2.95**

MORE ADVANCED USES OF THE MULTIMETER
R.A. Penfold
This book is primarily intended as a follow-up to BP239, (see above), and should also be of value to anyone who already understands the basics of voltage testing and simple component testing. By using the techniques described in chapter 1 you can test and analyse the performance of a range of components with just a multimeter (plus a very few inexpensive components in some cases). Some useful quick check methods are also covered.

While a multimeter is supremely versatile, it does have its limitations. The simple add-ons described in chapter 2 extend the capabilities of a multimeter to make it even more useful. The add-ons described include an active r.f. probe, a high resistance probe, an a.c. sensitivity booster, and a current tracer unit.
84 pages **Order code BP265** **£2.95**

TEACH-IN THEORY & REFERENCE

EVERYDAY ELECTRONICS DATA BOOK
Mike Tooley BA
(published by EE in association with PC Publishing)
This book is an invaluable source of information of everyday relevance in the world of electronics. It contains not only sections which deal with the essential theory of electronic circuits, but it also deals with a wide range of practical electronic applications.

It is ideal for the hobbyist, student, technician and engineer. The information is presented in the form of a basic electronic recipe book with numerous examples showing how theory can be put into practice using a range of commonly available "industry standard" components and devices.

A must for everyone involved in electronics!
256 pages **Order code DATA** **£8.95**

ELECTRONICS TEACH-IN 88/89—INTRODUCING MICROPROCESSORS
Mike Tooley BA (published by *Everday Electronics*)
A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303). The book contains everything you need to know including full details on registering for assessment, etc.

Sections cover Microcomputer Systems, Microprocessors, Memories, Input/Output, Interfacing and Programming. There are various practical assignments and eight Data Pages covering the most popular microprocessor chips.

An excellent introduction to the subject even for those who do not wish to take the City and Guilds assessment.
80 pages (A4 size) **Order code TI-88/89** **£2.45**

ELECTRONICS TEACH-IN No.4
INTRODUCING DIGITAL ELECTRONICS (published by *Everyday Electronics*)
Michael J. Cockcroft
Although this book is primarily a City & Guilds Introductory level course (726/301), approximately 80% of the information forms a very basic introduction to electronics in general, it therefore provides an excellent introductory text for beginners and a course and reference book for GCSE students.

Full details on registering for C&G assessment, details of assessment centres, components required and information on the course in general are given.

The City & Guilds introduction to module 726/301 reads: "A candidate who satisfactorily completes this module will have a competence to identify basic components and digital integrated circuits and connect them together to form simple working circuits and logic units." This provides an excellent introduction to the book
112 pages (A4 size) **Order code TI4** **£2.95**

ELECTRONICS TEACH-IN No. 3 — EXPLORING ELECTRONICS (published by *Everyday Electronics*)
Owen Bishop
Another EE value for money publication aimed at students of electronics. The course is designed to explain the workings of electronic components and circuits by involving the reader in experimenting with them. The book does not contain masses of theory or formulae but straightforward explanations and circuits to build and experiment with.

Exploring Electronics contains more than 25 useful projects, assumes no previous knowledge of electronics and is split into 28 easily digestible sections.
88 pages (A4 size) **Order code TI3** **£2.45**

THE ILLUSTRATED DICTIONARY OF ELECTRONICS—4th EDITION
Rufus P. Turner and Stan Gibilisco
With more than 27,000 terms used in electronics today, this collection is THE most comprehensive dictionary available. Including all practical electronics and computer terms, it is as up-to-date as the latest advances in the field itself! Tables and data on subjects most often consulted for projects and experiments are included. Other conversion tables include English/metric and metric/English conversions for units of measurement of energy, power and volume, and Fahrenheit/Celsius temperature conversion charts.

Setting this edition apart from other electronic dictionaries is its emphasis on illustration. Featuring more than complete definitions, this fourth edition includes over 450 detailed drawings and diagrams.

All entries are listed in alphabetical order. Abbreviations and initials are listed in sequence with whole words. All terms of more than one word are treated as one word. (An American book.)
648 pages **Temporarily out of print**

ELECTRONICS—A "MADE SIMPLE" BOOK
G. H. Olsen
This book provides excellent background reading for our *Introducing Digital Electronics* series and will be of interest to everyone studying electronics. The subject is simply explained and well illustrated and the book assumes only a very basic knowledge of electricity.
330 pages **Order code NE10** **£4.95**

PRACTICAL ELECTRONICS CALCULATIONS AND FORMULAE
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Bridges the gap between complicated technical theory, and "cut-and-tried" methods which may bring success in design but leave the experimenter unfulfilled. A strong practical bias—tedious and higher mathematics have been avoided where possible and many tables have been included.

The book is divided into six basic sections: Units and Constants, Direct-current Circuits, Passive Components, Alternating-current Circuits, Networks and Theorems, Measurements.
256 pages **Order code BP53** **£3.95**

MICROELECTRONIC SYSTEMS N2 CHECKBOOK
R. Vears
The aim of this book is to provide a foundation in microcomputer hardware, software and interfacing techniques. Each topic is presented in a way that assumes only an elementary knowledge of microelectronic systems and logic functions. The book concentrates on 6502, Z80 and 6800 microprocessors and contains 60 tested programs, 160 worked problems and 250 further problems.
Order code NE04N **£8.95**

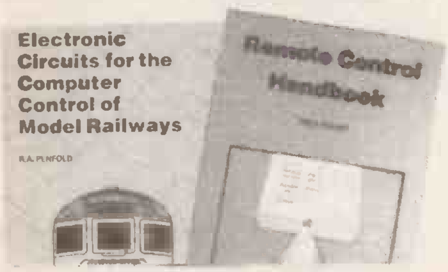
TEACH-IN, THEORY & REFERENCE

PRACTICAL DIGITAL ELECTRONICS HANDBOOK
Mike Tooley (Published in association with *Everyday Electronics*)
The vast majority of modern electronic systems rely heavily on the application of digital electronics, and the *Practical Digital Electronics Handbook* aims to provide readers with a practically based introduction to this subject. The book will prove invaluable to anyone involved with the design, manufacture or servicing of digital circuitry, as well as to those wishing to update their knowledge of modern digital devices and techniques. Contents: Introduction to integrated circuits; basic logic gates; monostable and bistable devices; timers; microprocessors; memories; input and output devices; interfaces; microprocessor buses. Appendix 1: Data. Appendix 2: Digital test gear projects; tools and test equipment; regulated bench power supply; logic probe; logic pulser; versatile pulse generator; digital IC tester; current tracer; audio logic tracer; RS-232C breakout box; versatile digital counter/frequency meter. Appendix 3: The oscilloscope. Appendix 4: Suggested reading. Appendix 5: Further study.
208 pages **Order code PC100** £6.95

ELECTRONICS-BUILD AND LEARN
R. A. Penfold
The first chapter gives full constructional details of a circuit demonstrator unit that is used in subsequent chapters to introduce common electronic components–resistors, capacitors, transformers, diodes, transistors, thyristors, fets and op amps. Later chapters go on to describe how these components are built up into useful circuits, oscillators, multivibrators, bistables and logic circuits.
At every stage in the book there are practical tests and experiments that you can carry out on the demonstrator unit to investigate the points described and to help you understand the principles involved. You will soon be able to go on to more complex circuits and tackle fault finding logically in other circuits you build.
120 pages **Order Code PC103** £5.95

CIRCUITS & DESIGN

ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF MODEL RAILWAYS
R.A. Penfold
Home computers may easily be applied to the control of model railways and really quite sophisticated control, which needs only simple programming, is not too difficult to achieve. The main problem lies in interfacing the computer to the layout, but fortunately it is not too difficult or expensive to build suitable interfaces, and this book shows you how.
The projects consist of various types of controller, including a high quality pulse type, as well as circuits for train position sensing, signal and electric points control etc. The use of computers does not have to be restricted to massive layouts. Something as simple as an oval of track with a single siding can be given a new dimension by adding computer control and much fun can be had from these relatively simple set-ups.
88 pages Order code BP180 £2.95



REMOTE CONTROL HANDBOOK
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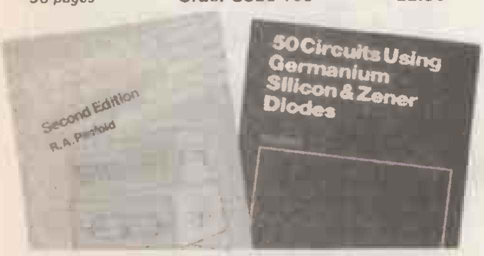
Remote control systems lend themselves to a modular approach. This makes it possible for a wide range of systems, from the simplest to the most complex, to be built up from a number of relatively simple modules. The author has tried to ensure that, as far as possible, the circuit modules in this book are compatible with one another. They can be linked together in many different configurations to produce remote control systems tailored to individual requirements. Whether you wish simply to switch a table lamp on and off, or to operate an industrial robot, this book should provide the circuit you require.
226 pages Order code BP240 £3.95

COIL DESIGN AND CONSTRUCTION MANUAL
B. B. Babani
A complete book for the home constructor on "how to make" RF, IF, audio and power coils, chokes and transformers. Practically every possible type is discussed and calculations necessary are given and explained in detail. Although this book is now rather old, with the exception of torroids and pulse transformers little has changed in coil design since it was written.
96 pages **Order Code 160** **£2.50**



30 SOLDERLESS BREADBOARD PROJECTS – BOOK 1
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Each project, which is designed to be built on a "Verobloc" breadboard, is presented in a similar fashion with a brief circuit description, circuit diagram, component layout diagram, components list and notes on construction and use where necessary. Wherever possible, the components used are common to several projects, hence with only a modest number of reasonably inexpensive components, it is possible to build in turn, every project shown. Recommended by BICC-Vero.
160 pages Order Code BP107 £2.95
BOOK 2 – All projects use CMOS i.c.s but the items on component identification etc., are not repeated from Book 1
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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
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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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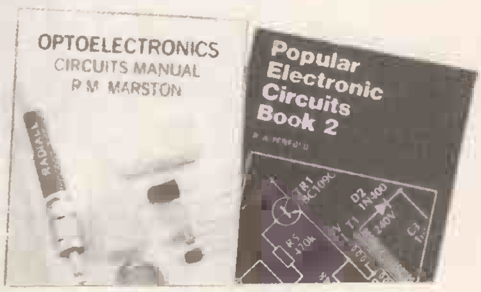

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Starts by designing a small computer which, because of its simplicity and logical structure, enables the language to be easily learnt and understood. The shortcomings are then discussed and the reader is shown how these can be overcome by changes and additions to the instruction set. In this way, such ideas as relative addressing, index registers, etc., are developed.
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POPULAR ELECTRONIC CIRCUITS –BOOK 2
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Each book provides a wide range of designs for electronic enthusiasts who are capable of producing working projects from just a circuit diagram without the aid of detailed construction information. Any special setting-up procedures are described.
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Written for the professional engineer, student or enthusiast. It describes the basic principles and characteristics of these devices and includes over 200 circuits.
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Contains twenty of the best projects from previous issues of EE each backed with a kit of components. The projects are: Seashell Sea Synthesiser, EE Treasure Hunter, Mini Strobe, Digital Capacitance Meter, Three Channel Sound to Light, BBC 16K Sideways Ram, Simple Short Wave Radio, Insulation Tester, Stepper Motor interface, Eprom Eraser, 200MHz Digital Frequency Meter, Infra Red Alarm, EE Equaliser Ioniser, Bat Detector, Acoustic Probe, Mainstester and Fuse Finder, Light Rider – (Lapel Badge, Disco Lights, Chaser Light), Musical Doorbell, Function Generator, Tilt Alarm, 10W Audio Amplifier, EE Buccaneer Induction Balance Metal Detector, BBC Midi Interface, Variable Bench Power Supply, Pet Scarer, Audio Signal Generator.

128 pages Order code EP1 £2.45

HOW TO DESIGN AND MAKE YOUR OWN P.C.B.s
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Deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.

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BEGINNER'S GUIDE TO BUILDING ELECTRONIC PROJECTS
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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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RADIO, TV, SATELLITE

BEGINNER'S GUIDE TO RADIO – 9th EDITION
Gordon J. King

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AN INTRODUCTION TO RADIO DXING
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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SATELLITE TELEVISION INSTALLATION GUIDE – 2nd EDITION
John Breeds

This book is now firmly established as a leading study manual for satellite TV installers, technical colleges who run City & Guilds courses, and training schools in major companies. It will be invaluable to anyone who wants to set up a dish receiver.

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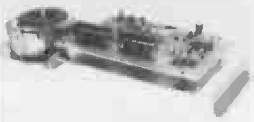

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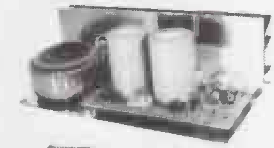

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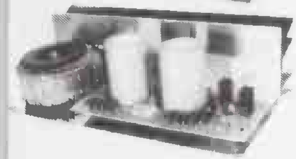

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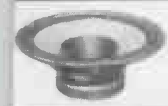

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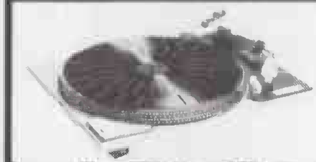

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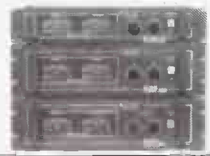
USED THE WORLD OVER IN CLUBS, PUBS, CINEMAS, DISCOS ETC.

SIZES:— MXF 200 W19"×H3½" (2U)×D11"
MXF 400 W19"×H5¼" (3U)×D12"
MXF 600 W19"×H5¼" (3U)×D13"



PRICES: **MXF200 £171.35**
MXF400 £228.85
MXF600 £322.00

SECURICOR DELIVERY £12.00 EACH

OMP LINNET LOUDSPEAKERS

THE VERY BEST IN QUALITY AND VALUE

MADE ESPECIALLY TO SUIT TODAY'S NEED FOR COMPACTNESS WITH HIGH OUTPUT SOUND LEVELS, FINISHED IN HARDWEARING BLACK VYNIDE WITH PROTECTIVE CORNERS, GRILLE AND CARRYING HANDLE. INCORPORATES 12" DRIVER PLUS HIGH FREQ. HORN FOR FULL FREQ. RANGE: 45Hz-20KHz BOTH MODELS 8 OHM, SIZE H18" × W15" × D12".

CHOICE OF TWO MODELS

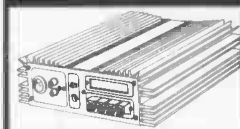
POWER RATINGS QUOTED IN WATTS RMS FOR EACH CABINET

OMP 12-100 (100W 100dB) PRICE £159.99 PER PAIR

OMP 12-200 (200W 102dB) PRICE £209.99 PER PAIR

SECURICOR DEL.:— £12.00 PER PAIR

IN CAR STEREO BOOSTER AMPLIFIER



TWO SUPERB HIGH POWER CAR STEREO BOOSTER AMPLIFIERS

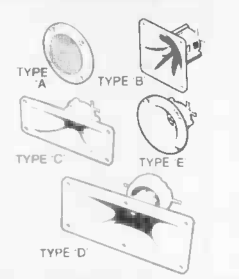
150 WATTS (75+75) INTO 4 OHMS
300 WATTS (150+150) INTO 4 OHMS
FEATURES:—
- HIGH & LOW INPUT IMPEDANCES
- HIGH & LOW INPUT SENSITIVITIES
- VARIABLE INPUT GAIN CONTROL
- SHORT CIRCUIT OUTPUT PROTECTION
- POWER REQUIREMENT 12V. D.C.

PRICES: 150 WATT £43.00
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.

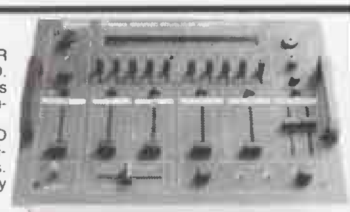
TYPE 'C' (KSN6016A) 2"×5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £6.99 each** + 50p P&P.

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.

Price £134.99 — £4.00 P&P

ACCESS

POSTAL CHARGES PER ORDER £1.00 *MINIMUM*. OFFICIAL ORDERS WELCOME FROM SCHOOLS, COLLEGES, GOVT. BODIES, ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER. VISA ACCESS ACCEPTED BY POST, PHONE OR FAX.

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WELCOME to our 1991 SPRING Catalogue Supplement. In this supplement you will find many new exciting lines and also some **amazing** special offers, most of which can never be repeated so we stress a prompt order to avoid any disappointment.
Our full 124 page 1991 catalogue is now available, simply send £1-50,

VELLEMAN KITS. We have included in this supplement many of these very high quality kits. Our **Full Colour** Kit catalogue is now available which contains of course our complete range of Kits. This colour catalogue is available free when you buy our full 1991 catalogue or, simply send a SAE and request a copy.

JUST ARRIVED: When you read this our **NEW LINES** 32 page **FULL COLOUR** supplement will be available. Free with our full 1991 catalogue and Free with every order. This full colour supplement contains 100's of new and exciting lines! Don't miss it.

FREE GIFT: 4 x AA Rechargeable Ni-Cad batteries with every order over £30-00 when using the enclosed **and only** the enclosed order form. This offer is valid until **MARCH 31st 1991.** Orders received after March 31st will not be eligible for this offer.

DELIVERY: All orders weighing under 750gms will be despatched by First Class post. All heavier orders will either be sent by Second Class Letter post or by Royal Mail Parcelforce.

WE TRY TO DESPATCH ALL ORDERS RECEIVED BEFORE 4.00pm THE SAME DAY.
(Subject to availability)

ORDERING: Our minimum order is £5-00. We are happy to accept orders by post enclosing your cheque, postal order or credit card number. Or by telephone using your credit card or by Fax or Telex, again using yout credit card. We accept **ACCESS & VISA.**

We welcome official orders from schools, Colleges, Universities, I.T.E.C.'s and other Government bodies. Account facilities are available to companies , please contact us for further information.

EXPORT: We export to all parts of the world. Payment by Sterling Bank Draft, International Money Order, Euro-Cheque quoting Euro-card number on the back. **Air Mail/Surface Mail at cost.**
Overseas orders are exempt from UK VAT. Simply divide the total by 1.15 which shows the correct Export total.
RETURNS: Only by prior arrangement and must be postage paid. We accept no responsibility for goods returned without our consent.

Illustrations in this supplement are for guidance only. We reserve the right to change prices without prior notice.

ALL PRICES IN THIS SUPPLEMENT ARE MAIL ORDER ONLY PRICES. SHOP PRICES WILL DIFFER.

VISA

ALL PRICES INCLUDE 15% VAT **SIMPLY ADD £1-75 POST & PACKING PER ORDER**

VELLEMAN KITS

COME ON BUILD YOUR OWN KIT

Most of our kits are shown in this supplement but not all. If you want our 1991 32 page, full colour catalogue simply send an SAE and ask for your free copy. Or, send £1-50 for our 1991 125 page full catalogue and you will receive our colour Kit catalogue free.

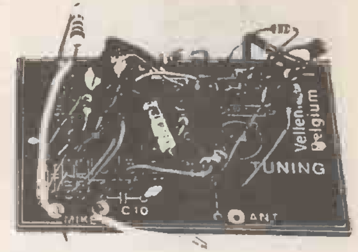
Please remember that these VELLEMAN Kits are of the highest quality and should not be confused with the cheap rather poor quality kits on the market.

IS ELECTRONIC KIT BUILDING A DIFFICULT MATTER?

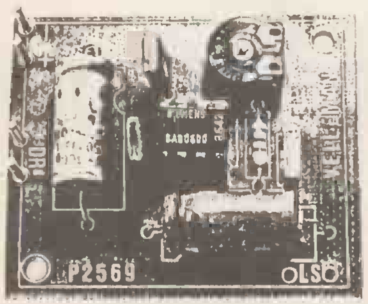
YES, if you:
- totally ignore the instruction for use
- want tot finish the job in half an hour
- use a 300 Watt plumber's type soldering iron
- have only oversized and/or rusty tools available
- treat technical specs extremely lightheartedly; then you're in for trouble and a catastrophe can hardly be avoided!

NO, if you:
- carefully read the instruction manual and follow the step by step assembly instructions as described
- take sufficient time to do proper job
- use a suitable (±30W) soldering iron with a tinplated and clean tip
- apply tools suitable for the job
- respect the technical data and take care of the connecting and final adjustment of the kit; in that case no major trouble will be experienced, as shown by thousands of successfully assembled kits

No, if you carefully read the instruction manual



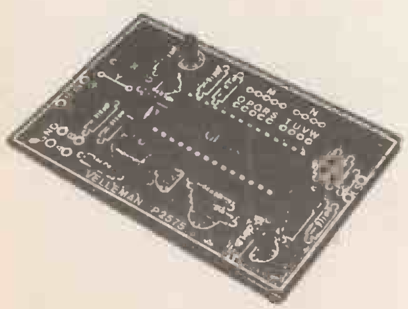
Yes, if you totally ignore the instruction for use...



K2569 3 TONE CHIME

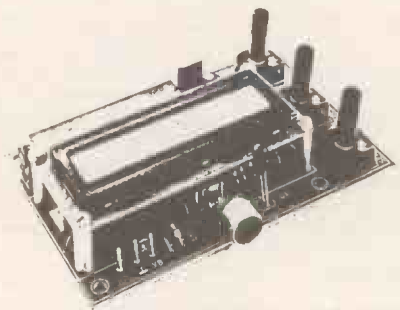
This inexpensive kit gives a 3 tone harmonic sound every time you activate it. Speed and tone are synchronous and adjustable. The only extras required are a small loudspeaker and a battery.
Power supply: 7-12VDC.
Output: 8 Ohms.

PRICE: £12-55



K2575 MICRO PROCESSOR DOOR BELL

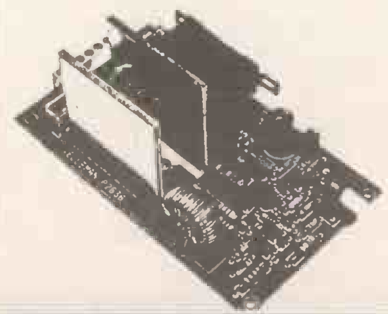
People looking for a very special doorbell, a melody generator or a selective call, will find it all in this kit.
24 different tunes from all parts of the world, changing automatically to the next one after pushing the button (permanent supply operation), or individually selectable.
Power supply: typ. 9VDC (maximum 12V).
Supply current: max. 100mA when playing, 30mA in stand-by.
Battery stand-by current: neglectable.
Output: 8 Ohm, 0.5W typ. **PRICE: £21-30**



K2659 MORSE DECODER WITH LC-DISPLAY

Everybody who owns a shortwave receiver may already have tried to decode those mysterious morse messages. Unfortunately, an intensive training is required to follow experienced signallers or automatic stations. This decoder easily keeps up with the quickest signallers, and neatly 'notes' everything on a display. You can easily read all messages, although you are not familiar with morse at all!
Technical data: Alphanumeric LC-display, 1 line of 16 characters. • Decodes morse at almost any speed. • Centre tone and maximum tone deviation adjustable. • Power supply: 2×7 to 8VAC/150mA or 9 to 12VDC/100mA.

PRICE: £73-10



K2636 DRILL SPEED CONTROLLER

Designed to control universal AC motors (with carbon brushes). High torque even at low r.p.m. Also applicable for low voltage loads (24V), i.e. for halogen lighting. Supply and load circuits are electrically isolated.
Supply: 110-125V or 220-240VAC.
Load: 24-240VAC, max. 5A.
Minimum r.p.m. adjustable.
Low interference level.
Control range: 5-95%.

PRICE: £25-10

ALL PRICES INCLUDE 15% VAT SIMPLY ADD £1-75 POST & PACKING PER ORDER

K612/K613 DIMMER

High-Q light intensity regulator with minimal hysteresis. Triac is protected against inductive voltage transients. Includes pre-set for minimum level. Applications: lamps, heating elements, AC motors, etc.
Max. load: 5A.
K613 is the suppressed version of K612.

K612 - £9-80

K613 - £14-20

NEW ● ● ● ● ● ●

K2600 2 AMP DIMMER

Small dimmer for lighting purposes only. Can be interchanged with normal switches in conventional light installations. Max. load: 2A. Range: 5-95%. • Dimensions: 45×45×53 mm.

PRICE: £9-15

K5000 MULTI-FUNCTION TIP KEY DIMMER

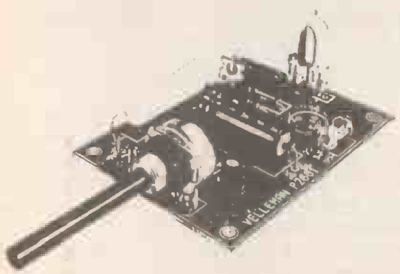
This small dimmer can dim in 3 different ways and in addition has a memory function. The whole can be built into a standard wall light switch box. • Dimming time: 3.5 seconds • Max. load 2A (4A with cooling) • Dimensions: 45×48mm.

PRICE: £ - PoA

K2657 SLOW ON / SLOW OFF DIMMER

One could name this dimmer a "soft switch": the lamp does not go on or off instantly, but slowly. Dimming times are adjustable within a wide range while the number of possible applications is increased by the following two working modes:
a) dimming slowly. Dimming on and off times adjustable independently (2 seconds up to 1 hour).
b) Timer/dimmer. On-time and dimming speed adjustable independently (1 sec. up to 30 min.). Technical data:
Mains voltage: 110 - 125 or 220 - 240V, 50 or 60Hz.
Max. load: 2A (400W at 220V or 200W at 110V).

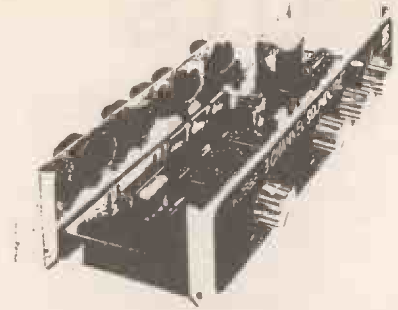
PRICE: £21-35



K2601 STROBOSCOPE

Flashing light effect for disco. Make your own snapshots and "lightning" light effects. Flash frequency adjustable from 2 to 20Hz. Requires 220-240VAC.

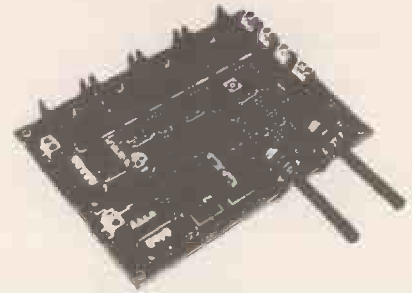
PRICE: £14-90



K2588 3-CHANNEL LIGHT ORGAN

Add amusing colours to your music. 3 outputs for high, middle and low tones are separately adjustable. Compatible with your amplifier, tape/cassette recorder, etc.
Input sensitivity: 100mV to max. 10V.
Channel separation 20dB.
TRIAC-outputs: 500W max. each (uncooled).
Supply: 200-240VAC.

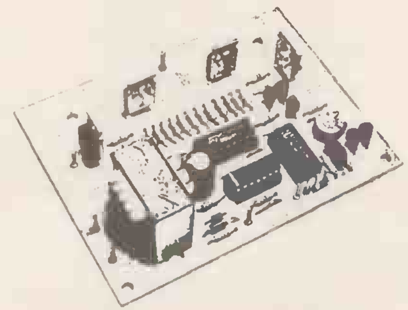
PRICE: £39-75



K2602 MUSIC MODULATED RUNNING LIGHT

Get your running lights to keep pace with your favourite discohits. Compatible with all sound equipment. Isolated input is adjustable (100mV-5V sensitivity). Speed adjustable from 0.25-3Hz. Operates on 220-240VAC. 400 Watt TRIAC-outputs.

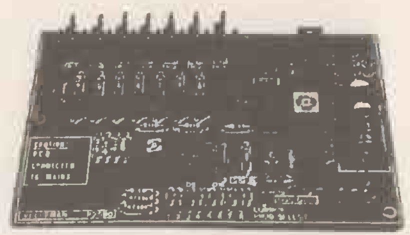
PRICE: £35-15



K5200 4 CHANNEL MULTI-FUNCTION RUNNING LIGHT

This circuit does more than an ordinary running light: it not only runs in both directions, but it also flashes with two groups of lamps (flip-flop) and with all the lamps at the same time. The four light effects follow each other automatically.
Technical data: Multi-function: running to the right, running to the left, flip-flop, and all the lamps flashing at the same time. • Four triac outputs: max. 2A each (400W at 220V or 200W at 110V). • Can be synchronized by mains or can work asynchronously. • Running speed: adjustable in asynchronous mode, constant speed in synchronous mode. • Suppression of radio noise in synchronous mode. • Power supply and transformer supplied with the kit.

PRICE: £22-95

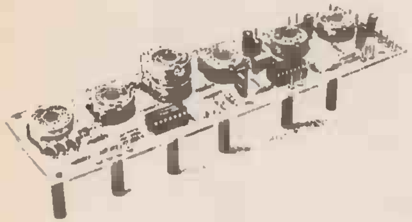


K2590 LIGHT COMPUTER

16 amazing light-effect-programmes for a unique light show. Attractive advertising, disco-bars. Rotary programme select switch included. Cascading of units allows unlimited extension of outputs. (Synchro Programme for 14 outputs Included).
7 TRIAC-outputs: 24-240VAC, max. 2A each (uncooled).
Power supply: 7-8VAC, 0,5A.
Speed adjust: 1-15Hz.
External reset input.
Input for external clock (CMOS 5V level).

PRICE: £38-60

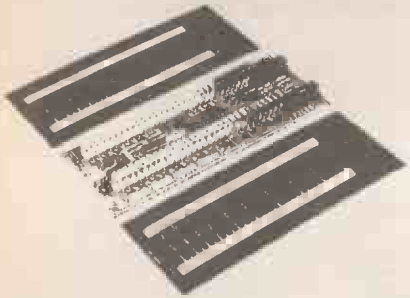
ALL PRICES INCLUDE 15% VAT   SIMPLY ADD £1-75 POST & PACKING PER ORDER



K2665 MONITOR AND EFFECTS MODULE

Monitor mixing amplifier (mono). Parametric equaliser with attenuation, center frequency and band width controls. Volume control. Three output levels: 775mV, 1.55V and 2.5Vrms.
Effects mixing amplifier with output level control. Nominal output level 775mV. Effects "return" control to mix the treated signal directly into the master output, without using an additional input channel.

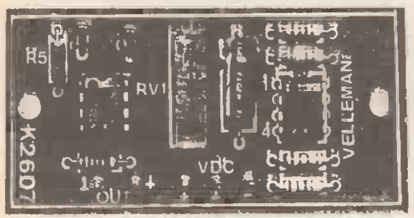
PRICE: £23-65



K2666 PRECISION STEREO VU-METER

Extremely precise VU-meter. 2×30 LED's "flying dot" readout. dB-linear scale from +6 to −6dB (0.75dB per LED). Steadily increasing scale partitions under −6dB. Peak measurement. No adjustments. Maximum error 0.5dB.

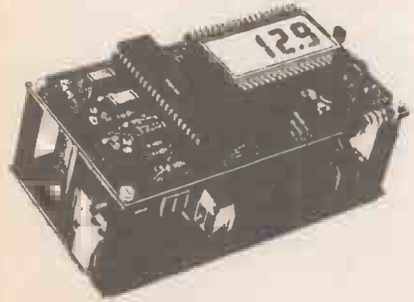
PRICE: £47-85



K2607 THERMOMETER ADAPTOR

It can be very usefull to have a voltage at your disposal which varies proportionally with the temperature: just think about computerised or non-computerised control systems.
Selectable sensitivity. Zero-output adjustable for a wide temperature range. Buffered output for analog or digital millivoltmeter.
Sensitivity: 10, 20 or 40mV per degree Kelvin (Celsius).
Range: −25 to +85 degree Celsius.
Linearity: typically 0.5%.
Remote sensing capability.
Supply voltage: + and −12 to 15VDC, symmetric, not stabilised.

PRICE: £13-30

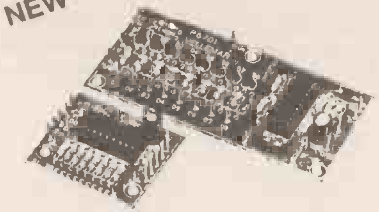


K2649 THERMOSTAT WITH LCD DISPLAY

Wide range: −50° to 150°C (−60° to 300°F).
Adjustable hysteresis: 0.2 to 10°C (0.5 to 20°F).
Can be calibrated in degrees Celsius or Fahrenheit.
Resolution: 0.1°C or 1°F.
Economy switch input: lowers temperature when external switch (or relay contact of a timer) is closed, e.g. at night.
Relay output: max. 240V/3A.
Power supply and transformer included.
Dimensions: 124×62×65 mm.
Plastic housing to match (B2649) separately obtainable.

PRICE: £51-25

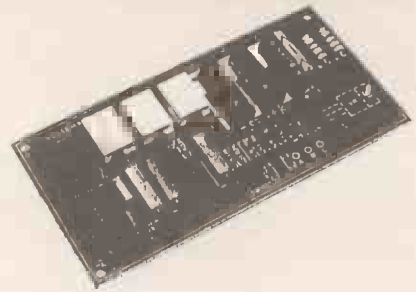
NEW



K6700: 2 WIRE COMMUNICATION TRANSMITTER
K6701: 2 WIRE COMMUNICATION RECEIVER

These kits allow you to open or close 8 (extendible to up to 16) different contacts via only two wires. For use in model building, model train, or wherever you want to establish several switching connections with only two wires available.
Technical data: • Power supply 6 to 16VDC • Feeding of the transmitter through the data line • Transmitter and receiver extendible to up to 16 channels • Open collector outputs with LED indication (max. 200mA) • Tested with a distance of more than 50m between transmitter and receiver.

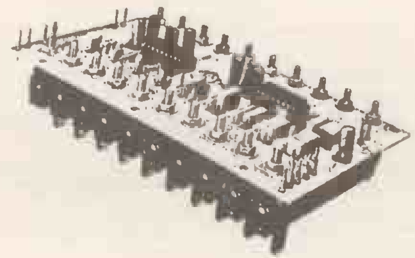
K6700 - £15-60   K6701-£21-70



K2557 DIGITAL THERMOMETER

Compared to a mercury or alcohol one, the digital thermometer offers lots of advantages: it can be read error-free (no parallax), with a precision of 0.1 degree, and at fairly big distances. Moreover, the sensor can be installed apart from the pcb (and the readout), in almost any place.
Power supply: 2×12VAC, 350mA. 3 digit, 1/2 inch display.
Accuracy: 0.1°C.
Temperature range: −10°C through +70°C.
Absolute maximum sensor temperature: 85°C.
Sensor in 8 pin DIL housing.

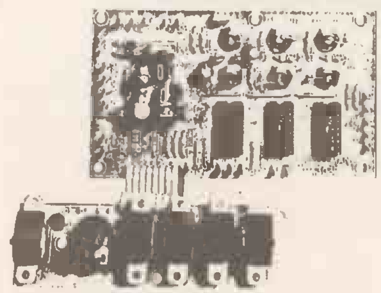
PRICE: £39-05



K4302 10 BAND GRAPHIC EQUALIZER

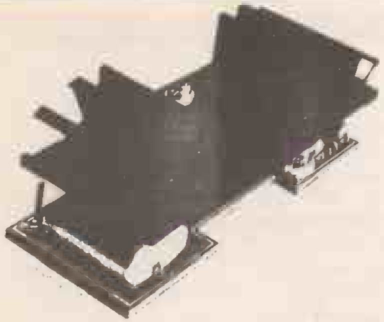
This equalizer enables you to adjust the whole audio spectrum to your own taste octave by octave, so as to eliminate the influence of the listening room. The equaliser is built up in such a way that it can easily be extended for stereo application (1×K4302).

PRICE: £42-10



K4303 POWER SUPPLY AND SWITCHING-MODULE FOR VELLEMAN EQUALIZER

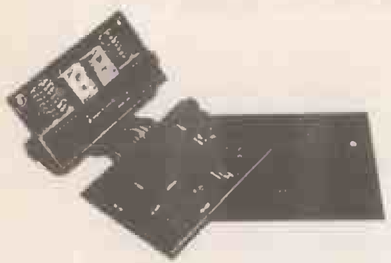
The kit comprises 2 different parts:
1. Power supply- and connection-module: (goes onto the back-panel). This module comprises: power supply for all the components (transformer 2×12VAC/1A not included). • All the connections for the equalizer: EQUALIZER INPUT - EQUALIZER OUTPUT - TAPE RECORDER OUTPUT.
2. Switching-module for all the functions of the spectrum analyser and the equalizer. This module comprises: Main-switch: ON/OFF + LED indication. • Equalizer input: PINK NOISE/LINE. • Taperecorder output: LINE/EQUALIZER. • Analyser input: LINE/MICROPHONE - Output: LINE/EQUALIZER. • Levelregulator for the spectrum analyser. **PRICE: £28-50**



K2543 ELECTRONIC IGNITION SYSTEM FOR CARS

Gives your car the drive of an expensive motor. Better starting and smoother running particularly at very high and very low RPM. Lower fuel consumption, less pollution, lower servicing costs. Drive economically. Drive electronically!

PRICE: £15-60



K2625 DIGITAL TACHOMETER

For every car or motor cycle running on petrol or gas. Can act as a general purpose rev. counter. Range: 100-9900 RPM. Easy to calibrate. Requires 10-15VDC.

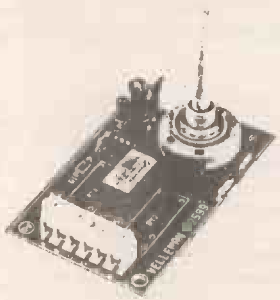
PRICE: £31-70

NEW

K3504 CAR ALARM

This alarm detects snap voltage drops of the battery, caused e.g. by the courtesy light or luggage boot light being switched on. To ensure the good working of the alarm, the kit has the following two control indicators:
- Flashing LED to indicate that the adjustable step out delay time has expired and that the alarm is armed.
- Pre-alarm (built-in buzzer) to remind the user of the fact that the alarm is armed, so that he doesn't forget to switch it off. The alarm can be switched on and off very easily, either automatically through the ignition lock or remotely controlled by e.g. our infrared code lock K6704 & K6705.

PRICE: £21-00



K2599 SCREEN WIPER ROBOT

You can select up to 3 time intervals (5-10-15 sec.) for the windscreen wipers on your car. It can also be used for automatic slide projection. Manual includes installation instructions for most cars. Relay on board. Requires 12-15VDC. Dimensions: 82×56×41 mm.

PRICE: £15-60

K2644 FROST INDICATOR

Drive more safely now when weather is frosty. This kit indicates with a flashing led that temperature is reaching the freezing point; below that point the led is on continuously. A rugged temperature sensor with mounting stud is included.
Power supply: 10-15VDC, 25mA max.
Dimensions: 56×42×18 mm.

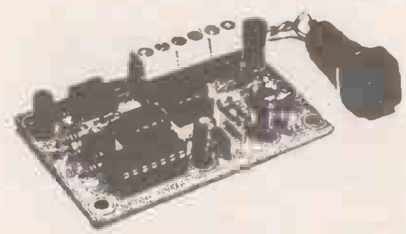
PRICE: £11-00

NEW

K3503 2×100W CAR BOOSTER AMPLIFIER

Finally a kit enables you to build an affordable high power amplifier for your car yourself. Thanks to its universal connections, this power amplifier can be connected to any installation. For trucks it can be adapted so that it can be fed from a 24V source. Complete with cooling beam and housing.
Technical data: • 2×100W max. output power • Power supply: 14.3VDC (10 to 16V allowed) • Adaptable for 24VDC (20 to 30V allowed) • Dual switching power supply (PWM) with MOS FET transistors • Compact Disc / LINE / LS input adjustable. • Frequency response 10Hz-100KHz (CD input).

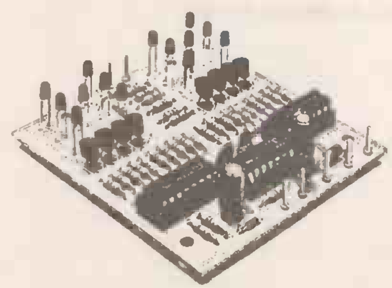
PRICE: £155-00



K3500 MULTIFUNCTION CAR-INTERIOR ILLUMINATOR

After your stepping in and closing the door, this circuit makes the interior light burning for an adjustable time.
Technical data:
- Switch off delay adjustable between 0 and 60 seconds.
- Simple connection to practically all cars.
- Current consumption: 13mA min.

PRICE: £14-55



K3400 DUAL ELECTRONIC DICE

Round games offer pleasant and healthy entertainment, but the dice are always a source of offence; they fall off the table, allow cheating, one or more players didn't see the result well and so on... There can be no doubt at all about the result on the displays of this electronic dice, and cheating is out of the question.
Technical data
Two fully independant dice. • At choice you can play with one or two dice. • Displays are switched off automatically after 30 seconds to save the battery. • Power supply: 8 to 12VDC.

PRICE: £14-50

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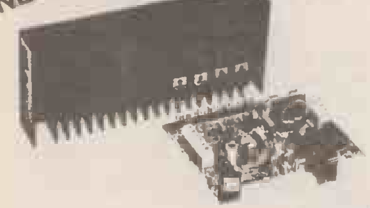
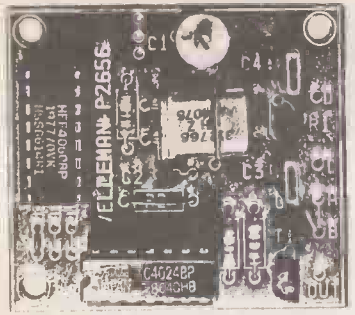
NEW



K3501 12V OR 24V TO 220VAC CONVERTER

For use in cars, trucks, boats, caravans or other places where there is only a 12 or 24 volt battery available. For feeding audio equipment, video recorder, TV, computer, electric shaver, etc...
Technical data: • 300W output power with 24VDC input • 160W output power with 12VDC input • 50Hz crystal oscillator • FET power transistors (cooling beam included) • Output voltage monitoring • Battery voltage monitoring • Transformer separately obtainable (for 12 or 24V).

PRICE: £57-10

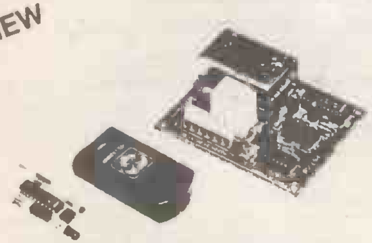


K2656 UNIVERSAL CRYSTAL TIME BASE

In many clocks and circuits with built-in clock (e.g. during power failure), another time base has to be provided, otherwise the clock would stop.
Technical data:
- Output frequency: 50, 100 or 400Hz.
- X-tal: 3.276800MHz.
- Can be adapted for 1Hz output signal.
- Supply voltage: 5 to 25V.
- Supply current: 2 to 5mA depending on the configuration.

PRICE: £13-30

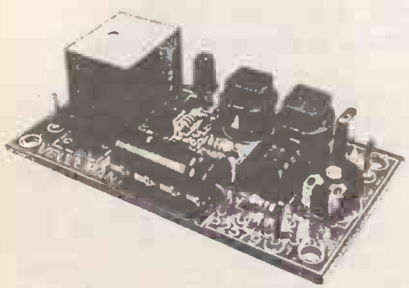
NEW



K6705 INFRARED CODE LOCK RECEIVER
K6704 INFRARED CODE LOCK TRANSMITTER

When you find mechanical locks too difficult and always forget the combination of your keyboard code lock, then these two kits are the ideal solution. An additional advantage consists in the possibility of remote control of the "lock". Can be used for all sorts of applications like switching your car alarm or central car-door locking on and off, securing buildings or houses, opening garage doors, etc... You can determine the code of the system (60.000 combinations) yourself. Hence it is possible to combine several transmitters with one receiver or vice versa.

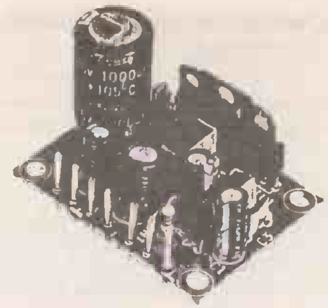
K6704 - PRICE: £19-85
K6705 - PRICE: £28-25



K2579 UNIVERSAL TIMER

Miniature universal timer, ranging from a few seconds to 15 minutes. Relay output: 2A/240V. Requires 12VDC.

PRICE: £11-90



K2637 SUPERMINI 2.5 WATT AUDIO AMPLIFIER

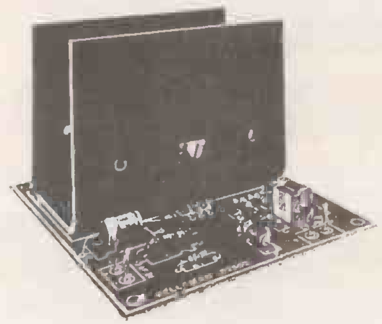
Small board complete with both pre- and power amplifier, which can be used separately. No adjustment required. Short circuit protected.
Power supply: 4,5 to 15VDC. • Input sensitivity: power-amplifier: 150mV (12V) • Pre-amplifier: 20mV (12V). • Max. output power: 2.5W (4 Ohm, 12V). • Dimensions: 42×32×27 mm.

PRICE: £10-20

K611 7 WATT AUDIO AMPLFIER

Easy to build low cost single chip amplifier.
Output power: 7W at 16V/4 Ohm. • Power supply: 4-20VDC. • Input sensitivity: 80mV. • Distortion: 0.3% at 3W/14V.

PRICE: £8-65



K2576 40 WATT AUDIO AMPLIFIER

High power version of K2592.
Power supply: 2×6 through 2×18V, symmetric and unstabilized, 2A.
• Input sensitivity: typ. 250mV.

PRICE: £19-05

K2592 20 WATT AUDIO AMPLIFIER

Hi-Fi Power amplifier to DIN 45500. Heat sink included. Short circuit proof. No adjustments required.
Power supply: 2×6 through 2×18V, symmetric and unstabilized, 1A.
• Input sensitivity: typ. 200mV. • Dimensions: 88×100×65 mm.

PRICE: £15-60

K1804 60 W POWER AMPLFIER

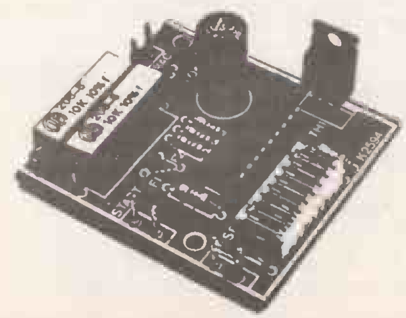
Compact and easy to build hifi power-amplifier. • Output power: 60W at 4 Ohm. • Total harmonic distortion: 0.5%. • Input: 1V. • Power supply: max. 2×28VSC, symmetric, not stabilised. • Short circuit protected. • Power supply available: K1861 (excl. transformer).

PRICE: £32-35

K1861 POWER SUPPLY FOR K1804

Supplies: 2×K1804 (stereo). • Requires: 2×18VAC-5A max. • Output: 2×28VDC.

PRICE: £27-20

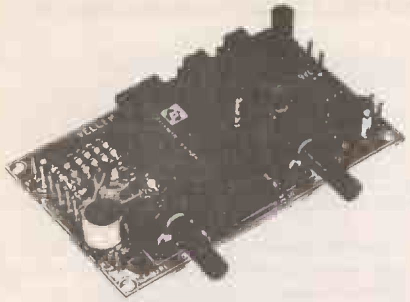


K2594 ZERO-CROSS PROGRAMMABLE TIMER

The timer allows to generate time delays form 1 second up to 31.5 hour The triac output of the timer enables to switch resistive, inductive as well as capacitive loads.
Some applications: automatic money- and game machines - industrial controls - dark room applications - stairs lighting. Direct start of the interval, or start at end of pulse (selectable).
Supply voltage: 220-240VAC.
Time base: 50Hz line frequency.
Max load: 500W.

PRICE: £16-85

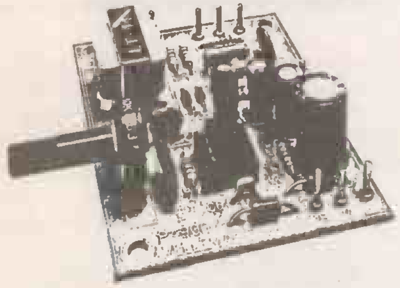
ALL PRICES INCLUDE 15% VAT   SIMPLY ADD £1-75 POST & PACKING PER ORDER



K2653 DIGITAL VOICE RECORD/PLAYBACK MODULE

It sounds like magic and it certainly is a long cherished dream of electronic fans to be able to record and playback the human voice without need for mechanics. Short messages can be repeated frequently to allow welcoming of visitors or greeting of customers. And there are also the "just for fun" applicators, e.g. hidden in toys, or imagine the effect on parties when someone hears his own voice being repeated on and on... Technical data:
Max. recording time: 10 to 12 seconds. • Microphone included. • Loudspeaker output: 2W at 4 Ohm. • Supply voltage: 9VDC regulated, or batteries (6×1.5V).

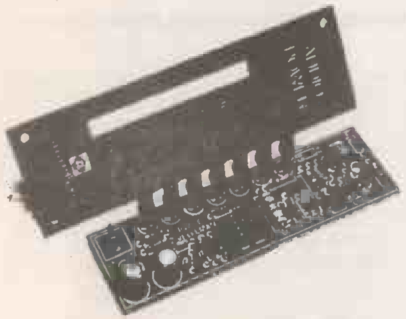
PRICE: £34-10



K4900 TELEPHONE-AMPLIFIER

This telephone-amplifier can be used either as an independent amplifier with loudspeaker, for instance to follow a telephone-conversation, or one can connect its output to an amplifier or a mixing-panel (f.i. free radio-stations). This module is perfectly suitable to be built into the modular VELLEMAN mixing-panel. Technical specifications: Input: separation-transformer coupling. • Output: loudspeaker: 0.5W/8 Ohm. • Line: 0dB (0.775VRMS). • Power supply: 7 to 9VAC or 9 to 12VDC (*) max. 150mA.
(*) For building it into the mixing-panel, the possibility to connect the module to 15V exists as well.

PRICE: £12-20



K2606 LED AUDIO POWER METER

Connects to the loudspeaker output of your amplifier. Demonstrates the power of your amplifier on a seven led scale. Now power supply needed. Front panels are included. Four scale ranges:
2- 40W at 8 Ohm
4- 80W at 4 Ohm
5-100W at 8 Ohm
10-200W at 4 Ohm

PRICE: £22-50

K1798 STEREO LED VU-METER

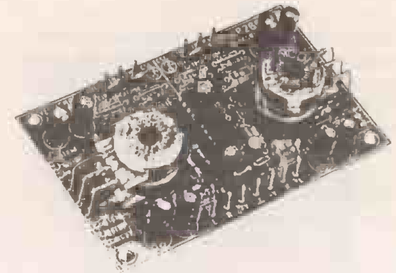
Stereo 2×16 LED VU-meter (Spot Ind.) with adjustable input. Power supply 12VDC. Two front panels included for vertical or horizontal mounting.

PRICE: £27-95

K610 LED VU-METER

V12-LED-scale VU-meter with adjustable input. Power supply: 12VDC. Light-bar display. 2 front panels included.

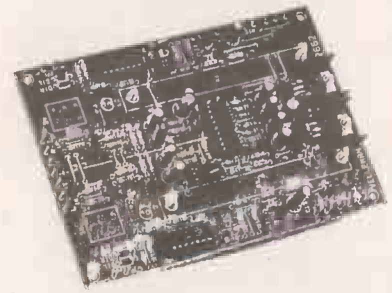
PRICE: £16-75



K2661 DUAL INPUT AMPLIFIER MODULE

Two input amplifiers that each can be built up as a: - symmetrical or asymmetrical mono microphone input - symmetrical or asymmetrical mono line input - stereo line input - stereo phone input.
Both amplifiers have a gain control facility (range ca. 25dB).

PRICE: £20-65



K2662 DUAL FADER MODULE

Electronic faders for two stereo channels. Both channels are equipped with a PFL switch (Pre-Fade-Listening), a peak-detector (+3dB), and an automatic starting control circuit for record players (by pulse or continuously). Creaking produced by the sliding potentiometers has been eliminated completely through the use of high quality electronic volume control circuitry (DC-control). A standard mono potentiometer becomes as performant as a high cost professional slider. Moreover no concessions have been made to the quality: adjustment range exceeds 100dB, and noise produced by the faders is kept below −95dB!

PRICE: £40-90

K2663 DUAL TONE CONTROL MODULE

Two stereo channels on one single pcb. Independent control of:
- balance or panorama
- bass, middle tones, and treble
- monitor level
- effects level

The monitor and the effects signals, coming from the different tone control modules, are converted by the monitor and effects module K2665 to a mono monitor output (for stage and live concerts) and a mono effects output (for echo chamber, reverb, etc...).

PRICE: £40-25

K2664 MASTER AND HEADPHONE MODULE

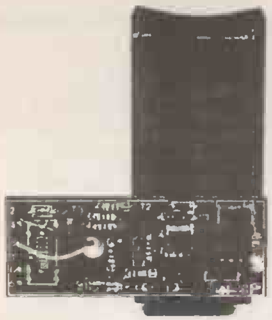
Stereo mixing amplifier with controls for output level, balance, treble and bass. Mono/stereo switch. Three output levels: 775mV, 1.55V and 2.5Vrms.
Small VU-meter with two rows of 5 LED'S each. Light bar read-out.
Headphone amplifier with volume control and selection switch for PFL, master output, monitor or effects. Output power 2×1W. Suited for headphones with an impedance between 4 and 400 Ohm.

PRICE: £55-85

K2549 INFRARED ALARM TRANSMITTER

Together with kit nr. 2550 (alarm receiver) an infrared light barrier is constructed. The receiver will activate its output whenever the beam is interrupted. The distance between the transmitter and receiver may be up to 5 metres.
Supply: 6-9VDC, 250mA.
Housing included.

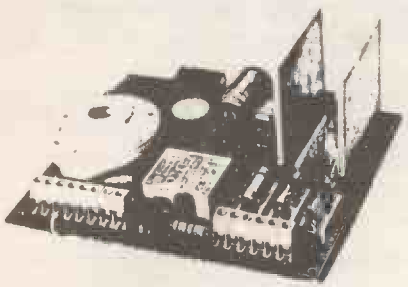
PRICE: £21-75



K2550 INFRARED ALARM RECEIVER

Supply: 12VDC, 50mA.
Output: open collector, max. 24VDC, 50mA (reed relay optional).
Dimensions: 72×28×28 mm.
Housing included.

PRICE: £26-95



K2551 IR ALARM CENTRAL UNIT

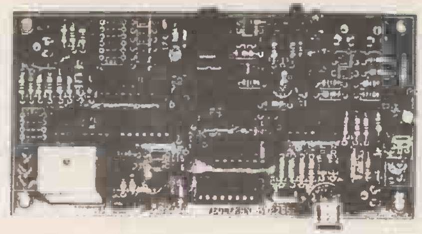
Designed to build a complete and sophisticated alarm-system together with kits K2549 and K2550. On-board power supply for three transmitter/receiver pairs. Possibility to add normal open as well as normal closed switches as extra sensors. Adjustable activating delay-time and alarm trigger delay-time make this unit extra versatile. In case of mains failure, it automatically switches over to battery-supply (batteries not included).
Supply: 2×6VAC, 1A.
Output: relay 240V, 3A (included).
Dimensions: 126×110 mm.

PRICE: £37-15

K2655 ELECTRONIC WATCH DOG

A realistically barking circuit, with a sensitive ear for what's happening around. It loyally watches, never sleeps, and doesn't ask for much: only a 2×8V transformer or an (unstabilized) 9 to 12VDC power supply.
Technical data:
- Choice of two different dogs.
- Reacts to environment noise, with adjustable sensitivity.
- Loudspeaker output (2W at 4 Ohm).
- Power supply: 2×8V/0.5A transformer or 9 tot 12VDC.
- Supply curent: stand-by: 75mA. When barking: max. 400mA.

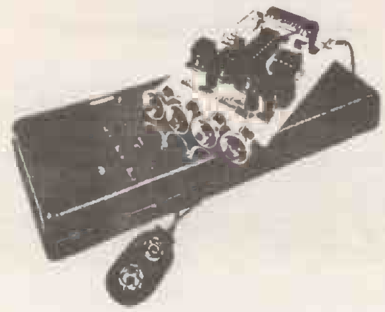
PRICE: £36-40



K2650 CALL CODE ACTIVATED SWITCH

The present remote control system requires no permission at all as there is no connection to the telephone line. Moreover, it spares your budget: its use is free, even when you are at the other side of the globe, because the telephone only needs to ring, and no communication is established. There are a lot of applications: turning on and off the lights at irregular points of time during a long absence, turning on the heating before you drive home or to your weekend residence or starting the microwave oven before leaving the office in the evening, and so on...
Technical data: Coded (42 different codes can be set), so abusing the system is almost impossible. • Timer, can be set from 3 seconds up to 56 hours. • Relay output: 240V/3A maximum. • Supply voltage: 12V regulated, 90mA max.

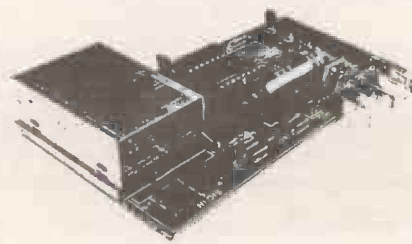
PRICE: £29-40



K2547 4-CHANNEL INFRARED TRANSMITTER

This unit is designed to work in combination with kit nr. K2548 infrared receiver. The units are sold separately since some applications may require one receiver together with two or more transmitters, or two or more receivers, with only one transmitter. This means a possibility of unlimited extension. There are lots of applications, such as: switching on/off the lights without leaving your armchair; turn on/off your radio set, opening your garage door without leaving your car... etc...

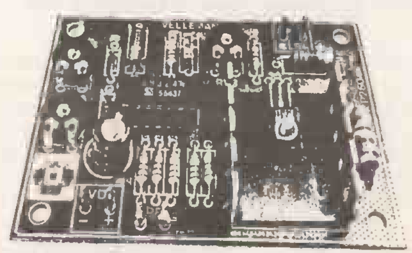
PRICE: £38-60



K2548 4-CHANNEL INFRARED RECEIVER

This kit, together with the 4-channel IR transmitter kit nr. 2547, forms a complete unit. Together, they make it possible to install a practically trouble-free remote-control, with unlimited applications (see IR transmitter). Four independent outputs are available and may be used as you like. This kit is supplied without a housing.
Max. distance: ± 20 meter. • Supply receiver: 12-14vdc/300mz. • Dimensions reciever: 120×67 mm. • Supply transmitter: 9VDC (battery). • Dimensions transmitter: 145×45 mm.

PRICE: £40-85

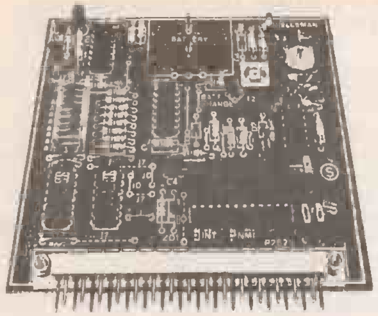


K2604 KOJAK SIREN

Enter the world of amazing electronic sounds and noises. Create or imitate sirens of all kinds by adjusting three trimmers. Powerful sound with extra 2 Watt on-board amplifier. Requires 8-14VDC, 1A.

PRICE: £10-30

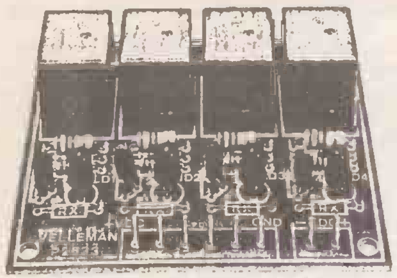
ALL PRICES INCLUDE 15% VAT   SIMPLY ADD £1-75 POST & PACKING PER ORDER



K2629 "REAL-TIME CLOCK" INTERFACE PRINT

Sometimes it might be important to execute certain actions at a well-defined moment. If your computer does not nave a real time clock, this might be a difficult task. This kit has been designed for making it possible to realise such tasks. By means of a battery-backup, time and date are kept in memory even when your interface system is switched off.

PRICE: £37-99



K2633 RELAY PRINT

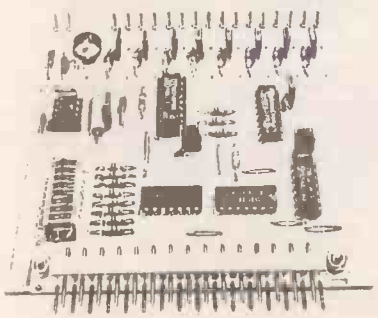
Connecting a number of relays to the outputs of an electronic network may seem very simple, but in reality it might possibly create some problems regarding the cabling. This kit, together with the Open Collector Output Card K2609, offers an attractive and compact alternative. Moreover, it can be assembled and connected very rapidly.

PRICE: £17-95

K2634 TRIAC PRINT

To switch AC-voltages by means of an electronic control, one mostly uses relays because of their simplicity. When the switching happens too frequently or too fast, the life time of the contact points will be shortened considerably. This can be solved perfectly by replacing the relays by a triac. Using optocouplers, the entire interface network remains galvanically separted from the voltage that has to be switched.

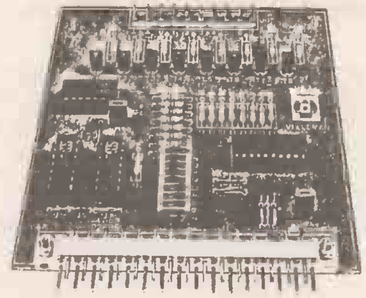
PRICE: £16-75



K2635 8 TO 1 ANALOG MULTIPLEXER PRINT

In most of the measuring and regulating systems, several varying parameters have to be measured or controlled continuously. The combination of an analog multiplexer print (a kind of electronic switch with 8 positions) and an A/D converter K2610 replaces the use of eight individual A/D converter prints, which means not only a saving of costs, but a saving of space as well.

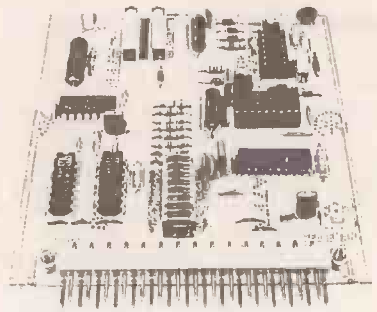
PRICE: £30-75



K2609 OPEN COLLECTOR OUTPUT PRINT

By means of this print you can provide your interface system with 8 outputs. These outputs, coupled with relays or triacs, allow you to switch different devices such as lamps, motors, alarm-devices etc...

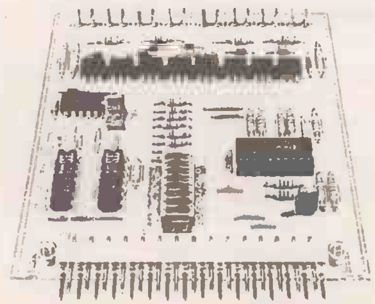
PRICE: £28-25



K2610 ANALOG/DIGITAL CONVERTER PRINT

By coupling this print to your interface system, it is possible to measure voltages from 0 up to 5 Volts with a resolution of 20mV. Using the appropriate converter, you can use this output for measuring currents, temperature, pression, light-intensity, axe-orientation etc. as well.

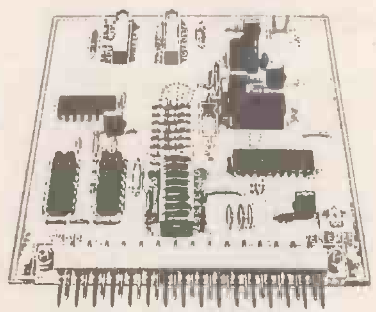
PRICE: £37-50



K2611 OPTOCOUPLER INPUT PRINT

This print allows you to check the state of switches, detectors, safety-devices etc. The use of optocouplers has the great advantage that the inputs are galvanically separated from the rest of the network.

PRICE: £25-95



K2618 DIGITAL/ANALOG CONVERTER PRINT

For controlling servo-systems, speed-regulators, dimmers etc. an analog control voltage is required. In order to be compatible for these applications, this kit converts a digital word into an analog voltage of 0 up to 1V in steps of 4mV.

PRICE: £33-99

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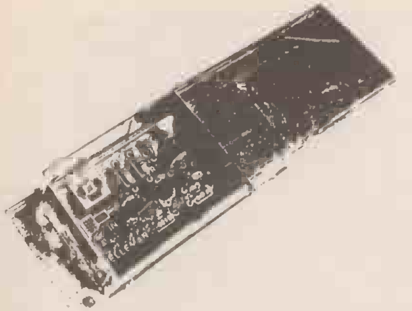
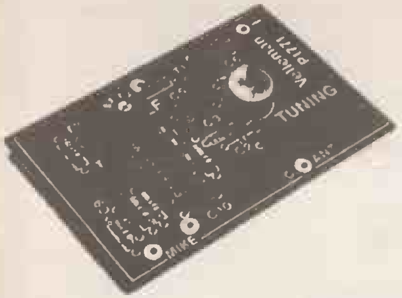


K2622 AM-FM ANTENNA AMPLIFIER

Do away with noisy signals! The K2622 gives you 22dB gain where it's needed. DC supply direct or via the coax cable (50-75 Ohm impedance), metal box included.

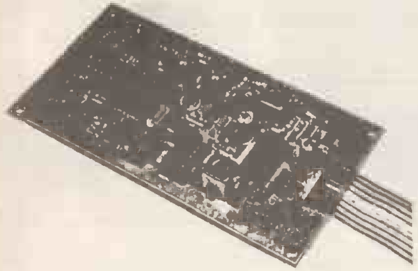
PRICE: £11-90



K1771 FM OSCILLATOR

Mini FM transmitter with good frequency stability (100-108MHz).
Built-in preamp (5mV sensitivity) interfaces to all microphones. Requires 9-12VDC.
Family broadcasts, babyphone, security. Can be received by any FM portable radio or tuner.

PRICE: £8-65



K2554 HIGH QUALITY FM TUNER

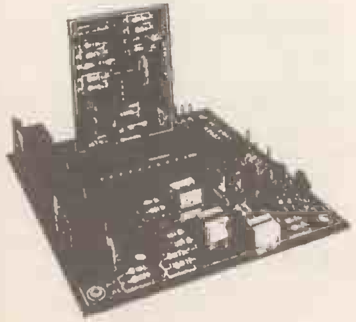
All features that a modern design can offer. Built-in "strip-line" technique-varicap tuning - adjustable mute level - automatic fine tuning - automatic gain control - tuning meter output. • Tuning frequency: 88-108MHz. • Operating voltage: 12VDC, regulated. • Input impedance: 75 Ohm (coax). • Sensitivity (20dB S/N): 1.2uV

PRICE: £40-50

K2553 FM STEREO DECODER

Hifi radio sounds much better in stereo. LED stereo indicator. Optional on-off switch 19KHz suppression for interference free tape recording. • Power supply: 8 to 15VDC. • Channel separation (stereo): 40dB. • Gain: typ. 1. • Input signal: min. 20mV to max. 2.5V

PRICE: £20-15



K2582 STEREO AUDIO INPUT SELECTOR

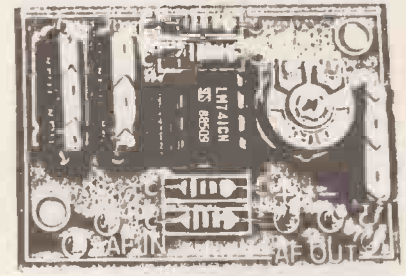
Electronic switching of 4 audio inputs.
Can accomodate up to 4 pre-amps (K2572-73). Minimises screened wiring. Can be interfaced to a home computer via K2609 output card to control audio signals.
Power supply: 10-15VDC, stabilized.
Maximum input signal: 750mV eff.
Standard DIN connectors.

PRICE: £19-05

K2581 STEREO VOLUME AND TONE CONTROL

DC voltage control of treble and bass plus separate volume control. Simple wiring.
Power supply: 12-15VDC, stabilized.
Frequency response: 20Hz to 20KHz (−1dB).
Harmonic distortion: typ. 0.2%.
Bass and treble control: −17dB to +17dB.

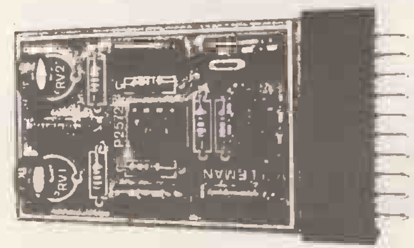
PRICE: £24-80



K1803 UNIVERSAL MONO PRE-AMPLIFIER

Ideally suited as: microphone amplifier - signal matching of tuner or tape outputs - etc...
Supply voltage: 10-30VDC (stabilized).
Gain: typ. 40dB.
Adjustable output level.
Frequency range: 20Hz to 20KHz (±3dB).
Max. input voltage: 40mV.

PRICE: £6-80



K2572 UNIVERSAL STEREO PRE-AMPLIFIER

Universal stereo low noise pre-amplifier.
Frequency range: 40Hz-30KHz (−3dB). • Adjustable gain, typ. 40dB. • Max. input voltage: 50mV. • Power supply: 10-30VDC, stabilized.

PRICE: £9-95

K2573 STEREO RIAA CORRECTION AMPLIFIER

RIAA stereo low noise pre-amplifier for md pickup.
Power supply: 10-30VDC, stabilized. • Amplification (1KHz): 35dB. • Input signal: 5 to 10mV.

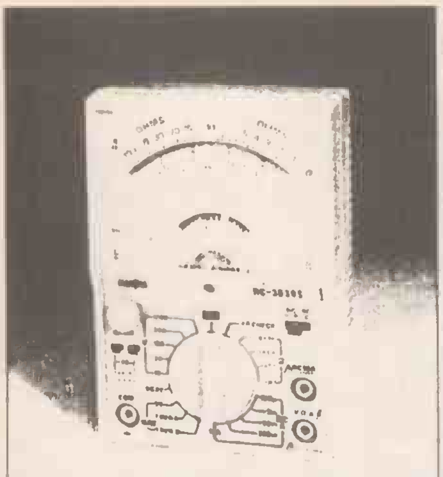
PRICE: £11-30

K4700 LOUDSPEAKER PROTECTION

This stereo loudspeaker protection will protect the loudspeakers against the switch-impulsions and the direct current component on the output of the connected amplifier.
Technical specifications:
- Switching delay: ± 6 sec.
- DC-protection: +1V/−1V.
- Max. input-voltage: 200VPP+DC.
- Max. switching current: 10A.
- LED-display for: - WAIT (switching delay)
  - ERROR (DC on loudspeaker output)

PRICE: £20-20

ALL PRICES INCLUDE 15% VAT   SIMPLY ADD £1-75 POST & PACKING PER ORDER



PRICE: £23-50

30kZ/V MULTIMETER Y121A (HC3030S)

- 24 ranges including 10Adc
- Diode and fuse protection
- Polarity reverse switch
- Transistor test ranges
- Battery test ranges
- Test leads with shrouded 4mm plugs

Battery and instruction leaflet included.

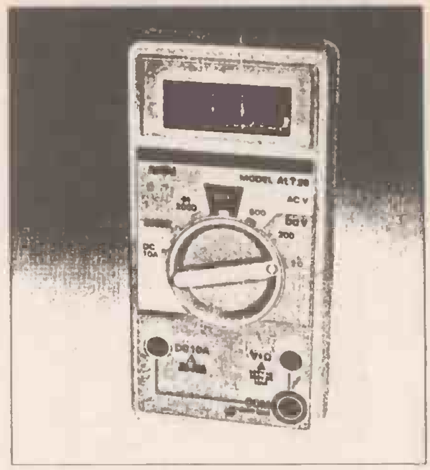
AC volts	0-10-30-10-300-1000Vac ±3%
DC volts	0-3-10-30-100-300-1000Vdc ±3%
DC current	0-100μ-3m-30m-300m-10Adc ±3%
Resistance	0-1k-10k-1M-10MΩ ±3%
Battery test	1.5V AA, 1.5V C & D, 9V PP3
Protection	Fuse and diodes
Dims	160 x 110 x 50mm

1MΩ MULTIMETER Y122AA (ALT26)

- 7 ranges including 10Adc
- 3.5 digit 12mm LCD display
- Diode test
- Auto polarity and zero
- Low battery and over range indication
- Test leads with fully shrouded 4mm plugs

AC volts	0-500-Vac ± 1.2%
DC volts	0-20-200Vdc ± 0.7%
DC current	0-10Adc ± 1.5%
Resistance	0-2k-2MΩ ±0.75%
Dims	148 x 73 x 32mm

PRICE: £15-50

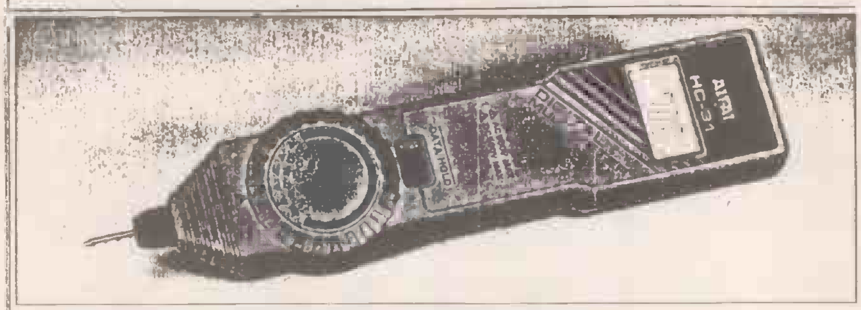


PRICE: £21-75

10MΩ MULTIMETER Y122AL (KD320P)

- Super slim design (10mm thick)
- 3200 count with bargraph
- Fully autoranging
- Data hold function
- Continuity test
- Diode test
- Carrying wallet

AC volts	0-3-30-300-450Vac ±2.3%
DC volts	0-300m-3-30-300-450Vac ±1.3%
Resistance	0-300-3k-30k-300k-3M-30MΩ ±2%
Dims	106 x 51 x 10mm



10MΩ PROBE MULTIMETER Y123PA (HC31)

- 3.5 digit 8mm LCD display
- Fully autoranging
- Display hold facility
- Probe styling
- Auto polarity and zero
- Complete with extended probe, fully shrouded test leads and vinyl carrying wallet

AC volts	0-2-20-200-500Vac ±1.2%
DC volts	0-200m-2-20-200-500Vdc ±1.0%
Resistance	0-200-2k-20k-200k-2M-2MΩ ±1.0%
Dims	160 x 35 x 20mm

PRICE: £29-99

PRICE: £21-25

10MΩ MULTIMETER Y122L (M2308)

- 18 ranges including 10Adc
- 3.5 digit 12mm LCD display
- Diode test
- Battery test
- Auto polarity and zero
- Over range and low battery indication
- Test leads with part shrouded 4mm plugs

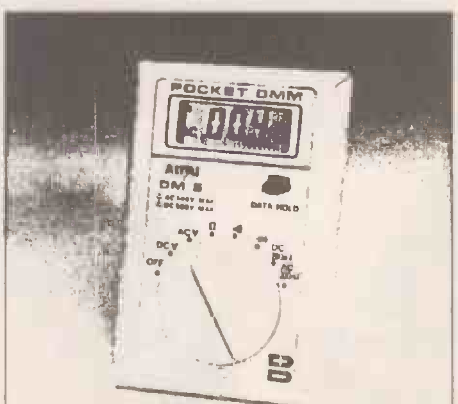
AC volts	0-200-500Vac ±1.2%
DC volts	0-2-20-200-1000Vdc ± 0.8%
DC current	0-2m-20m-200m-10Adc ±1.0%
Resistance	0-200-2k-20k200k-2MΩ + 1.0%
Battery test	1.5V battery (100mA load current)
	9V battery (6mA load current)
Protection	Fuse
Dims	130 x 72 x 33mm

10MΩ MULTIMETER Y122BA (HC32)

- Super slim design (14mm thick)
- Autoranging ACV, DCV and Ω ranges
- Continuity buzzer
- Diode test
- Data hold
- Integral test leads stored on rear of case

Battery and instruction manual included.

AC volts	0-20-200-500Vac ±1.2%
DC volts	0-200m-2-20-200-50Vdc ±1%
AC current	0-200mA ±1.2%
DC current	0-200mA ±1%
Resistance	0-200-2k-20k-200k-2M-20MΩ ±1%
Dims	100 x 68 x 14mm



PRICE: £22-50

ALL PRICES INCLUDE 15% VAT SIMPLY ADD £1-75 POST & PACKING PER ORDER

KITS - COMPONENT

ATTENTION RETAILERS!! - Order 100 packs (may be mixed) and header cards can be printed with your company name, address and logo. Contact our sales desk for further details.

RESISTOR KIT - 0.25W (5 OFF)

A pack containing 305 resistors. Values as listed below. Each value individually packed and each bag marked with the value enclosed.

CONTENTS: 5 OFF EACH VALUE:

10R, 12R, 15R, 18R, 22R, 27R, 33R, 39R, 47R, 56R, 68R, 82R, 100R, 120R, 150R, 180R, 220R, 270R, 330R, 390R, 470R, 560R, 680R, 820R, 1K, 1K2, 1K5, 1K8, 2K2, 2K7, 3K3, 3K9, 4K7, 5K6, 6K8, 8K2, 10K, 12K, 15K, 18K, 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 120K, 150K, 180K, 220K, 270K, 330K, 390K, 470K, 560K, 680K, 820K, 1M.

ORDER CODE	1+	5+
KIT/RES/25/5	£3.75	£3.25

STAR BUY

RESISTOR KIT - 0.25W (10 OFF)

A pack containing 610 resistors. Values as listed below. Each value individually packed and each bag marked with the value enclosed.

CONTENTS: 10 OFF EACH VALUE:

10R, 12R, 15R, 18R, 22R, 27R, 33R, 39R, 47R, 56R, 68R, 82R, 100R, 120R, 150R, 180R, 220R, 270R, 330R, 390R, 470R, 560R, 680R, 820R, 1K, 1K2, 1K5, 1K8, 2K2, 2K7, 3K3, 3K9, 4K7, 5K6, 6K8, 8K2, 10K, 12K, 15K, 18K, 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 120K, 150K, 180K, 220K, 270K, 330K, 390K, 470K, 560K, 680K, 820K, 1M.

ORDER CODE	1+	5+
KIT/RES/25/10	£5.10	£4.60

RESISTOR KIT - 0.25W POPULAR

A pack containing a total of 1,000 ¼W 5% carbon film resistors ranging in value from 10R to 10M.

In this pack we have included larger quantities of the more popular values.

Each value individually packed.

CONTENTS:

No.	VALUE	No.	VALUE	No.	VALUE	No.	VALUE	No.	VALUE	No.	VALUE	No.	VALUE	No.	VALUE
10 x	10R	10 x	82R	10 x	390R	10 x	1K8	10 x	8K2	10 x	39K	15 x	180K	5 x	820K
10 x	12R	20 x	100R	30 x	470R	25 x	2K2	30 x	10K	30 x	47K	20 x	220K	20 x	1M
10 x	18R	10 x	120R	20 x	560R	20 x	2K7	15 x	12K	20 x	56K	15 x	270K	10 x	2M2
10 x	22R	10 x	150R	20 x	680R	20 x	3K3	15 x	15K	15 x	68K	15 x	330K	5 x	3M3
10 x	33R	10 x	180R	10 x	820R	15 x	3K9	15 x	18K	10 x	82K	10 x	390K	10 x	4M7
20 x	47R	20 x	220R	40 x	1K	25 x	4K7	20 x	22K	30 x	100K	20 x	470K	5 x	6M8
10 x	56R	20 x	270R	15 x	1K2	20 x	5K6	15 x	27K	20 x	120K	10 x	560K	20 x	10M
10 x	68R	20 x	330R	15 x	1K5	15 x	6K8	20 x	33K	15 x	150K	10 x	680K		

ORDER CODE	1+	5+
KIT/RES/25/POP	£6.99	£5.99

RESISTOR KIT - 0.5W POPULAR

A pack containing a total of 1,000 ½W 5% carbon film resistors ranging in value from 2R2 to 10M.

In this pack we have included larger quantities of the more popular values. Each value individually packed.

CONTENTS:

No.	VALUE	No.	VALUE	No.	VALUE	No.	VALUE	No.	VALUE	No.	VALUE	No.	VALUE	No.	VALUE
5 x	2R2	10 x	12R	10 x	120R	20 x	680R	10 x	3K9	20 x	22K	20 x	120K	10 x	680K
5 x	2R7	10 x	18R	10 x	150R	10 x	820R	25 x	4K7	10 x	27K	10 x	150K	5 x	820K
5 x	3R3	10 x	22R	10 x	180R	40 x	1K	20 x	5K6	20 x	33K	10 x	180K	20 x	1M
5 x	3R9	10 x	33R	20 x	220R	10 x	1K2	10 x	6K8	10 x	39K	20 x	220K	10 x	2M2
10 x	4R7	20 x	47R	20 x	270R	10 x	1K5	10 x	8K2	30 x	47K	15 x	270K	5 x	3M3
5 x	5R6	10 x	56R	20 x	330R	10 x	1K8	30 x	10K	20 x	56K	15 x	330K	10 x	4M7
5 x	6R8	10 x	68R	10 x	390R	25 x	2K2	15 x	12K	10 x	68K	10 x	390K	5 x	6M8
5 x	8R2	10 x	82R	30 x	470R	20 x	2K7	15 x	15K	10 x	82K	20 x	470K	20 x	10M
10 x	10R	20 x	100R	2- x	560R	20 x	3K3	10 x	18K	30 x	100K	10 x	560K		

ORDER CODE	1+	5+
KIT/RES/5/POP	£10.75	£9.75

RESISTOR KIT - 0.5W (10 OFF)

A pack containing 730 resistors. Values as listed below. Each value individually packed and each bag marked with the value enclosed.

CONTENTS: 10 OFF EACH VALUE:

2R2, 2R7, 3R3, 3R9, 4R7, 5R6, 6R8, 8R2, 10R, 12R, 15R, 18R, 22R, 27R, 33R, 39R, 47R, 56R, 68R, 82R, 100R, 120R, 150R, 180R, 220R, 270R, 330R, 390R, 470R, 560R, 680R, 820R, 1K, 1K2, 1K5, 1K8, 2K2, 2K7, 3K3, 3K9, 4K7, 5K6, 6K8, 8K2, 10K, 12K, 15K, 18K, 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 120K, 150K, 180K, 220K, 270K, 330K, 390K, 470K, 560K, 680K, 820K, 1M, 1M2, 1M5, 1M8, 2M2.

ORDER CODE	1+	5+
KIT/RES/5/10	£8.75	£7.75

RESISTOR KIT - 0.5W (5 OFF)

A pack containing 365 resistors. Values as listed below. Each value individually packed and each bag marked with the value enclosed.

CONTENTS: 5 OFF EACH VALUE:

2R2, 2R7, 3R3, 3R9, 4R7, 5R6, 6R8, 8R2, 10R, 12R, 15R, 18R, 22R, 27R, 33R, 39R, 47R, 56R, 68R, 82R, 100R, 120R, 150R, 180R, 220R, 270R, 330R, 390R, 470R, 560R, 680R, 820R, 1K, 1K2, 1K5, 1K8, 2K2, 2K7, 3K3, 3K9, 4K7, 5K6, 6K8, 8K2, 10K, 12K, 15K, 18K, 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 120K, 150K, 180K, 220K, 270K, 330K, 390K, 470K, 560K, 680K, 820K, 1M, 1M2, 1M5, 1M8, 2M2.

ORDER CODE	1+	5+
KIT/RES/5/5	£5.40	£5.00

STAR BUY

RESISTOR KIT - 1W

A pack containing 365 1W resistors. Values as listed below. Each value individually packed and each bag marked with the value enclosed.

CONTENTS: 5 OFF EACH VALUE:

10R, 12R, 15R, 18R, 22R, 27R, 33R, 39R, 47R, 56R, 68R, 82R, 100R, 120R, 150R, 180R, 220R, 270R, 330R, 390R, 470R, 560R, 680R, 820R, 1K, 1K2, 1K5, 1K8, 2K2, 2K7, 3K3, 3K9, 4K7, 5K6, 6K8, 8K2, 10K, 12K, 15K, 18K, 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 120K, 150K, 180K, 220K, 270K, 330K, 390K, 470K, 560K, 680K, 820K, 1M, 1M2, 1M5, 1M8, 2M2, 2M7, 3M3, 3M9, 4M7, 5M6, 6M8, 8M2, 10M.

ORDER CODE	1+	5+
KIT/RES/1/5	£15.25	£14.00

RESISTOR KIT - 2W

A pack containing 365 2W resistors. Values as listed below. Each value individually packed and each bag marked with the value enclosed.

CONTENTS: 5 OFF EACH VALUE:

10R, 12R, 15R, 18R, 22R, 27R, 33R, 39R, 47R, 56R, 68R, 82R, 100R, 120R, 150R, 180R, 220R, 270R, 330R, 390R, 470R, 560R, 680R, 820R, 1K, 1K2, 1K5, 1K8, 2K2, 2K7, 3K3, 3K9, 4K7, 5K6, 6K8, 8K2, 10K, 12K, 15K, 18K, 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 120K, 150K, 180K, 220K, 270K, 330K, 390K, 470K, 560K, 680K, 820K, 1M, 1M2, 1M5, 1M8, 2M2, 2M7, 3M3, 3M9, 4M7, 5M6, 6M8, 8M2, 10M.

ORDER CODE	1+	5+
KIT/RES/2/5	£25.00	£23.00

CERAMIC KIT - 50V - Over £9.70 worth at catalogue prices - Saving you £5.71!!

A pack containing 125 50V disc and plate ceramics ranging in value from 1pF to 10nF (0.01mF).

Each value individually packed and each bag marked with the value enclosed.

CONTENTS: 5 OFF EACH VALUE:

1.0pF, 1.8pF, 2.7pF, 3.3pF, 4.7pF, 5.6pF, 6.8pF, 8.2pF, 10pF, 12pF, 22pF, 27pF, 47pF, 68pF, 82pF, 100pF, 150pF, 180pF, 270pF, 470pF, 560pF, 1000pF, 2200pF, 4700pF, 10nF.

ORDER CODE	1+	5+
KIT/CER/50V	£3.99	£3.50

STAR BUY

ELECTROLYTIC KIT - RADIAL - Over £11.00 worth at catalogue prices - Saving you £2.50.

A pack containing 100 miniature radial lead electrolytic capacitors. 12 different values.

Each value individually packed.

CONTENTS:

No.	VALUE	VOLTAGE	No.	VALUE	VOLTAGE	No.	VALUE	VOLTAGE	No.	VALUE	VOLTAGE
10	1mF	63V	15	10mF	25V	15	100mF	16V	5	1000mF	16V
10	2.2mF	63V	10	22mF	25V	5	220mF	16V	2	1000mF	25V
10	4.7mF	63V	10	47mF	25V	5	470mF	16V	3	2200mF	16V

ORDER CODE	1+	5+
KIT/ELEC/RAD	£8.50	£7.50

FUSE KIT - 20mm QUICK-BLOW

A pack containing 80 Quick-Blow 20mm Fuses.

Each value individually packed.

Contents:

No.	VALUE	No.	VALUE	No.	VALUE
5 x	100mA	10 x	500mA	10 x	3.15A
5 x	250mA	20 x	1A	5 x	5A
5 x	315mA	5 x	1.6A	5 x	6.3A
		10 x	2A		

ORDER CODE	1+	5+
KIT/FUSE/QB2	£4.75	£4.25

FUSE KIT - 20mm ANTI-SURGE

A pack containing 80 Anti-Surge 20mm Fuses.

Each value individually packed.

CONTENTS:

No.	VALUE	No.	VALUE	No.	VALUE
5 x	100mA	10 x	500mA	10 x	3.15A
5 x	250mA	20 x	1A	5 x	5A
5 x	315mA	5 x	1.6A	5 x	6.3A
		10 x	2A		

ORDER CODE	1+	5+
KIT/FUSE/AS2	£8.50	£7.50

PRE-SET POTENTIOMETER KIT - HORIZONTAL

A pack containing a total of 120 miniature horizontal mounting pre-set potentiometers. A total of 13 different values. Each value individually packed.

CONTENTS:

No.	VALUE	No.	VALUE	No.	VALUE	No.	VALUE
5 x	100R	5 x	2K2	10 x	47K	5 x	1M
5 x	220R	15 x	4K7	20 x	100K		
5 x	470R	20 x	10K	5 x	220K		
15 x	1K	5 x	22K	5 x	470K		

ORDER CODE	1+	5+
KIT/POT/HORIZ	£7.75	£7.25

PRE-SET POTENTIOMETERS - VERTICAL

A pack containing a total of 120 miniature vertical mounting pre-set potentiometers. A total of 13 different values. Each value individually packed.

CONTENTS:

No.	VALUE	No.	VALUE	No.	VALUE	No.	VALUE
5 x	100R	5 x	2K2	10 x	47K	5 x	1M
5 x	220R	15 x	4K7	20 x	100K		
5 x	470R	20 x	10K	5 x	220K		
15 x	1K	5 x	22K	5 x	470K		

ORDER CODE	1+	5+
KIT/POT/VERT	£7.75	£7.25

ZENER DIODE KIT - 400 M/W

A pack containing 55 zener diodes. 400M/W. Ranging from 3V6 to 30V. Each value individually packed and each bag marked with the value enclosed.

CONTENTS: 5 OFF EACH VALUE:

3V3, 4V7, 7V5, 8V2, 11V, 12V, 13V, 15V, 16V, 20V, 24V.

ORDER CODE	1+	5+
KIT/ZEN/400	£3.99	£3.50

POLYESTER CAPACITOR KIT

ITT PMT type 100V miniature or similar. Pack contains 110 capacitors. Each value individually packed and each bag marked with the value.
10 each value: 0.01uF, 0.015uF, 0.022uF, 0.033uF, 0.047uF, 0.068uF, 0.1uF, 0.15uF, 0.22uF, 0.33uF 0.47uF.

Order Code: KIT/POLY PRICE: £5-00

NUT & BOLT KIT

A useful pack containing 800 assorted BA nuts, bolts and washers. Bolts are cheesehead type. All cadmium plated steel. All types are individually packed.

100 each: 6BA ¼" bolts, 6BA ½" bolts, 6BA nuts, 6BA washers.
100 each: 4BA ¼" bolts, 4BA ½" bolts, 4BA nuts, 4BA washers.

STAR BUY

ORDER CODE: KIT/NB PRICE: £5-99

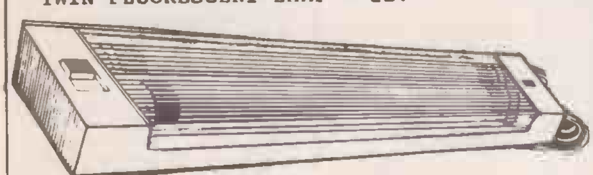
SELF TAPPING SCREW KIT

A choice of 3 kits, all slotted pan head self-tapping screws. Type AB screws finished in clear passivated zinc plate.

No. 4 Size
Thread dia. 2.9mm. 200 screws: 50 x 12.7mm, 100 x 9.5mm, 50 x 6.4mm.
No. 6 Size
Thread dia. 3.5mm. 220 screws: 20 x 19.1mm, 100 x 12.7mm, 50 x 9.5mm, 50 x 6.4mm.
NO. 10 SIZE
Thread dia. 4.8mm. 170 screws: 20 x 25.4mm, 50 x 19.1mm, 50 x 12.6mm, 50 x 9.5mm.

ORDER CODE: KIT/ST4 £3-75 ORDER CODE: KIT/ST6 £3-25 ORDER CODE: KIT/ST10 £4-00

TWIN FLUORESCENT LAMP - 12V



A very attractive twin tube lampholder with two 12V 8W fluorescent tubes. White plastic case with clear plastic ribbed diffuser and ON/OFF switch. Supplied with 90cms of twin flex for connection to 12V battery (Red stripe to positive). Ideal for caravans, boats, vans etc.

Overall dimensions: 370 x 65 x 41mm.

ORDER CODE		1+	10+	50+
OPTO/TFL12	PRICE -	£5.99	£4.99	£4.50

ORDER CODE OPTO/QHS **QUARTZ HALOGEN SPOTLIGHT** PRICE 1+ £5-99 10+ £5-25

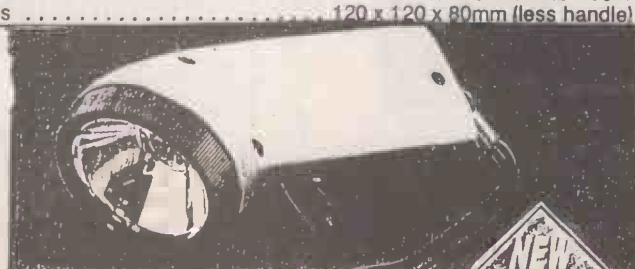
Hand held quartz halogen spotlight. 55W bulb produces more than 50,000 candle power. Highly polished reflector. Black plastic body. On/off slide switch. Retractable hanger. 3.6m coiled lead fitted with car cigar lighter plug.

Power 12V 4.5A 55W
Dims .... 120 x 120 x 80mm (less handle)

ORDER CODE OPTO/DYN **DYNAMO TORCH** PRICE: £2-75

Handy dynamo powered torch which requires no batteries. Well designed body fits neatly into hand and gives an easy hand-pumped action to generate sufficient power to light bulb brightly. Yellow plastic body with robust shock-proof construction. A must for every glove compartment.

Dims .... 130 x 55mm



CASIO

SOLAR POWERED

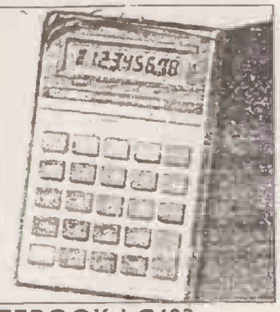
CALCULATOR HS8

- Solar powered. ● 8 digit LCD.
- +/−/x/÷/%/ sq root keys. ● 3 key memory. ● Operating brightness 150 lux.
- Weight: 40g.
- Dims: (HWD) 14 x 66.5 x 116mm.

QUOTE: CAS HS8

PRICE: £2-99

40 FUNCTIONS



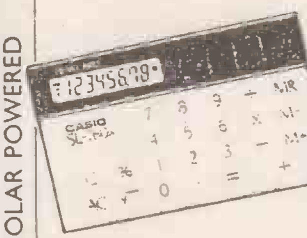
NOTEBOOK LC403

- Battery powered. ● 8 digit LCD.
- +/−/x/÷/%/ sq root keys.
- 4 key memory.
- Dims: (HWD) 6.5 x 66.5 x 109mm.

QUOTE: CAS LC403

PRICE: £3-99

SOLAR POWERED



SOLAR SL760

- Solar powered. ● 8 digit LCD.
- +/−/x/÷/%/sq root keys. ● 3 key memory. ● Operating brightness: 50 lux
- Dims: (HWD) 0.8 x 85.5 x 54mm.

QUOTE: CAS SL760

PRICE: £3-99

SOLAR POWERED

SOLAR SL300

- Solar powered. ● 8 digit LCD.
- +/−/x/÷/%/ sq root keys. ● Floating decimal point. ● 3 key memory.
- Operating brightness: 50 lux.
- Weight: 41g.
- Dims: (HWD) 7.1 x 60 x 101mm.

QUOTE: CAS SL300

PRICE: £4-45

STORES 50 DATA ITEMS

DATA CALCULATOR DC150

- Battery powered.
- Stores up to 50 data items alphabetically.
- Secrecy function for private data.
- +/−/x/÷/sq root keys and key memory.
- Weight: 67g.
- Dims: (HWD) 7 x 68 x 115mm.

QUOTE: CAS DC150

PRICE: £8-95

59 FUNCTIONS

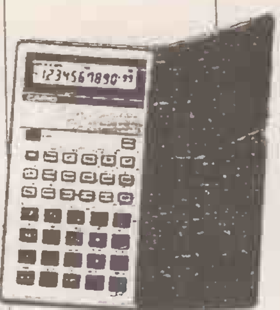
SCIENTIFIC FX82

- Battery powered.
- 8 digit LCD.
- +/−/x/÷ keys.
- 59 scientific functions.
- Independent memory.
- Algebraic logic.
- Weight: 135 g.
- Dims: (HWD) 19.6 x 76 x 149mm.

QUOTE: CAS FX82

PRICE: £8-95

96 FUNCTIONS



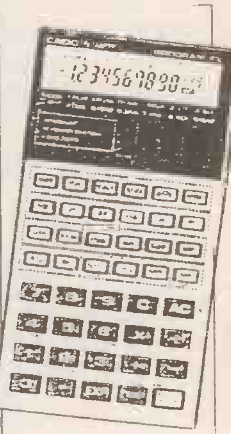
SCIENTIFIC FX570

- Battery powered.
- 10 digit LCD.
- +/−/x/÷ keys.
- 96 scientific functions.
- Binary, Octal and Hexadecimal conversions.
- Independent memory.
- Algebraic logic.
- Weight: 64g.
- Dims: (HWD) 8.7 x 71.5 x 134mm.

QUOTE: CAS FX570

PRICE: £15-75

6 CONST. MEMORIES



SCIENTIFIC FX3400P

- Battery powered.
- 10 digit LCD.
- +/−/x/÷ keys.
- 171 scientific functions.
- Floating decimal point.
- 1 independent memory.
- 6 constant memories.
- 5 statistical functions.
- Weight: 59g.
- Dims: (HWD) 85 x 73 x 140mm.

QUOTE: CAS FX3400P

PRICE: £15-95

SOLAR

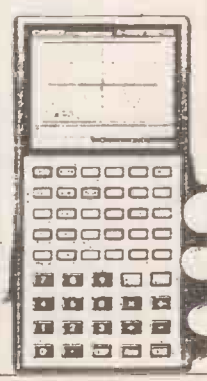
SCIENTIFIC FX451M

- Solar powered with battery back up.
- 10 digit LCD.
- +/−/x/÷ keys.
- 116 scientific functions.
- Fixed decimal point.
- Binary, Octal and Hexadecimal conversions.
- Independent memory.
- Algebraic logic.
- Operating brightness: 50 lux.
- 1 x GR927 back up battery.
- Weight: 79.5g.
- Dims: (HWD) 7.6 x 16.2 x 125mm.

QUOTE: CAS FX451M

PRICE: £17-90

20 FUNCTION GRAPHS



GRAPHIC CALCULATOR FX7000G

- Battery powered.
- 10 + 2 digit dot matrix display.
- +/−/x/÷/%/sq. root keys.
- 20 built-in graphic functions.
- 92 scientific functions.
- Programmable.
- 26 memories.
- Algebraic logic.
- Weight: 155.5g.
- Dims: (HWD) 14 x 83.5 x 167mm.

QUOTE: CAS FX7000G

PRICE: £49-50

ALL PRICES INCLUDE 15% VAT SIMPLY ADD £1-75 POST & PACKING PER ORDER

64K BYTE MEMORY

DIGITAL DIARY SF7500

- 62,092 character memory.
- 6 line x 32 column dot matrix display.
- 8 functions: telephone directory, business card library, memo function, schedule keeper, calendar, home/world time, calculator and schedule alarms.
- Secrecy function for private data.
- 12 digit calculations.
- +/-/x/÷/%/ ±/sq root keys.
- 4 key memory.
- ASCII key layout.
- Weight: 148g.
- Dims: (HWD) 15 x 133 x 74mm.

QUOTE: CAS SF7500

PRICE: £125-00

64K BYTE MEMORY

DIGITAL DIARY SF9000

- IC card system with 62,092 character memory and memory back-up.
- Can be connected to an IBM personal computer or SF7500 digital diary.
- 6 line x 32 column dot matrix display.
- 8 functions: telephone directory, business card library, memo function, schedule keeper, calendar, home/world time, calculator and schedule alarms.
- Secrecy function for private data.
- 12 digit calculations.
- +/-/x/÷/%/±/sq root keys.
- 4 key memory.
- ASCII key layout.
- Weight: 247g.
- Dims: (HWD) 18 x 150 x 166mm.

QUOTE: CAS SF9000

PRICE: £160-00

TELEVISION

2" SCREEN

TV-430

- Colour, LCD 2" screen.
- Crisp clear images.
- External antenna jack, earphone jack, external power jack.
- UHF, ch 21-68.
- Touch tuning.
- Power: 4 x UM3 batteries or mains operated with optional AD-K65 adaptor.
- Battery life: 3 hours approx.
- 3.2 watts approx.
- Weight: 330g.
- Dims: (HWD) 133 x 92 x 32.5mm.
- Case included.

FINISH: Black.

QUOTE: CAS TV430

£99-99

- *Mains adaptor.*

QUOTE: CAS ADK65 **£19-99**

BATTERIES

RECHARGEABLE BATTERIES - NI-CADS

A range of Nickel Cadmium batteries that will replace dry cell batteries. Capable of being recharged some 1000 times they are very economical in all applications. (We offer a suitable charger for these Ni-Cads at the end of this section)

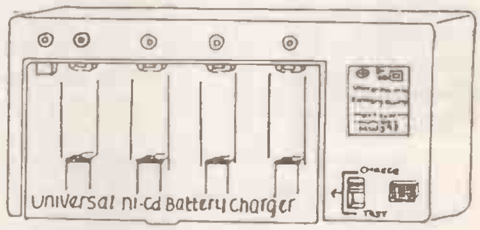
Type	Volt	Ah	Order Code	Price 1+	Price 10+
AAA	1.2V	180mAh	BAT/AAA	£1-50	£1-30
AA	1.2V	500mAh	BAT/AA	95p	85p
C	1.2V	1.2Ah	BAT/C	£1-95	£1-80
C	1.2V	2.0Ah	BAT/CI	£3-40	£3-20
D	1.2V	1.2Ah	BAT/D	£2-00	£1-85
D	1.2V	4.0Ah	BAT/DI	£4-75	£4-50
PP3	9V	110mAh	BAT/PP3	£3-90	£3-75

BATTERY CHARGER (Universal Nickel Cadmium)

An attractive nickel cadmium battery charger ideal for charging to rechargeable batteries detailed above. The charger will charge all the sizes listed: AAA, AA, C, D and PP3 and up to four AAA, AA, C and D types and one PP3 can be charged at the same time. The charger has a hinged plastic dust cover for easy viewing. The five battery positions have L.E.D. 'CHARGE' indicators. The unit also has a switch allowing batteries to be checked for current state of charge.

SPECIFICATION

Power	240V a.c.
Dimensions	210 x 100 x 50mm



ORDER CODE
BAT/CHARGE/UNI

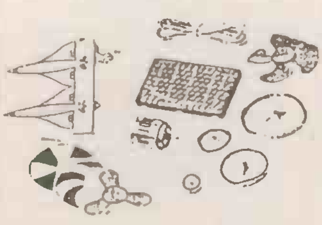
	1+	10+
PRICE -	£4.99	£4.75

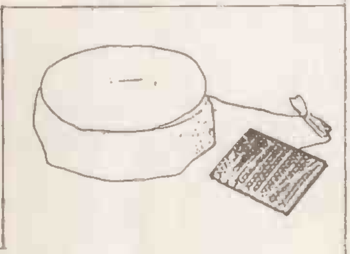
STAR BUY

KITS - SOLAR

Very useful educational kit, ideal for beginners. Safe energy drives the motor which is included in the kit.

ORDER CODE: KIT/SOLAR Price: £6-99





SOLAR TURNTABLE

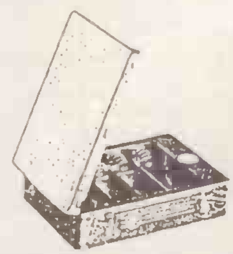
Solar powered turntable, ideal for shop window displays etc. Turns any display items up to 30lb's in weight when the solar panel is placed in direct sunlight.

ORDER CODE: SOLAR/SAT2 PRICE: £13-50

SOLAR BATTERY CHARGER

Takes up to 4 x AA cells. Depending on sunlight intensity the charging time is 2-3 hours or more for one battery and 10-14 hours or more for all four batteries.

ORDER CODE: SOLAR/BAT PRICE: £8-50



SOLAR CELL - 700m/a 0.5V

Complete in a plastic frame , combine these cells in series for higher voltage &/or in parallel for a higher current output. Max current 700mA in bright sunlight.

ORDER CODE: SOLAR/CELL Price: £3-99

FM Wireless Microphones

Wireless microphone systems available as a complete kit or in seperate parts. All operate on the standard frequencies allocated to wireless microphones systems (173.8MHz, 174.1MHz, 174.5MHz, 174.8MHz and 175.0MHz).
Please note that unless specific frequencies are requested, orders will be supplied with random frequencies from current stock.

G200 PROFESSIONAL WIRELESS MIC SYSTEM WMS202

A complete wireless microphone system comprising a G201 receiver with matching G202 microphone, windshield, 1.4m patch lead for connection of receiver to amp/mixer and one pair of racking brackets for the receiver. All packed in a tough vinyl case.

Receiver

Receiving frequencies	173.8MHz, 174.1MHz, 174.5MHz, 174.8MHz or 175.0MHz
Receiving system	Single super heterodyne conversion FM detector
Intermediate frequency	10.7MHz
Antenna impedance	75Ω
RF sensitivity	0.7μV
S/N ratio	Better than 90dB
Squelch threshold	Adjustable from 10dBμV to 40dBμV
Image and spurious rejection	At least −80dB
De-emphasis	75μS
Audio output level	250mV at 600Ω
Audio harmonic distortion	Less than 0.5%
Power	240Vac 50Hz/12Vdc
Dims	190 x 54 x 200mm

Transmitter:

Receiving frequencies	173.8MHz, 174.1MHz, 174.5MHz, 174.8MHz or 175.0MHz
Frequency stability	0.005%
Modulation system	Crystal controlled FM
Harmonic and spurious output power	Less than −45dB below carrier level
Pre-emphasis	75μS
Max frequency deviation	±50kHz
Frequency response	70Hz - 12000Hz
Distortion	Less than 0.5%
S/N ratio	Better than 87dB
Ambient temperature range	0°C - 40°C
Operating voltage range	3.8V to 4.5Vdc

G201 SIGNAL RECEIVER RC300

Professional wireless microphone receiver for use with G202, G203 and G204 transmitters. Single super heterodyne system for dependable operation. 2-channel, 5-LED indicators for carrier and output signal levels. Output gain and signal squelch controls.

Power .... 240Vac 50Hz or 12Vdc via external adaptor (not supplied)

Receiver specification same as G200 (WMS202)

£79-75

G202 WIRELESS MIC HT300

Professional wireless mic. Shock proofed high quality dynamic insert. Crystal controlled direct FM transmission for stable oscillation frequency under changing temperature and battery voltage conditions. Low battery and mic on indicators on base.

Power .... 3 x AA batteries (not included)

Receiver specification same as G200 (WMS202)

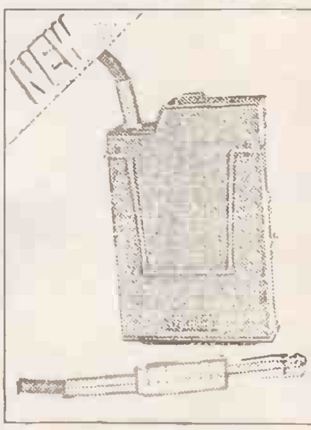
£78-50

TIE CLIP MIC
G203 PT300

Tie clip wireless mic. High quality electret insert connected to transmitter pack by 1.6m lightweight screened lead. Lightweight transmitter pack (125g with batteries) with belt clip and on/off switch.

Power ...... 3 x AA batteries (not included).

Transmitter specification same as G200 (WMS202)



£75-90

GUITAR TRANSMITTER
G204 GT300

Professional wireless guitar transmitter. Guitar connected to transmitter pack via a 1.4m double screened noiseless lead, with 6.35mm plug. Lightweight transmitter pack (125g with batteries) with on/off switch and belt clip.

Power ...... 3 x AA batteries (not included).

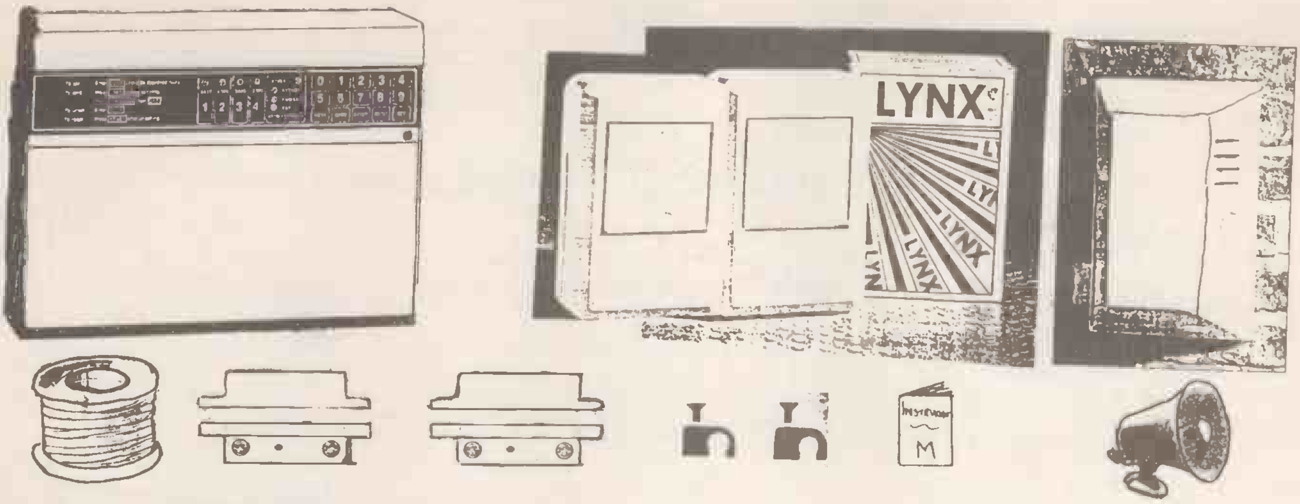
Transmitter specification same as G200 (WMS202)

SPECIAL OFFER

PURCHASE G201 + G203 TOGETHER AND PAY ONLY £165-00 (Saving £15-50)

PURCHASE G201 + G204 TOGETHER AND PAY ONLY £160-00 (Saving £17-90)

HOME ALARM PACKAGE SPECIAL

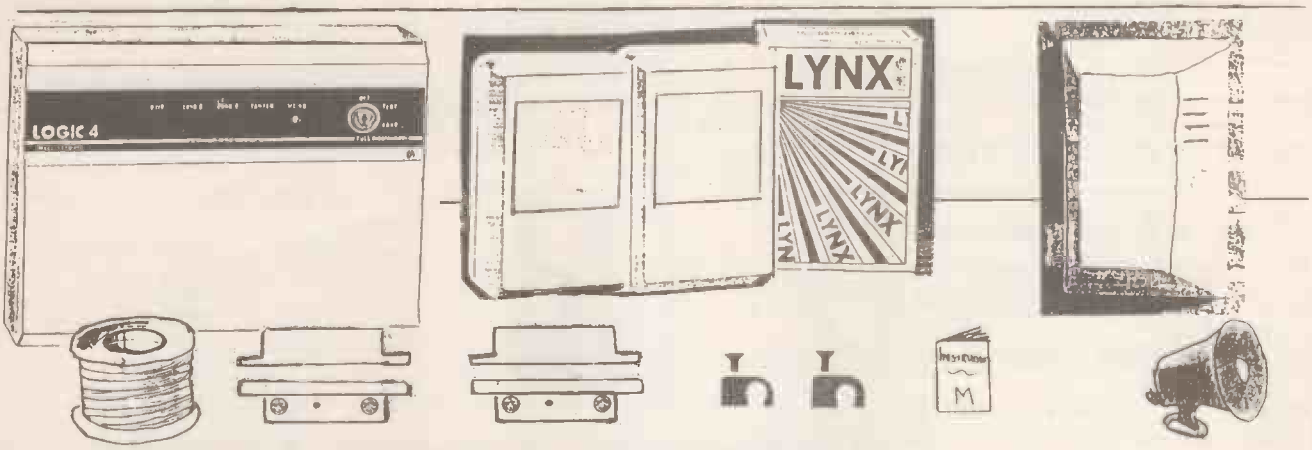


We have sold hundreds of these Home Alarm Security Packages. They are excellent value for money offering a substantial saving on list prices.
OK So what do you get? Contents as follows:

* OPTIMA ALARM CONTROL PANEL
* EXTERNAL RED BELL BOX
* SIREN FOR BELL BOX
* 2 X INTERNAL P.I.R.'s
* 2 X DOOR CONTACTS
* 100Mts CABLE & CLIPS

************************************** FULL FITTING INSTRUCTIONS ********************************

ORDER CODE: SEC/PACK/OPT **PRICE: £127-50**



A new package to our range, offering excellent value for money.
All our alarms come complete with full fitting instructions.

Logic 4 package contains:

* LOGIC 4 CONTROL PANEL
* EXTERNAL BELL BOX
* SIREN FOR BELL BOX
* 2 X INTERNAL LYNX P.I.R.'S
* 2 SETS OF DOOR CONTACTS
* 100Mts Cable & Clips

************************************FULL FITTING INSTRUCTIONS**********************************

ORDER CODE: SEC/LOG/PACK **PRICE: £115-00**

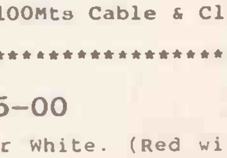
* AVAILABLE OPTIONS
At no extra charge, a choice of colour of bell box i.e. Red, Yellow or White. (Red will normally be sent if no preference stated).

Cable: If you wish to use the anti-tamper on the P.I.R's 6 core will be required. (Anti-tamper on P.I.R's not really necessary on house installations).
4-core cable will be sent unless 6-core requested. Again, at no extra charge.

All the items in the above packages, and more, are available seperately in our 1991

RECHARGEABLE LEAD ACID BACK UP BATTERY
12V 1.9Ah
Suitable lead acid battery for the above alarm system. Stays on contstant charge in the Alarm Panel. ORDER CODE: SEC/BAT/1.9A Price: £14-00

LEAD ACID BATTERY CHARGER (MADE in UK) £19-99
All the above panels have built in chargers but these are a most useful accessory should you ever wish to charge Lead Acid's for Hobby use etc.



EXTERIOR FLOOD LIGHT
Super weatherproof exterior floodlight which could be used with the External PIR on the previous page.
Black in colour, supplied complete with 500W halogen bulb.
Adjustable mounting bracket & hinged glass front for changing bulbs.

SEC/EFL

PRICE: £19-99

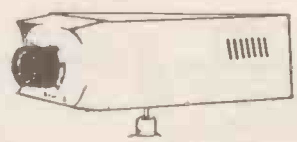
SPARE HALOGEN BULBS
Standard length bulbs in 3 Wattages.

200W	SEC/200W	PRICE: £3-50
300W	SEC/300W	PRICE: £3-75
500W	SEC/500W	PRICE: £4-00


TUNGSTEN HALOGEN LAMP

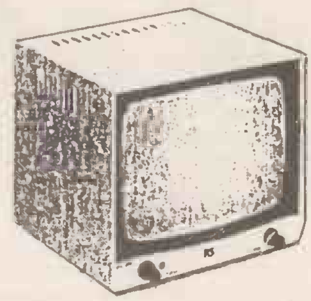
SECURITY EQUIPMENT - SURVEILLANCE

C.C.T.V. CAMERA - (USED)
A steel cased, closed-circuit monochrome TV camera. Ideal for internal or outside (using the weatherproof housing) security and for industrial surveillance.
All camera's are supplied with lens fitted - normally 8mm.
These units are secondhand the style and overall design may change to the illustration shown. All camera's are thoroughly tested before despatch and should give very long trouble free service. Never mount the camera facing a window or bright light as this wilburn the camera tube. Voltage generally 240V, if lower we will supply a suitable PSU



SEC/CAMERA/USED PRICE: £120-00

C.C.T.V. MONITOR - (USED)
Steel cased, good quality black & white monitors. Depending on availability we can offer sizes from 9" up to 17". State your preferred size and we will send nearest size available.
Voltage: 240V



SEC/MON/USED PRICE £75-00

C.C.T.V. CAMERA BRACKET - (NEW)
Quality, British made mounting bracket to suit not only our camera's but any standard CCTV camera.
White, plastic coated steel with standard ¼"-20 mount. Locking swivel allows camera to be adjusted and fixed in any position.

SEC/CB PRICE: £7-75

SPECIAL OFFER

BUY THE COMPLETE PACKAGE ABOVE i.e. 1 x Camera, 1 x Monitor, & 1 x Bracket

AND PAY ONLY ------- **£175-00** (Extra Carr. £10-00)

PASSIVE INFRA-RED DETECTOR - EXTERNAL
Super quality, 1500W switching capability. Full control of Range, Timing and Daylight level. Large Coverage and Full R.F.I. protection.
Weatherproof to I.P.64. Built in junction box.

SEC/PIR/EX PRICE: £39-95

Features include:-

- ★ Interchangeable lenses
- ★ 1500W switching
- ★ Full control
- ★ Large coverage
- ★ Low cost
- ★ Dual output
- ★ Dual supply (240Vac/12Vdc)
- ★ Full R.F.I. protection
- ★ Weatherproof to I.P. 64
- ★ Built-in manual over-ride
- ★ Built-in junction box

Description and Specification

Range:	Standard Lens	15m x 110°
	Multiplane Lens	15m x 110° (three planes)
	Long Range Lens	25m x 3.5m (four planes)
Capacity:	Power Relay	1,500 watts (incandescent)
	Auxiliary Relay	1 amp. 24Vdc S.P.C.O. relay
Timer:	Continuously variable	5 seconds to 10 minutes
Controls:	Daylight sensor level	full dark to full daylight
	Timer	5 seconds to 10 minutes
	Detection sensitivity	100% to approx 50%
Manual Over-ride:	Integral via wall switch (see text)	
Power Supply:	Optional 240Vac or 12Vdc (see text)	
Weather Protection:	Designed to IP64	

FM TRANSMITTER - Made in U.K.

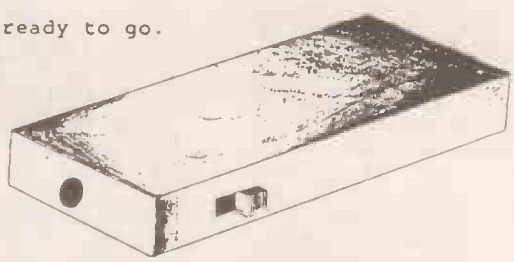
Very high quality 'Mini-Bug' - Ideal for baby alarm etc.!!

A very good range is obtainable - we have obtained over ½ mile, but it does depend on conditions.

Simply remove cover - insert battery - and you're ready to go.

Reception can be obtained on any FM radio.

Frequency .... 105-109MHz FM
Power .... PP3 9V Battery (Not Included)
Dimensions .... 4.25" x 2.25" x 3/4"



ORDER CODE
SEC/FMB1

PRICE: £9-99

FM TRANSMITTER KIT

For those of you who enjoy building kits - we now offer the above transmitter in kit form. Ideal for the beginner - supplied complete with full, easy to follow, instructions.

Box NOT INCLUDED - See our BOXES Section for suitable housing.

ORDER CODE
SEC/FMKIT

PRICE: £7-50

PRICE - £7.50

 ALL PRICES INCLUDE 15% VAT SIMPLY ADD £1-75 POST & PACKING PER ORDER

ASTEC SWITCH MODE POWER SUPPLY
MODEL: AC 9355

Input: 115-230VAC

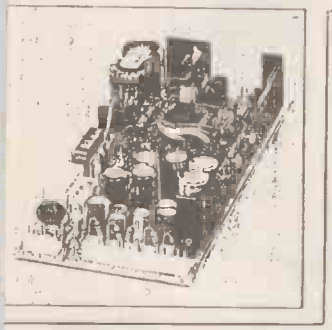
OUTPUT: 65 Watts

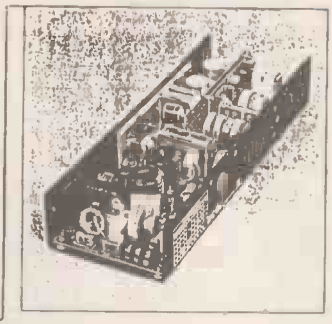
V1	+5V @ 6A
V2	+12V @ 1.5A
V3	+12V @ 2.1A
V4	-12V @ 0.25A

Dimensions: 195x115x45mm

These power supplies really are of the highest quality. Demand will be high so they will be sold on a strictly first come first served basis.

ORDER CODE: ASTEC/9355 PRICE: 1+ £19-99 5+ £15-99





SWITCHED MODE POWER SUPPLY
ASTEC - MODEL BM-41001

Brand new, good quality, fitted onto aluminium chassis. Size: 415 x 120mm

- Input : 115-230Vac 50-60 Hz
- Output : 110Watts
- V1 : +5V 3A
- V2 : +38V 2.5A

ORDER CODE: SO/ASTEC PRICE: £9-99

SWITCHED MODE POWER SUPPLY - WEIR
Made by Weir UK. Custom built PSU so no further info, hence very low price. Some of these units mays have been used. Following spec. taken off units.

- Input : 120V ac 60Hz
- Output : 200Watts (4 way type Molex plug for outputs)
- V1 : +5V 4A
- V2 : -5V 4.5A
- V3 : +16V 3.4A
- V4 : -16V 3.4A

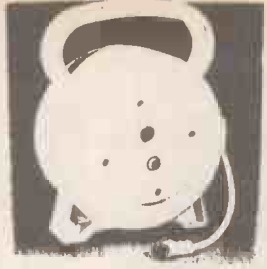
These units must have cost between £100-£200 each originally. They really are top quality.

ORDER CODE/SO/WEIR-2 PRICE: £12

B.S.R. TURNTABLES
These need no introduction, brand new, complete with cartridge and stylus.
Also, complete with turntable belt.
12V 0.06A motor fitted. Simply construct your own plinth.

Absolute bargain.

ORDER CODE/ SO/BSR PRICE: £9-99



AERIAL EXTENSION LEAD
F104BA (5490)
10m co-axial aerial extension lead on a compact wind on reel. Reel contains a built-in TV/radio splitter.

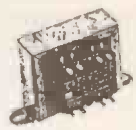
PRICE: £5-99

HI RES MONITOR Made in UK GREEN SCREEN
Very high quality monitor, complete apart from the case.
Resolution at Centre is 900 lines therefore ideal for computer applications.
Simply input 12V @ 1.2A.
COMPOSITE VIDEO!
Supplied complete with full handbook and circuit diagram and full parts list.
(Manual available seperately £2-00 each)
SPEC:

CRT Size	7" (178mm)
Power	12V/1.2A
Line Frequency	15-19KHz
Vertical Frequency	50-60Hz
Resolution at Centre	900 lines
Linearity	<2%
EHT Typical	12.0Kv
Line Blanking	12-7.5uS
Vertical Blanking	750uS
Video Input unterminated	12K
terminated	75R
Video Response	22MHz
Video Rise/Fall	17nS
Video in for 35V output	1Vp-p

ORDER CODE: SO/MONITOR PRICE: £27-50 each
4 for £100-00

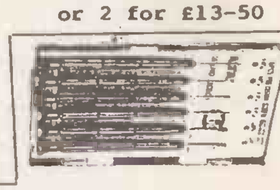
TRANSFORMER Made in UK
DRAKE Type: C2515 25VA
Very high quality still in production at nearly three times the price!
Primary: 240Vac (0-120 0-120)
Secondary: 15v - 0 - 15v @ 1.6A
Dims: 70 x 55 x 50mm
Fixing Centres: 80mm
Approx 500 pcs available.



	1+	10+	50+
ORDER CODE: SO/308	£3-75	£3-00	£2-50

ILLUMINATED MAGNIFIER
Very handy illuminated magnifier with main lens X2 and pull out lens X8 magnification.
Main lens can be illuminated for map or book reading.
Uses 2x AA batteries, which are supplied!
Overall length extended 6" (150mm)

ORDER CODE: SO/ILLMAG PRICE: £7-50
or 2 for £13-50



SCREWDRIVER SET
6 piece set in a plastic hinged box.
Contains: One each
1.4, 1.8, 2.0, 2.4, 3.0, 3.8mm
ORDER CODE: SO/016A PRICE: 99p

POWER SUPPLIES - EUROPEAN - 2 PIN

Manufactured by Commodore Business Machines (CBM) ltd. These power supplies are ideal for running radio's, cassette recorders, calculators etc etc. They fit the UK shaver adaptor (See our Electrical section). We have substantial quantities of these items and can offer attractive discounts for bulk buyers.

TYPE: EOB -DC
Input: 220/240V
Output: 4.5V @ 200mA
Plug: 2.5mm Jack

SO/POW/EOB

1+	10+	100+
70p	60p	50p

TYPE: MM3-AC
Input: 220/240V
Output: 6V @ 200mA
Plug: 3.5mm Jack

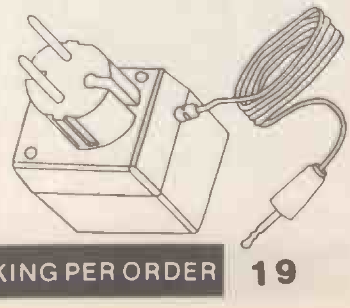
SO/POW/MM3

1+	10+	100+
95p	90p	75p

TYPE: EO9-DC
Input: 220/240V
Output: 6V @ 400mA
Plug: 3.5mm Jack

SO/POW/EO9

1+	10+	100+
£1-20	£1-10	90p



SPACERS - RS 606-692
Nickel plated hexagonal spacer, M3 hole tapped at one end and an M/ threaded stud at the other.
Spacer length: 15mm. Stud length: 8mm
Hole Depth: 8mm
RS Price: 14p ea

ORDER CODE: SO/261	10	50
	£1-00	£4-00

IEC filter plug units

IEC FILTER PLUG UNIT - BELLING LEE
TYPE- L2133C/L
Chassis mounting plug with integral mains filter. Designed to filter mains borne interference where capacitors alone may prove inadequate. Connection by ¼" receptacles.
Widely used to protect business machines, computer peripherals and electronic test instruments against mains borne transients and interference.
Current Rating: 2Amp Operating Volt: 250
Line Frequency: 0-400Hz
Inductance 3mH per line.
RS Price: £9-50 each!

ORDER CODE: SO/262 PRICE: £4-50

IEC FILTER PLUG UNIT - BELLING LEE
TYPE - L2131C/L
Chassis style as above but: 6A
ORDER CODE: SO/262A PRICE: £4-75

RIBBON CABLE CLIP - 20 way
RS 544-140
Aluminium cable clips specifically designed for use with ribbon cables. Self adhesive base. Working temperature range -40°C to +70°C. Width: 25.7mm
RS Price: 6p each
ORDER CODE: SO/267 PRICE: 10 for 45p

METAL OXIDE VARISTOR
Made By Philips.
RS 238-621

For suppressing a.c. mains borne transients, arcs etc.
Energy transient J 61. May be used on dc circuits also. Further spec. upon request
Dia: 12.5mm Lead length: 20mm
RS Price: £1-03 each!
ORDER CODE: SO/269 PRICE: 50p each

JUMPER SOCKETS - 0.1"
Stackable jumper sockets giving an alternative to the on board programming method of DIL switches. They have twin leaf Phosphor Bronze contacts plated with Gold over Nickel, designed to be used with 0.64mm round or square pins on a 2.54mm pitch.
Current Rating: 2A

L=6.5, W=5, D=2.54

ORDER CODE: SO/270 PRICE: 10p

COMPUTER LEAD
20 way IDC to 20 way IDC. Grey Ribbon.
Length: 400mm.
ORDER CODE: SO/271 PRICE: £1-00

INDUSTRIAL FUSE - 100Amp
Dorman (Hawker Siddeley) CEO100
Highest quality. To full 1975, BS88 etc etc.
550Vac 80kA 400Vdc 40kA.
Normal Price: over £7-50 each
HURRY HURRY

ORDER CODE: SO/272 PRICE: £3-50

TOROIDAL TRANSFORMER
Made in UK
Manufactured to very high standard by 'St. Ives Windings'.
Primary: 0-120 Secondary: 9V @ 4A
0-120 15v-0-15v @ 500m/A
Dimensions: Dia: 75mm Thickness: 38mm
Subject to availability we will supply fixing hardware. (Only while stocks last)
Original Price in tens, : £24-00 each!!
ORDER CODE: SO/268 PRICE: £10-00

TOROIDAL TRANSFORMER - 50VA
Made in UK. High Quality
Input: 120/240VAC
Output: 0-9v 0-15v
Max Load: 25VA per winding
Dimensions: Dia: 92mm
Thickness: 40mm
ORDER CODE: SO/268A PRICE: £8-50

JEWLERS EYEGLASS
Used for examination of small components, Hall marks etc. Available in two focal lengths. which is the optimum distance from the lens to the work piece when the item being viewed is in focus.

Focal length 2 SO/EYE-1 Price: £1-50
Focal length 3.5 SO/EYE-2 Price: £1-55

MINIATURE PUSH SWITCH - RS 332-830
Gold plated contacts for low level and dry circuit switching.
N/O + N/C. 4 tags. Complete with black cap & fixing nuts etc.
Panel cut out: 6.5mm
Body Dia: 10mm
Rating: 100mA 30Vdc.

ORDER CODE: SO/253 RS Price: £2-24
OUR PRICE: £1-00

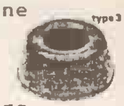
MAGNIFIERS - HANDHELD
A choice of three sizes of magnifiers, super quality at a very "Special Offer" price.
Black strong plastic surround.

DIA	ORDER CODE	PRICE
60mm	SO/MAG-1	£1-75
70mm	SO/MAG-2	£2-75
85mm	SO/MAG-3	£3-50

HEADER PLUG - Single Row - 36way
Gold Plated, very high quality.

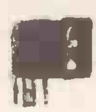
		1+	10+
ORDER CODE: SO/250	**Price:**	**15p**	**12p**

STICK ON FEET - RS 600-919
Moulded in non-conductive polyurethane with a strong pressure sensitive adhesive backing.
Height: 9.6mm Dia: 22.4mm
Colour: Grey



ORDER CODE: SO/251	per10	per 50
	£1-00	£4-50

2.5mm DC SOCKET
3 Tags, Black Plastic
Very large Quantity



1+	10+	100+
10p	8p	6p

ROCKER SWITCH - ILLUMINATED
Very high quality. Must have every approval mark available!!
Push In fit, 4 tag.
Rating: 3A 250V.
Cut out required: 30mm x 22mm

ORDER CODE: SO/252	1+	10+
	85p	75p

 ALL PRICES INCLUDE 15% VAT SIMPLY ADD £1-75 POST & PACKING PER ORDER

Equipment Wire

SPECIAL OFFER

STAR BUY

CABLE - CABLE - JUST ARRIVED- EQUIPMENT WIRE
We have just purchased over 2000, 100 metre reels of cable. Thats over 200,000 metres!!
This means, once again we can offer substantial savings to you.
As always, first come first served.
All the cable is made in the UK and of the highest quality.
Available in 10/0.1mm and 7/0.2mm.

10/0.1mm (0.078mm²)
Diam. approx 1.05mm. Max voltage RMS 1000V
Nominal Current 0.5Amp.
Available in the following colours:
BLACK, RED, BLUE, BROWN, GREEN.

7/0.2mm (0.22mm²)
Dia. approx 1.2mm. Max voltage 1000Volts (RMS)
Nominal Current: 1.4Amps
Available in the following colours:
BLACK, RED, GREEN, WHITE, GREEN/YELLOW, & BLUE
We are selling this cable by the roll and you may mix colours and types to get a better price break.

	1+	10+	50+	100+
Price per reel	£1-95	£1-75	£1-50	£1-25

If we are out of stock of a paricular colour we will substitute with another.

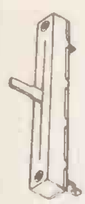
VIDEO CAMCORDER BATTERIES
Now in stock! Available for all models, telephone or fax with your model number & we will quote you. Too many to list here but we have listed the 2 market leaders. Simply quote JVC or SONY.

PRICE: JVC £35-00 SONY £27-95

VHS-C ADAPTOR (Motorised)
Simply put your VHS-C 30 minute tape into this unit and then use as a normal VHS tape in your VCR. This unit is a must for anyone using VHS-C tapes.

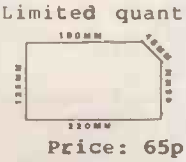
SPECIAL OFFER PRICE: £25-00

STEREO SLIDERS
60mm travel, manufactured by **NOBLE.**
Very high quality, all metal construction. Two values only:
500R LOG and 1Meg LOG

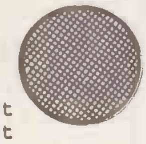


		1+	10+	100+
500R	SO/131/500R	40p	35p	25p
1Meg	SO/131/1MEG	40p	35p	25p

ALUMINIUM SHEET
You always need this. Limited quantity, useful size, see below:



ORDER CODE: SO/014 Price: 65p



SPEAKER GRILL - CHROME - 12"
Very attractive chrome speaker cabinet grill with black rubber surround. Robust construction made from 1.1mm thick steel. Grill pitch approx. 11 x 11mm

ORDER CODE: SO/026 Price: £3-00

HEATSINKS
Several standard heatsinks to choose from & OK for general purpose use.

L	W	D	Order Code	1+	10+
125 x	50 x	27	SO/045	70p	60p
125 x	115 x	27	SO/046	65p	55p
127 x	38 x	27	SO/044	£1.30	£1.15

DC MOTORS - MINIATURE
Model: 35-016
Working Voltage..........................6-12V
Approx. Body Dims...............38 x 40mm
Pulley Dia.................................10mm
Mounting Bracket fixing centres......45mm

ORDER CODE: SO/147	1+	10+
	95p	80p

Model SPDC
FUJIYA motor, complete with speed control board. Simply adjust speed by turning pre-set on the board.
Working Voltage.........................12V
Approx. Body Dims..............32 x 38mm
Approx shaft Dia..........................2mm
PCB Dims.........................65 x 30mm

ORDER CODE: SO/148	1+	10+
	£2-90	£2-50

HIGH TORQUE MINIATURE MOTOR
Ideal for higher power requirements. Operating voltages 1.5 to 3VDC. Clockwise rotation. Solder by termination. Bi-directional rotation.

	1.5V	3V
No load speed	4200	8300
Current (A)	0.14	0.17
At Max efficiency:		
speed	2400	7020
current (A)	0.6	0.94
torque (g/cm)	10.4	18
efficiency (%)	50.6	56.1
Stall torque (g/cm)	56	117
Weight	42g	

ORDER CODE: SO/148B	1+	10+	100+
	60p	56p	48p

MINIATURE DC
A low cost miniature DC motor with many applications including models, robotics and educational demonstration equipment. Operating voltage 1.5 to 3VDC. Ideally suited for mounting to PCB's with two flat surfaces. Solder tag termination. Bi-directional rotation.

	1.5V	3V
No load speed	8700	14000
Current (A)	0.32	0.38
At maximum efficiency		
Speed	5800	9400
current (A)	0.76	1.1
torque (g/cm)	5.3	8.6
efficiency (%)	32	30.5
Stall torque (g/cm)	16	26
Weight	17g	

ORDER CODE: SO/148A	1+	10+	100+
	50p	42p	32p

SANYO AMPLIFIER - STK015
Sorry, no further info.

ORDER CODE: SO/086 Price: £3-50

TOOL WALLET
Very useful wallet, made from strong PVC complete with 'belt loop'. Fix it to your belt! Approx: 265 x 125mm.
Colour: Black

ORDER CODE: SO/273 PRICE: 50p

PHILIPS CCTV CO-AX LEADS
BRAND NEW - Leads, 10Mtr long.
Co-Ax plug to Right Angle Co-Ax plug.
(Moulded Plugs)

Colour: GREY	1+	10+
ORDER CODE: SO/350	**£1-75**	**£1-50**

ASTEC VIDEO MODULATOR TYPE - UM1286

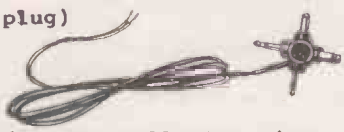
A UHF modulator primarily intended for use as an interface for a colour or black & white television and computer graphics, computer games, Teletext and Viewdata etc. The modulator is high performance featuring low radiation and harmonics in line with European specifications.
Pretuned to channel 36 and a 75 ohm output from a standard phono socket. In addition it has a built in 6Mhz intercarrier facility for use where a sound carrier is required.
SPEC:

Cannel E36	E36
Channel frequency (nominal)	591.5Mhz
Supply Voltage	5V
Supply Current	9mA
Bandwidth	8Mhz
Sound subcarrier	6Mhz
Transfer characteristic	Negative
Audio Signal	5Vp-p
Maximum RF output (nominal)	2.0mV

If you still require further info. send a SAE. **Normal price is over £10 each!**
Full data sheet supplied with each order.

ORDER CODE: SO/351 **PRICE: £6-50**

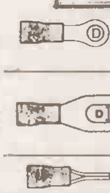
SPIDER LEAD (4 way plug)



4 way spider plug with the following size plugs: One each size:
2.1mm DC, 2.5mm DC, 2.5mm Jack, 3.5mm Jack.
Fitted with moulded cable grip on other end terminating in stripped wire.
Colour: Black with white tracer stripe.
Length: Approx 2.5Mtrs

ORDER CODE: SO/352 **PRICE: 50p each**

INSULATED CRIMP PACKS



Super offer, highest quality crimps, random mix of Red, yellow & Blue.
Plugs & sockets.
Each pack contains approx. 100 mixed crimps.
ORDER CODE: SO/353 **PRICE: £1-50**

SUPER POWER BEAM TORCH

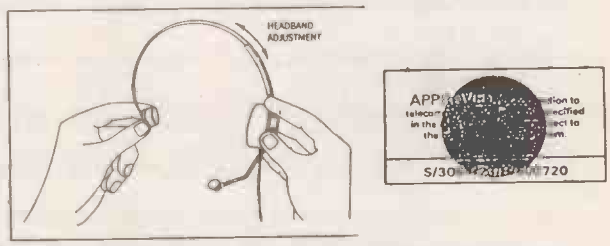
Fitted with **HALOGEN** bulb, thus **300%** brighter than a conventional torch.
Waterproof, tested to a depth of 10 Mtrs. (Should cope with the heaviest downpour!).
Robust plastic case, ring hanger for easy storage/carrying.
Uses 2 x D cells (Not supplied) 1.5V HP2.
Spare bulbs available.
Colour: Black with Red trim.

ORDER CODE: SO/354 **PRICE: £9-99**

DIALATRON ZR HEADSET TELEPHONE.
A very impressive telephone with lots and lots of features. i.e.
* Auto storage of last number dialled
* Facility to mute transmission of outgoing speech.
* Switch from decadic to DTMF signalling by button depression.
* Variable 'Ringing' Tone (selected)
* Headset Operation
* May be used as normal telephone.

ETC ETC ETC
These telephones look identical to a normal telephone but have a socket on the side for plugging in a headset.
BRAND NEW only one catch limited quantity so, first come first served!
HEADSETS ARE NOT SUPPLIED WITH THIS TELEPHONE. THEY MUST BE PURCHASED SEPERATELY.
The Headsets below are suitable.
NORMAL PRICE £99-99!!

ORDER CODE: SO/356 **OUR PRICE: £55-00**



RACAL FREEDOM HEADSET Type RA130/1005
Highest quality, Racal need no introduction. Suitable for the above telephones.
Complete with headband, earpiece and boom mic. fitted with lead and plug.
Brand new, even supplied with neat cloth storage bag.
Only one catch, yes, limited quantity.
FIRST COME FIRST SERVED!!
These monaurel headsets allow the operator to listen to other people in the office at the same time.
NORMAL PRICE OVER £130 each!!

ORDER CODE: SO/357 **OUR PRICE: £60-00**

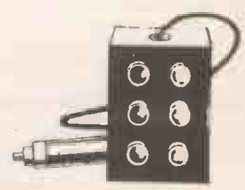
METAL AND VOLTAGE DETECTOR

Very high quality, every tool box should have one.
Locates power cables, gas & water pipes, screws, metal conduit etc etc.
Helps avoid electric shock, power disruption gas leaks and flooding.
Instant visual and audible warning.
Adjustable sensitivity control.
Uses PP3 9V battery (Not supplied)
Colour: Black

ORDER CODE: SO/355 **PRICE: £8-50**

TERMINAL BOX

Terminal junction box for powering d.c. accessories. Gives three pairs of pillar screw terminals, colour coded red and black. 90cm lead fed from cigar lighter plug.
Current:- .... 3A max.
Dims:- .... 84 x 55 x 32mm



ORDER CODE: SO/158 **PRICE: £1-50**

ɪARCO TRADING
ROPS: MINICOST TRADING LTD.

'he Maltings, High Street,
VEM, Shrewsbury, SY4 5EN.

EL: 0939 32763
AX: 0939 33800
ELEX: 35565

.A.T. REG. NO. 280 5760 51

ORDER FORM

CUSTOMER NAME & ADDRESS

DATE:

DESCRIPTION	QTY.	UNIT PRICE	TOTAL PRICE
1991-132 page Catalogue		£1-50	

TICK THE BOX BELOW TO RECEIVE YOUR FREE 4 x AA Ni-CAD BATTERIES. ORDERS MUST BE OVER £30 AND PLACED BEFORE MARCH 31st91 SORRY NO PHOTO-COPIES! ☐

SUB.TOTAL FROM OVERLEAF

Add here any extra P&P for heavy items

ADD P & P £1-75

SUB.TOTAL

TOTAL

IF PAYING BY CREDIT CARD, PLEASE STATE:

NO.:

EXPIRY DATE:

SIGNATURE:

PAYMENT ENCLOSED: VISA/ACCESS, CHEQUE, POSTAL ORDER, CASH, CREDIT NOTE.(Delete As Applicable.)

If any items are not available from stock, tick appropriate box for action required.

Send Order Balance To Follow A. S. A. P. ☐ Hold Order Until Complete ☐ Credit for Out of Stock Items ☐

DESCRIPTION	QTY.	UNIT PRICE	TOTAL PRICE
		SUB.TOTAL	

£99-00

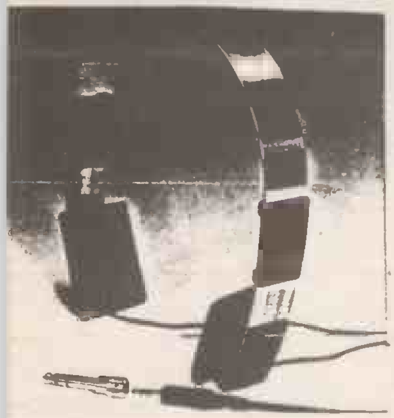
2 FOR

£180-00

CD PLAYER
G060 (CDP10)

- 3-beam semi-conductor laser
- 16 track programmable memory
- Repeat one - repeat all facility
- Built-in 3" disc adaptor
- Track search and index

System Compact disc digital audio system
Optical pick-up 3-beam semi-conductor laser
Error correction CIRC
Sampling frequency 41.1kHz
D/A conversion 16-bit linear
Filter Digital filter + active filter
Frequence response 20-20000Hz
Harmonic distortion <0.09%
S/N ratio >80dB
Channel separation >70dB
Max. output voltage 2Vrms
Power 240Vac 10W
Dims 350 x 90 x 290mm

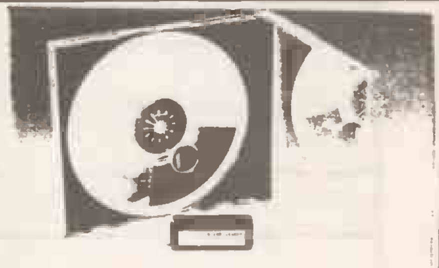


CD DIGITAL HEADPHONES
A080A (HP160JCS)

Uniquely designed high performance digital compatable headphones. The rectangular ear pads contain samarium cobalt transducers, producing an exceptionally broad frequency response and excellent sound quality. The ratchet adjustable broad stainless steel headband and padded earpieces make for a very comfortable fit.

Impedance........22Ω
Frequency response........15-25000Hz
Power........100mW
Lead........2.5mm straight screened
Plug........3.5mm stereo + 6.35mm adaptor
Weight........125g

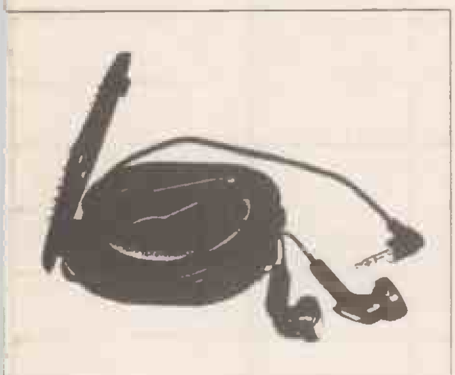
PRICE: £16-75



PRICE: £8-99

CD LENS AUTOCLEANER
A161A (TBY9112)

Wet or dry laser lens cleaning system utilising two brushes built into a standard disc. Supplied complete with a storage case, spare brushes and a bottle of cleaning fluid.

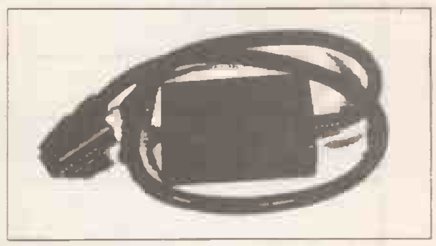


CD DIGITAL EARPHONES
A084B (CD192)

Superb quality stereo earphones using the latest techniques and materials, producing exceptional sound quality over the broad frequency range produced by digital audio equipment. Comes complete with a clam shell storage case.

Impedance........32Ω
Response........20-20000Hz
Power........30mW
Lead........1.2m straight screened
Plug........3.5mm stereo
Weight........34g

PRICE: £7-50



SCART ADAPTOR
T113Z (2XSC) £9-99

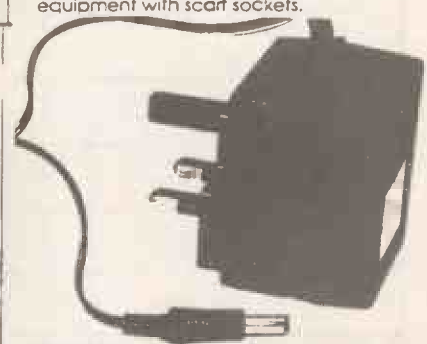
Scart plug to two scart sockets. For coupling together three pieces of audio/video equipment with scart sockets.

SMOKE MACHINE
G002A (NSM2)

The "Nimbus Superfog" is a high quality, powerful smoke machine using an industrial quality pump and heater. Smoke generation is remotely controlled by an electronic handset connected by two-core cable to the smoke machine. The fluid tank is removable for clean filling.

PRICE: £250-00

Heat up time........6 minutes
Fluid flow........1.5 sec/min @ max.
Max. continuous output........30 seconds
Reheat time after max. output..1.5 mins approx.
Smoke generation........0-max. Infinitely variable



PRICE: £2-99

POWER SUPPLY/BATTERY CHARGER
P007G (Z2580)

Plug-in 13.8Vdc 100mA power supply designed to charge 10x AA ni-cad batteries found in mobile CB's, etc. Plugs directly into a 13A socket. Output via integral lead with 2.5mm DC power plug, tip positive. Thermal fuse overload protection.

Input voltage........240Vac 50Hz
Output voltage........13.8Vdc
Output current........100mA
Stability........40%
Ripple........1V
Dims........62 x 51 x 49mm1.00

SMOKE MACHINE FLUID

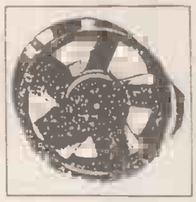
5 litre bottle recommended for the above unit. Non Toxic. Medium persistance. **PRICE: £19-99**

2-WAY ADAPTOR
F342E (CSA134)

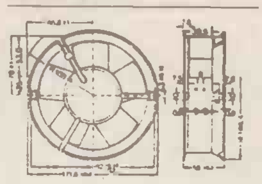
An in-car adaptor to provide two cigar lighter sockets from the single socket provided in the car. Internally fusd at 15A. £2-25

PAPST FAN - TYPE 6124
172 x 55mm 206CFM
Metal Fan housing, impeller of fibreglass reinforced plastic (PA). Electronically commutated dc motor. Counterclockwise rotation viewed from rotor, air output over struts.
Super quality.
List Price: £82-00 each !!!

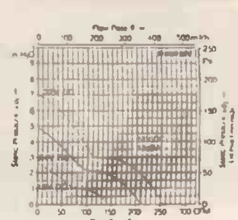
ORDER CODE: SO/256A PRICE: £25-00



Dimensions in mm

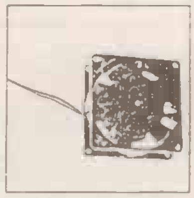


Static pressure v flow rate

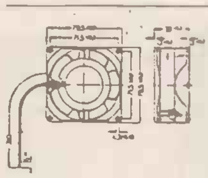


PAPST FAN - TYPE 8112 K
Super quality, in cast aluminium housing. Compact axial dc fan offering high air flow and extremely low power consumption.
SIZE: 80mm x 80mm Depth 38mm
Cut out req: 77mm
Voltage: 12VDC Voltage range: 8-16Vdc.
Power: 3Watts. Air Flow 36 cu.ft/min.
Farnell Price: £34-82!!

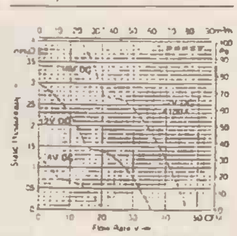
ORDER CODE: SO/255 PRICE: £15-00



Dimensions in mm



Static pressure v flow rate



FINGER GUARD - PLASTIC - 80mm
PAPST finger guard to suit above fans.
Farnell Price: £1-32 ea (LZ32P)

ORDER CODE: SO/256 PRICE: £1-00

EBM FAN - TYPE W2G075-AE21
80mm Depth: 38mm
Super quality, latest model. 12V (8-16V) 2.6W 3450u/min. Made in West Germany.
All aluminium construction. Would cost you over £30-00 each!!

ORDER CODE: SO/257 PRICE: £15-00

TORIN FAN - TYPE TA300
80mm. Depth: 38mm
MADE IN UK ! Aluminium Body
240VAC 0.060/.052 Amps
Impedance protected. Super quality

ORDER CODE: SO/258 PRICE: £5-95

DESOLDERING PUMP
Super quality Desoldering tool. Supplied complete with Teflon Tip.

ORDER CODE: SO/DESOLD £2-99

EPROM SPECIAL - 27C256
Brand new, 250ns. Limited quantity, approx 800 pcs. First come first etc

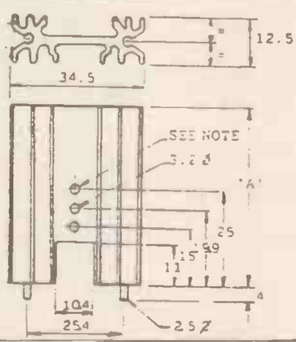
	1+	10+
ORDER CODE: SO/EPROM	£3-00	£2-50

CO-AXIAL SOCKET - PANEL MOUNTING
Very high qulity, Push In panel mounting socket. Mounting hole 18 x 18mm.

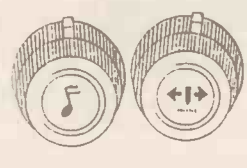
	1+	10+	100+
ORDER CODE: SO/003	18p	15p	10p

HEATSINK REDPOINT TYPE SW50-4
High performance heatsink, designed for plastic power transistors including TO-220, TO-3P, TO-126, TO-218 and TO-202. Fitted with solderable pins & may be vertically mounted.
Design of fins adjacent to mounting face prevents the metal tab touching side fins.Black anodised body. Pre-drilled
Length: 50mm Width: 34.5mm, Depth: 12.5mm
Thermal Rating: 8.6°C/W (List price 95p)

	1+	10+
ORDER CODE: SO/260		
PRICE:	50p	45p



CAR STEREO KNOBS



F209A SK05

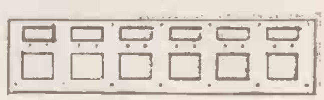
Complete set of silver knobs for car stereo radio/cassette player. 4 knobs gives one each for volume, tuning, balance and tone. Serrated edges. Push on with anti-rotation spigots.
Max. dia:- 34mm

	1+	10+
PRICE:	50p	40p

RELAY MOUNTING PLATE - RS 349-119
Pre-punched aluminium mounting plate to take six 'continental' relays, two or four-pole types only, or their sockets, side by side.
Length: 158mm Width: 38mm Thickness 1.6mm
RS Price: 46p each

ORDER CODE: SO/254 Price: 25p each

mounting plate



L.158 W.38 T.16

IEC MAINS LEADS -

6A 250V

Good quality moulded leads, all the approved marks i.e. VDE, D, S, FI, N, etc.

Moulded IEC socket on one end with 2-pin European style plug on other end. To use in U.K. simply cut off European plug and fit standard 13A mains plug.

Colour: Black
Length: 2 metres

RIGHT-ANGLE VERSION

We can offer substantial discounts on larger quantities.

ORDER CODE: SO/IEC/RA

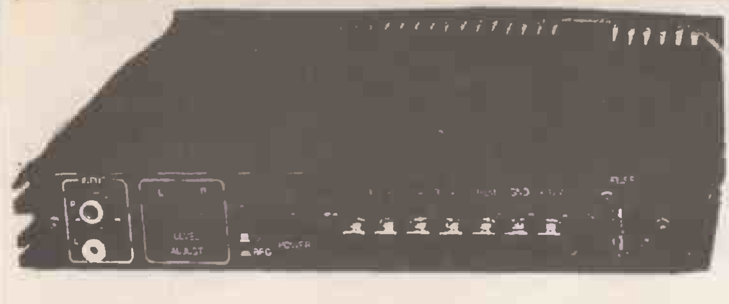
	1+	10+	100+
PRICE -	85p	80p	65p

STAR BUY

IEC LEAD 250V 10A Right Angle
Made By BELDEN
This may be the highest quality lead available. Fully screened cable, moulded IEC socket one end with USA plug on the other.
To use in UK, simply cut off the USA plug and wire up a standard 13A plug.
At time of printing we have over 12,000 of these leads and therefore able to offer very attractive quantity prices.
Markings on cable: 18-3 Type SJT E-3462 LL-7874 Shielded GE
Colour: BLACK
Length: 2 Mts

	1+	10+	100+
ORDER CODE: SO/307	£1-25	£1-00	75p

ALL PRICES INCLUDE 15% VAT SIMPLY ADD £1-75 POST & PACKING PER ORDER



2 x 60W CLASS "A" AMPLIFIER
B005LA (CPA100)

PRICE

£39-99

Class "A" stereo in-car amplifier capable of delivering 2 x 60W stereo or 120W mono in bridge mode. Inputs are low level phono, with left and right level controls. Full thermal and overload protection.

Output power .... 2 x 60W stereo 0.1%THD
120W mono 0.1%THD
Signal to noise ratio .... >80dB
Frequency response 20-20000Hz
Input sensitivity .... 100mV-3V adjustable
Input Impedance .... Low level input 20kΩ
Output impedance 4Ω
Power 14.4Vdc 15A
Dims .... 240 x 120 x 50mm

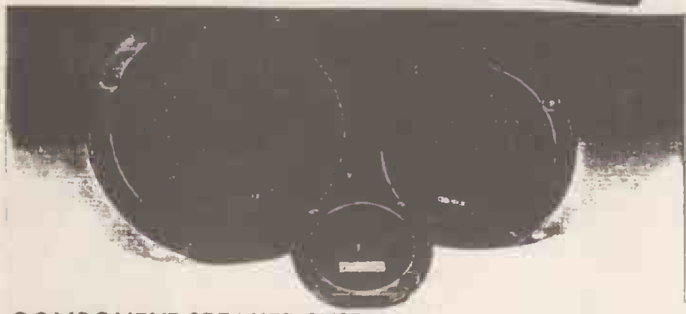
2x 200W CLASS "A" AMPLIFIER
B005M CPA200

PRICE

£99-99

High power class "A" amplifier capable of delivering 2x 200W stereo or 400W mono in bridge mode. Inputs are direct from the speaker outputs of the car radio/cassette or low level phono inputs, with left and right level controls. Full thermal and overload protection.

Output power .... 2x 200W stereo 0.08%THD
400W mono 0.2% THD
Signal to noise ratio .... >90dB
Frequency response 10-50000Hz
Input sensitivity .... 100mV-3V adjustable
Input impedance .... High level input 100Ω
Low level input 20kΩ
Output Impedance 4Ω
Damping factor .... >180 into 4Ω
Power .... 14.4Vdc 43A nom
Dims .... 240 x 180 x 50mm



COMPONENT SPEAKER SYSTEM
B020 (TC6500) PRICE: 19-99

Good quality 2 x 3-way component speaker system comprising: two 6.5" woofers, two 4" mid range, two 2.25" tweeters and all leads, filters and fixing screws. Finished in black with black mesh grilles.

Maximum power 60W
Frequency response 60-20000Hz
Speaker sizes .... 6.5" woofer, 4" mid range, 2.25" tweeter
Impedance 4Ω

40W SHELF SPEAKERS
B020B (TX300E) PRICE: £10-50

Good quality 3-way bass reflex shelf mounting speaker system. Dual ported wedge shaped black plastic case with metal grilles. 40W max. power handling per speaker.

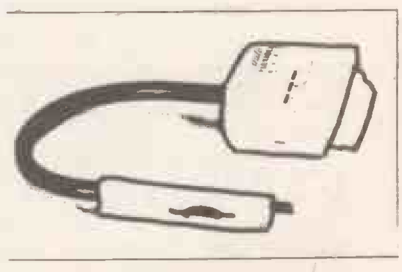
Maximum power 40W
Frequency response 80-18000Hz
Speaker size .... 3" woofer, 2" mid range, 1" tweeter

12Vdc CAR FAN
B047 (SC711) £4-99

A 12Vdc oscillating car fan with a large suction cup for attaching the fan to the dashboard. Fully adjustable for tilt and angle. Supplied with a 1.7m lead fitted with a cigar lighter plug.

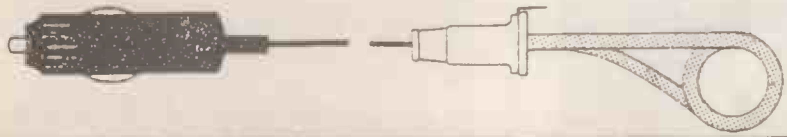
POWER SUPPLY
CAR/PSU/1 £3-25

DC to DC adaptor. Plugs into car cigar lighter aperture. Outputs 3, 4.5, 6, 7.5, 9, 12V @ 800mA. Has universal output spider plug, also 9V battery snap and polarity reversing facility.



BATTERY ANALYSER /MAP LIGHT
B034A (L910) £3-99

A plug-in car battery charge analyser with built-in two-colour map light. Three LEDs indicate the battery level. A switch on the side switches on the map light with either green or white illumination. Flexible stem allows adjustment for best view. Plugs directly into a cigar lighter socket.



IMMERSION HEATER
CAR/IH £2-99

A handy mobile immersion heater for boiling water, soup, etc. Plugs into cigar lighter socket. Power 12Vdc 120W
Lead length 1m.

SECONDHAND TEST EQUIPMENT

TEST EQUIPMENT SPECIAL
All secondhand, good quality, therefore demand is high. We offer a list of items available at time of printing. This list changes almost daily. Contact us as soon as possible to avoid disappointment.

HEWLETT PACKARD LOGIC ANALYZER & ACCESSORIES
Model HP1631D complete with Disc Drive HP9122D, Printer HP2225A, various probes listed at over £200!
This analyzer is a current model and would cost you over £14,000 without the disc drive etc!
We only have one left now, special price £1500.
Supplied complete with any manuals we have.

ORDER CODE: SO/HP PRICE: £1500-00

TEKTRONIX 475 OSCILLOSCOPE
Dual Trace 200MHz Delay Sweep PRICE: £575

PHILIPS PM3217 OSCILLOSCOPE
Dual Trace 50MHz Delay Sweep PRICE: £420

PHILIPS PM3312 OSCILLOSCOPE
Dual Trace 25MHz TV Trig. PRICE: £320

PHILIPS PM321 OSCILLOSCOPE
Dual Trace 100MHz Delay Time Base PRICE: £775

CARRIAGE: £15-00 ON ALL SCOPES.

AVO 8 METERS
Complete with carrying case & leads and user instruction booklet. PRICE:£49
(Carr. £3-50)

BASF CASSETTES
Type 90 - used once, bulk erased as above. All fully guaranteed.
Sorry, but at time of printing no inlay cards with these tapes. If we get some we will send them with the tapes.

ORDER CODE: SO/BASF £5-00 per 10
£30-00 per 100

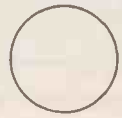
SKC GX90 CASSETTES
Very high quality tapes. which although not well known in the retail market are indeed well known to the professional user.
These tapes are supplied complete with inlay cards and labels.
As with the BASF tapes, these tapes have been used once and then bulk erased.
ALL FULLY GUARANTEED

ORDER CODE: SO/SKC £6-00 per 10
£40-00 per 100

NEONS
Highest quality IMO range of Neon indicators. Limited stock.
These neons are offered at almost half price, are perhaps the highest quality you can buy.
These neons are all in the 1991 IMO range of product.

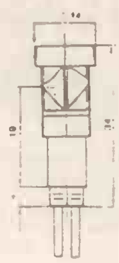
IMO CODE	Volts	Colour	Neon Size	Shape	Mount. Hole	Connect.	ORDER CODE
NI12RL240AS	240VAC	AMBER	14mm	Round	12mm	Lead	SO/400
NI12RL240GS	240VAC	GREEN	14mm	Round	12mm	Lead	SO/401
NI12RL240RS	240VAC	RED	14mm	Round	12mm	Lead	SO/402
NI12RT240AS	240VAC	AMBER	14mm	Round	12mm	Tag	SO/403
NI12RT240CS	240VAC	CLEAR	14mm	Round	12mm	Tag	SO/404
NI12RT240GS	240VAC	GREEN	14mm	Round	12mm	Tag	SO/405
NI12SL240AS	240VAC	AMBER	14x14mm	Square	12x12mm	Lead	SO/406
NI12SL240CS	240VAC	CLEAR	14x14mm	Square	12x12mm	Lead	SO/407
NI12SL240GS	240VAC	GREEN	14x14mm	Square	12x12mm	Lead	SO/408
NI12SL240RS	240VAC	RED	14x14mm	Square	12x12mm	Lead	SO/409
NI12ST240AS	240VAC	AMBER	14x14mm	Square	12x12mm	Tag	SO/410
NI12ST240CS	240VAC	CLEAR	14x14mm	Square	12x12mm	Tag	SO/411
NI12ST240GS	240VAC	GREEN	14x14mm	Square	12x12mm	Tag	SO/412
NI12ST240RS	240VAC	RED	14x14mm	Square	12x12mm	Tag	SO/413
NI9RL240AS	240VAC	AMBER	10mm	Round	9mm	Lead	SO/414
NI9RL240CS	240VAC	CLEAR	10mm	Round	9mm	Lead	SO/415
NI9RL240GS	240VAC	GREEN	10mm	Round	9mm	Lead	SO/416
NI9RL240RS	240VAC	RED	10mm	Round	9mm	Lead	SO/417
NI9RT240AS	240VAC	AMBER	10mm	Round	9mm	Tag	SO/418
NI9RT240CS	240VAC	CLEAR	10mm	Round	9mm	Tag	SO/419
NI9RT240GS	240VAC	GREEN	10mm	Round	9mm	Tag	SO/420
NI9RT240RS	240VAC	RED	10mm	Round	9mm	Tag	SO/421
NI9SL240AS	240VAC	AMBER	10x10mm	Square	9x9mm	Lead	SO/422
NI9SL240CS	240VAC	CLEAR	10x10mm	Square	9x9mm	Lead	SO/423
NI9SL240GS	240VAC	GREEN	10x10mm	Square	9x9mm	Lead	SO/424
NI9SL240RS	240VAC	RED	10x10mm	Square	9x9mm	Lead	SO/425
NI9ST240AS	240VAC	AMBER	10x10mm	Square	9x9mm	Tag	SO/426
NI9ST240CS	240VAC	CLEAR	10x10mm	Square	9x9mm	Tag	SO/427
NI9ST240GS	240VAC	GREEN	10x10mm	Square	9x9mm	Tag	SO/428
NI9ST240RS	240VAC	RED	10x10mm	Square	9x9mm	Tag	SO/429

14mm dia.

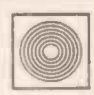


14 x 14mm

10mm dia.



10 x 10mm

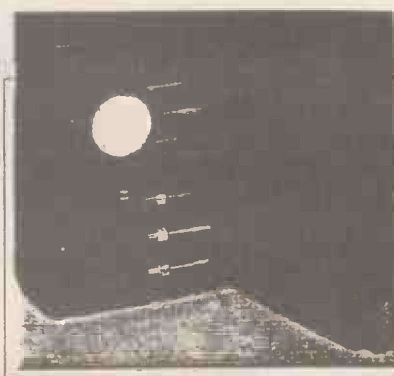


Only a few hundred of each type, don't delay, order to-day
Colours and types may be mixed to obtain 10+ price.

PRICE: 1+ 50p 10+ 40p

£12-50

GAS SOLDERING IRON
Y060H (S1752)
Butane powered catalytic soldering iron with cap containing the starting flint. A fully portable soldering iron, re-fillable from standard butane lighter fuel canister.



£27-99

GAS SOLDERING IRON KIT
Y060G (S1751)
Butane powered catalytic soldering iron kit comprising: gas tank and regulator, catalytic soldering iron tip, catalytic hot knife tip, heat blower tip, blow torch, 3 auxiliary cold tools, sponge, cap with flint and carrying case. A fully portable hot tool kit. Re-fillable from standard butane lighter fuel canisters.

GAS SOLDERING IRON ACCESSORIES

Y060GA (GST1) 1mm soldering iron tip
Y060GF (GSTFT) Flat flame tip
Y060GB (GST24) 2.4mm soldering iron tip
Y060GG (GSTHA) Hot air tip
Y060GC (GST36) 3.6mm soldering iron tip
Y060GH (GSTHK) Hot knife tip
Y060GD (GST48) 4.8mm soldering iron tip
Y060GJ (GSTPC) Polyform cutter tip
Y060GE (GSTB) Blow torch tip

£3-50 each

ALL PRICES INCLUDE 15% VAT SIMPLY ADD £1-75 POST & PACKING PER ORDER

SPECIAL OFFER

Unexpectedly, we have obtained further stocks of this super multimeter which was our December special offer. Therefore, we are extending this amazing offer until our stock is all sold. Limited quantity available, order to-day to avoid disappointment. In December we sold hundreds of these meters!!

10MΩ MULTIMETER

- ★ 19 ranges
- ★ 3½ digit 12mm LCD display
- ★ Signal injector function
- ★ Diode test
- ★ Fuse protection
- ★ Automatic polarity and zero
- ★ Test leads with 4mm plugs

AC volts..............0-200-750Vac ±1.2%
DC volts..............0-200m-2-20-200-1000Vdc ±0.8%
DC current......0-200µ-2m-20m-200m-2Adc ±1.0%
Resistance..............0-200-2k-20k-200k-2MΩ ±0.8%
Signal Injector ....50Hz square wave. 5V peak to peak
Dims ....126 x 70 x 24mm

Battery and instruction manual included.

STAR BUY

Y122AJ (MX190)

SPECIAL PRICE £15-99

(NORMAL PRICE £39-50)

LATEST CATALOGUE

HAVE YOU GOT YOUR COPY YET ???

- * 132 illustrated pages
- * Super Free Gifts Offer
- * First Class Pre-paid Envelope
- * Full Colour Kit Catalogue
- * Full Colour 32 page New Lines Supplement
- * 10 Pages of Special Offers
- * Order Forms
- * Quanity Price Offers
- * Video & TV Spares section
- * Very latest Special Offer List
- * Details of our 3 Retail Shops

ALL THIS FOR ONLY £1-50 !!!

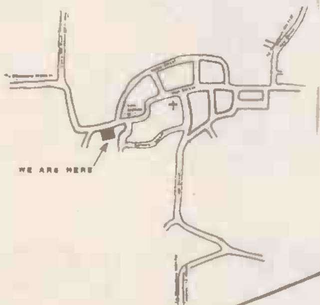
SEND FOR YOUR COPY NOW.........

ALL PRICES INCLUDE 15% VAT — SIMPLY ADD £1-75 POST & PACKING PER ORDER

HEAD OFFICE

MARCO TRADING,
THE MALTINGS,
HIGH STREET,
WEM,
SHREWSBURY. SY4 5EN

TEL:0939-32763 FAX:0939-33800 TELEX:35565



HOURS OF BUSINESS

MON.	9.00-6.00
TUES.	9.00-6.00
WED.	9.00-6.00
THURS.	9.00-6.00
FRI.	9.00-6.00
SAT.	9.00-12.0
SUN.	CLOSED

BRANCHES

SUPERTRONICS,
65 HURST STREET,
BIRMINGHAM. B5 4TE

TEL: 021 666 6504

HOURS OF BUSINESS

MON.	9.00-6.00
TUES.	9.00-6.00
WED.	9.00-6.00
THURS.	9.00-6.00
FRI.	9.00-6.00
SAT.	9.00-6.00
SUN.	CLOSED

WALTONS,
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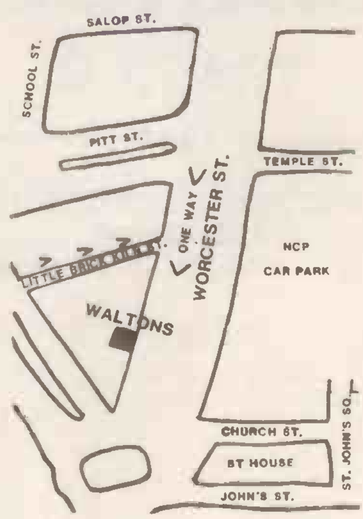
WOLVERHAMPTON.
WV2 4LL

TEL: 0902 22039



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MON.	9.00-6.00
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WED.	9.00-6.00
THURS.	9.00-6.00
FRI.	9.00-6.00
SAT.	9.00-6.00
SUN.	CLOSED