DECEMBER 1990

EVERYDAY ELECTRONICS

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DESIGN YOUR OWN CIRCUITS

EIGHT CHANNEL MICROCOMPUTER CONTROLLED LIGHT SEQUENCER

VERSATILE BENCH POWER SUPPLY

FREE INSIDE!
MAGENTA ELECTRONICS 1991 CATALOGUE

PLUS INDEX FOR 1990

ISSN 0262-3617

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The No.1 Magazine for Electronic & Computer Projects

ONE POUND PACKS

All packs are £1 each. Note the figure on the extreme left of the pack ref number and the next figure is the quantity of items in the pack, finally a short description.

BD2 5 13A spurs provide a fused outlet to a ring main where devices such as a clock must not be switched off.

BD9 2 6V 1A mains transformers uprioht mountino with fixing clamps.

BD13 12 30 watt reed switches, it's surprising what you can make with these—burglar alarms, secret switches, relay, etc., etc.

BD22 2 25 watt loudspeaker two unit crossovers.

BD30 2 Nicad constant current chargers adapt to charge almost any nicad battery.

BD32 2 Humidity switches, as the air becomes damper the membrane stretches and operates a microswitch.

BD42 5 13A rocker switch three tags so on/off, or change over with centre off.

BD45 1 24hr time switch, ex-Electricity Board, automatically adjust for lengthening and shortening day, original cost £40 each.

BD49 5 Neon valves, with series resistor, these make good night lights.

BD56 1 Mini uniselector, one use is for an electric jigsaw puzzle, we give circuit diagram for this. One pulse into motor, moves switch through one pole.

BD67 1 Suck or blow operated pressure switch, or it can be operated by any low pressure variation such as water level in water tanks.

BD103A 1 6V 750mA power supply, nicely cased with mains input and 6V output leads.

BD120 2 Stripper boards, each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc.

BD132 2 Plastic boxes approx 3in cube with square hole through top so ideal for interrupted beam switch.

BD134 10 Motors for model aeroplanes, spin to start so needs no switch.

BD137 1 6½ inch 4 ohm speaker 10W rating.

BD139 6 Microphone inserts—magnetic 400 ohm also act as speakers.

BD148 4 Reed relay kits, you get 16 reed switches and 4 coil sets with notes on making c/o relays and other gadgets.

BD149 6 Safety cover for 13A sockets—prevent those inquisitive little fingers getting nasty shocks.

BD180 6 Neon indicators in panel mounting holders with lens.

BD193 6 5 amp 3 pin flush mounting sockets make a low cost disco panel.

BD199 1 Mains solenoid, very powerful, has tin pull or could push if modified.

BD201 8 Keyboard switches—made for computers but have many other applications.

BD211 1 Electric clock, mains operated, put this in a box and you need never be late.

BD221 5 12V alarms, make a noise about as loud as a car horn. Slightly soiled but OK.

BD252 1 Panostat, controls output of boiling ring from simmer up boil.

BD259 50 Leads with push-on ¼in tags—a must for hook ups—mains connections etc.

BD263 2 Oblong push switches for bell or chimes, these can mains up to 5 amps so could be foot switch if fitted into pattress.

BD268 1 Mini 1 watt amp for record player. Will also change speed of record player motor.

BD305 1 Tubular dynamic mic with optional table rest.

BD653 2 Miniature driver transformers. Ref. LT44. 20k to 1k centre tapped.

BD548 2 3.5V relays each with 2 pairs changeover contacts.

BD667 2 4.7 µf non-polarised block capacitors, pcb mounting.

There are over 1,000 items in our Catalogue. If you want a complete copy please request this when ordering.

METAL PROJECT BOX Ideal for battery charger, power supply etc. Sprayed grey size 8" x 4" x 4½". Louvred for ventilation. Price £3.00. Ref. 3P75.

FLOPPY DISCS 5¼" pack of 10 £5.00 Ref. 168 3½" pack of 15 £10.00 Ref 10P88

PERSONAL STEREOS Again customer returns but complete and with stereo head phones. A bargain at only £3.00 each. Our ref 3P83.

MICROWAVE CONTROL PANEL Mains operated, with touch switches. This unit has a 4 digit display with a built in clock and 2 relay outputs—one for power and one for pulsed power level. Could be used for all sorts of timer control applications. Only £6.00. Our ref 6P18.

EQUIPMENT WALL MOUNT Multi adjustable metal bracket ideal for speakers, lights, etc. 2 for £5.00. Our ref 5P152.

NEW MAINS MOTORS 25 watt 3000 rpm made by Framco. Approx 6" x 3" x 4". Priced at only £4.00 each. Our ref 4P54.

SHADED POLE MOTORS Approx 3" square. Available in 24V and 240V AC. Both with threaded output shaft and 2 fixing bolts. Price is £2.00 each. 24V Ref 2P65, 240V Ref 2P66.

SUB-MIN TOGGLE SWITCH Body size 8mm x 4mm x 7mm SBDT with chrome dolly fixing nuts. 3 for £1. Order ref BD649.

COPPER CLAD PANEL for making PCB. Size approx 12in long x 8½in wide. Double-sided on fibreglass middle which is quite thick (about 1 16in) so this would support quite heavy components and could even form a chassis to hold a mains transformer, etc. Price £1 each. Our ref BD683.

POWERFUL IONISER

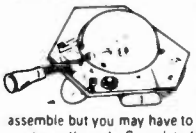
Generates approx. 10 times more IONS than the ETI and similar circuits. Will refresh your home, office, workroom etc. Makes you feel better and work harder – a complete mains operated kit, case included. £18. Our ref 18P2.

2KV 500 WATT MAINS TRANSFORMERS. Suitable for high voltage experiments or as a spare for a microwave oven etc. £10.00 Ref 10P93

REAL POWER AMPLIFIER for your car, it has 150 watts output. Frequency response 20hz to 20Khz and signal to noise ratio better than 60dB. Has built in short circuit protection and adjustable input level to suit your 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 6½" woofer, 2" mid range and 1" tweeter. Ideal to work with the amplifier described above. Price per pair £30.00. Order ref: 30P7.

VIDEO TAPES These are three hour tapes of superior quality, made under licence from the famous JVC Company. Offered at only £3 each. Our ref 3P63. Or 5 for £11. Our ref 11P3. Or for the really big user 10 for £20. Our ref 20P20.



ELECTRONIC SPACESHIP. Sound and impact controlled, responds to claps and shouts and reverses when it hits anything. Kit with really detailed instructions. Ideal present for budding young electrician. A youngster should be able to assemble but you may have to help with the soldering of the components on the pcb. Complete kit £10. Our ref. 10P81

COMPUTER KEYBOARDS Brand new, uncased. £3.00 each. ref 3P89.

12" HIGH RESOLUTION MONITOR. Amber screen, beautifully cased for free standing, needs only 12V 1.5 amp supply. TTL input separate syncs. Brand new in makers' cartons. Price £22.00. Order ref 22P2

SINCLAIR C5 WHEELS

Including inner tubes and tyres. 13" and 16" diameter spoked poly carbonate wheels. Finished in black. Only £6.00 each.
13" Ref 6P10, 16" Ref 6P11

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

LINEAR POWER SUPPLY Brand new +5v 3A, +/−12v 1A. Complete with circuit diagram. Short circuit protected. Our price £12.00. Ref 12P21

3½in FLOPPY DRIVES We still have two models in stock: Single sided, 80 track, by Chinon. This is in the manufacturers metal case with leads and IDC connectors. Price £40, reference 40P1. Also a double sided, 80 track, by NEC. This is uncased. Price £60.00, reference 60P2. Both are brand new.

10 MEMORY PUSHBUTTON TELEPHONES These are customer returns and "sold as seen". They are complete and may need slight attention. Price £6.00. Ref. 6P16 or 2 for £10.00. Ref. 10P77. BT approved.

INDUCTIVE PROXIMITY SWITCHES These will detect ferrous or nonferrous metals at approx. 10mm and are 10-36V operation. Ideal for alarms position sensors, etc. RS price is £64.00 each! Ours £12.00. Ref. 12P19.

BOSCHERT SWITCHED MODE POWER SUPPLIES −5V at 15A, +12V at 3A, −12V at 2A, +24V at 2A. 220V or 110V input. Brand new and guaranteed. Retail price is £180!! Ours £20. Ref. 20P30.

TV SOUND DECODER. Nicely cased, mains powered with 8 channels. Will drive a small speaker directly or could be fed into HI FI system etc. £12.00 each. Ref 12P22.

PC POWER SUPPLIES Brand new with built in fan and power switch on the back. +5, −5, +12, −12V. 150 watt made by AZTEC £25.00 each. Ref 25P18

VERY POWERFUL 12 VOLT MOTORS. ½rd Horsepower. Made to drive the Sinclair C5 electric car but adaptable to power a go-kart, a mower, a rail car, model railway, etc. Brand new. Price £20. Our ref 20P22.

AS ABOVE with gearbox. £40. Ref 40P8

PHILIPS LASER

This is helium-neon and has a power rating of 2mW. Completely safe as long as you do not look directly into the beam when eye damage could result. Brand new, full spec. £35. Our ref. 35P1. Mains operated power supply for this tube gives 8kv striking and 1.25kv at 5mA running. Complete kit with case £15.

PANEL METERS 270 deg movement. New, £3.00 each. Our ref 3P87

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

CB CONVERTERS Converts a car radio into an AM CB receiver. £4.00. Our ref 4P48.

GEIGER COUNTER KIT includes PCB, tube, loudspeaker, and all components to build a 9v battery operated geiger counter. Only £39. Our ref 39P1.

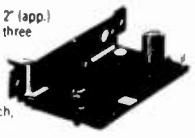
12V TO 220V INVERTER KIT This kit will convert 12v DC to 220v AC. It will supply up to 130 watts by using a larger transformer. As supplied it will handle about 15 watts. Price is £12. Our ref 12P17.

5¼" 360K DISC DRIVES. Brand new HALF HEIGHT disc drives made by Mitsubishi. Limited quantity available at £35.00. Ref. 35P5.

HIGH RESOLUTION MONITOR 9in black and white, used Philips tube M24/360W. Made up in a lacquered frame and has open sides. Made for use with OPD computer but suitable for most others. Brand new. £20. Our ref 20P26.

12 VOLT BRUSHLESS FAN. Japanese made. The popular square shape (4½in x 4½in x 1¾in). The electronically run fans not only consume very little current but also they do not cause interference as the brush type motors do. Ideal for cooling computers, etc., or for a caravan. **£8 each.** Our ref 8P26.

MINI MONO AMP on p.c.b. size 4" x 2" (app.) Fitted Volume control. The amplifier has three transistors and we estimate the output to be 2W rms. More technical data will be included with the amp. Brand new, perfect condition, offered at the very low price of £1.15 each, or 13 for £12.00.



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POPULAR ITEMS — MANY NEW THIS MONTH

MAINS FANS Snail type construction. Approx. 5" x 4" mounted on a metal plate for easy fixing. New. £5.00 each. Our ref 5P166.

MICROWAVE TURNTABLE MOTOR Complete with weight sensing electronics that would have varied the cooking time. Ideal for window displays, etc. Only £5.00. Our ref 5P165.

PC STYLE CASES 18" X 18" X 6" Complete with fan and grill illuminated power switch and IEC filtered power input plug. Priced at only £15.00. Ref. 15P38.

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

MAINS AXIAL FANS. Brand new 5" diameter powerful silent fans with shaped pole motors. Yours for £3.00. Ref 3P112

AA CELLS Probably the most popular of the rechargeable NICAD types. 4 for £4.00. Our ref. 4P44.

20 WATT 4 OHM SPEAKER With built in tweeter. Really well made unit which has the power and the quality for hifi 6½" dia. Price £5.00. Our ref. 5P155 or 10 for £40.00 ref. 40P7.

MINI RADIO MODULE Only 2in square with ferrite aerial and solid dia. tuner with own knob. It is superhet and operates from a PP3 battery and would drive a crystal headphone. Price £1.00. Our ref. BD716.

BULGIN MAINS PLUG AND SOCKET The old and faithful 3 pin with screw terminals. The plug is panel mounted and the socket is cable mounted. 2 pairs for £1.00 or 4 plugs or 4 sockets for £1.00. Our ref: BD715, BD715P, or BD715S.

MICROPHONE Low cost hand held dynamic microphone with on/off switch in handle. Lead terminates in 1 3.5mm and 1 2.5mm plug. Only £1.00. Ref. BD711.

MOSFETS FOR POWER AMPLIFIERS AND HIGH CURRENT DEVICES 140V 100 watt pair made by Hitachi. Ref 2SJ99 and its complement 2SK343. Only £4.00 a pair. Our ref: 4P51.

TIME AND TEMPERATURE LCD MODULE A 12 hour clock & Celsius and Fahrenheit thermometer & too hot alarm and a too cold alarm. Approx 50x20mm with 12.7mm digits. Requires 1AA battery and a few switches. Comes with full data and diagram. Price £9.00. Our ref. 9P5.

REMOTE TEMPERATURE PROBE FOR ABOVE. £3.00. Our ref. 3P60.

PAPST fan 80 x 80mm 230V. Our ref 9P7. Price £9.

PAPST fan 120 x 120mm 230V. Our ref 6P6. Price £6.

600 WATT AIR OR LIQUID MAINS HEATER Small coil heater made for heating air or liquids. Will not corrode, lasts for years. Coil size 3" x 2" mounted on a metal plate for easy fixing. 4" dia. Price £3.00. Ref. 3P78 or 4 for £10.00. Our ref. 10P76.

EX-EQUIPMENT POWER SUPPLIES Various makes and specs, ideal bench supply. Only £8.00. Our ref. 8P36.

ACORN DATA RECORDER Made for the Electron or BBC computer but suitable for others. Includes mains adaptor, leads and book. £12.00. Ref. 12P15.

SOLDER

22 SWG 60/40 resin cored solder, ½KG reel, top quality £4.00. Ref 4P70

NEW PIR SENSORS Infra red movement sensors will switch up to 1000W mains. UK made. 12 months manufacturers warranty. 15-20m range with a 0-10mm timer, adjustable wall bracket. Our ref 25P16. Price £25.

GEARBOX KITS Ideal for models, etc. Contains 18 gears (2 of each size), 4 x 50mm axles and a powerful adjustable speed motor. 9-12V operation. All the gears, etc. are 2mm push fit. £3.00 for the complete kit. Ref. 3P93.

MINI HIFI SPEAKERS Made for televisions, etc. Two sizes available. 70mm x 57mm 3W 8 ohm, 2 for £3.00. Ref 3P99. 127mm x 57mm 5W 8 ohm, 2 for £3.00. Ref. 3P100.

TELEPHONE EXTENSION LEAD 5m phone extension lead with plug on one end, socket on the other. White. Price £3.00. Our ref. 3P70 or 10 leads for only £19.00! Ref. 19P2.

LCD DISPLAY 4½" digits supplied with connection data £3.00. Ref. 3P77 or 5 for £10. Ref. 10P78.

CROSS OVER NETWORK 8 Ohm 3 way for tweeter midrange and woofer nicely cased with connections marked. Only £2.00. Our ref. 2P255 or 10 for £15.00. Ref. 15P32.

BASE STATION MICROPHONE Top quality uni-directional electret condenser mic 600r impedence sensitivity 16-18KHz – 68db built in chime complete with mic stand bracket. £15.00. Ref. 15P28.

MICROPHONE STAND Very heavy chromed mic stand, magnetic base 4" high. £3.00 if ordered with above mic. Our ref. 3P80.

SOLAR POWERED NICAD CHARGER 4 Nicad AA battery charger. Charges 4 batteries in 8 hours. Price £6.00. Our ref. 6P3.

YUASHA SEALED LEAD ACID BATTERIES. 6V 10AH only £9.00 each or 2 for £15.00. Ref 15P37

STC SWITCHED MODE POWER SUPPLY. 220V or 110V operation giving 5V at 2A, +24V at 0.25A, −12V at 0.15A and +90V at 0.4A £12.00 each. Ref 12P27

SOLDERING IRON STAND Price £3.00. Our ref. 3P66

INCAR GRAPHIC EQUALIZER/BOOSTER Slimline 7 band with built in 30 watts per channel amplifier. 12V operation, twin 5 LED power indicators, 20-21KHz with front and rear fader plus headphone output! Brand new and guaranteed. Only £25.00. Ref. 25P14.

MODEMS Dial up brand new units. Made by GEC. No data available, but good value at £18.00. Ref 18P6.

CAR IONIZER KIT Improve the air in your car, clears smoke and helps prevent fatigue. Case req. Price £12.00. Our ref. 12P8.

NEW FM BUG KIT New design with PCB embedded coil 9v operation. Priced at £5.00. Our ref. 5P158.

NEW PANEL METERS 50UA movement with three different scales that are brought into view with a lever. Price only £3.00. Ref. 3P81.

ELECTRONIC SPEED CONTROL KIT Suitable for controlling our powerful 12v motors. Price £17.00. Ref. 17P3 (heatsink required).

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

JOYSTICKS. Brand new, can be adapted for most machines by changing the connector. Complete with 2 fire buttons and suction feet 2 for £5.00. Ref 5P174

FIVE POUND MYSTERY PACKS. We have decided to reintroduce our mystery packs once again. After a gap of 4 years we have amassed quite a lot of stock! For £5.00 you will receive a selection of goods containing at least £12.00 worth of goods at our normal low prices. Ref 5P175.

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EVERYDAY ELECTRONICS
INCORPORATING ELECTRONICS MONTHLY
ABC

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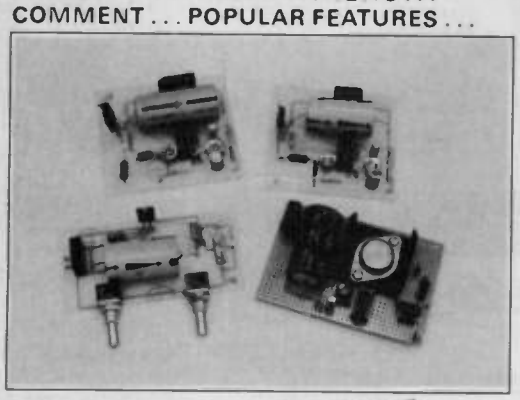
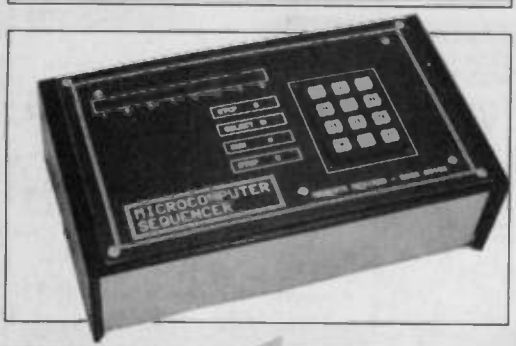
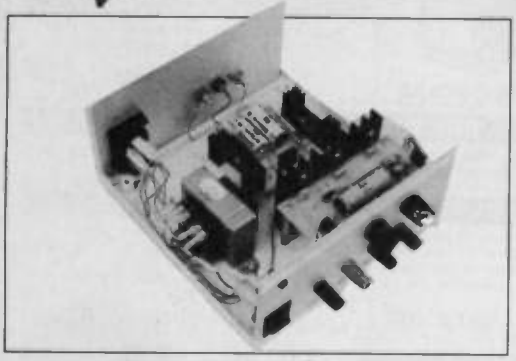
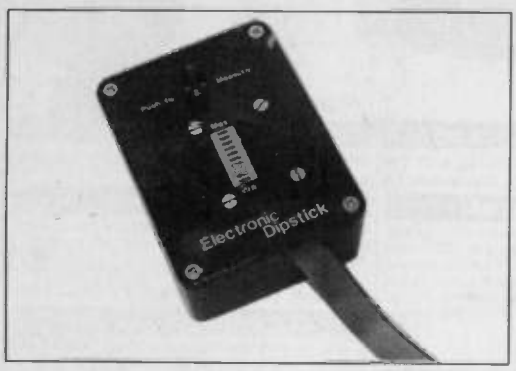
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .









Projects

Series

Features

FREE WITH THIS ISSUE

Magenta Electronics Ltd 1990-1991 catalogue, between pages 800 and 801

Our January '91 Issue will be published on Friday, 7 December 1990. See page 813 for details.

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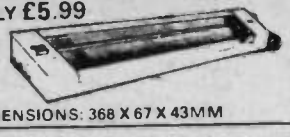

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AA	95p	85p
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1W 5 off (365)	£15.25
2W 5 off (365)	£25.00
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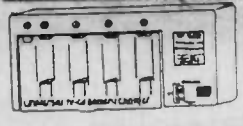

Charges AA, AAA, C, D & PP3 Ni-Cads 240V AC

£4.99

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Includes:
- ★ Optima Alarm Control Panel
- ★ External Red Bell Box
- ★ 2 x 1 Internal Passive I.R.
- ★ 2 x Door Contacts
- ★ Siren for bell box
- ★ 100 mtrs. cable and clips
- ★ Full fitting instructions

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1 x CAMERA

1 x CAMERA BRACKET NEW

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SOLDER 18 & 22 SWG -500gm REEL

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18swg	£4.95	£4.70
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Remember: Our prices INCLUDE VAT!

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Approx 10 lengths odd assorted sizes from 1.6mm to 12.7mm. Lengths 12"

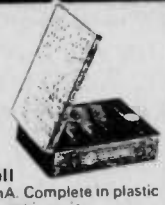
PRICE £1.00 ea

BRS TURNTABLE

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

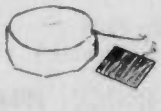
ONLY £9.99

SOLAR PRODUCTS



Battery charger
Charges up to 4 x AA Ni-cads in 10-14 hours (2-3 hours per battery).
Price: £8.50

Solar Cell
0.5V 700mA. Complete in plastic frame, connect in series for higher voltage.
Price: £3.99



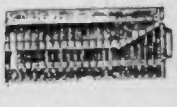
Solar Turntable
Ideal for shop window, house plants etc. Simply place in sunlight. Will turn up to 30lb load.
Price: £13.50

Educational Kit
A must for beginners. Contains instruction book, DC motor, solar panel, wire clips, spinner disc, etc.
Price £6.99

21-PIECE TOOL SET

21 pc precision tool set in plastic moulded clear case with sliding lid. Set contains: 6 x flat blade screwdrivers, 0.9-3.5mm; 2 x cross head screwdrivers No0 & No 1; 3 hex key wrenches 1.5, 2.0, 2.5mm; 5 nut drivers, 3.0, 3.5, 4.0, 4.5, 5.0mm; 5 spanners, 4.0, 4.5, 5.0, 5.5, 6mm and a tommy bar. TOOL/21PC

£6.50



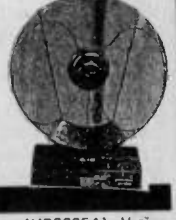
ILLUMINATED MAGNIFIER

Very handy, illuminated magnifier with mains lens X2 and pull out lens X8 magnification. Main lens can be illuminated for map or book reading. Uses 2 x AA batteries (Yes, supplied). Overall length, extended 6" (150mm)

PRICE: 7.50. HURRY LIMITED QTY

12V/240V UHF/VHF/FM AERIAL

Ideal for either home or caravan, boat, picnic, etc. Turn aerial for best reception and if required, switch on built-in amplifier.
Gain.....20dbVHF, 30db UHF
Gain Control.....0-30db
HURRY, HURRY, LIMITED QUANTITY



PRICE: £29.95

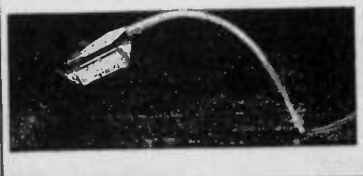
LOGIC ANALYZER

Hewlett Packard HP1631D Complete with Disc Drive (HP9122D), Printer (HP2225A). Various probes, etc. Approx. 4 years old. List price over £14,000! **OUR PRICE £1,500**

L100 CONSOLE LAMP

For disco consoles, Hi-Fi equipment, CB rigs, etc, where extra illumination is essential, 12V lamp in enclosed head with switch. Flexible chrome gooseneck on mounting plate with screw holes. Flying leads for connection to external 12Vdc supply. Length 300mm. Lamp 12V dc 5W tubular filament. L100

£2.95



STROBE LIGHT

Strobe light with circular reflector housed in veneered wooden cabinet. Various speed control.
Power.....240V ac 50Hz
Dimensions.....150 x 150 x 120mm
Order code: AUD/STROBE **Price £27.50**

MICROPHONE MIXER

4-channel mono microphone mixer. Inputs via 6.35mm mono sockets with individual volume controls. Output via 6-35mm mono socket with master volume control. ON/OFF switch and LED ON indicator. Tough steel case. Powered by 9V battery. Complete with 1.5m patch lead.
Input impedance.....600 ohms
Output Impedance.....1.2Kohms
Output level.....90mV (for 5mV input)
Power.....9V d.c. (PP3) battery
Dimensions.....148 x 86 x 46mm
ORDER CODE MIC/MIXER **£19.50**

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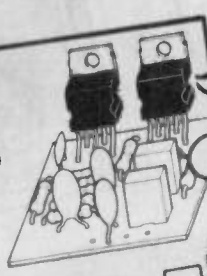
MATCHBOX AMPLIFIERS



Amazingly powerful amplifier modules – small enough to fit in a matchbox!

50W amplifier ~~£11.27~~ £8.95 ☐

20W amplifier ~~£7.59~~ £5.95 ☐

BIO-FEEDBACK MONITOR

Measures your stress level. Take life easy!

~~£19.32~~ £12.65 ☐

FREE

with every order received by December 10th

100 mixed high grade components ☐

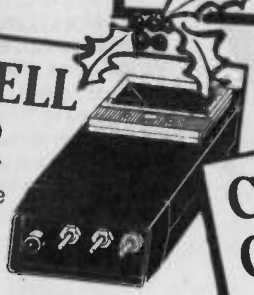
OR

Mini bio-feedback kit ☐

Please tick box for the gift you would like.

Orders over £35 get both!

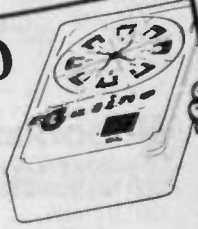
TACHO/DWELL METER



Essential for the motoring enthusiast

~~£18.86~~ £14.85 ☐

CREDIT CARD CASINO

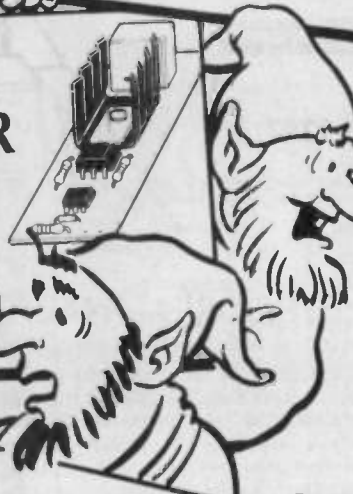


with five extra games FREE!

The tiny pocket gambling machine

~~£6.78~~ £5.25 ☐

MAINS CONTROLLER



For the expert. Control mains powered equipment from your logic circuits

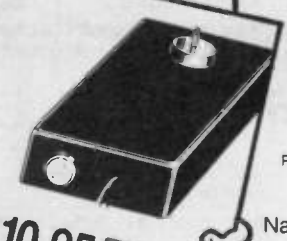
~~£7.13~~ £5.95 ☐

BURGLAR BUSTER

Protect your home and valuables

~~£14.72~~ £10.95 ☐

IONISER



Get healthy without pills, drugs or jogging!

Black ioniser ~~£14.49~~ £10.95 ☐

White ioniser ~~£14.72~~ £11.25 ☐

Please tick the boxes for the kits you would like and return the entire list to us. All prices include VAT, but please don't forget to add £1.20 for postage and packing. No orders accepted at these prices after 20th December 1990.

Please debit my ACCESS card no. ..... I enclose cheque for £.....

Name .....

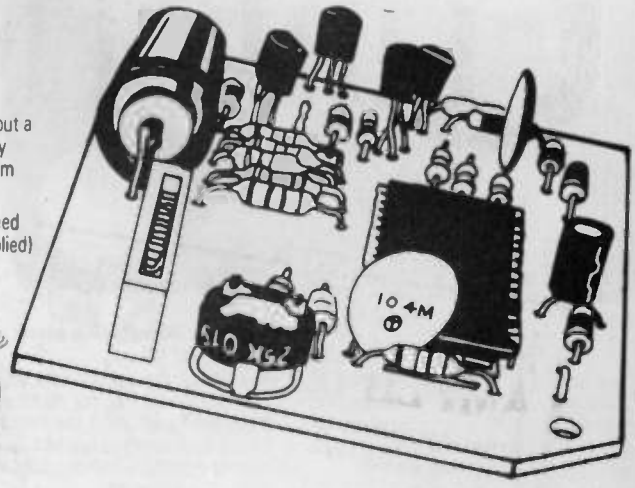
Address .....

.....

SPECIALIST SEMICONDUCTORS LTD, FOUNDERS HOUSE, REDBROOK, MONMOUTH, GWENT NP5 4LU. Tel: 0600 3715

Welcome to the 1990 Christmas list! Whether you intend to make somebody an original Christmas present or to treat yourself to a project for the holidays, there's just so much to choose from. To be sure of getting your products for Christmas, please allow enough time for postal delays in both directions and for our staff (who are very busy at this time of year, bless 'em) to pack your order. If you have an ACCESS card, you can speed things up by phoning in your order on 0600 3715, and we'll post your projects the very same day.

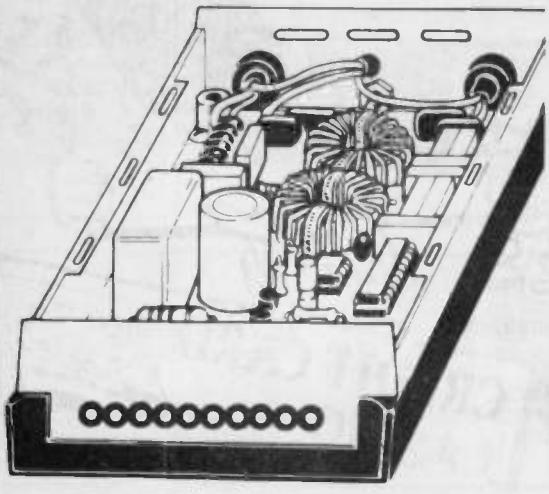
SOUND FX COMPUTER ▷



This super project will make the most outrageously realistic sounds you've ever heard! How about a motor rally complete with revving engines and gear changes? Or a ship hooting its mournful way through the fog? Or a fly so realistic it'll have you running for the swat! Sirens, helicopters, steam trains, aliens—you name it, it's in there. In one mode you can even play it like a synthesizer!

The computer is ready built and programmed, and has its own audio amplifier built in. All you need to do is to connect up the speaker (supplied), wire together the 13 programming switches (supplied) and you're ready for action! What a Christmas present!

~~£14.72~~ £10.95 ☐



◁ POWER CONDITIONER

You don't have to be a hi-fi nut to notice the huge improvement in sound quality when you run your music system from a clean mains supply. How do you describe the difference? It's as if all this time your favourite artists have been playing and singing inside a wardrobe . . . and someone has just opened the door and let them out. You could spend 20 times as much on special cables, plugs, mats and stuff without achieving a tenth of the difference. But don't take my word for it, Try it for yourself.

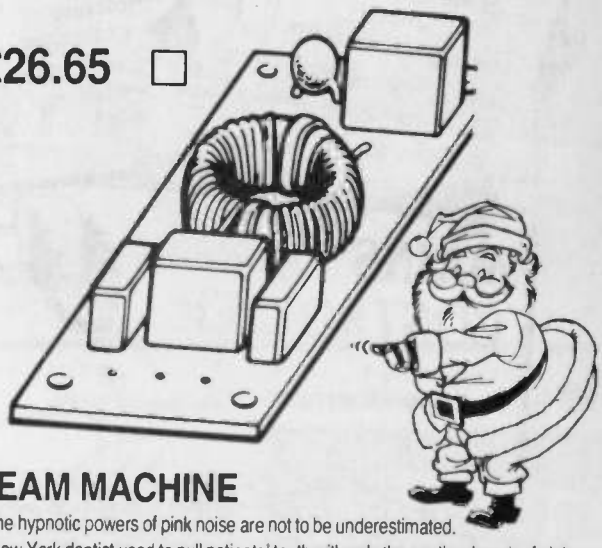
The sophisticated circuitry of the Power Conditioner begins with a bank of six VDRs to eliminate impulsive spikes. Then comes a massive filter with thirteen capacitors and two current-balanced inductors to smooth away every trace of noise and interference, A ten LED logarithmic display flicks up and down as each spike is eliminated, and gives a second by second account of the interference removed. Maximum load 1.5kW.

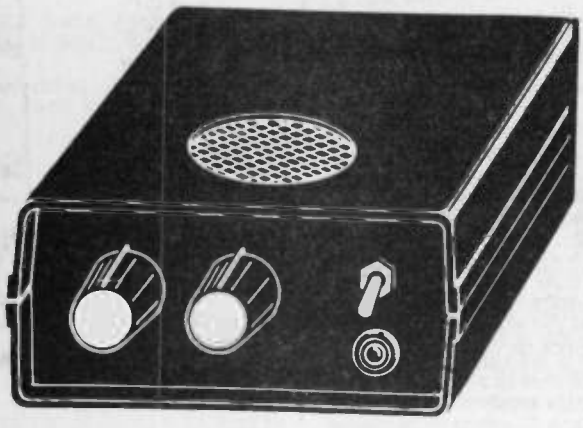
~~£34.27~~ £26.65 ☐

MAINS CONDITIONER ▷

If the budget won't stretch to the full Power Conditioner, its smaller brother the Mains Conditioner will give you a taste for the clear sounds. Just the thing for computer supplies too – it catches the spikes before they can do any harm.

~~£6.21~~ £5.65 ☐ Rugged plastic case £2.07 ☐





◁ THE DREAM MACHINE

What a project this is! The hypnotic powers of pink noise are not to be underestimated.

Legend has it that a New York dentist used to pull patients' teeth with only the gentle whoosh of pink sound to soothe them. No anaesthetic! Not something I'd care to try myself, but having experienced the effects of the Dream Machine I can well believe it.

The main function of the project is to give a truly refreshing sleep. One that leaves you feeling alert and ready for anything, not half dead until the third cup of coffee. For babies and young children it's just the thing. They drift into sleep quickly and are far less likely to wake in the middle of the night.

As for me, I enjoy experimenting with lucid dreams – ones where I'm completely in control of the action. The night time can be more exciting than the day!

~~£22.77~~ £16.95 ☐

SILVER SOLUTION

We stock this for plating the electrodes on our Brainwave Monitor, but it's such fascinating stuff I just had to add it to the Christmas list. Just run a little onto any metal surface – coins, ornaments, PCB tracks – and a silver coating appears. This is real silver, bonded just as thoroughly to the metal as if it has been silver plated. Amazing stuff! Have a bottle for yourself and a few to give away as presents.

Silver solution £4.37 ☐ Three bottles of Silver Solution £11.95 ☐

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ULTRASONIC CAR ALARM

This system is specially designed to protect your car and its contents against potential thiefs. Low current consumption and high noise immunity are just two of its distinguishing features.

Complete kit including case
44.367BKL ..... £ 30.40

In addition the system has a voltage sensing device i.e. the alarm is also triggered if appliances are switched on by an unauthorised person (e.g. the interior lighting when the door is opened).

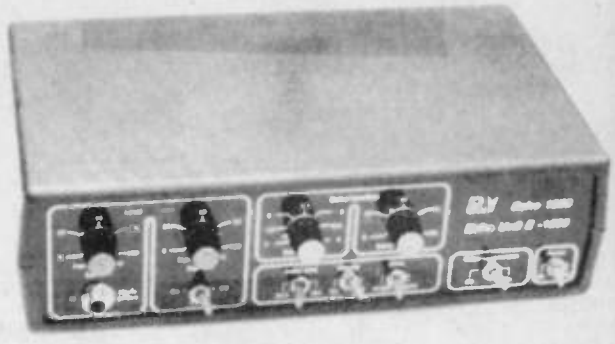
DIGITAL PROFESSIONAL ECHO 1000

(Elektor Electronics June 89)

This low cost echo unit is certain to impress music lovers - amateur and professional - everywhere. Excellent specification and top performance make the EU 1000 a winner and despite meeting professional requirements the unit will not make too big a hole in your pocket.
Working on the delta modulation principle on a digital base, delay times up to one second are possible at full bandwidth and large signal to noise ratio.

Complete kit
44.255BKL ..... £ 99.50

Ready assembled module
44.255F ..... £ 134.50



Specification

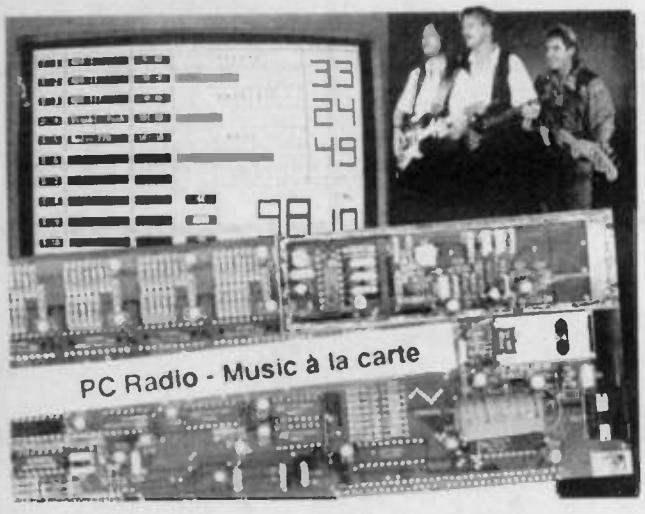
Input sensitivity:
Input 1 : 2 mV
Input 2 : 200 mV

Dealy Time:
variable from 60 ms to 1 s

Bandwidth :
100 Hz to 12 kHz

Additional features:
- inputs mixable
- single and multiple echo
- adjustable delay level
- switchable vibrator
- switch-controlled noise suppression

PC Radio (Elektor Electronics Febuary 1990)



This FM radio consists of an insertion card for IBM PC-XTs, ATs and compatibles and is available as a kit or a ready-built and aligned unit. The radio has an on-board AF power amplifier for driving a loudspeaker or a headphone set, and is powered by the computer. A menu-driven program is supplied to control the radio settings.

Complete kit
44.544BKL ..... £ 82.75

Ready assembled module
44.544F ..... £ 137.30

VM 1000 Video-Modulator (Elektor Electronics March 90)

Many inexpensive or older TV sets lack a SCART or other composite video input, and can only be connected to a video recorder or other equipment via an RF modulator. The modulator operates at a UHF TV channel between 30 and 40. Use is made of a single-chip RF modulator that couples low cost to excellent sound and picture quality.

Complete kit
44.546BKL ..... £ 36.90

RFK 7000 RGB-CVBS Converter

(Elektor Electronics October 89)

Nearly all computers supply as an output signal for colour monitors RGB signals. With the help of the RFK 7000 it is possible to record this signals with a videorecorder or to give them onto a colour TV (This is only possible, if the computer delivers a vertical sync. of 50 Hz and a horizontal sync. of 15.625 Hz).
The voltage supply is gained from a 12V/300mA-DC voltage mains adaptor.

Complete kit
44.525BKL ..... £ 66.50

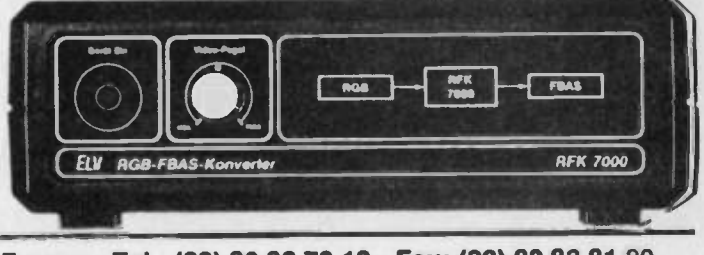
Ready assembled module
44.525F ..... £ 119.50

FRK 7000 CVBS-RGB Converter

With the help of the FRK 7000 e.g. it is possible to use a cheap clour monitor with RGB input on a video recorder.
The voltage supply is gained from a 12V/300mA-DC voltage mains adaptor.

Complete kit
44.509BKL ..... £ 66.50

Ready assembled module
44.509F ..... £ 119.50



Ordering and payment:

- **all prices excluding V.A.T.** (french customers add 18.6%T.V.A.)
- send Euro-cheque, Bank Draft or Visa card number with order. Please add £ 3.00 for p & p (up to 2 kg total weight)
- postage charged at cost at higher weight Air/Surface -
- we deliver worldwide except USA and Canada
- dealer inquiries welcome

ELV France - B.P. 40 - F-57480 SIERCK-LES-BAINS - France - Tel.: (33) 82.83.72.13 - Fax: (33) 82.83.81.80

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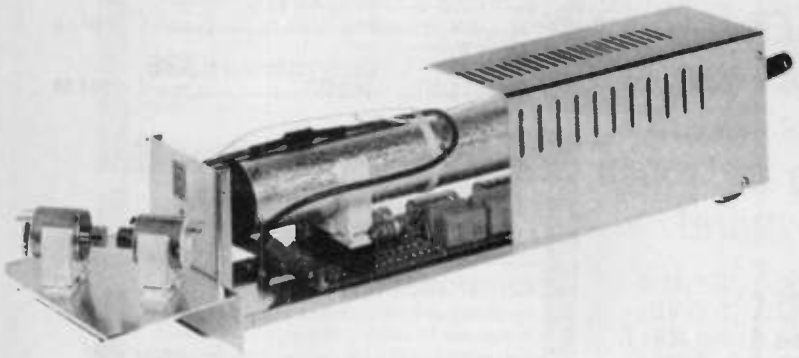
LPS 8000 / LC 7000 Low Cost Show Laser

(Electronics The Maplin Magazine Dec 88 + Feb-Mar 90)



An almost infinite number of circular patterns can be projected onto a wall or ceiling with this super laser show equipment.
The complete project includes a laser tube and accompanying power supply, housed in a metal case, and a laser controller, LC 7000. The laser controller drives the accompanying deflection unit, fixed onto the laser power supply case, which produces the numerous configurations.
Naturally the laser tube, together with the power supply, can produce beams without the laser controller and the controller can be used with other, similar lasers.

LPS 8000 Laser Power Supply, complete kit
Version 240 Volts AC
44.428BKL220 ..... £ 86.90
Version 220 Volts AC
44.428BKL240 ..... £ 86.90

LPS 8000 Laser Power Supply, ready assembled module
Version 240 Volts AC
44.428F240..... £ 156.50
Version 220 Volts AC
44.428F220..... £ 156.50

LC 7000 Laser Controller, complete kit
Version 12 Volts DC
44.427BKL ..... £ 60.80

LC 7000 Laser Controller, ready assembled module
Version 12 Volts DC
44.427F..... £ 104.30

H-N Laser Tube 2 mW
44.428LR ..... £ 60.80

Laser Motor-Mirror Set, complete kit
44.506M ..... £ 22.95

VIDEO RECORDING AMPLIFIER

(Elektor Electronics April 89)

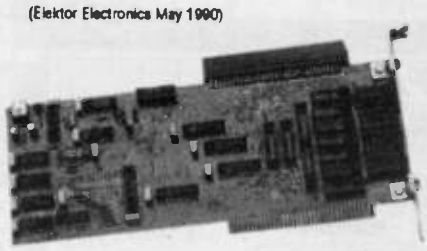
Losses can easily occur when copying video tapes resulting in a distinct reduction in quality. By using this video recording amplifier, with no less than four (!) outputs, the modulation range is enlarged and the contrast range of the copy increases.
Two level controllers for edge definition (contour) and amplification (contrast range) allow individual and precise adaptation.

Complete Kit
(including Box, PCB and all parts
44.324BKL ..... £ 14.75

IBM PC Service Card

(Elektor Electronics May 1990)

This card was developed for assistance in the field of service, development and test. The card is used as a bus-extension to reach the measurement points very easy. It is also possible to change cards without having a "hanging computer".



Complete kit
44.517BKL ..... £ 77.95

Ready assembled module
44.517F..... £ 137.95

TA 1000 Telephone Answering Unit

(Elektor Electronics January 1990)

This automatical telephone answering unit uses a 256-kbit voice recording circuit to store and replay your spoken message of uo to 15 seconds. Noteworthy features are that it is available as a complete kit, providesd a battery back-up facility and does not require alignment. No provision is made, however, to record incoming calls.

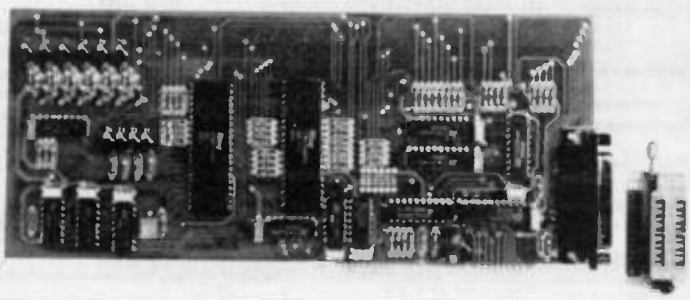
Complete kit
44.433BKL ..... £ 45.65

Ready assembled module
44.433F..... £ 87.25

IC TESTER for IBM-PC-XT/AT

(Electronics The Maplin Magazine Jun-Jul 89 +
Elektor Electronics December 89)

With the ELV IC tester logic function tests can be carried out on nearly all CMOS and TTL standard components, accommodated in DIL packages up to 20 pin. The tester is designed as an insertion card for IBM-PC-XT/AT and compatibles. A small ZIF test socket PCB is connected via a flat band cable. Over 500 standard components can be tested using the accompanying comprehensive test software.



Complete Kit including Textool sokket, connectors, sockets, Flat band cable, PCB, Software
44.474BKL ..... £ 60.85

Ready Assembled Module
4.474F..... £ 113.00

Software, single
44.474SW ..... £ 17.85

ELV France - B.P. 40 - F-57480 SIERCK-LES-BAINS - France - Tel.: (33) 82.83.72.13 - Fax: (33) 82.83.81.80

INSULATION TESTER

EE APRIL 85

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

KIT REF 444 **£21.89**

PET SCARER

EE MAY 89

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

KIT REF 812 **£14.49**

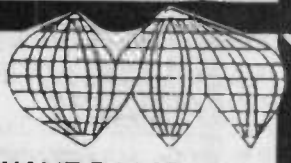
Mains Adaptor £1.98

DIGITAL CAPACITANCE METER

EE DEC 85

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

KIT REF 493 **£46.46**



3 BAND SHORT WAVE RADIO

EE AUG 87

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

KIT REF 718 **£29.66**

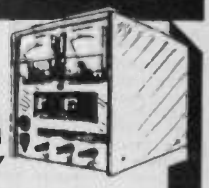
DIGITAL FREQUENCY 200 MHz METER

EE NOV 86

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

KIT REF 563 **£69.95**

MOSFET VARIABLE BENCH 25V 2.5A POWER SUPPLY



EE FEB 88

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

KIT REF 769 **£55.61**

MINI STROBE

EE MAY '86

A hand held stroboscope which uses 6 "ultra bright" LEDs as the light source. Designed to demonstrate the principles of stroboscope examination, the unit is also suitable for measuring the speed of moving shafts etc. The flash rate control covers 170–20,000 RPM in two ranges.

KIT REF 529 **£15.50**

ACOUSTIC PROBE

EE NOV '87

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

KIT REF 740 **£19.58**

4 CHANNEL LIGHT CHASER

EE Jan '90

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

KIT REF 833 **£31.45**

EE EQUALISER

EE MAY '87

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

KIT REF 707 **£17.37**

MUSICAL DOORBELL

EE JAN '86

This project uses a special I.C. pre-programmed with 25 tunes and 3 chimes. A Magenta design, the circuit is battery powered and only draws current whilst producing sounds. Two rotary switches select the tune required. Provision is made for three bell pushes, each of which sounds a different tune, so that three points of entry can be identified.

KIT REF 497 **£20.95**

EPROM ERASER

EE OCT '88

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

KIT REF 790 **£27.90**

LIGHT RIDERS

EE OCT '86

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

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

EE TREASURE HUNTER

EE AUG '89

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

KIT REF 815 **£41.95**

Headphones **£1.99**

SUPERHET BROADCAST RECEIVER

EE MAR '90

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

KIT REF 835 **£16.79**

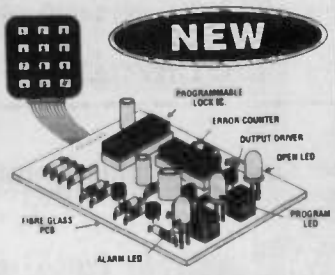
TK FOR KITS

GUARD DOG KIT

One of the best burglar deterrents is a guard dog and this kit provides the barking without the bite! Can be connected to a doorbell, pressure mat or any other intruder detector and produces random threatening barks. Includes mains supply and horn speaker.

XK125 **£21.95**

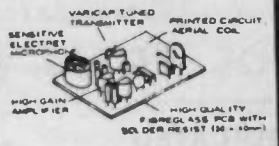
PROGRAMMABLE ELECTRONIC LOCK KIT



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

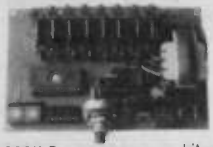
XK131 **£19.95**

SUPER–SENSITIVE MICROBUG



Only 45x25x15mm, including built–in mic. 88–100MHz (standard FM radio). Range approx. 300m depending on terrain. Powered by 9V PP3 (7mA). Ideal for surveillance, baby alarm etc. **XK128** **£6.35**

DISCO LIGHTING KITS



OL8000K 8–way sequencer kit with built–in opto–isolated sound to light input. Only requires a box and control knob to complete **£39.95**

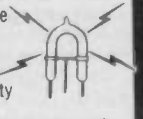
OL1000K 4–way chaser features bi–directional sequence and dimming 1kW per channel ..**£23.95**

DLA/1 (for DZ1000K) Optional op-to input allowing audio beat/light response.....**95p**

DL3000K 3–channel sound to light kit, zero voltage switching, automatic level control and built–in mic. 1kW per channel **£19.55**

XK139 Uni-directional chaser. Zero switching and built-in audio input.....**£12.95**

POWER STROBE KIT



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

XK124 STROBOSCOPE KIT. **£17.25**

SIMPLE KITS FOR BEGINNERS

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

SK1 DOOR CHIME plays a tune when activated by a pushbutton **£4.50**

SK2 WHISTLE SWITCH switches a relay on and off in response to whistle command **£4.50**

SK3 SOUND GENERATOR produces FOUR different sounds, including police/ambulance/fire–engine siren and machine gun **£4.50**

XK118 TEN EXCITING PROJECTS FOR BEGINNERS this kit contains a solderless breadboard, components and a booklet with instructions to enable the absolute novice to build ten fascinating projects including a light operated switch, intercom, burglar alarm and electronic lock. Each project includes a circuit diagram, description of operation and an easy to follow layout diagram. A section component identification and function is included, enabling the beginner to build the circuits with confidence **£17.25**

NEW

REMOTE CONTROL DIMMER KIT

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

XK132.....**£19.95**

IR TRANSMITTER KIT

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

MK 6.....**£4.95**

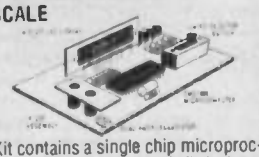
XK136 TDUCH DIMMER KIT.....**£12.95**

VERSATILE REMOTE CONTROL SYSTEM

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

MK12 IR Receiver.....**£19.55**
MK18 Transmitter.....**£8.95**
MK 9 4-way Keyboard.....**£2.75**
MK10 16-way Keyboard.....**£7.95**
601 133 Box for transmitter **£2.95**

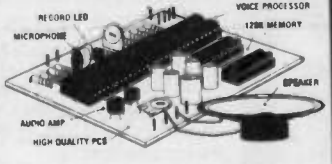
ELECTRONIC WEIGHING SCALE



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

ES1 **£8.25**

VOICE RECORD/ PLAYBACK KIT



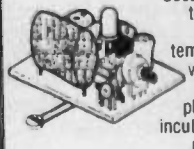
This simple to construct and even simpler to operate kit will record and playback short messages or tunes. It has many uses – seatbelt or light reminder in the car, welcome messages to visitors at home or at work, warning messages in factories and public places. In fact anywhere where a spoken message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

Size ..... 76 x 60 x 15mm

Message time ..... 1–5 secs normal speed, 2–10 secs slow speed

XK129 **£25.95**

PROPORTIONAL TEMPERATURE CONTROLLER KIT



Uses "burst fire" technique to maintain temperature to within 0.5°C. Ideal for photography, incubators, wine making, etc. Maximum load 3kW (240V AC). Temperature range up to 60°C. Size 50x40x25mm. **XK140**.....**£8.95**

TK ELECTRONICS

TK ELECTRONICS

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DEDICATED

I think I'm right in saying that the Light Sequencer in this issue is the first project we have published that uses a "dedicated" chip. In fact this statement is perhaps a little misleading because the chip is an 8-bit CMOS microcontroller with 8K bytes of EPROM and 256 bytes of RAM on board. The EPROM has been specially programmed for this unit and thus the "dedicated chip" is produced.

The advent of such a cheap microprocessor chip (less than £15 for one off) which can be programmed in small quantities in this way does open up the possibilities for various dedicated controllers that are now within the hobbyists price range. Previously the cost of development and production of low volume dedicated chips was prohibitive and the obvious answer was to use a microprocessor with a separate EPROM which could then be cheaply "blown" with appropriate software. The new device is essentially the same animal all on one chip, together with some RAM for user programming. There is even the option of battery back up to protect any user programs when the unit is not turned on.

The controller has, in this case, been pre-programmed with over 100 different lighting sequences that can be run individually or set to step one after the other, each being shown a few times before the next one is selected. This unit thus provides an incredibly versatile lighting unit which is compact, inexpensive and easy to use.

NOW READ THIS!

For those of you who read your magazine what follows might be a bit of a surprise, for the rest – well they won't read it anyway! Time and again people phone us for general information, 'phone numbers, addresses or prices of items that are clearly shown in the magazine. If you want information on the books we supply check the *Direct Book Service* pages; on p.c.b.s, see that page; for back numbers, subscriptions, binders and technical queries it's all on this page. If it's a query on component buying for one of our projects then the answer may be in *Shop Talk*. But of course you know all that, because you read the mag – how do we get at the others?

Mike Kenward

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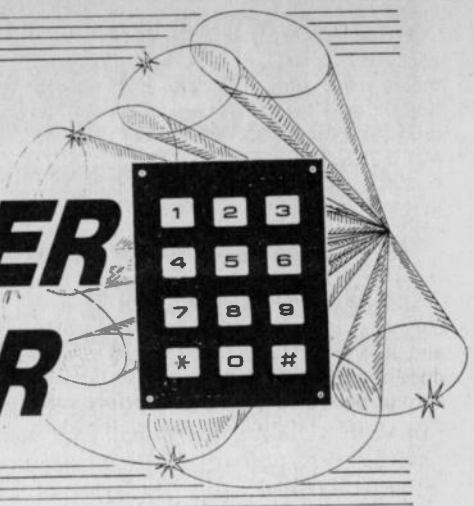
Constructional Project

8 CHANNEL MICROCONTROLLER LIGHT SEQUENCER



MARK STUART

Complete fingertip control for lighting effects for Discos and Stage shows are made possible by the use of a pre-programmed microcontroller chip.

THIS sequencer was designed to open up a new range of lighting effects for Discos, Stage Effects, and Commercial Displays at a reasonable price. It will no doubt find many other uses because of its versatility and low cost.

The circuit is based upon a pre-programmed microcontroller i.c. which drives eight triac mains switches via opto-isolators, and provides a full front panel mimic display along with four other indicators which display the current operating mode. The i.c. is controlled by a twelve key keypad, providing the following functions:

SELECT MODE:
Select lamp ON

1) Select pre-programmed sequence from memory by entering keypad code. Select from over 100 sequences, including standard 3 and 4 channel chases and a vast range of others including random and Light Rider eight lamp end-to-end sequences.

RUN MODE:
Run lamp ON

2) Runs the selected sequence, or continuous selection if none selected. Increase Speed / Decrease speed; continuously and smoothly varies sequence speed whilst running using UP/DOWN keys.

STOP MODE:
Stop lamp ON

3) Stop sequence at any position and individually control each lamp by use of its number button. Alternate toggle action: Press once for ON, once for OFF and so on. Useful for setting up colour effects.

STEP MODE:
Stop lamp ON and Step lamp ON

4) Automatically steps through the selected sequence one step at a time each time the STEP key is pressed. An external switch or contact pad may be connected to allow manual stepping to music beat.

FULL SEQUENCE MODE:
Run lamp ON

5) After switch on this mode is entered automatically. The controller runs through its entire sequence memory, running each sequence a number of times and then stepping on. At the end it returns to the first sequence and repeats.

PROGRAM MODE 1:
Stop lamp ON and Select lamp ON

6) Up to ten sequences each 16 steps long may be entered step by step and stored in memory. These are held in memory by on chip battery backed RAM. Any number of lamps may be on or off in each step.

PROGRAM MODE 2:
Stop lamp ON and Select lamp ON

7) A single sequence up to 160 steps long may be entered step by step and stored in memory. As with Mode 1, Battery Backed RAM is used. This program is particularly useful for stage effects and display lighting. The sequence may be stepped manually or run automatically, and will repeat continuously.

Note that Program Modes 1 and 2 cannot be used at the same time as they use the same memory space.

SAFETY

The 8-Channel Microcontroller Light Sequencer is compact and uses two standard 8 way sockets for lamp connections. All channels are individually fused. Sequence patterns are provided which allow existing three- and four-channel lamp set ups and rope lights to be connected, and give much better effects than standard chasers. The two 8 way sockets can be used simultaneously with different sequences programmed for each, provided that they are run at the same speed.

Opto-isolators are used to maintain all of the control board electronics at safe low voltages completely isolated from the mains. All lamps are switched at the mains Zero Crossing point to minimise interference and stress to the lamps and triacs.

The triacs are connected to the "Live" side of the mains for added safety, so that when they are off there is no mains live connection to any of the lamps. A double pole mains isolating switch is also used for additional safety.

CIRCUIT DESCRIPTION

The circuit diagram for the 8-Channel Microcontroller Light Sequencer is really straightforward but looks complicated because many parts are repeated eight times.

The power section and the control section are built on separate printed circuit boards and have been drawn as separate circuits. Either one may be used without the other in conjunction with other equipment. In particular the Power Board is *fully isolated* and can be driven from a computer I/O port or other low power circuits to control a range of mains powered equipment.

The Control Board could be operated from 12V d.c. and be fitted with power Darlington transistors to drive 12V lamps for use in car displays.

It is also practical to drive more than one power board from a single control board so that power boards can be built into the lamp units and connected using thin signal cables to a central controller.

POWER SECTION

The complete power section circuit diagram is shown in Fig. 1. Triacs CSR1 to CSR8 switch the mains Live via the bank of eight fuses to the output sockets. Triac CSR8 has a resistor R31 between its gate terminal and its common or MT1 terminal. This resistor holds the gate at the same voltage as MT1 and so the triac is held in the off state. It is inappropriate here to go into full detail about the operation of triacs, but a simple explanation will help the rest of the circuit to be understood better.

Normally a triac is in the OFF state and current cannot flow between its MT1 and MT2 terminals (MT stands for Main Terminal). A small current passed between the gate terminal and MT1 (the Gate Current) turns on the triac so that current can flow in either direction between the two Main Terminals.

If the gate current is now removed the triac will remain turned ON provided some current is still passing between the Main Terminals. With an a.c. supply the current is reduced to zero each time the voltage reverses between half cycles (this happens 100 times per second for 50Hz mains).

A triac turned on with a short pulse of gate current just after the beginning of a mains half cycle will therefore remain conductive until the mains voltage and current fall to zero at the end of the half cycle. To maintain a triac in what is effectively a permanently ON state only a small pulse of gate current is required after the beginning of each mains half cycle.

This is true with resistive loads such as lamps and heaters where the current rises as soon as voltage is applied, but with more complicated loads such as transformers and fluorescent lamp chokes, the current does not rise immediately, and so the gate current pulse comes and goes before sufficient current has built up between the Main Terminals to maintain the triac in the ON state. (There is a minimum current called the Hold Current which is required between the Main Terminals to maintain conduction, typically it is equal to the minimum gate current required to start conduction.)

The completed unit showing the keypad and channel mimic l.e.d.s.

PULSE TRIGGERING

To deal with these more complicated loads the ideal method is Hard Triggering, where gate current is applied continuously. This has only one drawback which is that it increases the current demand from the gate control circuit.

In this circuit it is particularly difficult to provide hard triggering because there could be eight triacs requiring 20mA each at the same time. This current is not available from the 20V tapping on the transformer being used and so an alternative method is used to combine low current operation and yet provide triggering over *all* of the mains cycle.

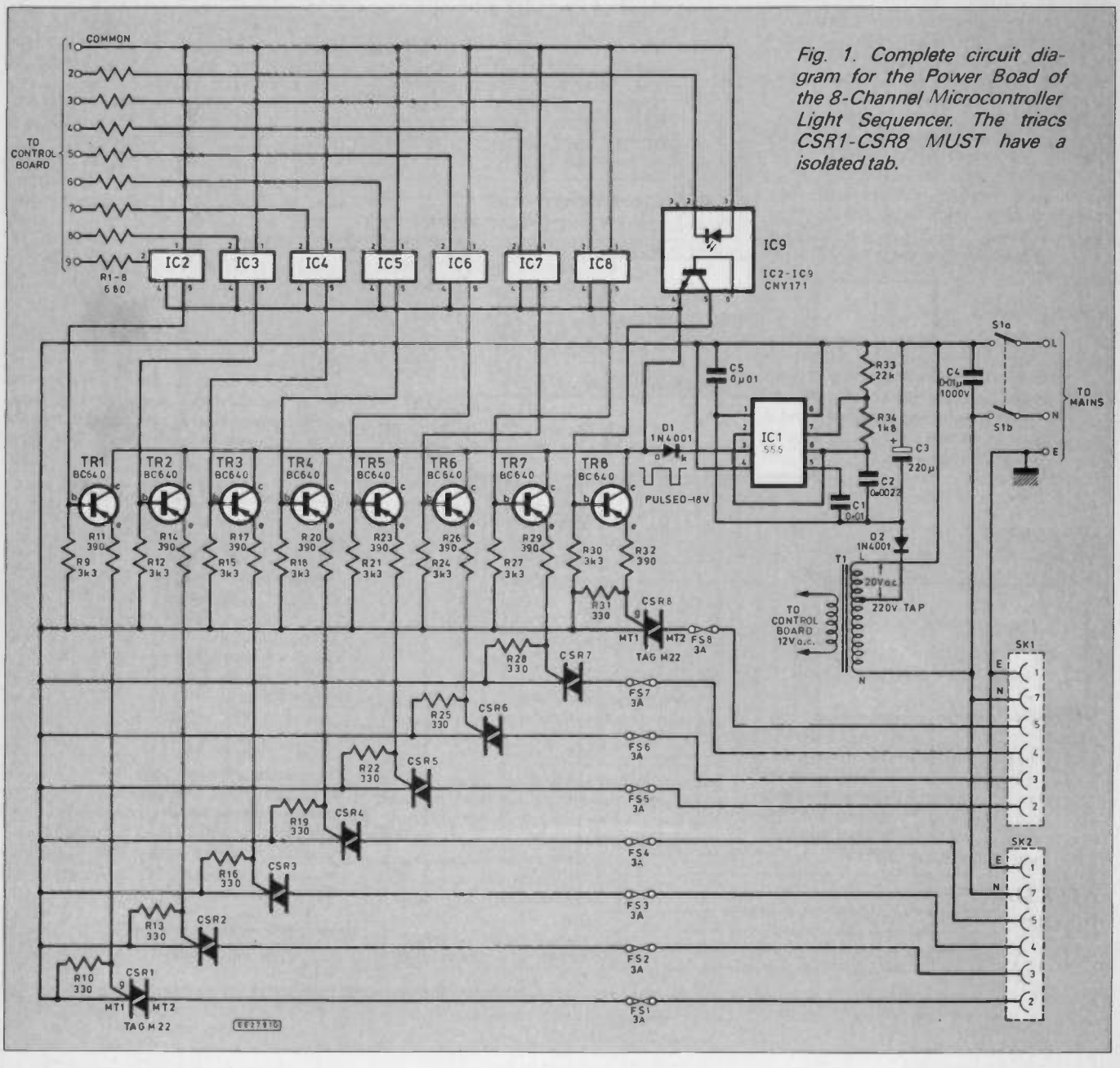


Fig. 1. Complete circuit diagram for the Power Boad of the 8-Channel Microcontroller Light Sequencer. The triacs CSR1-CSR8 MUST have a isolated tab.

Instead of applying gate current continuously it is applied in pulses throughout the mains cycle. The mark-space ratio of the pulses is 1 to 10 so that the average current flowing is one tenth of the peak.

The result is that 20mA gate pulses are available for only 2mA of supply current. The pulse rate is over 10kHz so that there are over 100 pulses per half cycle, a rate which is practically indistinguishable by the triac from continuous current.

TRIGGER CIRCUIT

Trigger pulses are produced by a standard 555 timer (IC1) operating in the astable mode. The circuit is powered from a 20 volt tapping (see Fig. 1) on the mains transformer primary after rectification by diode D2 and smoothing by capacitor C3.

The timing components are resistors R33, R34, and capacitor C2. Capacitors C1 and C5 provide essential decoupling for stable operation. The output of this circuit is a series of 18 volt negative pulses which are passed via diode D1 to the trigger circuits of the eight triacs.

Triacs are not too worried about the direction of the gate current and turn on happily with "positive" or "negative" drive. Negative drive has been chosen because the 555 timer is easier to use producing negative pulses and a simple circuit results. Also there is a slight increase in gate sensitivity when negative pulses are used.

Gate current to the triacs is supplied via transistors TR1 – TR8 which act as emitter followers, amplifying the small current available from the phototransistor inside the opto-isolators IC2 – IC9. The emitter resistors R32 etc. limit the maximum peak gate current to 20mA.

Resistor R30 is the load resistor for IC9 and determines the current which is required from the phototransistor to produce full gate drive. The value of 3k3 chosen requires 3mA to produce the 10V required for full drive at the base of TR8.

The l.e.d. side of the opto-isolator is completely insulated from the phototransistor and so provides complete mains isolation. Current in the l.e.d. illuminates the phototransistor and turns it on.

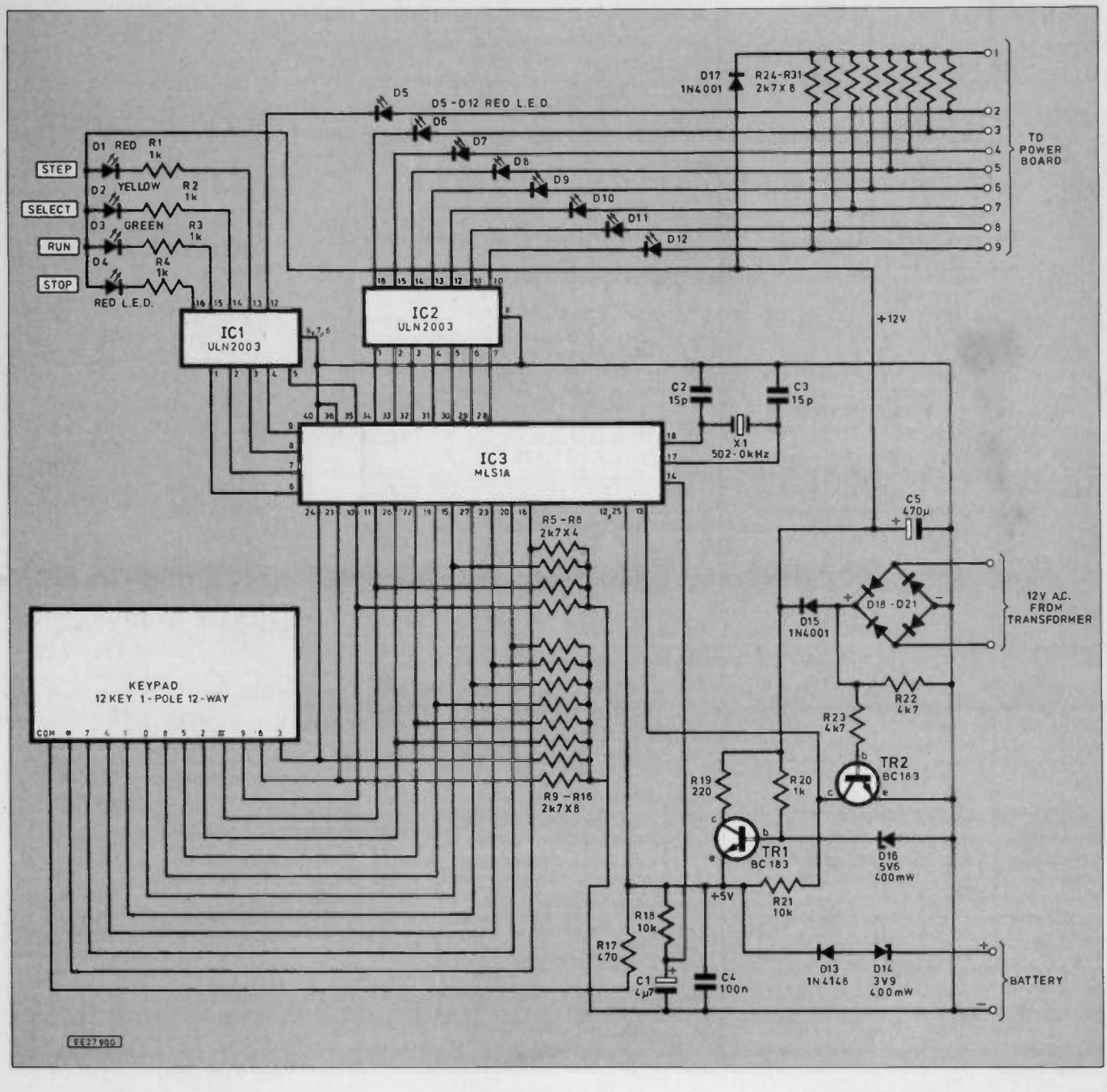
The CTR or Current Transfer Ratio of the opto-isolator indicates the ratio of phototransistor current to l.e.d. current. Average units give between 80 per cent and 20 per cent and so the design should allow for 20 per cent.

If 3mA is required from the phototransistor then with 20 per cent CTR the l.e.d. current should be 3 × 100/20 or 15mA. This sets the value of the series limiting resistors R1 to R8. In practice most opto-isolators will be well above this level of sensitivity and so ample current has been provided.

Sockets SK1 and SK2 provide two standard output connectors and are wired to match most commercial chasers. This allows existing three- and four-channel lamp units to be connected without re-wiring.

The secondary winding on the transformer is of course completely insulated from the mains and so provides an isolated supply for the control board. Capacitor C4 is a mains rated component that helps to reduce mains spikes and prevent them from triggering the triacs and upsetting the control board microcontroller.

Fig. 2. Complete circuit diagram for the control section of the 8-Channel Microcontroller Lights Sequencer.



CONTROL SECTION

The complete circuit diagram for the control section is shown in Fig. 2.

The Control Board uses a special pre-programmed Microcontroller i.c. which reads the keypad, drives the indicators and opto-isolators and works out the timing to ensure zero volt switching takes place correctly. It also contains a large array of sequences programmed into its ROM area and has an area of RAM that can be programmed with special sequences by the user.

As IC3 does most of the work the rest of the circuitry is simplified greatly and consists of a power supply, output buffers, a mains zero cross detector, and assorted pull-up and pull-down resistors. An optional battery backup connection is available to retain user programmed sequences.

INPUTS

The keypad is a one-pole 12-way type that connects straight into IC3. Resistor networks containing R5 to R8 and R9 to R16 pull the inputs down to zero without any keys pressed.

Pressing a key pulls the corresponding input high via resistor R17 which connects to the 5V rail. More than one key can be operated at a time in some modes in which case several inputs are pulled up together.

OUTPUTS

Outputs from IC3 are buffered by the Darlington drivers, IC1 and IC2. These contain seven separate stages each and so one section of IC1 and all of IC2 are required for the eight sequence outputs. Four other sections of IC1 are used to drive the four function indicator l.e.d.s (D1 to D4) via resistors R1 to R4.

All of the outputs from IC1 and IC2 are open collectors which turn on when the input voltage is 5V and off when it is zero. They have a current capability of 500mA each which is enough to drive several power boards.

The outputs to the power board are driven via the mimic l.e.d.s D5 to D12. These are in series with the opto-isolator l.e.d.s which are fed from the 12V positive supply rail via diode D17. Resistor network R24 to R31 contains eight resistors which allow a small current to flow in the l.e.d.s when the power board is not connected. This allows the control board to be tested fully on its own with just a 12V a.c. supply.

CLOCK

A 502kHz ceramic resonator X1 connected between pins 17 and 18 of IC3 provides the clock signal from which the microcontroller derives all of its internal timing functions. Capacitors C2 and C3 provide the necessary loading and phase shift to ensure oscillation.

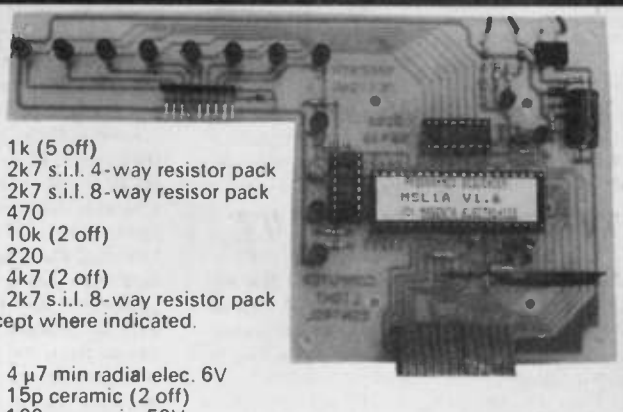
POWER SUPPLY

The 12V a.c. from the transformer secondary is rectified by the d.i.l. bridge rectifier containing D18 to D21. Before smoothing, the full wave rectified output is fed to transistor TR2 base via resistor R23. As long as the input exceeds 0.6V TR2 is turned on and holds the voltage at pin 13 of IC3 at zero.

When the voltage falls below 0.6V, which it does around the mains zero crossing points, TR2 is turned off and the voltage on its collector and on pin 13 of IC3 is

COMPONENTS

CONTROL BOARD



Resistors

R1-R4, R20	1k (5 off)
R5-R8	2k7 s.i.l. 4-way resistor pack
R9-R16	2k7 s.i.l. 8-way resisor pack
R17	470
R18, R21	10k (2 off)
R19	220
R22, R23	4k7 (2 off)
R24-R31	2k7 s.i.l. 8-way resistor pack

All 0.25W 5% carbon except where indicated.

Capacitors

C1	4 µ7 min radial elec. 6V
C2, C3	15p ceramic (2 off)
C4	100n ceramic, 50V
C5	470µ min. axial elec. 16V

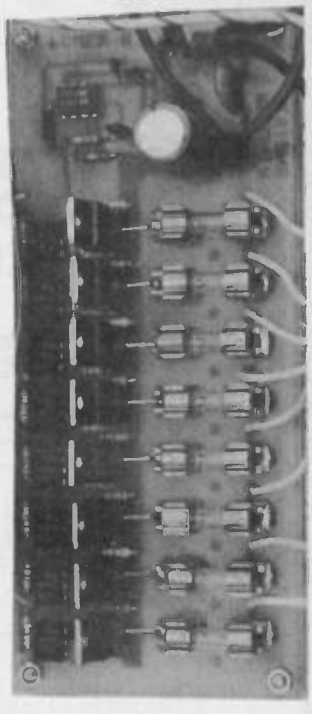
Semiconductors

D1, D4, D5-D12	5mm red l.e.d. (10 off)
D2	5mm yellow l.e.d.
D3	5mm green l.e.d.
D13	1N4148 signal diode
D14	3V9 400mW Zener diode
D15, D17	1N4001 1A 50V rec. diode (2 off)
D16	5V6 400mW Zener diode
D18-D21	d.i.l. bridge rec.
TR1, TR2	BC183 *npn* silicon transistor (2 off) (NOT BC183L)
IC1, IC2	ULN2003 Darlington driver (2 off)
IC3	MLS1A programmed sequencer (Magenta)
X1	502.0kHz ceramic resonator

See SHOP TALK Page

Miscellaneous

Keypad, 12 key 1-pole 12-way; printed circuit board available from the *EE PCB Service*, code EE708; 9-way 90° 0.1in. pitch pin header; 16-pin i.c. socket (2 off); 40-pin d.i.l. socket; single sided p.c.b. screening panel, 185mm × 106mm; mounting pillars and long screws (4 off); nuts (8 off); solder tag (2 off); washer; solder, etc.



POWER BOARD

Resistors

R1-R8	680 (8 off)
R9, R12, R15, R18, R21, R24, R27, R30	3k3 (8 off)
R10, R13, R16, R19, R22, R25, R28, R31	330 (8 off)
R11, R14, R17, R20, R23, R26, R29, R32	390 (8 off)
R33	22k
R34	1k8

All 0.25W, 5% min. carbon film

Capacitor

C1, C5	0µ01 ceramic, 50V
C2	0µ0022 Mylar, 50V
C3	220µ radial elec. 25V
C4	0µ01 ceramic, 1000V

Semiconductors

D1-D2	1N4001 1A 50V rec. diode (2 off)
TR1-TR8	BC640 *pnp* transistor (8 off)
CSR1-CSR8	TAG M22 isolated tab triac (Magenta) (8 off)
IC1	NE555 timer i.c.
IC2-IC9	CNY171 opto-isolators (8 off)

Miscellaneous

T1	3VA Mains transformer, with 220V primary tapping: 12V secondary (wire-ended connections)
S1	DPDT 13A mains rocker switch
SK1, SK2	8-pin chassis socket – P552 (2 off)
FS1-FS8	3A 20mm quick-blow fuse (8 off), with 0.4in. pitch fuse clip (16 off) – see text.

Printed circuit board available from *EE PCB Service*, code EE709; metal case, 230mm × 133mm × 63mm; 8-pin i.c. socket; 10A 250V mains cable; mains cable entry clamp; "star" or 3-way solder tag; self-tapping screws (4 off); insulating sleeving; solder, etc.

Approx cost guidance only **£56**

pulled up to 5V via resistor R21. This pulse which occurs every cycle is used by IC3 to determine when the mains cycle is crossing zero and is used to synchronise the sequence so that steps only occur at this time.

The rectified 12V is passed via diode D15 to smoothing capacitor C5. From here a simple regulated supply of 5V is provided via a standard emitter follower regulator consisting of Zener regulator diode D16, transistor TR1 and resistors R19, R20. This is a simple short-circuit proof regulator that protects IC3. C4 is a decoupling capacitor which keeps voltage spikes off the supply line.

Diodes D13 and D14 allow a 9V battery to power IC3 for intervals between use so that it can store the user entered programs. Just leave out the battery if this feature is not needed.

RESET

Two remaining components provide the vital function of resetting IC3 at switch on. This is necessary so that it knows where to begin.

As power is applied IC3 pin 14 is temporarily held at zero volts by capacitor C1 holding the microcontroller in the starting condition. As C1 charges via resistor R18 pin 14 rises to 5V and operation begins.

This action is not required when battery backup is used and the circuit re-starts automatically.

CONSTRUCTION

Before doing any electronic construction the case should be prepared. As there is a fair amount of drilling it is recommended that those without the necessary tools or skills might like to buy the kit version, which is supplied with a drilled case and fascia panel.

Those who enjoy "metal bashing" may buy the version with a blank case or may chose to make their own housing. A paper drilling template is available free from Magenta.

Alternatively it is quite effective to use the bare printed circuit boards as an aid to marking out to ensure that the mounting holes and l.e.d. drillings are made correctly. The power board should be fitted with its front edge 4mm from the front panel of the case to allow the heatsink (if used) to fit correctly.

The keypad position is not critical but should be approximately as shown. The sockets, switch and cable entry clamp on the rear panel must be mounted as low as possible to ensure there is enough room for the control board in the top of the case.

The best method of cutting out the larger holes is to use an Abraframe saw which can cut in all directions. First drill a pilot hole and then thread the blade and re-fit it to the saw frame. If the case has been marked out well it is fairly easy to make good holes in this way. A smooth file finishes the job.

A rectangular piece of copper clad board is needed to act as a screen and an "earthed" safety barrier mounted on the rear of the control board. This board must be cut to 102mm × 180mm and drilled using the control board as a template so that it fits with its *unclad* side facing the track side of the control board.

The rear panel holds the ON/OFF switch, mains cable entry clamp, output sockets, and most important of all, a star earthing tag. This should be fitted using a single screw fitted with shakeproof washers and two nuts. *It is NOT acceptable to use a component mounting point for earthing purposes.*

When all of these components have been mounted the mains connections should be

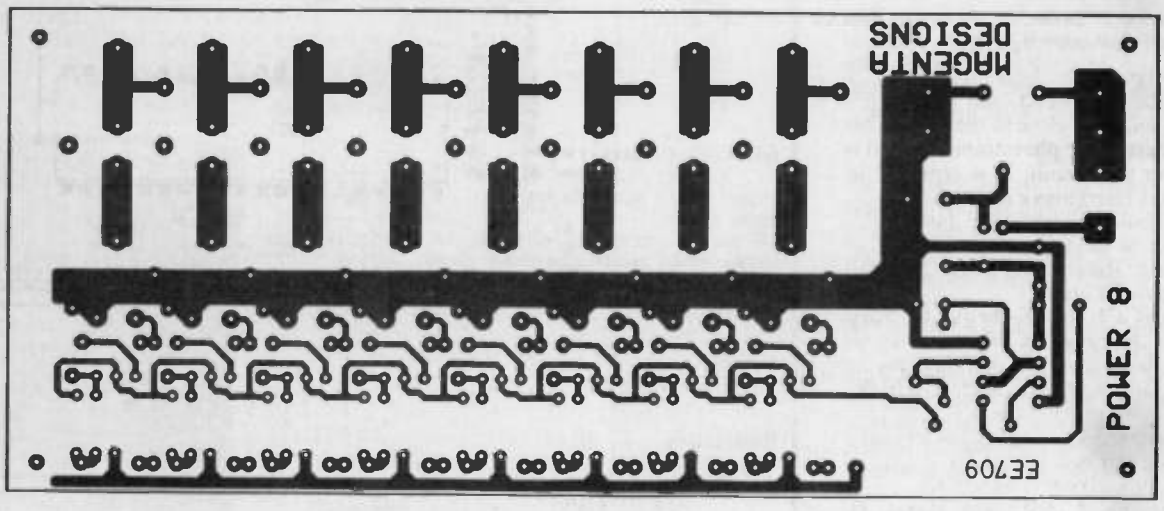
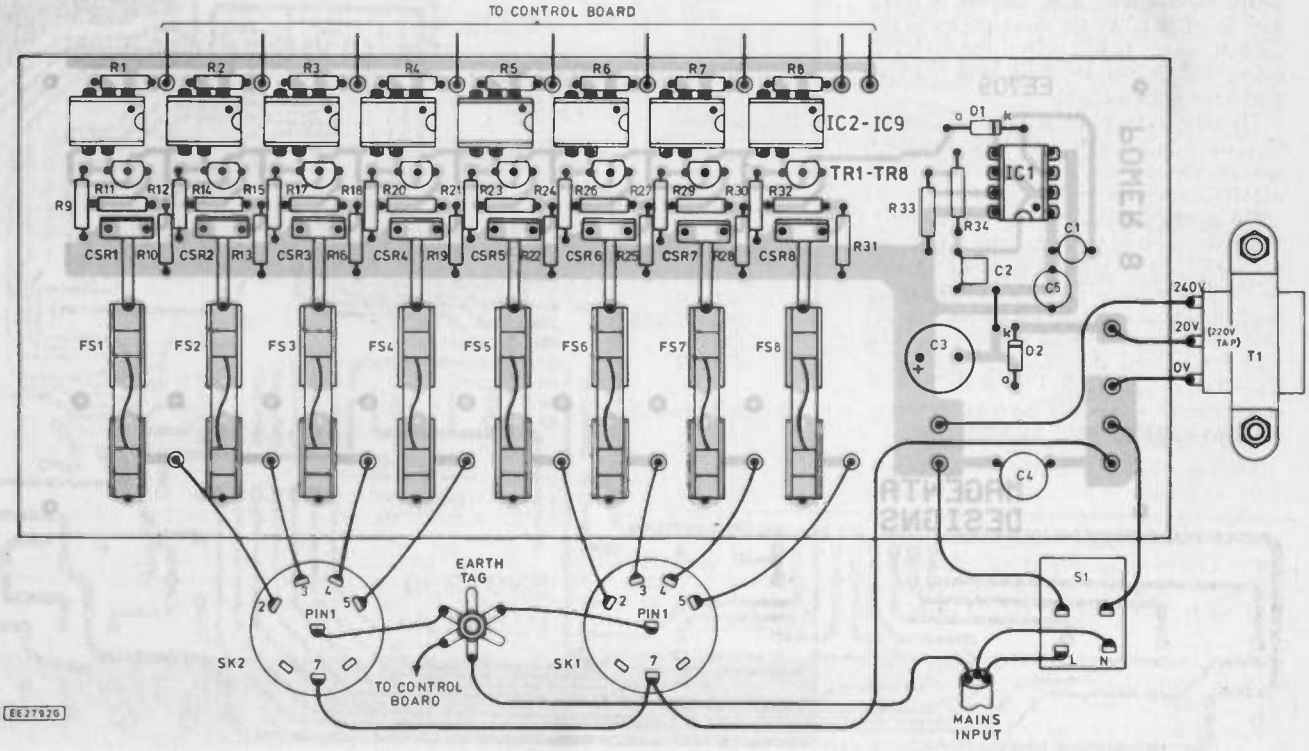


Fig. 3. Printed circuit board component layout and full size copper foil master for the Power Board



made between them following the wiring diagram Fig. 3. All mains connections should be covered with insulating sleeving.

POWER BOARD

The component layout and full size copper foil master pattern of the Power Board is shown in Fig. 3. Fit all of the resistors first. Care is required because they are closely spaced to keep board area to a minimum. It is best to fit R11, R14, etc first.

Next fit the opto isolators, IC2 to IC9, *directly* to the board. Sockets should not be used as they reduce the clearance between the two isolated sides. Make sure that they are the right way round, and remove pin six by clipping it off close to the body. This pin is the base of the phototransistor and is not used in this circuit. It is removed to prevent stray interference pick-up.

The fuseholders should be fitted next. These must be the right way round as inspection will show. They must be fitted right down to the board.

Capacitors C1 to C5 should be fitted next, C3 is the only one that can only be fitted one way round. The markings on the case indicate the negative lead. Fit diodes D1 and D2 with their cathode (k) marking bands as shown. A socket is recommended for IC1 as it can be a great help to remove or change the i.c. when fault finding.

Eight lengths of 16/0.2 wire should be fitted to the board to make the connections to the output sockets. The other side of the board should have nine lengths of 7/0.2 wire fitted to make the connections to the control board. It will help if the standard colour code is used for these, with black as the common connection.

The transistors must be fitted as close to the board as possible with their flat sides towards the opto-isolators. Check that they are all the correct type before fitting.

Fitting the triacs is slightly unusual because the centre leads are bent across the surface of the board and soldered directly to the fuseholders. This method makes a huge simplification in board layout, and allows the main live input voltage to use a wide track along the middle of the board linking all of the triac MT1 terminals. Note that the metal tab side of the triacs is facing the opto-isolators.

The centre leads of the triacs must be bent 3mm from the plastic case towards the non metal side. The other two leads should then be inserted into the board down to the shoulder on the pins and soldered in.

Straighten the triacs up on the board and then solder the centre leads to the point where the fuseholder tag passes into the board. It is important that the correct isolated tab triacs are used. Each one MUST be checked before insertion by an ohmmeter between the centre lead and the tab to ensure that there is NO connection.

The remaining connections between the mains input and the transformer should be left until later, because the board can be tested at low voltage before making these final connections.

CONTROL BOARD

The construction of the Control Board requires care because the l.e.d.s must be aligned with the front panel drillings. It is best to do this first without the clutter of other components. The Control Board component layout and full size printed circuit copper foil master pattern is shown in Fig. 4.

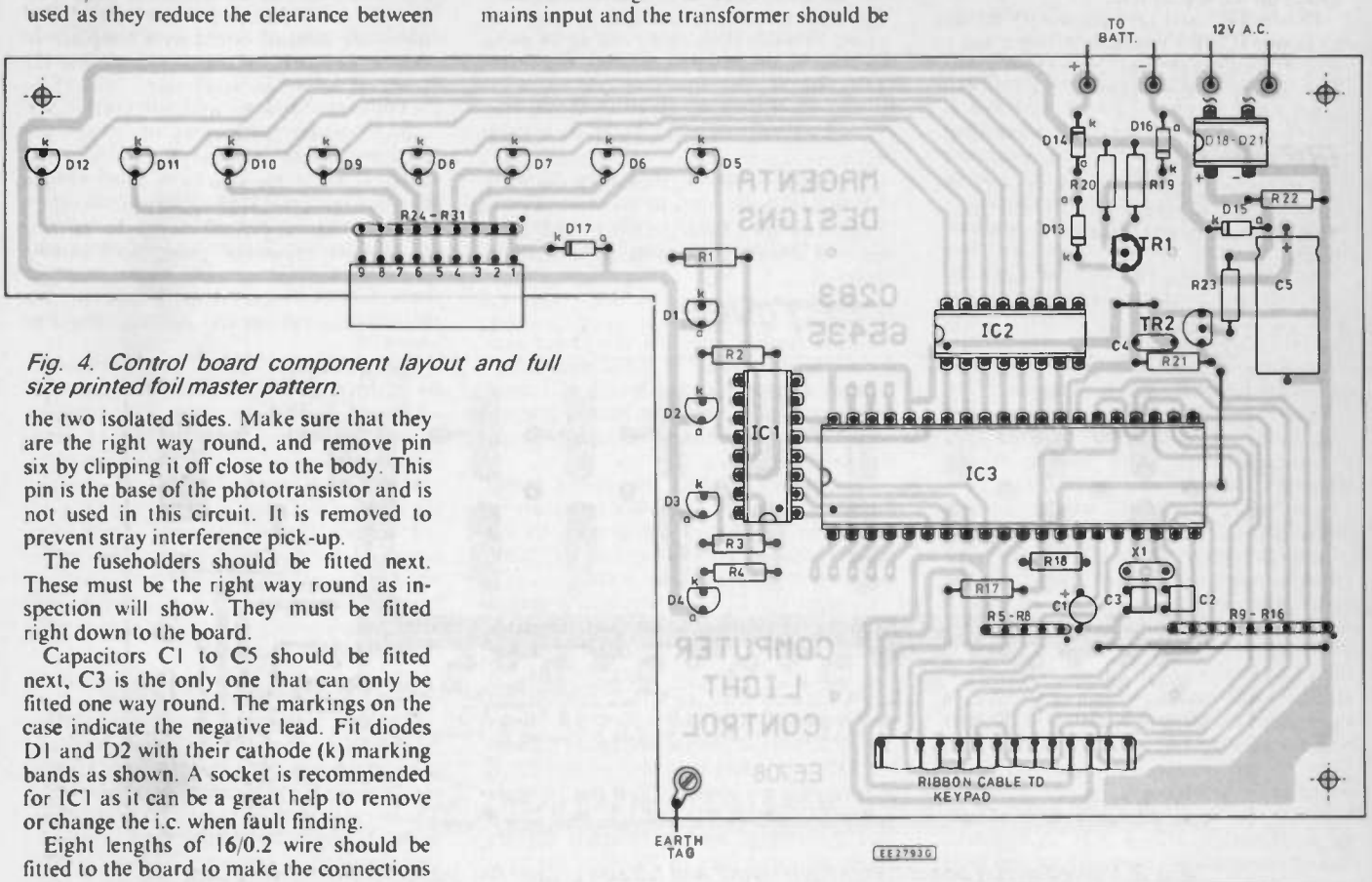
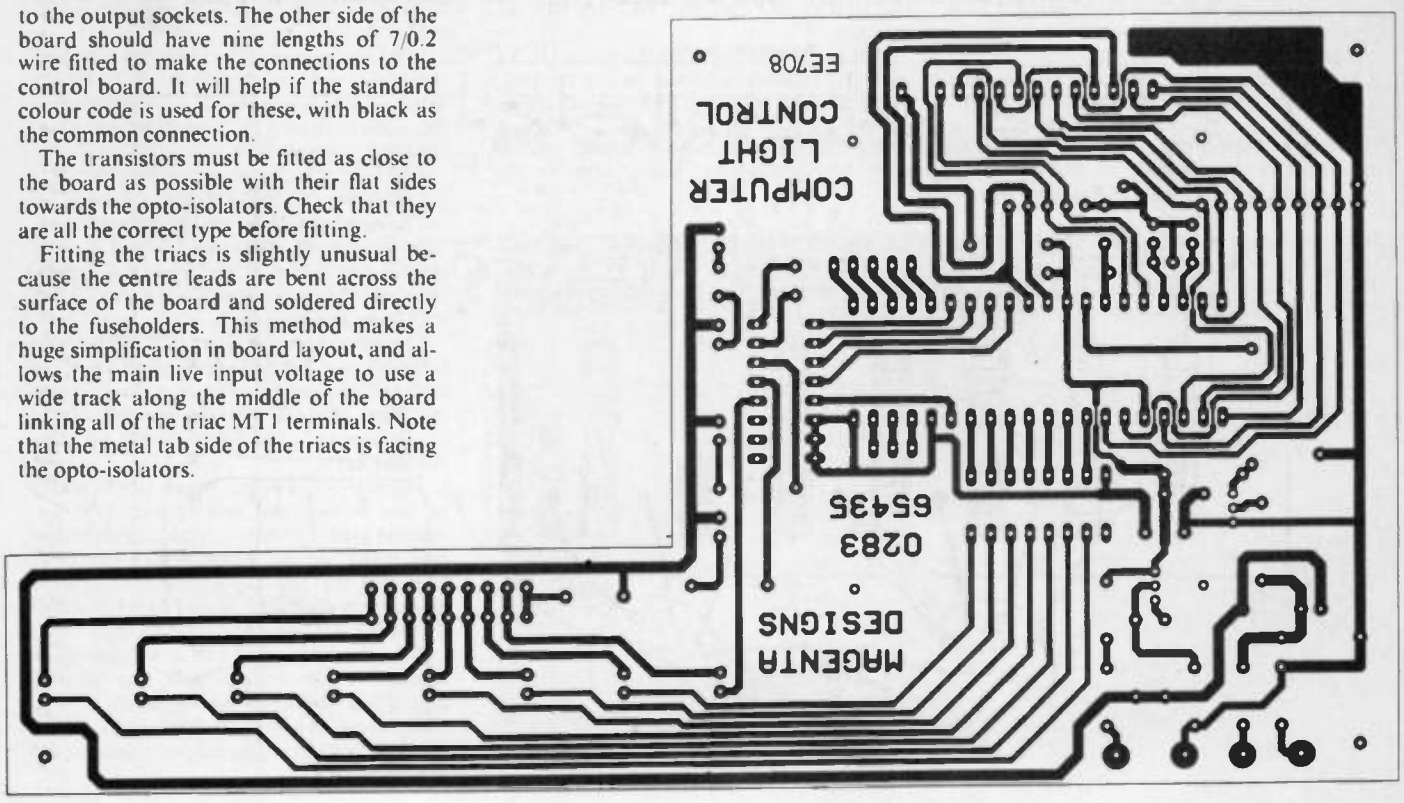


Fig. 4. Control board component layout and full size printed foil master pattern.



Insert the l.e.d.s into the board but do not solder them. With the l.e.d.s in position fit the board to the front panel using long screws and 12mm spacers. In this position the l.e.d.s can be fitted one by one into their front panel holes so that their lenses fit evenly, and then soldered in place.

When this is done, remove the front panel and fit all of the resistors and capacitors, the wire links and the resistor networks. Note that the resistor networks have a dot marking the common end which must match the dot in Fig 4. Curious things will happen if they are the wrong way round. Capacitors C1 and C5 must be fitted correctly as they are polarised.

All three i.c.s should be fitted in sockets. IC1 and IC2 are power types which can be damaged by short circuits, and IC3 is CMOS. There are no particular handling difficulties with any of the i.c.s, but make sure they are the right way round, and fit them only after testing the power circuits.

The bridge rectifier should be soldered directly into the board in the direction shown. Transistors TR1 and TR2 are the same type and must be fitted with their flat sides as shown. Diodes D14, D15, D16, and D17 need careful identification using a magnifier and must be inserted with their cathode (k) marking bands as shown.

There are three wire links, the two longer ones should be made from insulated wire, or tinned wire fitted with sleeving. Wiring between the keypad and the board requires 13 equal lengths of 7/0.2 wire or a short length of 0.1in. pitch ribbon cable. A length of approximately 50mm allows plenty of room to move the keypad away from the board when testing and is short enough to be tidy in the final assembly.

Standard ribbon can be used but it is flimsy and awkward to handle. Those constructors who prefer to use a different case can extend the keypad leads up to 300mm without problems as long as they are kept clear of mains carrying wires and other sources of interference.

Finally the 0.1in. pitch connector should be fitted next to R24 – R31. A standard straight connector is used with its pins bent over just above the moulded insulator. This is best done before inserting the connector into the board.

Two wires carrying 12V from the mains transformer need to be extended with 7/0.2 wire and the joins insulated with sleeving. These connections are made directly to the control board next to the bridge rectifier.

The nine leads from the power board must be routed as shown in the photographs and clipped inside the front of the case alongside the 12V power leads using a self-adhesive cable retainer. Cut the nine leads to equal lengths, strip 4mm of insulation from the ends and crimp on the female connectors for the 0.1in. pitch connector. A pair of pointed pliers will produce an adequate crimp which can be further secured by soldering for extra reliability.

The finished crimp tags are fitted into the rear of the housing so that the small barbs engage with the slots. They can be withdrawn if they are fitted in the wrong order by pressing in the barbs to release them.

A 10-way connector shell must be used as 9-way ones are hard to get. The unused position can be used as a polarising key by blocking the hole with a small piece of plastic.

TESTING

Before further assembly the power and control boards should be tested separately.

Begin with the Control Board. IC3 must be left out and the back up battery disconnected. The lead to the power board should also be unplugged.

Temporarily connect the mains transformer primary 0V and 240V terminals to the mains via sleeved connections to the power switch. Carefully insulate the "20V tap" and tie it out of harms way.

Connect the 12V a.c. secondary output from the transformer to the control board. Switch on and check that all lamps are out, that the voltage across capacitor C5 is approximately 16V and that the voltage across diode D16 is 5.6V.

Check that the emitter voltage of transistor TR1 is 5V and that pins 14 and 25 of IC3's *socket* are both at 5V. If pin 14 reads below 4.5V check R18 and C1. Next check that the voltage on pin 13 reads slightly above zero and rises to 5V when the base and emitter of transistor TR2 are shorted together.

Measure the voltages on the pins of IC3's socket that are connected to the keypad. These should read 0V and rise to above 4V when the corresponding key is pressed. Check that only the correct key changes each pin's voltage. This seems tedious but ensures that everything will go smoothly when IC3 is finally inserted.

The output circuits can now be checked by touching a one kilohm (1k) or similar value resistor between the 5V supply and each output pin in turn. This should result in the corresponding l.e.d.s lighting one by one. Failure of any l.e.d. to light could indicate a fault in IC1 or IC2, or more likely, a reversed or damaged l.e.d.

The l.e.d.s D5 to D12 will be dimmer than the others until the power board is connected, note also that incorrectly fitted resistor networks will produce very odd results. If D5 to D12 all fail to light then the odds are that diode D17 is at fault.

So far so good, now it is time to switch off, carefully insert IC3 and switch on again. If all is well an eight lamp chase sequence should greet the eye! If not, make sure that capacitors C2, C3, and X1 are all correctly fitted and that there are no short circuits or dry joints around them. Check also that the 5V supply is still correct and that pin 13 reads slightly above 0V.

The power to IC3 is current limited by resistor R19 and R20 so it should withstand reversed insertion. Don't forget to look for obvious things such as i.c. pins folding under and missing the socket, unsoldered joints and solder bridges account for 9 out of 10 faults, so check carefully. If the sequence runs correctly, check the action of the control keys and the number keys as explained later in the section headed "Operation". All i.c.s are tested after programming before despatch so any faults are likely to lie elsewhere.

POWER BOARD

Provided the mains connections have NOT yet been made to the Power Board, it is a useful test to connect the 9-way cable to the working Control Board and switch on. The immediate effect should be an increase in brightness of the Mimic l.e.d.s because they now have a current path through the opto-isolator l.e.d.s instead of just resistors R24 – R31.

If no increase occurs check the lead, and that the correct value resistors R1 to R8 are fitted on the power board. Check also that the opto-isolators (IC2 to IC9) are fitted the right way round.

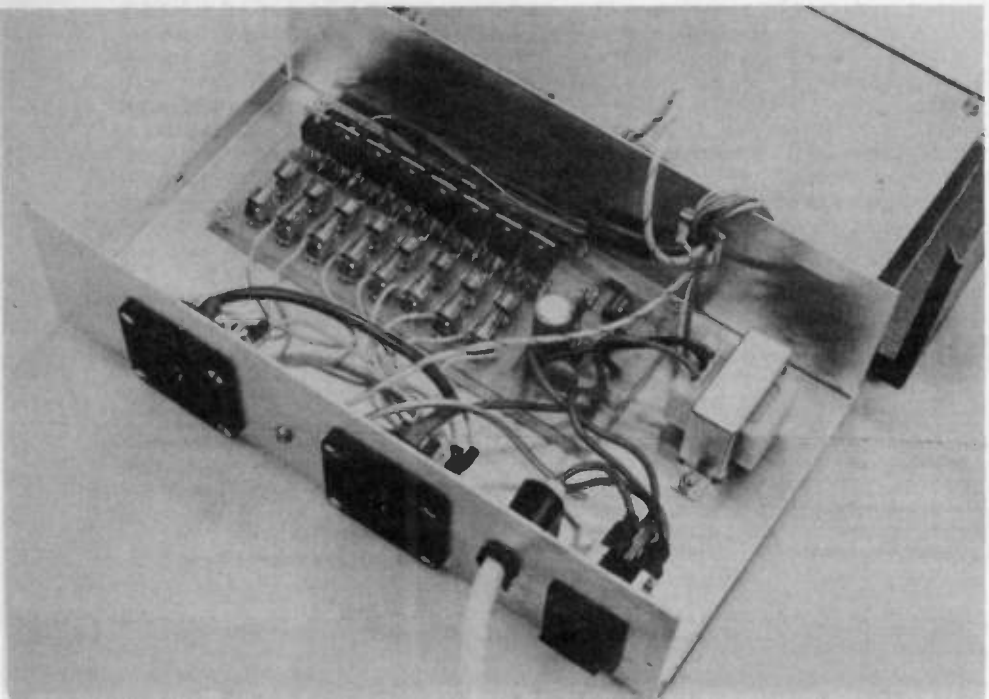
Any l.e.d. that is dimmer or brighter than its neighbours should direct attention to the associated section on the power board. This section of the power board is very simple, consisting of just one l.e.d. (inside the opto-isolator) and a resistor. Any faults should be unlikely.

The circuit on the other side of the opto isolators can not have any effect on these tests. It is easier to carry out these tests if the Stop mode is selected and all of the l.e.d.s are switched individually by their number keys.

The rest of the power board can be tested at low voltage by linking the 12V a.c. supply used by the control board to the two points on the board where the 240V live, and the 20V tap connections will be made later. ***DO NOT MAKE ANY MAINS CONNECTIONS TO THE BOARD.***

The transformer 12V secondary is capable of powering both the control board and the power board during testing. Once these connections have been made, check that the voltage across capacitor C3 is around 16V.

Complete sequencer with top panel removed to reveal the power board, mains transformer and wiring to the output sockets The "screening" panel shields the control panel mounted in the top cover.



The operation of IC1 on the power board can be checked by measuring between pins 3 and 4. Pin 3 should be negative by between 1V and 2V. This is the average reading of the pulsed waveform and will depend upon the meter used, a digital voltmeter could give readings which are way out as it reads the pulses and gaps alternately.

Next temporarily link the anode of diode D1 to the anode of D2 on the power board. This will bypass the pulses and apply 16V continuously to the triac gate trigger circuits. Connect the positive meter terminal to the MT1 terminal of any of the triacs and use the negative test meter probe to measure the voltage in the following tests.

With the control board connected and set in the Stop mode, set all of the l.e.d.s off. Check the voltage at the collectors of TR1 to TR8. This should be close to 15V. Next check the base and emitter voltages which should all be zero. Any irregularities here should direct attention to the corresponding transistors triacs and resistors.

Turn on one channel and check that the base voltage rises to 14V and the emitter to 13V. Check each channel in turn and investigate any differences.

The final test is to check that the triacs are turning on correctly. This can be done at low voltage by connecting a small 12V one or two watt bulb between the cathode of diode D2 and each fuseholder (the end nearer to the triacs). The bulb should turn on and off as expected on each channel.

FINAL ASSEMBLY

Having completed the tests, the transformer should be disconnected from both boards and the power board wiring should be completed. Ensure that the transformer connections to the Power Board are made exactly as shown, a reversed connection here will do some damage by applying near mains voltage to D2 and associated circuits (most of the components on the board).

The Control Board can now be mounted on the front panel by four long screws and 0.5in. pillars. The keypad fits snugly over the board and can be held in position either by sticking it to the front panel or by using the four screw holes.

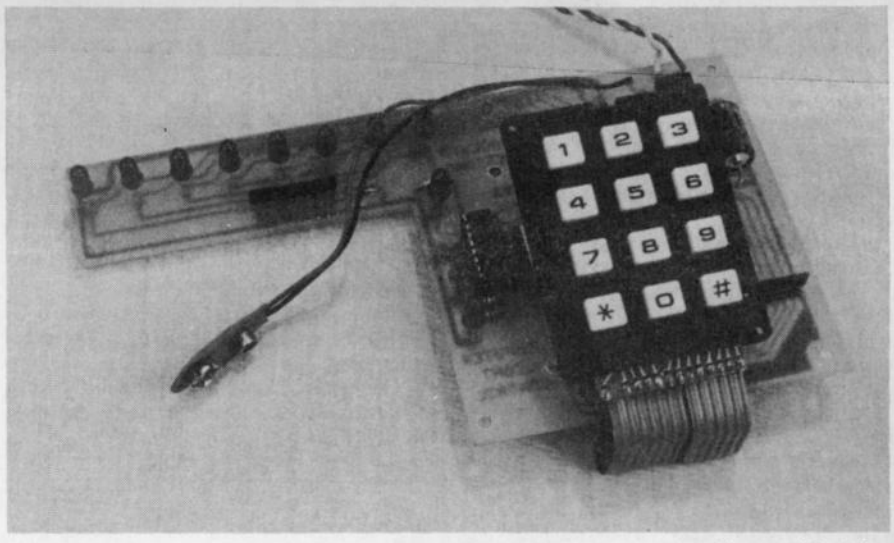
The glue method is neater and provided something like Bostik is used it allows the keypad to be removed if necessary. Check that the connections to the keypad do not contact the inside of the case, use a small strip of tape if necessary to make sure.

One of the control panel mounting screws should be fitted with a solder tag between the pillar and the inside of the front panel. Scrape away some paint to ensure that this tag will make a good Earth contact. When the four panel fixing nuts are fitted the battery clip and 12V a.c. connections should be made to the board.

Clip the 9-way lead to the front panel of the case and plug it into the control board. The leads should allow just enough movement to take off the case top and and lie it face down in front of the case bottom with all connections still made. Finally push the screening panel, plain side down onto the screws holding the control board.

The four nuts should allow sufficient space to accomodate the soldered joints on the rear of the board. If necessary clip any joints that stand too high or use extra nuts.

The Battery should be fitted between this panel and the front panel, using a sticky pad to hold it to the inside of the front. Position the battery so that the clip can be attached and will not fall among the mains connections if it comes loose.



The finished control board with the keypad wired in circuit with ribbon cable. The mimic l.e.d.s can be seen in the top left corner.

A second solder tag must be fitted between the copper side of the screening panel and the final fixing nut. This tag and the one next to the front panel must be linked to the Earthing tag on the case rear panel using green or green/yellow 16/0.2 wire. This lead must be threaded through the solder tag holes and wrapped around to make a good mechanical joint before soldering. Leave enough wire free to enable the case to be opened easily.

HEATSINK

The use of isolated tab triacs allows any type of heatsink to be connected to the triacs without insulation difficulties. In some applications a heatsink will not be required at all, and the circuit can certainly be run for test purposes in this state.

To get the best power output and efficiency requires a piece of 16s.w.g. folded to link the case to the triac tabs, or a piece of solid bar 25mm × 8mm × 100mm drilled to take self-tapping screws through the tabs and to be attached to the case at the other side by similar means. The option chosen is left to the constructor.

POWER

The specified triacs are rated at 8A 250V each. Since all triacs could be on together this gives a maximum rating of 64A! The limit of the mains supply and the surges generated by large tungsten filament lamps gives a very comfortable limit of something under 2A or 500W per channel.

With care, and sensible programming the situation where more than four lamps are on together can be eliminated. This allows 4A or 1000W per channel capability.

Whatever the chosen level of operation, reliability will be very much enhanced by good heatsinking. The aluminium bar method being the best.

The fuses should be as low as possible consistent with the load used. You should find 3A quick blow 20mm types cover most applications, but as with all fuses they cannot be guaranteed to protect the triacs under all conditions.

OPERATION

Running the 8-Channel Microcontroller Light Sequencer is easy, and largely self explanatory. After switch on the RUN mode is entered automatically. The Run lamp lights and the entire range of preprogrammed sequences are run automatically.

To select a particular sequence press the STOP key and the SELECT key. Enter a 3 digit number to select the required sequence followed by the RUN key. If you enter the wrong number, enter the correct three digits before pressing the RUN key. The sequencer acts only on the last three and will run that sequence continuously until another is entered.

To alter the speed of the sequence, press the 9 key for increase or the Hash key for decrease while the sequence is running. Holding the keys for longer produces a greater change.

The sequence can be stopped at any time by pressing the STOP key and can be stepped on manually in this mode by using the 9 key after pressing the STEP key. Lamps can be turned on and off manually whilst in the STOP and STEP mode without interfering with the selected sequence. Returning to RUN mode restores the sequence where it left off.

PROGRAMMING

To program sequences press STOP then STEP and then SELECT followed by a number from 0 to 9. Selecting 0 enters the PROGRAM MODE 2 which allows sequences up to 160 steps long to be entered and run.

Programs are entered one step at a time by setting up the lamps for each step and pressing the STEP key until the required number of steps have been programmed. Steps are entered into memory one byte at a time and are retained indefinitely until reprogrammed. Leave the program mode by pressing RUN.

Entering a number from 1 to 9 after STOP, STEP, SELECT enters PROGRAM MODE 1 and allows one of nine sets of 15 step long areas of memory to be programmed. These will run and repeat in the same way as the pre programmed sequences.

The length of the sequence is automatically set when the RUN key is pressed to exit the programming of each sequence. It can be different for each one and be anything from one to 15 steps long.

All 15 memory locations are reserved even if the sequence is short, so that the maximum number of user entered programs is nine. It is unlikely that more will be needed because the pre programmed sequences cover most requirements. A full list of the programs is supplied with the i.c., or can be obtained separately. □

Pocket Money Project

ELECTRONIC DIPSTICK

CHRIS BOWES

A novel circuit for measuring the depth of aqueous liquids, indicated by a bargraph display. Ideal for remote sensing.

AFTER a short break, we return to the pocket money projects with an Electronic Dipstick which will enable you to measure the depth of any aqueous liquid in a container. The depth of the liquid is indicated by means of 10 l.e.d.s arranged on a bar display.

This project has a number of potential uses, since the length of the sensor wire is not particularly critical. It may therefore be used for remote sensing of the level of liquid in, for example, the washer bottle of a car.

HOW IT WORKS

This, relatively simple circuit relies on the fact that a high gain transistor, such as the BC109 used in this circuit, provides such a large current gain that, when it is used to control a low current device such as a l.e.d., only a very minute current is required to flow through it's base/emitter connection to make a current flow through the emitter/collector circuit. The circuit also relies on the fact that all aqueous liquids allow a very minute current to flow through them, in this case this is sufficient to allow the transistor to "switch" the l.e.d. on.

CIRCUIT DESCRIPTION

The full circuit diagram for the Electronic Dipstick is shown in Fig. 1. At first sight the circuit may appear slightly complex but if you look at it carefully you will notice that it basically consists of one very simple circuit, consisting of one resistor and one transistor and a l.e.d. (with it's associated dropping resistor) repeated 10 times. Since the action of each of the driver circuits is identical, it is only necessary to consider the action of l.e.d. D10; the first l.e.d. to be operated.

When the sensor cable is dipped into the liquid sufficiently deeply for the liquid to complete the circuit between the positive power supply rail and the connection to resistor R10 then the movement of the charge carriers in the liquid is enough to cause a very small current to flow between these two points. This can not occur until switch S1 is depressed, connecting the battery to the two power supply rails.

The minute current which flows from the positive power supply rail through the sensor cable also flows, via resistor R10, to the base of transistor TR10. R10 is a 47 ohm resistor which is incorporated into the circuit to prevent an excessive current flowing through TR10 should a good conductor, such as a metallic object, accidentally short out the connections in the sensor cable.

If resistor R10 were not included in the circuit a direct short between the positive power supply and the base of TR10 would cause the base/emitter voltage of the transistor to exceed the safe limit of approximately 0.7 volts. The action of the transistor would then be to reduce the voltage by dissipating the excess energy as heat. This would cause destruction of the transistor.

The small current which passes through the liquid flows through the base/emitter junction of the transistor TR10 and, in so doing, allows a much larger current to flow through the collector/emitter circuit of the transistor. This in turn allows current to flow through the l.e.d. (D10), causing it to glow. Resistor R20 is included in the collector circuit to reduce the current flowing through the l.e.d. to a safe limit and allow the diode to glow without it being destroyed.

CONSTRUCTION

This project has been designed to be built on two stripboards, main circuit board and display board. It is advisable for the two boards to be constructed separately from each other and for the display board to be tested independently before being connected to the main board.

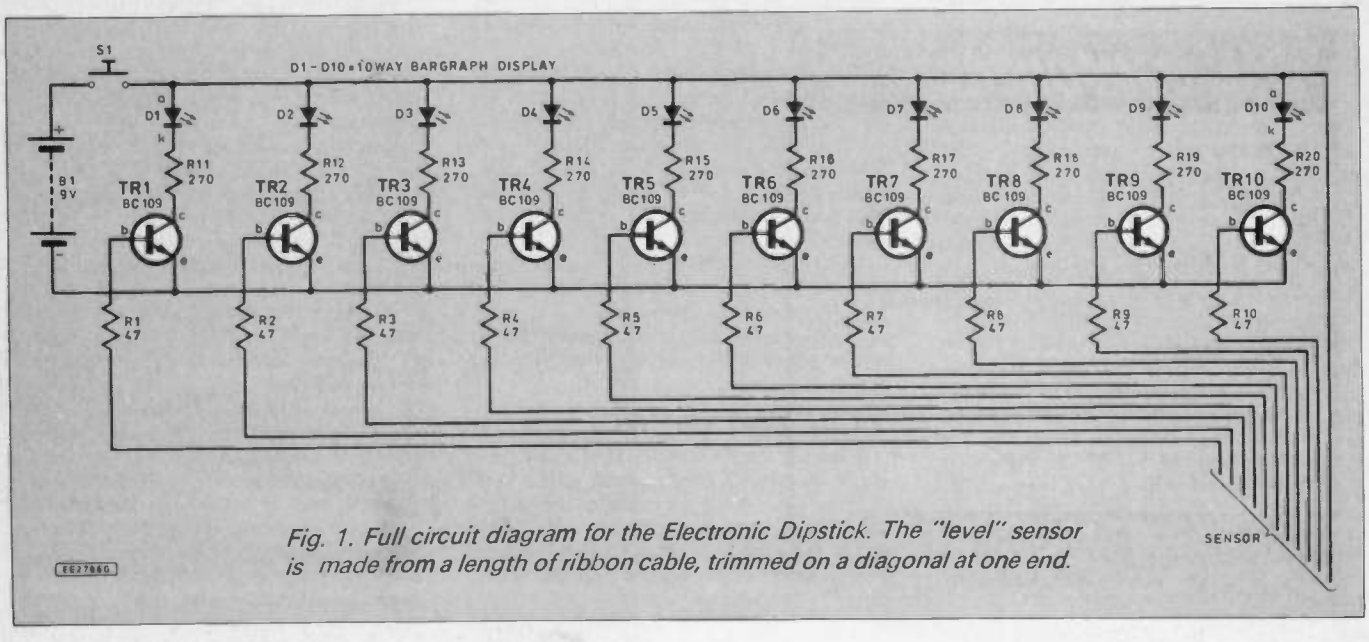


Fig. 1. Full circuit diagram for the Electronic Dipstick. The "level" sensor is made from a length of ribbon cable, trimmed on a diagonal at one end.

MAIN BOARD

The main circuit requires a piece of stripboard which is 7 strips by 40 holes. The component layout and details of breaks required in the underside copper strips are shown in Fig.2. It is very important that care should be taken to ensure the copper tracks are completely broken, with not even the merest silver of copper left to bridge across the broken track.

Although the operation of the circuit will not be affected in any way by the order in which the components are assembled onto the stripboard you will probably find it easiest to insert the smallest components first, in this case resistors R1 to R10. Care should be taken to ensure that the solder used for these connections is not allowed to bridge between adjacent tracks.

Once the resistors have been soldered into place then the transistors (TR1 to TR10) should be inserted into the correct spaces as shown in Fig.2. It is very important to ensure that the transistors are inserted the correct way round, with the little metal tabs on the transistor case pointing in the direction indicated.

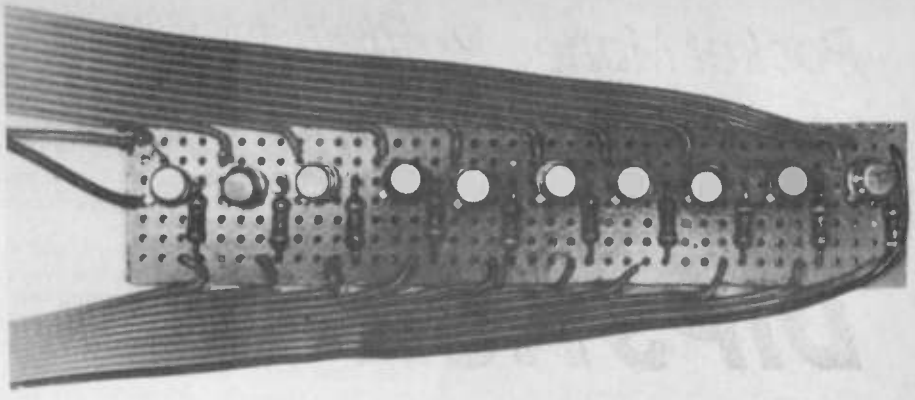
SENSOR CABLE

Once the board mounted components have been assembled on the board and soldered into place, the next stage of the process is to attach the sensor cable to the stripboard. The sensor cable should be made from a piece of 11 - core ribbon cable.

This size of cable is not a standard conformation and it will be necessary to obtain a larger size of cable and remove the excess cores. Once a suitable length of cable has been prepared one of the cores should be identified as the common positive connection.

Before the sensor cable is connected to the main board it should be prepared as shown in Fig.3. The distance through which the range of the liquid sensing should operate is measured and marked off on the opposite side of the ribbon cable to the common positive wire.

The ribbon cable should now be placed flat on a suitable cutting board and a steel ruler placed on the cable so that it marks the angle between the first sensor wire and the point marked on the opposite side of the cable. A sharp knife should be used to



The completed main driver circuit board.

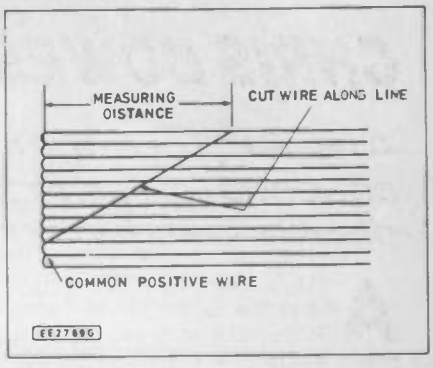


Fig. 3. Preparing one end of the sensor cable.

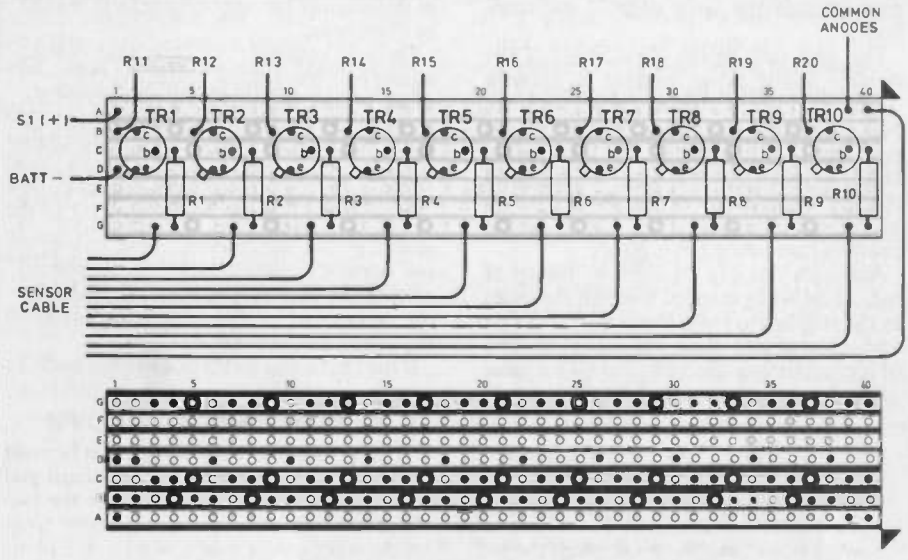


Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks.

COMPONENTS

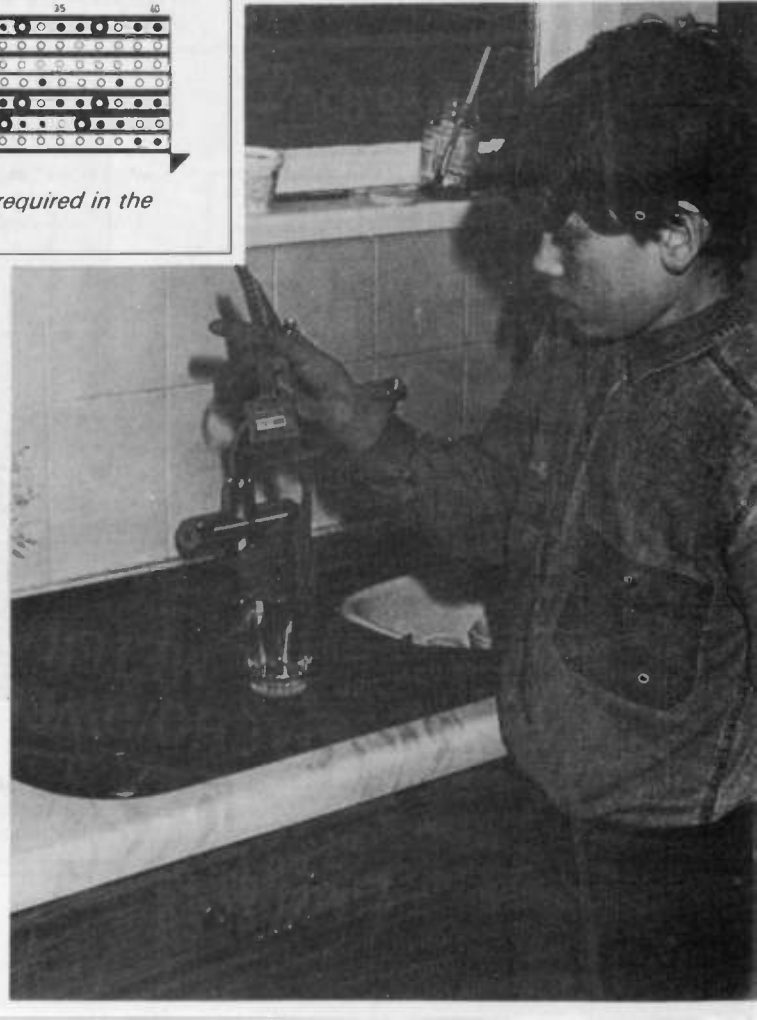
Resistors
R1-R10 47 (10 off)
R11-R20 270 (10 off)
All 0.25W 5% carbon

See SHOP TALK Page

Semiconductors
D1-D10 10-way l.e.d. display array
TR1-TR10 BC109 (or any *npn* signal transistor)

Miscellaneous
S1 S.P.S.T. push-to-make switch
B1 PP9 battery and connector
Stripboard, size 7 strips x 40 holes (1 off), 16 strips x 14 holes (1 off); 11-core ribbon cable (see text); plastic case, size 115mm x 75mm x 45mm; 4 x long bolts and 12 nuts.

Approx cost guidance only **£10**



cut the ribbon cable so that the end of the wire is cut at an angle as shown in Fig.3. It is not necessary to strip the wires at this end of the cable, since the wire bared by the cutting action will be sufficient to enable a current to flow.

The other end of the sensor cable should then be prepared by cutting, stripping and solder "tinning" the ends of the wires in the ribbon cable to connect at the points shown in Fig.2. The battery connections can also be made at this time with the negative connection of the battery connector lead soldered to the point shown as Batt – in Fig.2.

The positive wire of the battery connector should be connected to one of the terminals on switch S1 and a suitable piece of flexible insulated wire should be connected between the second terminal of S1 and the point marked plus (+) on Fig.2. Once these connections have been made the stripboard should be put to one side while the display stripboard is completed.

DISPLAY BOARD

The display for this project is a 10-segment bar l.e.d. array. The board needed to hold this display, and its associated series resistors, is made from a piece of stripboard which is 16 strips by 14 holes in size. The component layout and details of breaks required in the underside copper tracks as shown in Fig.4.

In order to mount the display board on the lid of the case which houses this project it is necessary to drill four mounting holes, in the positions shown in Fig.4. Once the stripboard has been cut the correct size then these should be drilled using a 4mm. drill bit. Once the stripboard has been prepared the resistors (R11 to R20) should be soldered in the appropriate places.

Although the 10 - segment bar l.e.d. display used in this project can be directly mounted onto the stripboard, fault finding will be made easier if this unit is mounted in a carrier in the same way as is used for integrated circuits. The easiest way to make a carrier of the type suitable for mounting the display is to obtain a 25 - way, single-in-line socket strip and cut it to give two 10-way strips. These are then inserted into the appropriate holes in the stripboard and soldered in the normal way. Care should be taken to ensure that both of the socket strips are mounted with their pins towards the same edge of the stripboard.

The next task in the completion of the display board is to connect a suitable length of 11-core ribbon cable, with the ends previously stripped and tinned to the positions shown in Fig.4. The final wiring task is to make sure that all of the common positive connections of the display (those on the opposite side of the display to the resistors) are connected together.

Although this can be done by means of individual wires inserted through the holes in the stripboard from the component side and soldered into place, the easiest method of accomplishing this task is to take a piece of single strand bare wire and solder it directly across the display carrier pins, which are on the side of the display which is opposite to the resistors, directly on the track side of the stripboard.

The ends of the ribbon cable used to connect the display board to the main driver board can now be stripped, tinned and soldered into place in the positions shown in Fig.4. The other ends of the cable should be cut to the correct lengths, stripped and tinned ready for termination on the main driver board. It is however advisable to delay connection of the display board to the main board until after the display board has been tested.

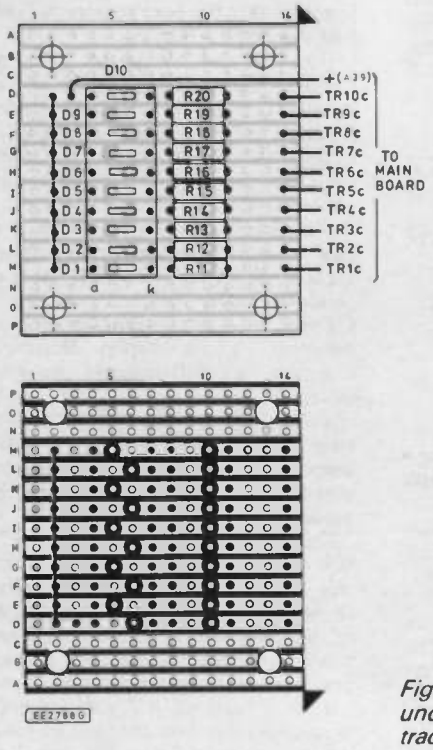
TESTING — DISPLAY BOARD

Fault finding on the completed project should commence with the Display Board since a fully working display board will enable testing of the main circuit board to be carried out with greater ease.

The Display Board is very simple to test, since all that is necessary to do this is to connect the end of the ribbon cable wire connected the common positive connections of the display, to the positive terminal of a 9V battery and then touch the end of each of the other wires in turn to the negative terminal of the battery. When each of the individual wires are connected in this manner the appropriate l.e.d. should be illuminated.

There is actually very little that can go wrong with the display board and the likely cause of any fault which might occur can be easily diagnosed by considering the pattern of which l.e.d.s do not illuminate when tested in this manner. If none of the l.e.d.s are illuminated then the most likely cause of the fault, assuming that the battery is sound, is that the common positive wire is not correctly connected to the stripboard or that the display has been inserted onto the stripboard or the connecting sockets the wrong way around.

If the l.e.d.s illuminate in sequence up to a certain point and then cease to function



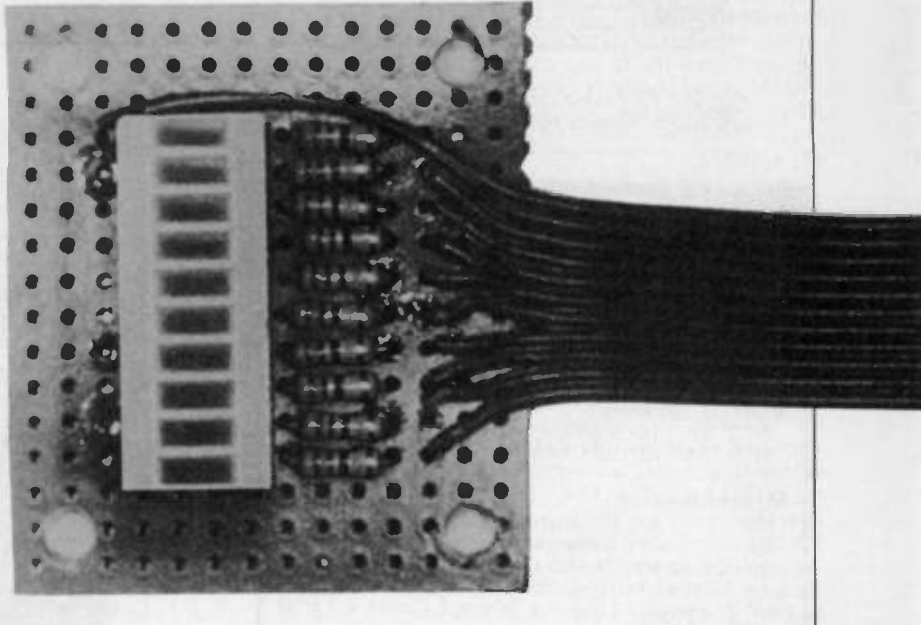


Fig. 4. (left). Stripboard component layout and details of breaks required in the underside copper tracks. Note the common anode link wire connection across the tracks. The completed display board is shown above.

after a specific point then the most likely cause is that the wire connecting the common anodes of the display has become open circuit at some point. In this case the cause of the problem will be found to be between the first l.e.d. which does not light and the last l.e.d. which does. The connection between these points should therefore be carefully checked to ensure that there are no breaks in the connecting wire.

If certain of the l.e.d.s illuminate but the others do not do so in a random pattern, then it will be necessary to check the connections throughout the circuit through each of the l.e.d.s which do not illuminate. Testing and fault finding should be done in a logical manner, starting with a resistance check along the wire in the ribbon cable associated with that particular l.e.d.

If this test proves that there is a complete circuit along the connecting cable then the next stage is to check the resistance between the point of termination on the cable on the stripboard and the nearest end of the appropriate series resistor. This is followed by a check on the actual resistance of the series resistor (which should be within + or - 20% of the stated value).

The next stage is to check the connection between the end of the series resistor and the cathode (k) of the l.e.d. in the bar display. If a break in continuity is discovered between any of these points, then the track associated with the connections and the associated soldered joints should be checked as should the soldering of the joint at the anode(a) of the l.e.d. which does not illuminate.

The integrity of the l.e.d. can also be checked by using the resistance setting of a multimeter. A sound l.e.d. should give a high resistance reading when the probes are connected with the polarity of the probes one way round and low resistance when the polarity of the test probes is reversed. (The precise polarity giving each of these two readings will depend upon the way in which the resistance measuring circuitry of the test meter has been constructed.)

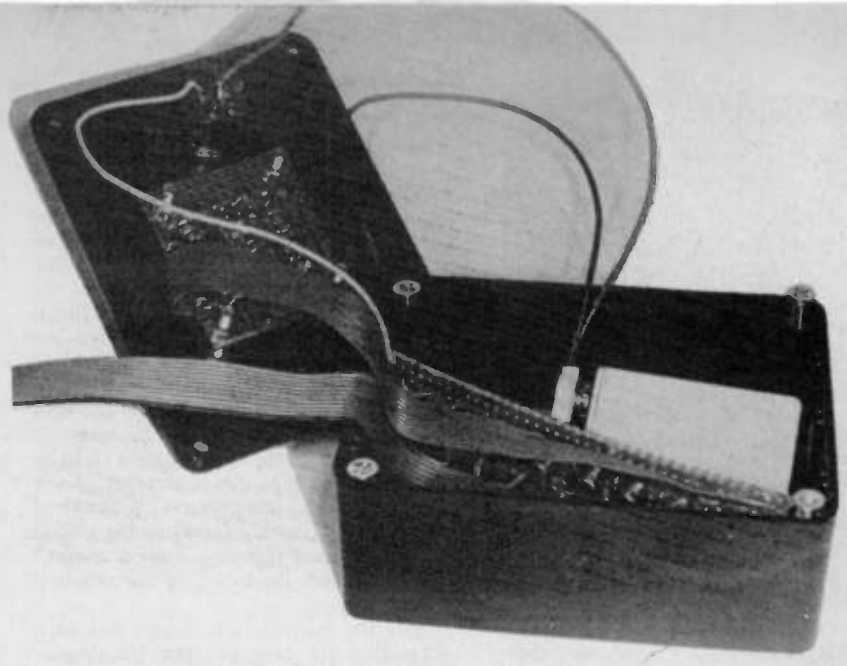
Once a fully working display has been obtained then the ribbon cable from the display board should be connected to the Main Board in the positions shown in Fig.2. It is then possible to test the complete project.

Once a fully working display has been obtained then the ribbon cable from the display board should be connected to the Main Board in the positions shown in Fig.2. It is then possible to test the complete project.

FINAL TESTING

The easiest method of testing the completed project is to lower the end of the sensor cable into a glass of water, whilst operating switch S1. As each of the cores of the sensor wire are submerged in the water then each of the l.e.d.s in the display should progressively illuminate.

As the number of illuminated l.e.d.s increases it is possible that there may be some fluctuation in the brightness of the display but this is not significant. It is, however, important to check that each l.e.d is turned on in turn, that no two l.e.d.s come on at the same time and that, when the sensor cable is completely immersed in the water, all of the l.e.d.s are illuminated.



The completed unit showing the display board mounted on the lid and the driver board positioned diagonally to allow room for the battery.

LIGHTING UP

The most likely fault to be encountered in this project is that one or more of the l.e.d.s does not illuminate as required. As all of the transistor driver circuits are identical then the same fault finding technique can be used for each of the l.e.d.s.

Before investigating the individual driver circuits in detail it is advisable to look at the pattern of which l.e.d.s light up and which do not, to see if any pattern emerges. If, when the sensor cable is inserted into the water, the first few l.e.d.s do not light up but the circuit then appears to be working after the cable has been immersed up to a certain level then, assuming that the display has tested out correctly, the most likely cause is that there is a break in the connections somewhere along the common negative track of the stripboard.

This can be most easily checked by connecting the multimeter, set to read 9V d.c. potential difference, so that the positive meter lead is connected to the connection to the battery positive wire at S1. The negative lead of the test meter should then be connected to each of the emitters of the transistors (TR1 to TR10) in turn and a note made of whether the battery voltage is measurable or not at each emitter.

If at any point the battery voltage ceases to be measured then a careful investigation should be made at the point at which the voltage was last measured and the first point at which the voltage was missing. The likely cause of any problems of this nature will be a break in the tract or a "dry" soldered joint.

TEST DRIVE

Testing of each individual circuit will be made easier if switch S1 is shorted out by temporarily soldering both of the connecting tags together since this saves the necessity of having to operate S1 every time you wish to make a test.

The next stage of fault finding in this circuit is to make a *temporary* short circuit between the emitter and collector of the transistor associated with any non working l.e.d. using a piece of wire. If this causes the l.e.d. associated with the transistor to be illuminated then this indicates that the fault lies on the main circuit board and not on the display board.

If this test fails to cause the l.e.d. to illuminate then the complete circuit between collector of the transistor and the common positive connection to the anode of the display l.e.d. should be carefully investigated, using the resistance setting of the multimeter. If all is well in the circuit through the l.e.d. and its series resistor to the battery positive connection and the negative connection to the emitter is also correct then it will be necessary to check the continuity of the circuit from the sensor cable, through the associated resistor to the base of the transistor.

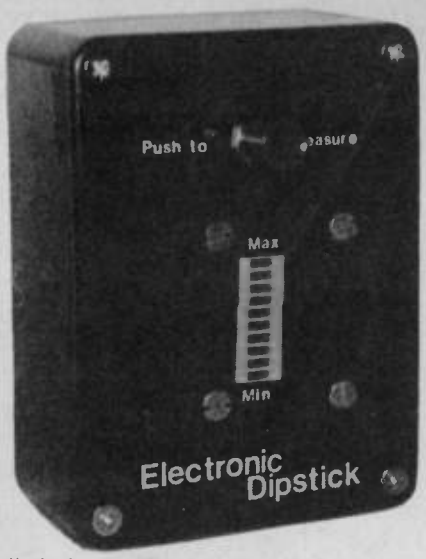
Connect a test meter, set to the resistance range, to the cut end of the sensor cable associated with the non working circuit and check through the circuit from there to the base of the transistor. It should be possible to measure a very low resistance (typically 47 ohms) between these two points. Taking the meter probe from the base to the emitter should give a similar reading. If a resistance significantly higher than this is measurable then this would indicate that the likely faults are dry solder joints or that the base resistor is "off spec" and should be replaced.

The final check required is to make a temporary connection between any battery positive connection (such as the wires connected to S1) and the end of the associated base resistor *furthest away from the transistor*. **It is very important to make sure that the connection is made to the correct side of the dropping resistor since a direct connection between the positive battery voltage and the base of the transistor will cause certain destruction of it.**

The effect of this on the display should be observed. If the display diode does illuminate, this will indicate that the fault lies in the sensor cable. If the l.e.d. does not light up then the voltage between the base and the emitter of the associated transistor should be measured, with the connection between the resistor and the battery positive still in place.

This should be approximately 0.7 volts. If 0 volts is measurable at this point then this would indicate the possibility of a short circuit between the base and emitter of the transistor. The most likely cause of this is a blobbed solder joint between the base and the emitter of the transistor.

If a voltage of 0.7 volts or more is measurable between the base or emitter of the transistor and the associated display



diode is not illuminated, but the display diode illuminates when a temporary short circuit is made between the collector and the emitter of the transistor then the most likely cause is that the transistor is defective. It should therefore be replaced with another transistor and the circuit checked to ensure that it operates correctly.

The only other form of fault that you are likely to encounter in this project is where two or more l.e.d.s come on at the same time. There is really only one cause of this fault which is that there is an incomplete tract break between two adjacent circuits.

CASE

The circuit, once completed and tested, should ideally be mounted in a case. The first stage is to allocate a position for the 10 - bar l.e.d. display and switch S1. When doing this care must be taken to ensure that the body of the switch and the display board will not foul the main stripboard when it is inserted into the case with the lid in position.

Once the position of S1 and the display have been allocated then these positions should be carefully marked onto the lid of the case. The hole for S1 can be drilled using an appropriate sized drill bit but the hole for the display is slightly more difficult to construct, because it will require the cutting of a rectangular hole in the case lid.

The easiest way to accomplish this is to carefully draw the required shape and drill a series of small holes around the inside of the marked rectangle, sufficiently close to each other so that the connecting plastic may be cut away using cutters. When all of the pieces of plastic connecting the drilled holes have been removed, a file is used to carefully finish the hole to the required shape.

Once the hole for the display has been shaped in the case lid then the display board should be offered into position and the location of the four mounting holes, previously drilled in the display board should be marked on the under side of the case. These holes should then be drilled through the case front using a 4mm drill bit. If desired, these may be counter sunk from the front of the case, to enable countersunk bolts to be used for retaining the display board.

The final cutting operation involving the case is to carefully cut out a slot, in both the case body and in the lip of the lid, through which the sensor cable can protrude when the case lid is secured in place.

The case can now be lettered, using rub down lettering which is secured in place by several layers of clear varnish, sufficient time being allowed between each coat for the previous application to thoroughly dry. Once the preparation of the case is completed then the case mounted components can then be installed in to the positions already prepared for them.

Although the mounting of the switch S1 is simple enough the method of mounting the display needs a little explanation. The display board is supported away from the case lid by means of four long bolts which are mounted in the holes already drilled in to the case lid for them. In order to achieve a satisfactory support for the board, whilst at the same time standing it away from the case lid itself, it is necessary for each bolt to be fitted with three nuts. One of these nuts is used to clamp the bolt firmly to the face of the case lid whilst the other two are used to position and clamp in place the display board.

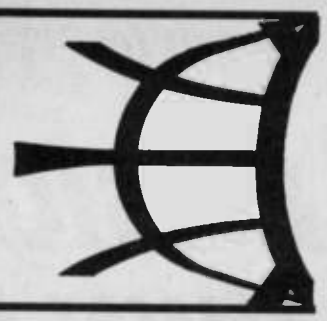
The main driver board and battery should now be positioned in the case. Because of the fact that the main driver board is rather long it may be necessary to mount it inside the case in a diagonal position.

When positioning the battery and the driver board care should be taken to ensure that when the case lid is fitted neither S1 nor the display board will foul the battery of the main driver board.

IN USE

When using the Electronic Dipstick to measure the depth of liquid in a container, all that has to be done is to insert the sensor cable into the container of liquid until the end of the cable reaches the bottom and press switch S1. The depth of the liquid in the container is immediately indicated on the l.e.d. display.

REPORTING AMATEUR RADIO



Tony Smith G4FAI

WHAT DOES AMATEUR RADIO OFFER ME?

The revised edition of the DTI's booklet *"How to become a Radio Amateur"* contains an introductory question and answer section beginning with the question "What Does Amateur Radio Offer Me?" This is difficult to answer in a few words because there are so many things that can be said about such a wide-ranging hobby. The booklet makes a good attempt, however, and is worth repeating here:

"Amateur radio is unique in the freedom it allows you to develop and experiment with radio communication equipment. It can even enable you to communicate around the world.

"Radio amateurs may make contact with people in any country. Even language differences need not be a barrier by using Morse code and "Q" codes (these are three-letter codes which have the same meaning throughout the amateur radio world).

"Radio amateurs are often at the forefront of radio technology and increasingly they are able to use their home computers to combine computer technology and radio. By becoming a radio amateur you can prepare yourself for a world which is increasingly technology based. For example, you can experiment with antennas, television, RTTY (radio teletype), data (including computer controlled communications such as packet radio), satellite communications and, of course, short or long range voice or Morse code transmissions.

FRIENDSHIPS

"The hobby frequently leads to participants making lasting friendships both in the United Kingdom and worldwide. In this way it has proved to be a great asset to those who are housebound, or who find mobility a problem, because of the opportunity it provides to make friends.

"Many other amateurs are able to offer their services to the first aid organisations and even the police at public events during disaster relief operations at home and abroad. For most amateurs, however, it is just the sheer excitement of that chance contact with an individual hundreds or even thousands of miles away that is so absorbing."

There's even more to it than that, of course, and the publication goes on to give the bare bones of it all in terms of the rules and regulations. In the meantime, keep reading this column as I put the meat on the bones, illustrating what amateur radio is in practical terms and what it means to the individuals involved in it. There is no short answer to that original question!

The booklet is available free of charge from *Radio Amateur Licensing Unit, Post Office Counters Ltd, Chetwynd House, Chesterfield S49 1PF.*

FURTHER READING

For those interested in taking the radio amateurs' examination, the DTI recommends a short "further reading" list. This includes *"How to Improve Television and Radio Reception"*, available from Post Offices; *"The Radio Amateurs' Examination Manual"* (RSGB); *"A Guide to Amateur Radio"* (RSGB); *"Amateur Radio Operating Manual"* (RSGB); and a number of DTI Information sheets which expand on some of the information contained in the booklet.

These are: No. 1, Radio Amateur Licensing; No. 2, Amateur Service Allocation in the 50MHz (6 metre) and 70MHz (4 metre) Band; No. 3, Morse; No. 4, Amateur Radio Call Signs; No. 5, Amateur Radio Clubs and Societies; No. 6, Radio Amateurs' Examination; No. 7, New Amateur Radio Licence; No. 8, Radio Investigation Service District Offices; No. 9, CEPT Amateurs (UK Licensees); and No. 10, CEPT Amateurs (Visiting Licensees). These sheets can be obtained, free of charge, from *Radiocommunications Agency, Information and Library Service, Waterloo Bridge House, Waterloo Road, London SE1 8UA.*

USING THE BUREAU

The most used service of the Radio Society of Great Britain is its QSL Bureau, whereby members send and receive QSL cards worldwide at minimal cost, and non-members can receive cards from members on the same basis. The Society recently re-organised the bureau, which is now sited at RSGB headquarters.

Cards for distribution are sent by individual amateurs, in quantity, to Potters Bar. Here they are sorted and despatched in bulk to overseas bureaux, usually operated by member-societies of the International Amateur Radio Union, or to UK sub-bureaux organised by call-sign series.

Members and licensed non-members can send stamped addressed envelopes to the appropriate sub-bureau and these are returned filled with cards when the weight of cards "waiting" reaches the maximum covered by the pre-paid postage. Cards for amateurs who have not lodged envelopes are kept for three months and then destroyed. The full facilities of the bureau are available to both transmitting and receiving members of the society, although reception reports relating to short-wave broadcasting stations cannot be accepted.

Although the bureau represents the cheapest way of exchanging QSL cards, it is not the fastest. By the time a card gets through the different stages of its journey, and its reply returns by the same route, some six to nine months can elapse. Some amateurs take a long time to send out cards and I sometimes receive QSLs for contacts I had four or five years ago!

The moral of all this is that those who desperately want a particular card should consider sending their own direct to the other station, enclosing an s.a.e., or two international reply coupons, to cover the cost of return postage. This won't guarantee a reply but it improves the chance of getting one quite considerably.

CALL-SIGN CONFUSION

For years, the UK call-sign system has been fairly easy to follow. The letter *G* signifies a British station and a second letter indicates a region other than England, thus *GW* – Wales; *GM* – Scotland; *GI* – Northern Ireland; *GU* – Guernsey; *GJ* – Jersey; and *GD* – Isle of Man.

A special series of call-signs using the prefix *GB* has been allocated to "special event" demonstration stations, which have been permitted to put unlicensed operators (eg, members of the public) "on-the-air", under supervision, to send simple greetings to other stations in the UK, the USA, Canada, the Falklands, and Pitcairn Island.

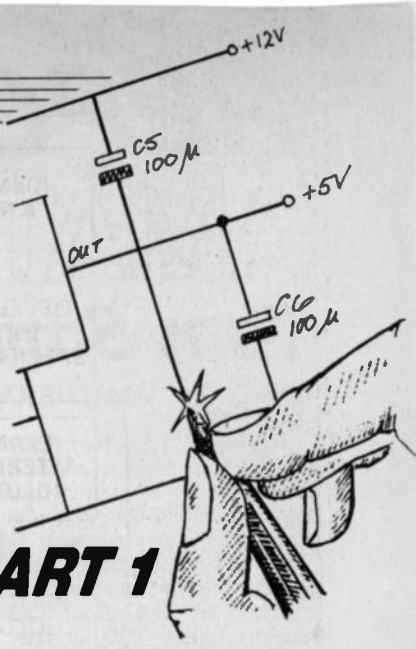
New regulations now permit licensed club stations to use the greetings message facility without the need for a special GB call-sign, but they have to modify their existing call to indicate when they are using the facility. A club station normally located in England, with a G prefix, would therefore become *GX*; Wales (normally GW) *GC*; Scotland (GM) *GS*; Northern Ireland (GI) *GN*; Guernsey (GU) *GP*; Jersey (GJ) *GH*; and Isle of Man (GD) *GT*; reverting to its regular call-sign when returning to normal amateur operation.

Even more confusing are the DTI's proposals for a new series of calls when either the remaining class *B* (G7s to be followed by G5s) or class *A* (G0) series run out. It is then proposed to abandon all further G-allocations and start a new series of calls beginning with the letter *M*.

A second letter will indicate the class of licence. Possibly MA-MJ prefixes will denote class A, and MK-MZ class B, although MB could be reserved for special event stations and MC for clubs. A number would indicate the region where the station is located; England – 2; Scotland – 3; Wales – 4; Northern Ireland – 5; Isle of Man – 6; Jersey – 7; Guernsey – 8. For example, MA2AAA would be a class A station in England, but if it moved to Wales it would become MA4AAA.

To add to the confusion, call-signs for the new Novice licences will probably start with the figure 2, with the series running from 2A1AAA to 2Z9ZZZ. The second symbol (letter) would again indicate the licence class (Novice A or Novice B), and the third symbol would again be a number, indicating the region where the station is located.

DESIGN YOUR OWN CIRCUITS



Getting started

MIKE TOOLEY BA

PART 1

This ten part series which is designed for the beginner and experienced reader alike, aims to dispell some of the mystique associated with the design of electronic circuits. It shows how even the relative newcomer to electronics can, with the right approach, design and realise quite complex circuits.
In this first part we introduce the series, describe the tools and test equipment you will require to follow the series, outline some basic concepts and get to grips with practical aspects of the design of electronic power supplies. Our companion project deals with the construction of a Versatile Bench Power Supply.

Introduction

Welcome to *Design Your Own Circuits*, a new and exciting series which has been designed especially for Everyday Electronics readers. The series deals with a topic which we feel almost every reader will wish to get to grips with and differs in a number of important respects from any of the previous "educational" features in this magazine. The series will lead you gently through all of the stages in designing a wide range of electronic circuits "from scratch". There is no "magic" in this; just logical thinking coupled with a basic understanding of electronic circuits and components!

In order to provide readers with an opportunity to develop their skills further, each part will incorporate a **design problem** together with a complete **practical project**. The problems have been included so that readers can test their knowledge and understanding as they progress through the series and, although "model answers" will be provided they should not be regarded as the ultimate solution. Readers should not therefore be discouraged if they find that their own answers differ markedly from those presented. In addition to the design problems, the text for each part will be interspersed with questions so that readers can rather more frequently check their understanding.

Practical projects have been included so that readers can follow the complete process of design, assembly, construction, testing and evaluation. Each project will be accompanied by a number of suggested modifications and improvements so that each one can be "customised" to suit the needs of individual readers. The practical projects have been designed to stand on their own as complete items of equipment in their own right and thus should appeal to those readers who may not necessarily be following the series.

Our overall aim in this series has been that of attempting to foster an intuitive approach to design. Such an approach does not rely on the mastery of complex mathematical formulae rather it is based upon an understanding of the behaviour of common electronic components and the application of a few basic principles. To this end, the approach will be somewhat unorthodox in that theory will only be introduced where it is directly relevant to a particular topic. By this means, we shall be able to get to grips with some fairly complex circuits at an early stage.

Readers

At this stage, you may perhaps be forgiven for wondering just what it is that we have assumed about you! Essentially, you should be able to:

1. Identify common electronic components and recognise their symbols.
2. Understand commonly used component markings and colour codes.
3. Use a multi-range meter to make voltage, current, and resistance measurements.
4. Know the basic electrical units and the symbols used to represent them.
5. Make use of multiples and submultiples and recognise the prefixes used to denote them.
6. Understand basic electrical concepts such as e.m.f., potential difference, and current flow.
7. Read and understand *simple* circuit diagrams (if you can cope with the majority of circuits published in E.E. then you will have little difficulty with any of those which will appear within this series).
8. Use a soldering iron and a range of small electronic tools.

If you are doubtful about topics 1 to 7, then it would be well worth investing in a copy of the *Everyday Electronics Data Book* (available at £8.95 from the *Everyday Electronics Direct Book Service*). This book contains all of the preliminary information that is required to follow the series and also contains numerous examples, hints and tips for the budding electronic circuit designer.

Tools and test equipment

In order to follow the series (and to build the modules and projects which we describe) you will need very little in the way of tools and test equipment. Most of the items will already be available but if this is not the case most of E.E.'s regular advertisers should be able to help. The following list should give readers some idea of what is required:

- ★ a soldering iron (15W to 20W) with a supply of multicore solder
- ★ a multi-range meter (preferably digital) with test leads
- ★ a set of small electronic tools including

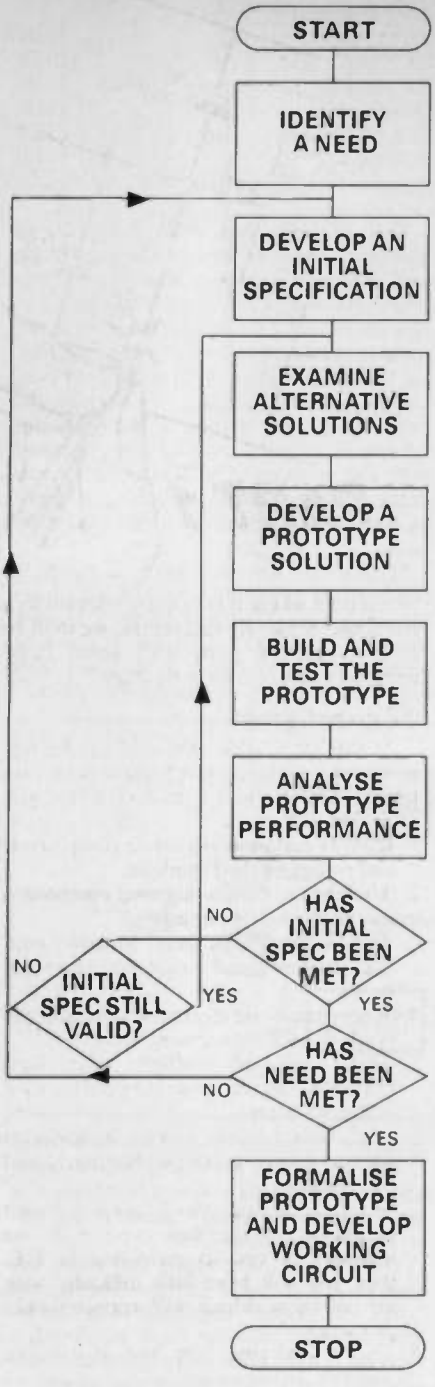


Fig. 1.1. Basic steps in the design process

side cutters, pliers and screwdrivers, a small drill (either a hand-drill or mini-electric drill), a set of drill bits (1mm to 10mm), and a trimming knife

★ a desoldering pump

The following additional items will be found useful in conjunction with our companion projects:

★ a small hacksaw

★ a set of small hand files

★ a tension file

★ a steel rule, scribe and centre-punch

Series summary

Each part of the series deals with a different topic area. In Part One, we start with a general introduction to the principles of circuit design before moving on to deal with the design of power supplies for use in a variety of electronic equipment. Our design problem features a simple oscilloscope voltage calibrator whilst our accompanying practical project involves the construction of a versatile bench power supply.

Parts Two and Three deal with amplifiers (transistor and operational amplifiers are introduced in Part Two whilst Part Three is largely devoted to consumer integrated circuits and power amplifiers). A number of important concepts are developed in these two parts including gain, phase-shift, feedback, noise and distortion. The design problems and projects include a microphone pre-amplifier, a guitar amplifier, an intercom system, and a bench amplifier/signal tracer.

Oscillator design is covered in Part Four. We shall be dealing with sinusoidal (both a.f. and r.f.) and square wave oscillator circuits and our project features a signal generator with sine, square and triangular wave outputs.

Part Five introduces the world of digital electronics and describes the use of logic gates, monostable and bistable circuits, counters and shift registers. Our design problem is based on an intruder alarm.

Integrated circuit timers are featured in Part Six and the complementary project features a versatile pulse generator. Radio is introduced in Part Seven whilst Part Eight deals with power control. Projects include an r.f. signal generator (with internal and external modulation) and a disco lights controller.

Part Nine is devoted to optoelectronics and features the use of photo-emitters and photo-detectors. Our design problem is based on an automatic porch light whilst the accompanying project shows readers how to design and construct an optical communications link. Finally, Part Ten (entitled *What Next?*) aims to round-off the series with feedback from readers as well as providing some "food for thought" for further work.

The design process

The process of design, whether it be in electronics or in any other field, is, of necessity a logical undertaking in which there is nonetheless plenty of scope for flair and imagination. As with many other pursuits, the sequence of events is crucial. Fig. 1.1 shows the basic steps within the design process. The first stage (and arguably the most important) is that of identifying a need. Without this, the rest of the process is meaningless. Indeed, if a need cannot be identified at an early stage, there is little point in progressing further.

The need for an electronic circuit may arise from a variety of sources; from a purely personal requirement to widespread commercial demand. Examples in the former category could include a requirement to produce a baby alarm consequent on the arrival of a brand new member of the family. Here, the designer is likely to be the "end-user".

In the commercial category, however, the end-user is not the designer and appropriate market research will be an essential pre-requisite when carrying out an analysis of needs. In addition, many commercial products are "test marketed" before large-scale production starts. This test marketing is instrumental in not only determining the size of the potential market but also yielding some very useful information about the end-user.

A commercial decision concerning the viability of a product will not usually be taken until both market research and test marketing has taken place. Financial backing may be dependent upon both of these elements as well as the viability of the overall "business plan" produced by an organisation.

Modular approach

A modular approach to circuit design offers a number of advantages, not the least of which is that it readily permit the assembly of quite complex equipment from a number of more easily assembled and tested sub-circuits. A further significant advantage (and one which is often forgotten at the early stages) is that a modular approach redily permits the replacement and upgrading of parts of the equipment as needs dictate.

A module may comprise as few as half a dozen active devices or perhaps as many as fifty or more. Each module should have a defined function and will probably be associated with one (or more) blocks within the functional block schematic of the equipment. The interface from one module to other modules within the equipment should be clearly defined in terms of the signals and voltage levels present. As far as possible, these should be standardised so that modules can be made fully interchangeable.

Throughout this series we have attempted to standardise on the range of connectors, signals and supply voltages so that, not only are the individual circuit modules compatible with one another but also those which provide similar functions are interchangeable.

A number of the circuits described in our series will be presented as "modules". A printed circuit layout (together with a component layout diagram and detailed component list) will be provided for each and, whilst each is a complete working circuit in its own right, modules may be interconnected to realise a number of more complex functional circuits. Our modules can thus be thought of as constituting the basic "building blocks" of a large number of practical electronic circuits.

Hence, for example, it would be possible to put together a complete audio amplifier system using standard modules taken from several parts of the series. The power supply module (a dual regulated supply providing ±15V rails at 1A) could be taken from Part One, a pre-amplifier/tone control module taken from Part Two, and a 10W high-quality output stage taken from Part Three.

A cumulative index of modules (together with brief specifications) will accompany each part of the series. This index will provide readers with a means of matching their requirements with circuits which have previously appeared in the series and which are thus available "off the shelf".

Specifications

At the outset, it is vital to form an initial specification for a circuit. This is an essential pre-requisite in any design project. Indeed, to start without any fixed idea of what is actually required is foolhardy to say the least!

The initial specification should be regarded as a target. In practice, it may not be possible to realise this initial specification for a whole host of reasons hence the initial specification should not be so fanciful that it is impossible to achieve.

Getting the initial specification right is an art in itself; if the specification is made too exacting it may be impossible to achieve, if made too undemanding there may be little incentive to improve on known technology.

Where a requirement is particularly novel, a little "brainstorming" can be useful when forming a specification. Try to think laterally and avoid falling into the trap of merely adapting an existing solution; a balance between lateral and traditional thinking is essential. Indeed, to go too far along either road at the expense of the other can be detrimental to the development of one's skills as a designer.

Lateral thinking

At this point, it is probably worth spending a little time to explain just what we mean by the term "lateral thinking". Lateral thinking involves dismissing (at least initially) traditional methods of solving a problem. As far as possible, one should abandon the "tried and tested" approach and think "around" the problem in a radical manner.

As an example, consider a requirement for a highly accurate 1MHz reference clock signal for use in an item of test equipment. Using the traditional approach, we might consider using the output of a highly stable crystal oscillator. In order to achieve the requisite stability, we would probably have to place the crystal and associated oscillator circuitry in a carefully temperature controlled environment (a "crystal oven"). Furthermore, the quartz crystal itself would have to be a very high quality and accurate component. Using this approach, we could hope to produce an arrangement which offers a frequency accuracy of around ± 20 parts-per-million.

Lateral thinking may, however, result in a totally different (and cost-effective) approach to this problem. Rather than adopt a circuit which is based on a locally generated signal, the "lateral thinker" may decide to make use of a broadcast standard frequency signal. This signal would be used as a "reference" to which a locally generated signal can be "locked". The "off-air" signal is simply received, amplified and squared before it is applied as the reference signal within a phase-locked loop (PLL). As a bonus, the frequency accuracy of such an arrangement is several orders of magnitude greater than that which can be obtained by the conventional "ovened-crystal" approach and the long-term stability is also greatly improved.

The traditional approach to the problem is illustrted in Fig. 1.2a whilst Fig. 1.2b shows the arrangement which results from lateral thinking. The arrangement of Fig. 1.2b is more complex than that in Fig. 1.2a however very considerable savings are achieved since individual component tolerances can be very much less stringent and there would be no need for a closely temperature controlled environment.

A representative breakdown in cost for the two approaches is as follows:

Traditional:	
Crystal (close tolerance)	£8.00
Oscillator circuitry	£3.00
Buffer/amplifier	£3.00
Voltage regulator circuit	£2.00
Temperature controller	£8.00
Thermally sealed enclosure	£5.00
PCB etc	£5.00
Approx. total component cost:	£34.00

Lateral approach:	
Ferrite antenna	£2.00
RF filter	£10.00
RF amplifier/squarer	£2.00
Divider stage	£2.00
PLL oscillator	£3.00
PCB etc	£5.00
Approx. total component cost:	£24.00

This example has been designed to highlight the differences in approach and, whereas it shows clearly the cost-effectiveness and advantages of the solution achieved by lateral thinking, there are some disadvantages (notably the fact that an "off-air" signal may not always be available!). This again highlights the importance of starting out with a meaningful specification; we should have specified that the equipment will operate in any normal environment (including a basement) – clearly this may not always be the case!

In practice, we may wish to adopt a compromise approach which benefits from the advantages of both techniques. In such an event, we could capitalise on the very significant improvement in accuracy and long-term stability offered by an "off-air" reference (typically 1 part in 10^{10} for a Droitwich locked standard) whilst being able to revert to the inherent reliability of a locally generated signal whenever the off-air standard is unavailable.

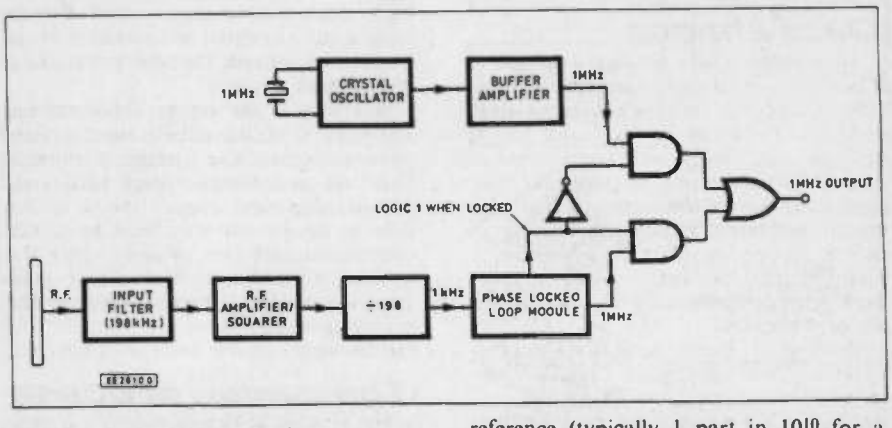


Fig. 1.3 A combined solution

The final solution might run along the lines shown in Fig. 1.3. By combining the "tried and tested" approach with the innovative approach we have produced a solution which offers very significant advantages over either method used alone.

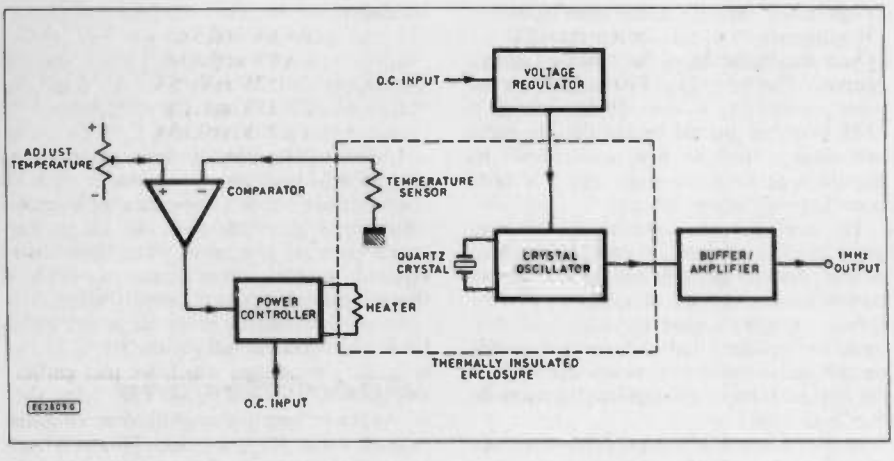
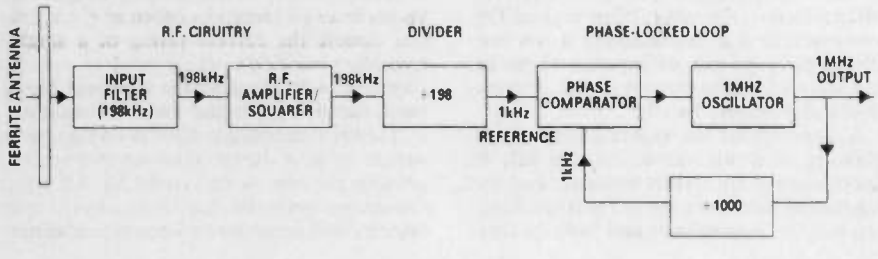


Fig. 1.2a Traditional approach to providing the highly stable 1MHz signal

Fig. 1.2b "Lateral thinking" approach based on a PLL and off-air standard



Data

Most electronics enthusiasts are avid collectors of data. Anyone involved within the design of electronic circuits will find that access to a bank of data is essential in order to make effective use of the huge variety of electronic components currently available. Magazine articles and application notes (published by component manufacturers) are an excellent source of ideas and are likely to contain numerous tested circuits. Would-be designers should not feel guilty about "borrowing" ideas from other people as one can learn a lot from others' ideas and there is absolutely no point in "re-inventing the wheel"!

Sources of data available to the electronics enthusiast include manufacturers' data sheets and data books, suppliers' catalogues, magazine articles, application notes, textbooks and technical reports. At the outset it is worth organising a data library into related topics using a filing cabinet or just simply a collection of cardboard boxes fitted with dividers.

Textbooks and data books can be stored in a conventional bookshelf along with magazines (preferably in binders) and the larger catalogues.

Sources of data which can be particularly recommended include:

The ***Maplin Buyer's Guide to Electronic Components.*** This excellent publication is more than just a catalogue since it contains a vast amount of information on just about every common type of electronic component. Several thousand semiconductors are listed and the section of the catalogue devoted to integrated circuits contains pin-connecting information and numerous application circuits.

Everyday Electronics. This monthly magazine never fails to provide a wide variety of electronic projects and educational features which are suited both to the beginner and the more experienced enthusiast.

The ***Modern Amateur Electronics Manual.*** This enormous reference work aims to provide a practical reference to modern electronic technology. It is a loose-leaf publication (in several volumes) with regular updating supplements which are published approximately bi-monthly.

Data sheets

All manufacturers provide data sheets (often free) and data books (usually available at moderate cost) which cover their products. These can be invaluable to the designer since they provide a great deal of useful information and, in particular, give some indication of the maximum and minimum operational parameters for a particular device. The designer is thus made aware of the limits within which he must work when designing a circuit based on the device in question.

Many data sheets (and data books) contain typical application circuits. Some manufacturers also provide detailed application notes which are written by their own applications design staff. These can make very useful reading since they give a considerable insight into the thought process of other designers and can sometimes point the way to some really novel applications.

As an example of using data sheets (and since this first part of our series is devoted to power supplies) it is worth taking a look at the first four pages of the National Semiconductor data sheet for the LM723 voltage regulator shown in Fig. 1.4.

The format of this data sheet is typical of that used by nearly every semiconductor manufacturer and comprises a general description of the device, internal schematic (circuit diagram) and pin connections for the device, absolute maximum ratings, electrical characteristics, derating curves, typical performance characteristics, and typical applications circuits.

Readers should spend a little time reading through the data sheet but should not be too worried if very little of it makes sense initially! Much of the data will be of relatively little significance in most applications and it is certainly not essential to understand everything on the data sheet to put the LM723 to good use.

Question 1: Use the National Semiconductor data sheets for the LM723 to determine the following:

(a) maximum continuous input voltage
(b) maximum operating temperature for an LM723C
(c) positive input connection for the dual-in-line version
(d) minimum input voltage
(e) minimum output voltage
(f) typical load regulation
(g) typical short-circuit current (at 25°C)
(h) typical short-circuit current (at 125°C)
(i) maximum power dissipation at 50°C for an LM723C in a TO5 package

Power Supplies

Having now set the scene (and hopefully whetted readers' appetites for what is to come!) we now get to grips with the first topic within our practical circuit design series: **Power Supplies**. Since every circuit that is not operated directly from a battery will require a power supply, this seems a very logical place to start!

The power supply is the hidden hero of every electronic circuit; we happily assume that it is there and doing its job. Rarely do we give it the attention that it really deserves.

In general a power supply should:

(a) provide the rated voltage of the circuit which it is to supply (within acceptable tolerance limits)
(b) provide current up to the rated maximum for the circuit which it is to supply (without the supply voltage falling outside the specified working range)
(c) maintain the rated output voltage (and current capability) over a range of conditions (e.g. ambient temperature, a.c. mains voltage variations, load circuit demand, etc)
(d) cope with short-circuit component failures which may arise within the circuit which it is to supply (and which may otherwise damage the power supply)
(e) have adjustable voltage and current limit (as required)

A typical power supply specification may run along the following lines:

Output voltage:	12V ±5%
Maximum output/ load current:	1A
Hum and noise:	less than 10mV
Regulation:	better than 2%
Output impedance:	less than 0.1 ohm
Input voltage:	220 to 240V a.c. 50Hz

Most of this should be reasonably self-explanatory. First we need to achieve an output voltage which is nominally 12V (but an output in the range 11.4V to 12.6V would be acceptable). The output voltage needs to be maintained within this range for load currents of up to 1A (note that the output voltage can be expected to fall as the load current increases).

There is residual hum (i.e. an a.c. signal component at mains or twice mains frequency) and noise (a random unwanted a.c. component) present on the output of every power supply. In practice this can be reduced to negligible proportions by regulation, smoothing and decoupling. We simply have to ensure that, in this case, the total amount of hum and noise superimposed on the d.c. output does not exceed 10mV r.m.s.

Regulation is a measure of how good the power supply is at maintaining its output voltage in the light of input voltage or load current variations. A regulation of 2% means simply that the output voltage should be maintained within 2% over the given range of a.c. input voltages (220V to 240V) and load current (zero to 1A). In practice (and since we may suffer from variations in line voltage and load current at the same time) we may wish to quote two figures for regulation: one for line and one for load.

Question 2: What is the maximum permissible change in output voltage from the power supply if the mains voltage falls from 240V to 220V? (Hint: we would expect the output to change by no more than 2%)

Transformers

Arguably the most important (but often most neglected) component in any power supply is the transformer. This component is used to provide both isolation from the a.c. mains supply (ensuring that the equipment which is being powered is not connected directly to either of the supply lines, line and neutral) and a means of stepping down (or stepping up) the mains supply voltage to a value which is within the range acceptable to the rectifying and stabilising stages which follow.

Transformers must be adequately rated for the service which they are required to perform. Not only does this mean the selection of the correct primary and secondary voltages but also consideration of the current which is drawn from the secondary. Transformer manufacturers often quote a "VA" rating for their components. This is simply the total secondary load, which can be determined by adding together the products of voltage, V, and current, A, in each secondary winding present.

If this is beginning to sound a little complex, consider the case of a mains transformer with two identical secondary windings each rated at 6V 0.5A. Its nominal VA rating would then be 6VA.

Question 3: A transformer has two secondary windings each rated at 12V 2.5A. Determine its VA rating.

Fortunately, most transformer manufacturers provide components which, within a particular VA rating, have identical size but different values of secondary voltage and current. Hence, a popular 6VA rated transformer for printed circuit board mounting is available with the following secondary windings:

2 × 6V at 0.5A
2 × 9V at 0.33A
2 × 12V at 0.25A
2 × 15V at 0.2A
2 × 20V at 0.15A

The range of secondary voltages and the provision of two separate secondary windings provides the designer with considerable scope. In addition, since the primary will generally also have two separate windings (each rated at 120V), this will provide even greater flexibility.

Fig. 1.5 shows the range of possibilities for the 6VA transformer with two 6V 0.5A secondary windings, which we met earlier are shown in Fig. 1.5. In Fig. 1.5a, the primary windings are connected in series to operate on a 240V a.c. supply whilst the two secondary windings (also connected in series) are wired to produce an a.c. output of 12V at 0.5A. The transformer in Fig. 1.5b is again connected for 240V a.c. operation however the parallel connected secondaries produce an output of 6V at 1A (i.e. double the current rating of a single secondary winding).

In Fig. 1.5c the primary windings have been parallel connected for 120V (rather than 240V) operation. The two secondary windings have been series connected to provide an output of 12V at 0.5A. Finally, the transformer in Fig. 1.5d has both primary and secondary windings connected

Voltage Regulators

LM723/LM723C voltage regulator

general description

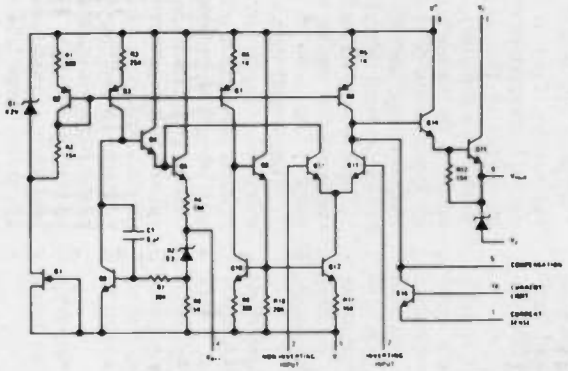
The LM723/LM723C is a voltage regulator designed primarily for series regulator applications. By itself, it will supply output currents up to 150 mA; but external transistors can be added to provide any desired load current. The circuit features extremely low standby current drain, and provision is made for either linear or foldback current limiting. Important characteristics are:

- 150 mA output current without external pass transistor
- Output currents in excess of 10A possible by adding external transistors
- Input voltage 40V max
- Output voltage adjustable from 2V to 37V
- Can be used as either a linear or a switching regulator.

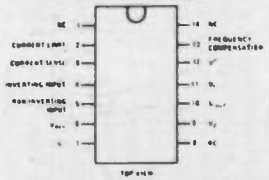
The LM723/LM723C is also useful in a wide range of other applications such as a shunt regulator, a current regulator or a temperature controller.

The LM723C is identical to the LM723 except that the LM723C has its performance guaranteed over a 0°C to 70°C temperature range, instead of −55°C to +125°C.

schematic and connection diagrams*



Dual-In-Line Package

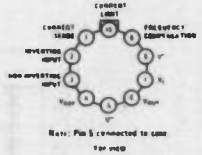


Order Number LM723D or LM723CD
See Package 2B

Order Number LM723N or LM723CN
See Package 22

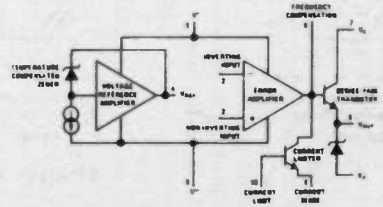
Order Number LM723J or LM723CJ
See Package 16

Metal Can Package



Order Number LM723H or LM723CH
See Package 12

equivalent circuit*



*Pin numbers refer to metal can package.

absolute maximum ratings

Pulse Voltage from V⁺ to V⁻ (50 ms)	50V
Continuous Voltage from V⁻ to V⁺	40V
Input Output Voltage Differential	40V
Maximum Amplifier Input Voltage (Either Input)	7.5V
Maximum Amplifier Input Voltage (Differential)	5V
Current from V_Z	25 mA
Current from V_{REF}	15 mA
Internal Power Dissipation Metal Can (Note 1)	800 mW
Cavity DIP (Note 1)	900 mW
Molded DIP (Note 1)	660 mW
Operating Temperature Range LM723	−55°C to +125°C
LM723C	0°C to +70°C
Storage Temperature Range Metal Can	−65°C to +150°C
DIP	−55°C to +125°C
Lead Temperature (Soldering, 10 sec)	300°C

electrical characteristics (Note 2)

PARAMETER	CONDITIONS	LM723			LM723C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Line Regulation	V_{IN} = 12V to V_{IN} = 15V		.01	0.1		.01	0.1	% V_{OUT}
	−55°C ≤ T_A ≤ +125°C			0.3				% V_{OUT}
	0°C ≤ T_A ≤ +70°C						0.3	% V_{OUT}
	V_{IN} = 12V to V_{IN} = 40V		.02	0.2		0.1	0.5	% V_{OUT}
Load Regulation	I_L = 1 mA to I_L = 50 mA		.03	0.15		.03	0.2	% V_{OUT}
	−55°C ≤ T_A ≤ +125°C			0.6				%V OUT
	0°C ≤ T_A ≤ +70°C						0.6	%V OUT
Ripple Rejection	f = 50 Hz to 10 kHz, C_{REF} = 0		74			74		dB
	f = 50 Hz to 10 kHz, C_{REF} = 5 μF		86			86		dB
Average Temperature Coefficient of Output Voltage	−55°C ≤ T_A ≤ +125°C		.002	.015				%/°C
	0°C ≤ T_A ≤ +70°C					.003	.015	%/°C
Short Circuit Current Limit	R_{SC} = 10Ω, V_{OUT} = 0		65			65		mA
Reference Voltage		6.95	7.15	7.35	6.80	7.15	7.50	V
Output Noise Voltage	BW = 100 Hz to 10 kHz, C_{REF} = 0		20			20		μVrms
	BW = 100 Hz to 10 kHz, C_{REF} = 5 μF		2.5			2.5		μVrms
Long Term Stability			0.1			0.1		%/1000 hrs
Standby Current Drain	I_L = 0, V_{IN} = 30V		1.3	3.5		1.3	4.0	mA
Input Voltage Range		9.5		40	9.5		40	V
Output Voltage Range		2.0		37	2.0		37	V
Input-Output Voltage Differential		3.0		38	3.0		38	V

Note 1: See derating curves for maximum power rating above 25°C.

Note 2: Unless otherwise specified, T_A = 25°C, V_{IN} = V^+ = V_C = 12V, V^- = 0, V_{OUT} = 5V, I_L = 1 mA, R_{SC} = 0, C_1 = 100 pF, C_{REF} = 0 and divider impedance as seen by error amplifier ≤ 10 kΩ connected as shown in Figure 1. Line and load regulation specifications are given for the condition of constant chip temperature. Temperature drifts must be taken into account separately for high dissipation conditions.

Note 3: L_1 is 40 turns of No. 20 enameled copper wire wound on Ferroxcube P36/22-3B7 pot core or equivalent with 0.009 in. air gap.

Note 4: Figures in parentheses may be used if R1/R2 divider is placed on opposite input of error amp.

Note 5: Replace R1/R2 in figures with divider shown in Figure 13.

Note 6: V^+ must be connected to a +3V or greater supply.

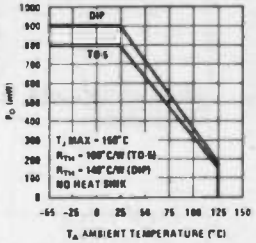
Note 7: For metal can applications where V_Z is required, an external 6.2 volt zener diode should be connected in series with V_{OUT}.

Fig. 1.4 National Semiconductor LM723 data sheet

maximum power ratings

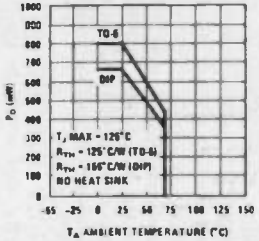
LM723

Power Dissipation vs Ambient Temperature



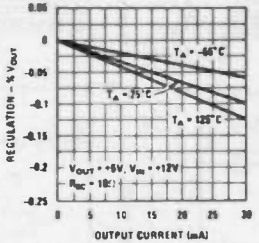
LM723C

Power Dissipation vs Ambient Temperature

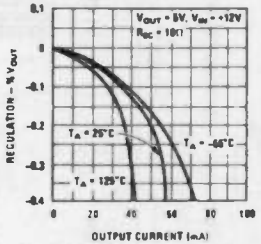


typical performance characteristics

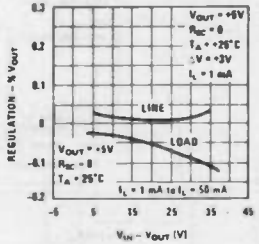
Load Regulation Characteristics with Current Limiting



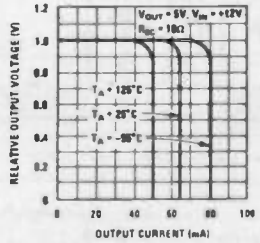
Load Regulation Characteristics with Current Limiting



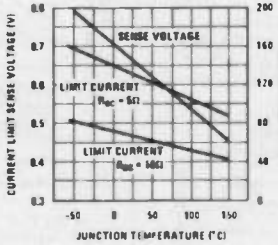
Load & Line Regulation vs Input-Output Voltage Differential



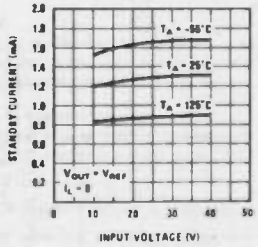
Current Limiting Characteristics



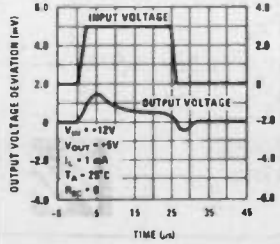
Current Limiting Characteristics vs Junction Temperature



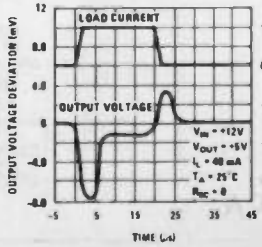
Standby Current Drain vs Input Voltage



Line Transient Response



Load Transient Response



Output Impedance vs Frequency

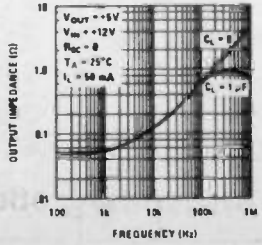


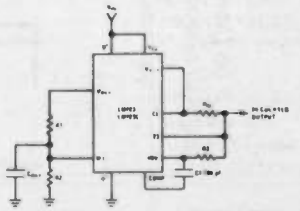
TABLE I RESISTOR VALUES (kΩ) FOR STANDARD OUTPUT VOLTAGE

POSITIVE OUTPUT VOLTAGE	APPLICABLE FIGURES	FIXED OUTPUT ±5%		OUTPUT ADJUSTABLE ±10% (Note 5)			NEGATIVE OUTPUT VOLTAGE	APPLICABLE FIGURES	FIXED OUTPUT ±5%		5% OUTPUT ADJUSTABLE ±10%		
	(Note 4)	R1	R2	R1	P1	R2			R1	R2	R1	P1	R2
+3.0	1, 5, 6, 9, 12 (4)	4.12	3.01	1.8	0.5	1.2	+100	7	3.57	102	2.2	10	91
+3.6	1, 5, 6, 9, 12 (4)	3.57	3.65	1.5	0.5	1.5	+250	7	3.57	255	2.2	10	240
+5.0	1, 5, 6, 9, 12 (4)	2.15	4.99	.75	0.5	2.2	-6 (Note 6)	3, (10)	3.57	2.43	1.2	0.5	.75
+6.0	1, 5, 6, 9, 12 (4)	1.15	6.04	0.5	0.5	2.7	-9	3, 10	3.48	5.36	1.2	0.5	2.0
+9.0	2, 4, (5, 6, 12, 9)	1.87	7.15	.75	1.0	2.7	-12	3, 10	3.57	8.45	1.2	0.5	3.3
+12	2, 4, (5, 6, 9, 12)	4.87	7.15	2.0	1.0	3.0	-15	3, 10	3.65	11.5	1.2	0.5	4.3
+15	2, 4, (5, 6, 9, 12)	7.87	7.15	3.3	1.0	3.0	-28	3, 10	3.57	24.3	1.2	0.5	10
+28	2, 4, (5, 6, 9, 12)	21.0	7.15	5.6	1.0	2.0	-45	8	3.57	41.2	2.2	10	33
+45	7	3.57	48.7	2.2	10	39	-100	8	3.57	97.6	2.2	10	91
+75	7	3.57	78.7	2.2	10	68	-250	8	3.57	249	2.2	10	240

TABLE II FORMULAE FOR INTERMEDIATE OUTPUT VOLTAGES

Outputs from +2 to +7 volts (Figures 1, 5, 6, 9, 12, (4)) $V_{OUT} = [V_{REF} \times \frac{R2}{R1 + R2}]$	Outputs from +4 to +250 volts (Figure 7) $V_{OUT} = [\frac{V_{REF}}{2} \times \frac{R2 - R1}{R1}]$, R3 = R4	Current Limiting $I_{LIMIT} = \frac{V_{SENSE}}{R_{SC}}$
Outputs from +7 to +37 volts (Figures 2, 4, (5, 6, 9, 12)) $V_{OUT} = [V_{REF} \times \frac{R1 + R2}{R2}]$	Outputs from -6 to -250 volts (Figures 3, 8, 10) $V_{OUT} = [\frac{V_{REF}}{2} \times \frac{R1 + R2}{R1}]$, R3 = R4	Foldback Current Limiting $I_{KNEE} = [\frac{V_{OUT}}{R_{SC}} \frac{R3}{R4} + \frac{V_{SENSE}}{R_{SC}} \frac{(R3 + R4)}{R4}]$ $I_{SHORT CKT} = [\frac{V_{SENSE}}{R_{SC}} \times \frac{R3 + R4}{R4}]$

typical applications

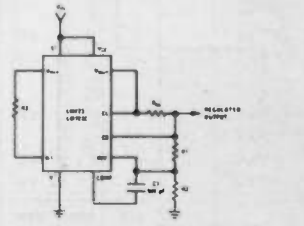


TYPICAL PERFORMANCE

Regulated Output Voltage	5V
Line Regulation (ΔV_{IN} = 3V)	6.5 mV
Load Regulation (ΔI_L = 50 mA)	1.8 mV

Note: $R3 = \frac{R1 \cdot R2}{R1 + R2}$ for minimum temperature drift.

FIGURE 1. Basic Low Voltage Regulator (V_{OUT} = 2 to 7 Volts)

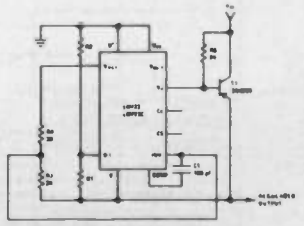


TYPICAL PERFORMANCE

Regulated Output Voltage	15V
Line Regulation (ΔV_{IN} = 3V)	1.8 mV
Load Regulation (ΔI_L = 50 mA)	4.8 mV

Note: $R3 = \frac{R1 \cdot R2}{R1 + R2}$ for minimum temperature drift.
R3 may be eliminated for minimum component count.

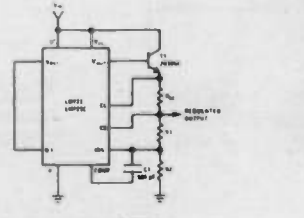
FIGURE 2. Basic High Voltage Regulator (V_{OUT} = 7 to 37 Volts)



TYPICAL PERFORMANCE

Regulated Output Voltage	-15V
Line Regulation (ΔV_{IN} = 3V)	1 mV
Load Regulation (ΔI_L = 100 mA)	2 mV

FIGURE 3. Negative Voltage Regulator



TYPICAL PERFORMANCE

Regulated Output Voltage	+15V
Line Regulation (ΔV_{IN} = 3V)	1.8 mV
Load Regulation (ΔI_L = 1A)	15 mV

FIGURE 4. Positive Voltage Regulator (External NPN Pass Transistor)

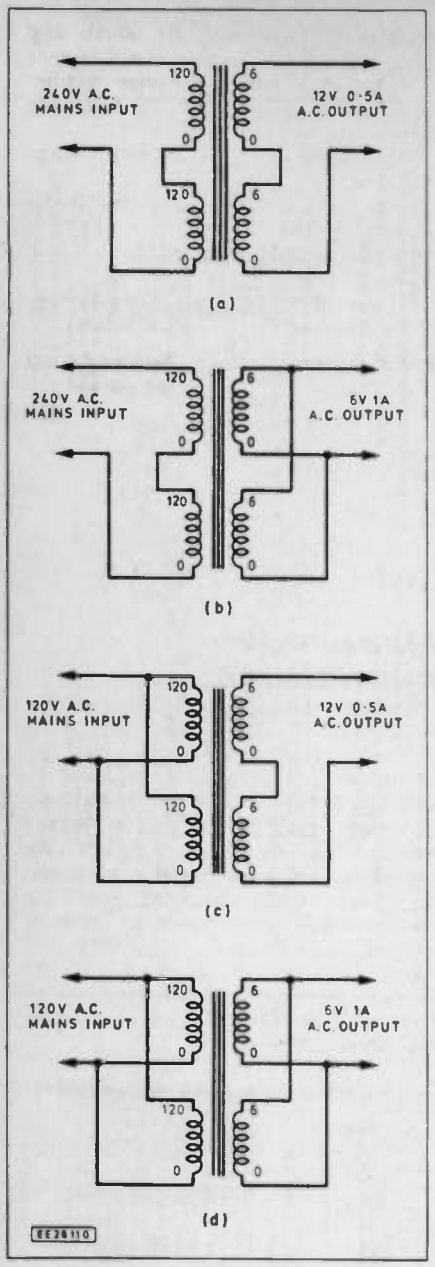


Fig. 1.5 Range of possibilities for connecting a 6VA transformer with two 6V 0.5A secondary windings

Fig. 1.7 Various rectifier arrangements

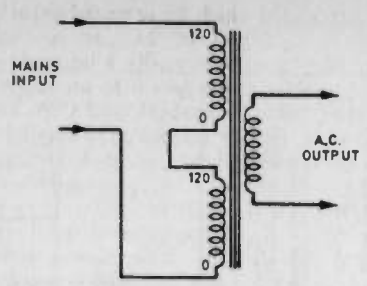


Fig. 1.6a Correct connections for series operation

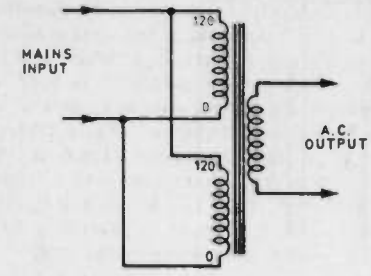


Fig. 1.6b Correct connections for parallel operation

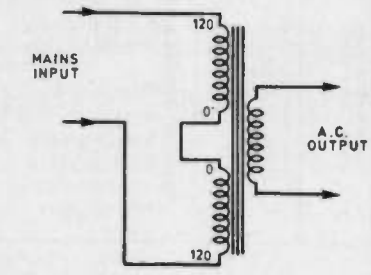


Fig. 1.6c Incorrect connections for series operation

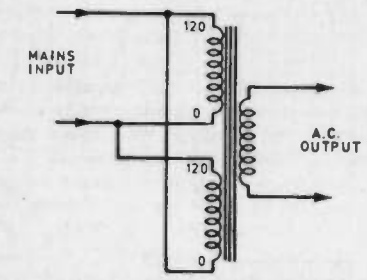


Fig. 1.6d Incorrect connections for parallel operation

in parallel providing a unit which will provide 6V at 1A from an a.c. mains input of 120V.

In either case, it is important to ensure that the transformer windings are connected **in the correct phase**. This simply means that, in the case of a series connection the "finish" of one winding must be connected to the "start" of the other whilst, in the case of the parallel connection, the two "starts" must be connected together and the two "ends" connected together. Fig. 1.6a and 1.6b show the correct connections for series and parallel operation (respectively) whilst Fig. 1.6c and 1.6d show ***incorrect connections.***

Non-resistive loads

Thus far, we have assumed that the transformer has been operating with a purely resistive load. Unfortunately, most rectifier arrangements impose a load on a transformer which is not equivalent to a pure resistance. Often the load will be capacitive although in some cases it may also be inductive. These **reactive** loads can result in the need to derate a transformer's a.c. current rating in order to prevent overloading. Recommended derating factors for various types of rectifier circuit have been included in Fig. 1.7.

Regulation

An important (though often misunderstood) characteristic of a transformer is its ability to maintain the rated output voltage at full-load. This **regulation** is usually quoted as a percentage and is determined from the following formula:

$$\text{Regulation} = \frac{V_{OL} - V_{FL}}{V_{OL}} \times 100\%$$

Where V_{OL} and V_F L are the off-load and full-load output voltages respectively.

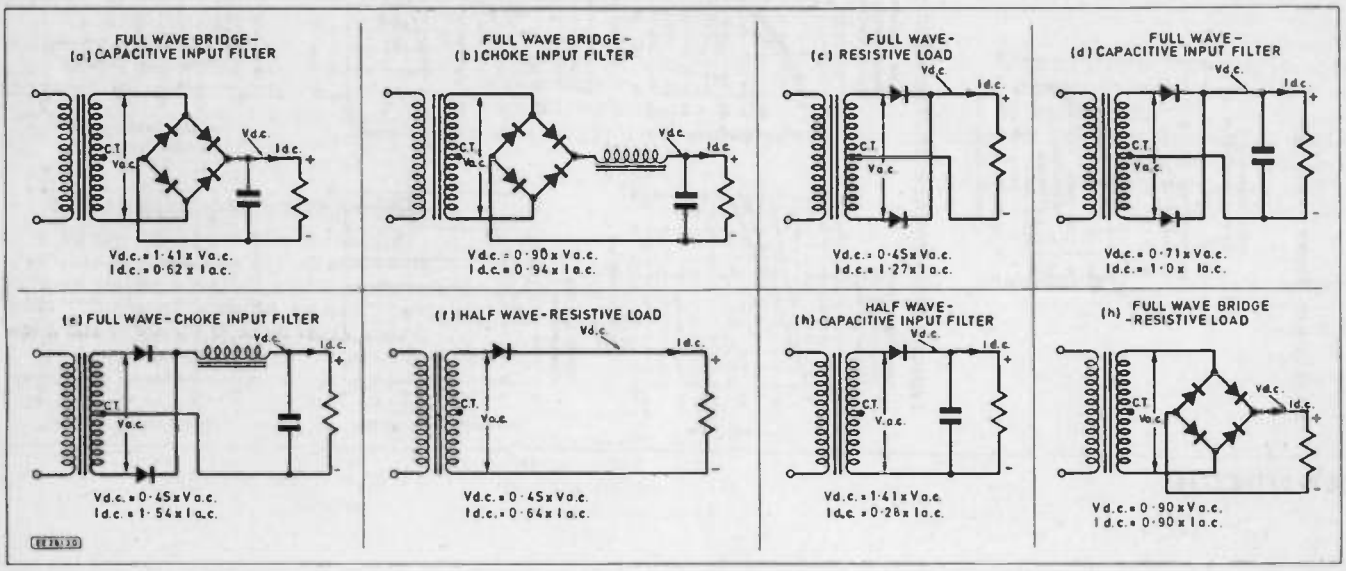
Typical transformers have regulation which varies from 5% (usually for larger transformers) to around 20% (for smaller components). The implication of this is quite important and is one reason why a voltage regulator is often required after the rectifier stage. Consider the following example for two different transformers, each providing a single secondary winding rated at 12V 1A:

Component A (regulation 20%)

Since the component provides an off-load output of nominally 12V (i.e. $V_{OL} = 12V$), its full-load output (V_{FL}) will have dropped by 20%, thus:

$V_{FL} = 12V - (12V \times 0.2) = 12V - 2.4V = 9.4V$

Clearly, this would be quite unacceptable in a number of applications!



Component B (regulation 5%)
Since the component provides an off-load output of nominally 12V (i.e. $V_{OL} = 12V$), its full-load output (V_{FL}) will have dropped by 5%, thus:
$V_{FL} = 12V - (12V \times 0.05) = 12V - 0.6V = 11.4V$
Unfortunately, the old maxim "you gets what you pays for" applies here since the cost of a transformer is very much related to the quality of the component and consequently is also related to the regulation which can be achieved. In practice, this means simply that, when purchasing a transformer, there is a trade-off between cost and performance!

Rectifiers

Rectifiers are another breed of component which, like transformers, are largely taken for granted. Here again, the choice of the "right" component can be crucial to the operation of a power supply.

Wire ended diodes are commonly available with maximum forward current (I_{FM}) ratings of up to around 6A and maximum repetitive reverse voltage (V_{RRM}) ratings of up to 1,250V. Stud-mounting diodes (designed for bolting to a heatsink) are available with forward current ratings ranging typically from 16A to 75A.

The following types of wire ended diode are commonly available:

Type	Encapsulation	Mounting	I_{FM} (typ)	Range of V_{RRM}
1N4000 series	Min. plastic	p.c.b.	1A	50V to 1000V
1N5400 series	Plastic	p.c.b.	3A	100V to 1000V
MR750 series	Plastic	p.c.b.	6A	200V to 800V
P600 series	Plastic	p.c.b.	6A	50V to 600V
BY126	Plastic	p.c.b.	1.5A	650V
BY127	Plastic	p.c.b.	1.5A	1250V
BYX10	Plastic	p.c.b.	0.35A	1600V

Most d.c. power supply circuits will make use of full-wave (bridge or bi-phase) rectification rather than half-wave. Hence the choice will involve either selecting two (or four) individual components or using an encapsulated bridge rectifier (comprising four individual bridge connected diodes). Fig. 1.7 shows a number of possible arrangements. Of these, the full-wave bridge with capacitive input is the most common, followed by the full-wave bi-phase circuit with capacitive input.

Rectifiers should be adequately rated in terms of both the maximum inverse voltage which they must withstand but also in terms of the maximum forward current which they must carry. In addition, components which are to be used in conjunction with capacitive input filters must generally be derated to around 80% of the quoted maximum forward current. As an example, a bridge rectifier rated at 1.6A used with a capacitive input filter should be derated to 1A maximum.

The following types of bridge rectifier are commonly available:

Type	Encapsulation	Mounting	I_{FM} (typ)	Range of V_{RRM}
DF series	4-pin d.i.l.	p.c.b.	0.9A	200V to 800V
Vm series	4-pin d.i.l.	p.c.b.	0.9A	200V to 800V
WO series	Cylindrical	p.c.b.	1A	50V to 800V
BY164	In-line	p.c.b.	1.5A	60V
SKB2 series	In-line	p.c.b.	1.6A	200V to 800V
KBPC series	Square	p.c.b.	2A/6A	200V to 800V
KBU4 series	In-line	p.c.b.	4A	200V to 800V
SKB25 series	Epoxy-potted	Heatsink	6A to 35A	200V to 1200V

Components which are expected to carry currents in excess of 2A, or so, will generally require fitting with a heatsink in order to reduce dissipation to an acceptably low value. A heatsink of 5°C/W will generally suffice for current up to about 5A forward current whilst a component rated at 2.1°C/W (or less) will be required for operation at 10A, or so. As with most semiconductor devices, rectifiers should be linearly derated at high temperatures (typically beyond 50°C) to zero at around 150°C.

The maximum inverse voltage (PIV or V_{RRM}) should be at least twice the peak value of the input voltage (purely resistive loads) or 2.8 times the input voltage (for a capacitive input filter). In practice, and to allow a margin for safety, it is wise to employ a component which is rated at **at least four times** the quoted r.m.s. secondary voltage of the transformer. Hence, a rectifier for use in conjunction with a transformer which has a 12V secondary should be rated at 48V, or more. In practice, a 50V or 200V component would be suitable.

Worst case conditions

As shown in Fig. 1.7, the output voltage developed across the capacitor of a capacitor input filter circuit will be approximately 1.4 times the transformer secondary voltage. On- load, this voltage will fall due in part to the regulation offered by the transformer and in part due to the forward voltage drop of the diodes within the bridge rectifier. In order to ensure that operation is within specification, it is important to be aware of the "worst case" condition" which occurs at full-load.

It is worth dwelling on this point a little! Let us suppose that we are making use of a transformer with a secondary voltage of 12V at 1A which offers a regulation of 10%. At full-load, the a.c. voltage provided by the secondary will fall by 10% to 10.8V and the corresponding peak output voltage developed across the reservoir capacitor will be 1.4 times this value **minus** the forward voltage drop associated with two silicon diodes within the bridge rectifier (note that there are two diodes in the current path at any one time). Hence the worst case output voltage will be given by:

V_O (worst case) = $1.4 \times 10.8V - 2 \times 0.7V$
$= 15.12V - 1.4V = 13.7V$

Question 2: Determine the worst case voltage developed across the reservoir capacitor in a full-wave bridge rectifier circuit which operates with the following parameters:

Transformer off-load secondary voltage (V_{OL}) = 9V
Diode forward voltage drop (per diode) (V_F) = 0.7V
Transformer regulation = 15%

Typical values of no-load output voltage for the circuit of Fig. 1.7a are as follows:

R.M.S. secondary voltage	No-load d.c. out put voltage
4.5V	6.3V
6V	8.5V
9V	12.7V
12V	16.9V
15V	21.2V
18V	25.4V
20V	28.2V
24V	33.9V

Reservoir capacitors

The value of reservoir capacitor used in the circuits shown in Fig. 1.7 will be governed by the load current and the amount of ripple that can be tolerated. In addition, maximum reservoir capacitance values are sometimes specified by rectifier manufacturers. As a "rule of thumb", the capacitance value (expressed in μ) should be between 2,000 and 5,000 times the maximum load current (expressed in A). If a regulator is fitted (and provided that sufficient headroom voltage is available) the value of capacitance may be closer to the lower limit. Hence the following values are recommended:

Nominal load current	Reservoir capacitance
125mA	220μ to 470μ
250mA	470μ to 1000μ
500mA	1000μ to 2200μ
1A	2200μ to 4700μ
2A	4700μ to 10000μ
4A	10000μ or greater

It is important to ensure that the component selected is adequately rated in terms of maximum working voltage. To provide a margin of safety, the reservoir capacitor should be rated at about twice the r.m.s. secondary voltage of the transformer. Hence, a component for use in a full-wave bridge rectifier circuit using a capacitive input filter Fig. 1.7a in which the transformer is rated at 12V a.c. output should be rated at a minimum of 24V d.c. working (even though, in normal operation, the off-load d.c. output voltage will only reach about 16V). In practice, reservoir capacitors are available in ranges of different working voltages (usually 16V, 25V, 35V, 50V, 63V and 100V).

Simple regulators

Regulation of the output voltage of a power supply is important in nearly every application and, in some simple applications, can be achieved by nothing more than a Zener diode, a transistor and a few additional components.

Zener diodes are available in various families (according to their general characteristics, encapsulation and power ratings) with reverse breakdown (Zener) voltages in the E12 and E24 series (ranging from 2.7V to around 68V).

The following data applies to the most common families of Zener diode:

Zener family	Power rating	Encapsulation	Voltage range
BZY88 series	500mW	Min. glass	2.7V to 15V
BZX85 series	1.3W	Min. glass	5.1V to 62V
BZX61 series	1.3W	Min. glass	7.5V to 72V
BZX55 series	500mW	Min. glass	2.4V to 91V
BZY93 series	20W	Stud mounting	9.1V to 75V
BZY97 series	1.5W	Plastic	9.1V to 37V
1N5333 series	5W	Plastic	3.3V to 24V.

Where accuracy of the Zener voltage is an important consideration, it is important to note that the temperature coefficient of the Zener voltage of a Zener diode tends to vary with the Zener voltage rating. The temperature coefficient for a 2.7V component will usually be of the order of −2mV/deg.C whilst a 6.8V component will exhibit a temperature coefficient of around +2mV/deg.C. The optimum voltage (at which the temperature coefficient approaches zero) is around 4.7V. Hence this voltage may be preferred for certain applications (particularly where the Zener voltage is used as a "reference" voltage).

Shunt regulators

The simple shunt Zener voltage regulator shown in Fig. 1.8 is only suitable for applications in which the load current is less than about 50mA. A regulation of about 10% can be achieved with this type of circuit which will exhibit an impedance of typically 15 ohm, or less.

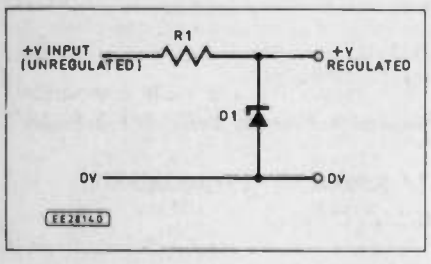


Fig. 1.8 Simple Zener diode shunt regulator

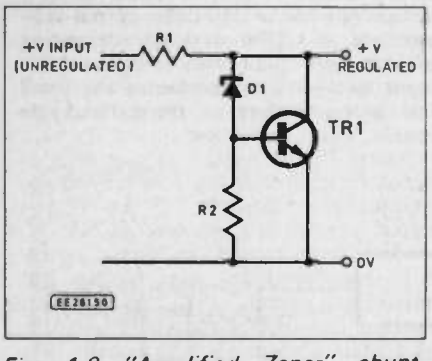


Fig. 1.9 "Amplified Zener" shunt regulator

The performance of a Zener regulator can be considerably improved by adding a shunt connected transistor, as shown in Fig. 1.9. This "amplified Zener" arrangement is suitable for applications in which the load current is very much greater than the maximum rated current of the Zener (found by dividing its maximum permissible power dissipation by its nominal Zener voltage). The compound arrangement of Zener and transistor behaves like a superior Zener diode having a much higher power rating.

The circuit shown in Fig. 1.9 has an output impedance of less than 1 ohm but note that, by virtue of the base-emitter voltage drop of the transistor, the output voltage will be approximately 0.8V greater than the nominal Zener voltage.

Unfortunately, high current shunt regulators have several obvious disadvantages not the least of which is associated with the power dissipation in the series dropping resistor. This must be adequately rated (a wirewound resistor will usually be required) and mounted so that convection cooling is possible. Another problem is that maximum dissipation in the shunt transistor occurs under no-load conditions. It, too, will probably require heatsinking!

Despite this, shunt regulators do offer one advantage over their series connected counterparts; they are inherently safe since a collector-emitter short circuit failure within the transistor will make the output fall to zero. A similar fault condition in a series regulated power supply will result in the full unregulated d.c. voltage being applied to the load. In some cases this can prove to be extremely embarrassing (not to mention expensive!) since it can result in wholesale destruction of any voltage sensitive devices present in the load which may have their maximum ratings exceeded whenever the series transistor fails!

Series regulators

The basic arrangement of a series regulator is shown in Fig. 1.10. The transistor is effectively connected as an emitter follower and thus the output voltage will be approximately 0.8V less than the nominal Zener voltage. Dissipation in the series element rises as the load current increases. Under worst-case conditions (i.e. under full-load and with the minimum expected value of the a.c. mains supply), the input voltage should be at least 2V greater than the desired output.

In order to minimise dissipation in the transistor (and thus minimise heatsink ratings) the d.c. input should not, however, be very much greater than this value. A recommended range for the input would be between 2V and 7V greater than the desired output voltage. Thus, for a nominal 12V output, the rectifier output should be within the range 14V (minimum) to 19V (maximum).

Integrated circuit voltage regulators

Integrated circuit voltage regulators are now so widely available in popular ranges of voltage and current output that discrete component regulator circuits are nowadays hardly ever necessary. In addition, integrated circuit regulators offer a number of significant advantages over simple circuits which employ discrete components including such useful features as foldback current limiting and thermal shut-down.

The 78 (positive output) and 79 (negative output) regulators are available in a range of voltages (e.g. 5V, 9V, 12V, 15V, 18V and 24V). Current ratings for different variants range from 100mA (L series) to 5A (H series). The most commonly available range are designed to operate at load currents of up to 1A.

Basic positive and negative regulated power supplies are shown in Fig. 1.11. The two 100n capacitors (C1 and C2) are included to ensure unconditional high frequency stability and they should be mounted as close to the regulator terminals as possible. C3 is placed in parallel with the output simply to provide additional decoupling. In practice, any value between 22µ and 100µ should prove adequate.

When using 78 series regulators, it is important to note that the worst-case unregulated d.c. input voltage should normally be at least 3V greater than the nominal regulated output voltage. The penalty for not observing this precaution will be poor regulation and an unacceptable level of residual mains hum present at the output. Furthermore, the worst-case unregulated d.c. input voltage should not be allowed to exceed the nominal regulated output voltage by more than about 15V otherwise regulator dissipation will be excessive. Failure to avoid this precaution can result in premature thermal shut-down. Typical characteristics of 100mA, 1A and 2A plastic fixed voltage regulators are shown opposite:

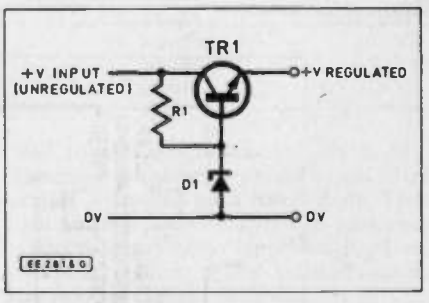


Fig. 1.10 Basic series regulator

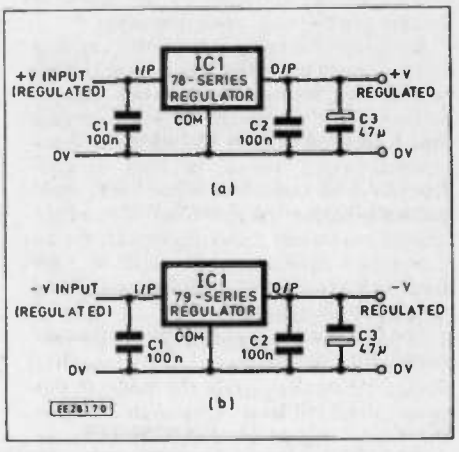


Fig. 1.11 Integrated circuit regulator arrangements, (a) positive output, (b) negative output

Dual output power supplies

When dual regulated outputs are required, a bridge rectifier can be used in

100mA series

Type	Positive output / Negative output		78L05 / 79L05	78L12 / 79L12	78L15 / 79L15	78L24 / 79L24
Input voltage range		(V)	7-30	14.5-35	17.5-35	27-35
Load regulation		(%)	0.2	0.2	0.3	0.4
Line regulation		(%)	1	1	1.5	1.5
Ripple rejection		(dB)	60	55	52	49
Output resistance		(mΩ)	200	400	500	850
Output noise voltage [10hZ TO 100KhZ]		(μV)	40	70	90	200
Short-circuit current		(mA)	75	35	25	20

1A series

Type	Positive output / Negative output		7805 / 7905	7812 / 7912	7815 / 7915	7824 / 7924
Input voltage range		(V)	7-25	14.5-30	17.5-30	27-38
Load regulation		(%)	0.2	0.4	0.5	0.6
Line regulation		(%)	0.2	0.2	0.3	0.3
Ripple rejection		(dB)	71	61	60	56
Output resistance		(mΩ)	30	75	95	150
Output noise voltage [10Hz to 100kHz]		(μV)	40	80	90	170
Short-circuit current		(mA)	750	350	230	150

2A series

Type	Positive output		78S05	78S12	78S15	78S24
Input voltage range		(V)	8-35	15-35	18-35	27-40
Load regulation		(mV)	100	160	180	250
Line regulation		(mV)	100	240	300	480
Ripple rejection		(dB)	60	53	52	48
Output resistance		(m)	17	18	19	28
Output noise voltage [10Hz to 100kHz]		(μV)	40	75	90	170
Short-circuit current		(mA)	500	500	500	500

COMPONENTS

Dual-Output Power Supply Module

See SHOP TALK Page

Capacitors

C1, C2 4700μ axial elect. 25V (2 off)
C3 to C6 100n miniature dipped case polyester (4 off)
C7, C8 100μ axial elect. 25V (2 off)

Semiconductors

REC1 200V min. 2.6A in-line type (e.g. KBU4D)
IC1 7805, 7812 or 7815 (see table)
IC2 7905, 7912 or 7915 (see table)

Miscellaneous

T1 20VA mains transformer with two secondary windings (see table)

Heatsink, 4°C/W (see text); p.c.b., available from the *EE PCB Service*, order code 712; Terminals, 0.042" terminal pins (6 off)

Approx cost guidance only **£8**

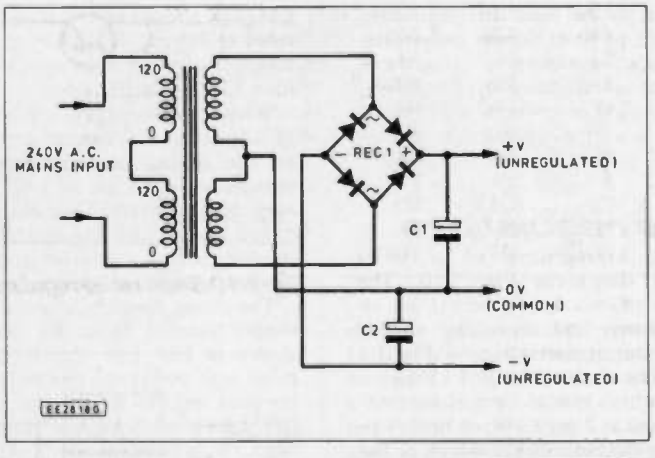
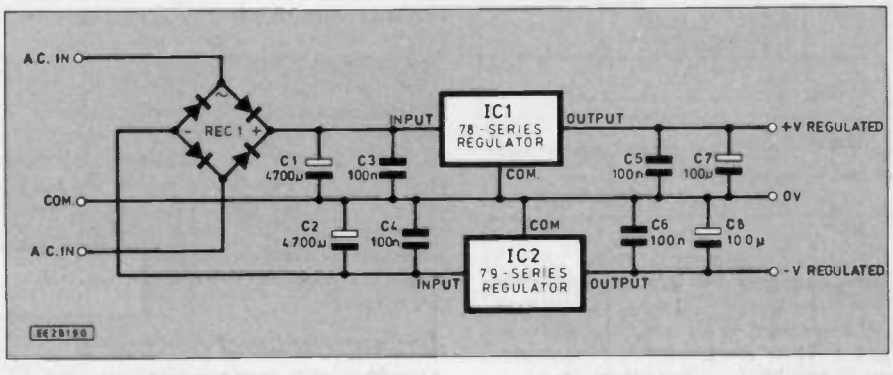


Fig. 1.12 Dual output rectifier circuit

Fig. 1.13 Circuit diagram of the dual output power supply module

conjunction with a transformer having two identical secondaries, as shown in Fig. 1.12. With this arrangement it is important to note that the maximum reverse repetitive voltage rating (V_{RRM}) for the diodes in this circuit should at least be equal to 2.8 times the r.m.s. voltage produced by each individual secondary winding.

The unregulated positive and negative outputs produced by the circuit of Fig. 1.12 can be regulated by means of two fixed voltage regulators of opposite polarity. Fig. 1.13 shows the complete circuit of a dual output power supply module based on standard 78 and 79 series regulators. The necessary component changes for different output voltages are given in the table below the circuit.



Output	IC1	IC2	Transformer secondaries (each rated at 2.2A minimum)	Transformer power rating (minimum)
±5V	7805	7905	2 × 4.5V or 1 × 9V	20VA
±12V	7812	7912	2 × 6V or 1 × 12V	27VA
±15V	7815	7915	2 × 9V or 1 × 18V	40VA

The copper foil and p.c.b. component layouts for the dual output power supply module are shown in Fig. 1.14

Variable power supplies

Where a variable regulated output voltage is required it is expedient to make use of a variable i.c. voltage regulator such as the LM317 or LM338. These versatile devices provide an adjustable output voltage range of 1.2V to over 30V (depending upon the upper limit of the unregulated d.c. input voltage) and incorporate the usual internal current limiting, thermal and safe operating area protection.

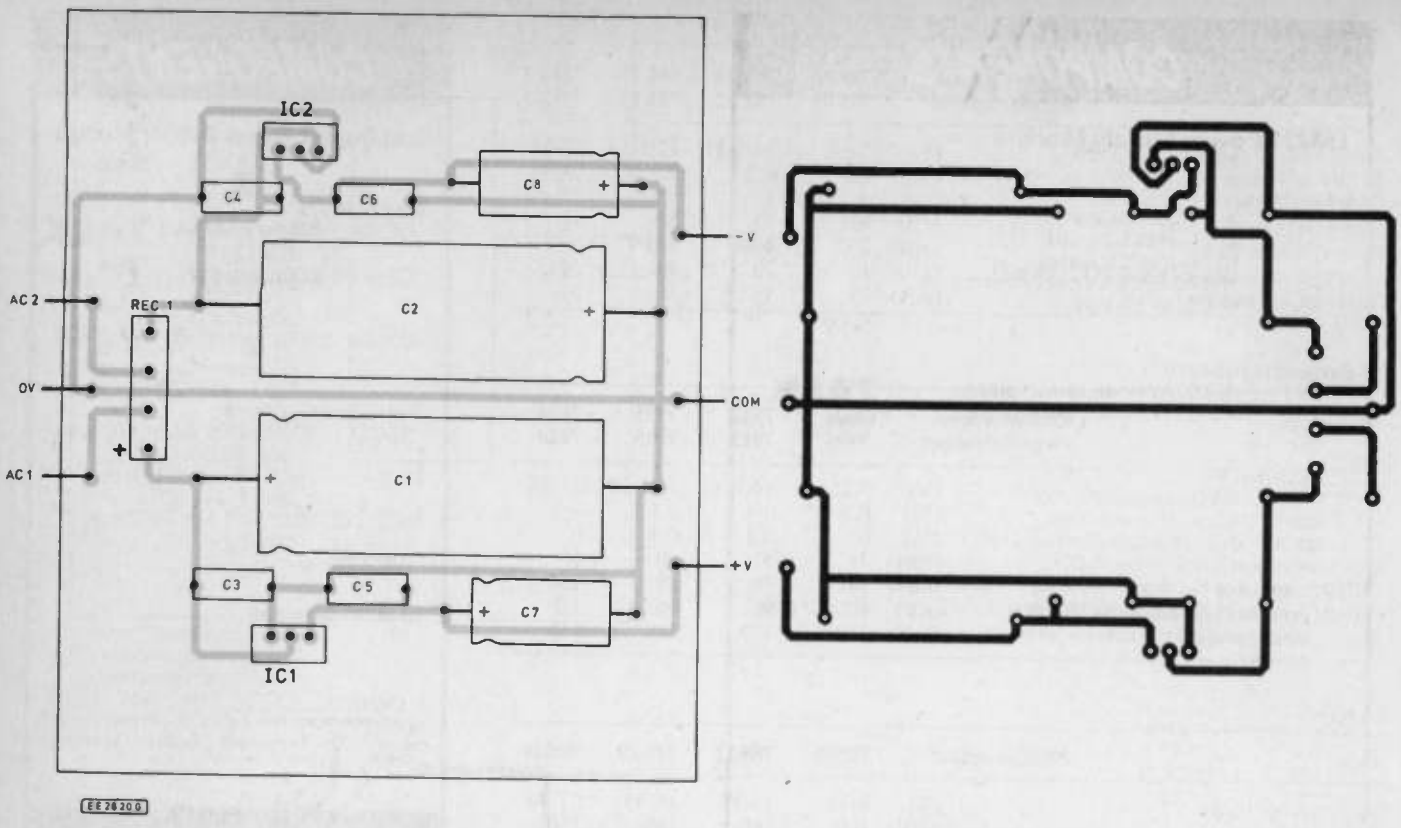


Fig. 1.14 P.C.B. copper foil and component layout for the dual output power supply module

The characteristics of the LM317/LM338 family are listed below:

Type		LM317L	LM317M	LM317T	LM317K	LM338K
Maximum load current		100mA	500mA	1.5A	1.5A	5A
Output voltage range	(V)	1.2-37	1.2-37	1.2-37	1.2-37	1.2-32
Input voltage range	(V)	4-40	4-40	4-40	4-40	4-35
Load regulation	(%)	0.1	0.1	0.3	0.1	0.1
Line regulation	(%/V)	0.01	0.01	0.02	0.01	0.005
Ripple rejection	(dB)	65	65	65	65	60
Output impedance	(m)	10	10	10	10	3
Adjustment pin current	(μA)	50	50	50	50	45
Thermal resistance [junction case]	(deg.C/W)	160	12	4	2.3	1
Maximum junction temperature	(deg.C)	125	125	125	125	125
Maximum dissipation	(W)	0.625	7.5	15	20	50
Package		TO92	TO202	TO220	TO3	TO3

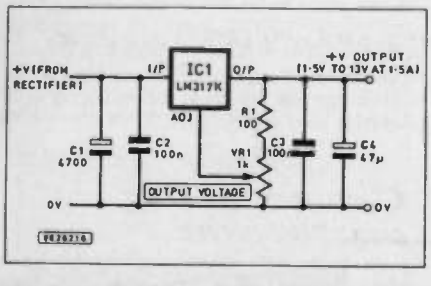


Fig. 1.15 Variable regulated power supply based on an LM317K

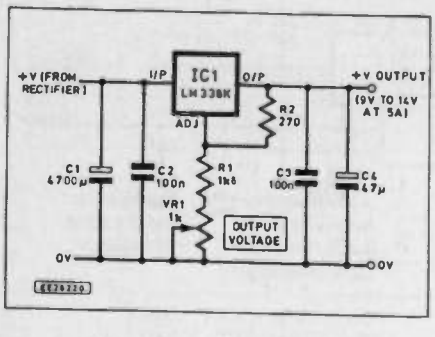


Fig. 1.16 Variable regulated power supply based on an LM338K

Representative circuits using variable voltage regulators are shown in Fig. 1.15 and 1.16. The circuit of Fig. 1.15 uses an LM317K (which should be mounted on a heatsink rated at 2 deg.C/W, or better) and provides an output voltage which is fully variable from 1.5V to 13V at load currents of up to 1.5A. Fig. 1.17 shows the circuit of a 5A power supply which has an adjustment voltage range of 9.5V to 13.8V (the LM338K should be mounted on a heatsink rated at 1 deg.C/W, or better). This power supply makes an ideal bench replacement for a 12V lead-acid battery!

Where it is necessary to provide a means of adjusting the output current as well as the output voltage provided by a monolithic regulator, an LM723 regulator may be preferred. This device was described earlier and has established a long track record as a reliable and predictable "industry standard" device.

The circuit diagram of a complete power supply module based on an LM723 is shown in Fig. 1.17. Almost any suitably rated high power *npn* silicon transistor can be used as the series pass device, TR1 (for which an adequate heatsink, e.g. 2 deg.C/W, will be required). Adjustment of the output voltage and current limit is

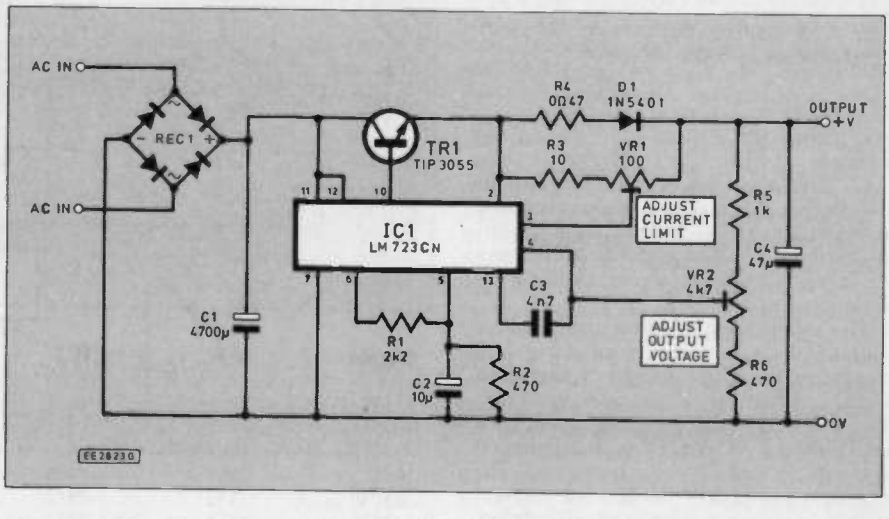


Fig. 1.17 Circuit diagram of the LM723 variable power supply module

COMPONENTS

LM723 Power Supply Module

Resistors

R1	2k2 0.25W 5% carbon
R2, R6	470 0.25W 5% carbon
R3	10 0.25W 5% carbon
R4	0Ω47 2.5W 5% vitreous coated
R5	1k 0.25W 5% carbon

See SHOP TALK Page

Potentiometers

VR1	100 0.5W horiz. cermet preset
VR2	4k7 0.5W horiz. cermet preset

Capacitors

C1	4700µ axial elect. 25V
C2	10µ radial elect. 16V
C3	4n7 miniature plate ceramic
C4	47µ radial elect. 50V

NB: Capacitor maximum working voltages are shown for a nominal 12V a.c. input. Values of working voltage should be uprated appropriately for higher voltage operation (see text).

Semiconductors

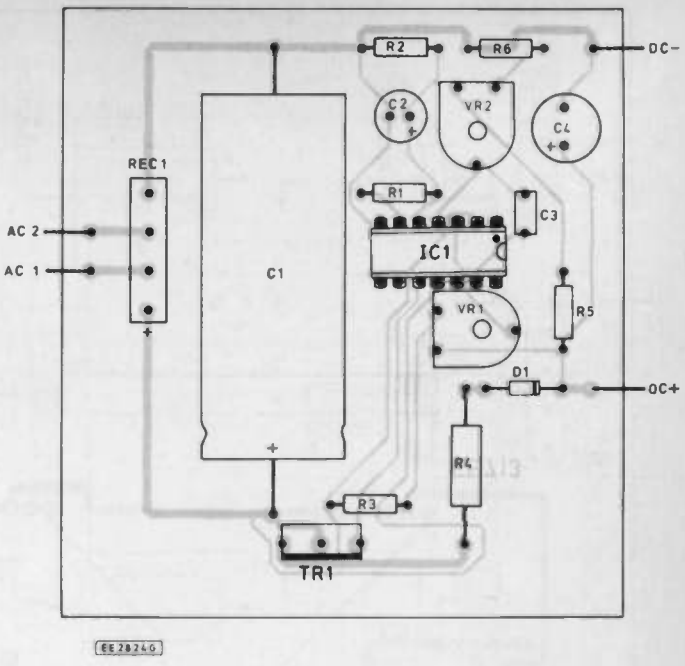
REC1	200V 4A in-line type (e.g. KBU4D)
IC1	LM723CN
TR1	TIP3055
D1	1N5401

Miscellaneous

T1 50VA (min.) mains transformer with suitable rated secondary windings (see text)

Heatsink, see text; terminals 0.042" terminal pins (4 off); p.c.b., available from the *EE PCB Service*, order code EE713.

Approx cost guidance only **£15**



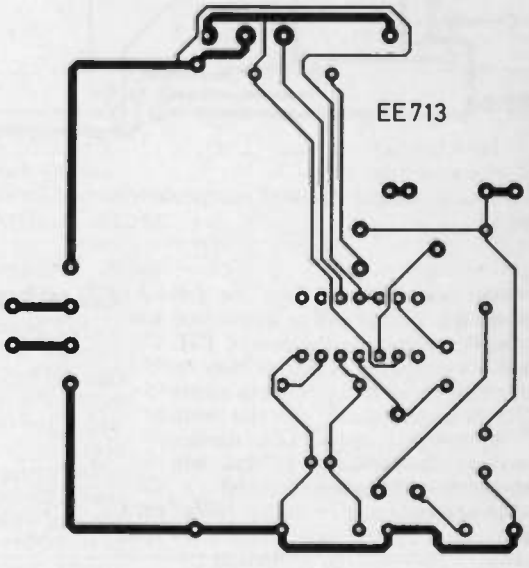


Fig. 1.18 P.C.B. copper foil and component layout for the LM723 power supply module

achieved by means of VR2 and VR1 and the circuit is capable of supplying outputs of up to 5A at voltages of up to 35V. The range of output voltage adjustment may be reduced (or increased) by appropriate changes to the potential divider formed by R5, R6 and VR2. The LM723 data sheet shown in Fig. 1.4 gives the necessary information.

The copper foil and p.c.b. component layouts for the dual output power supply module are shown in Fig. 1.18. Note that the power transistor, TR1, may be mounted on or off the p.c.b. according to the amount of heatsinking required. If a TO3 device is used (e.g. 2N3055) this can be wired to the p.c.b. by means of short lengths of insulated stranded wire (which MUST be capable of carrying the maximum rated output current).

In some cases, an L200 regulator may be preferred to the LM723. The L200 provides an adjustable output voltage range of 2.8V to 36V together with an adjustable output current range with a 2A upper limit. The device is housed in a 5-pin plastic package. Load regulation is typically 1.5% and the device incorporates safe operating area protection as well as input overvoltage protection (up to 60V, 10ms) and short-circuit protection.

The circuit of Fig. 1.19 shows how the L200 can be used in a simple power supply which produces an output which can be varied from approximately 2.7V to 35V at 2A maximum. It should be noted that, regulator dissipation will be large when operating near the maximum rated current (2A) with low output voltages. An adequate heatsink (2 deg.C/W, or better) is therefore essential in order to prevent premature thermal limiting of the output current.

The copper foil and p.c.b. component layouts for the L200 power supply module are shown in Fig. 1.20

Crowbar protection

Short circuit failure within the series pass element of a regulator can have

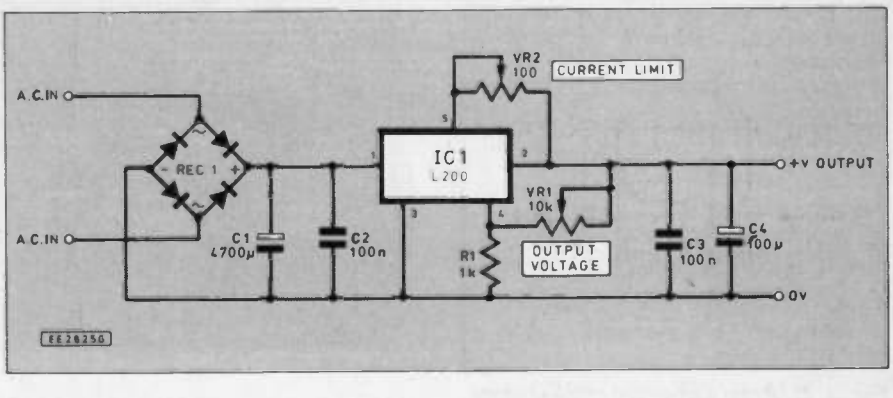


Fig. 1.19 Circuit diagram of the L200 variable power supply module

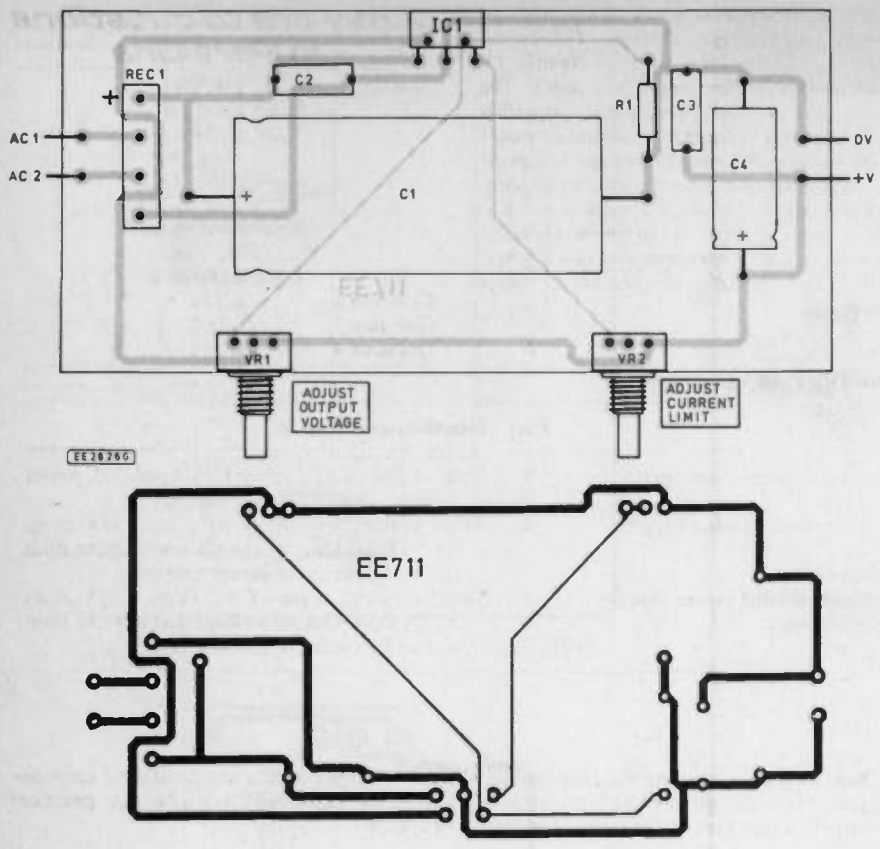


Fig. 1.20 P.C.B. copper foil and component layout for the L200 power supply module

COMPONENTS

L200 Power Supply Module

See SHOP TALK Page

Resistors

R1 1k 0.25W 5% carbon

Potentiometers

VR1 10k 1W p.c.b. mounting lin.
VR2 100 1W p.c.b. mounting lin.

Capacitors

C1 4700µ axial elect. 25V
C2, C3 100n miniature dipped case polyester (2 off)
C4 100µ axial elect. 25V

NB: Capacitor maximum working voltages are shown for a nominal 12V a.c. input. Values of working voltage should be uprated appropriately for higher voltage operation (see text).

Semiconductors

REC1 200V 2.5A (min.) in-line bridge rectifier
IC1 L200 regulator

Miscellaneous

T1 30VA (min.) mains transformer with suitable rated secondary windings (see text)

Heatsink, see text; terminals 0.042" terminal pins (4 off); p.c.b., available from the *EE PCB Service*, order code EE 711.

Approx cost guidance only **£13**

catastrophic consequences since the full unregulated d.c. voltage will be transferred directly to the output. In the case of TTL circuits, for example, a regulator may be fed with an unregulated d.c. input in excess of 10V. If the output should ever rise much above 7V, however, most TTL devices connected to the nominal 5V rail will self-destruct virtually instantaneously!

The dire consequences of such a failure can be avoided by the incorporation of a "crow-bar" over-voltage protection circuit of the type shown in Fig. 1.21. This circuit places a virtual short-circuit across the supply whenever the rail voltage exceeds approximately 6.1V. The circuit can be readily adapted for operation with other voltages using the formula:

Crow-bar voltage, $V = V_Z + V_{GT}$

where V_Z is the Zener voltage and V_{GT} is the thyristor gate trigger voltage (for the BT152, V_{GT} = 1V approx.).

It is important to note that once triggered, the thyristor remains in the conducting state until the supply is disconnected or a mains fuse ruptures. The action of the circuit may appear to be somewhat crude but it does make a useful "last-ditch" protection!

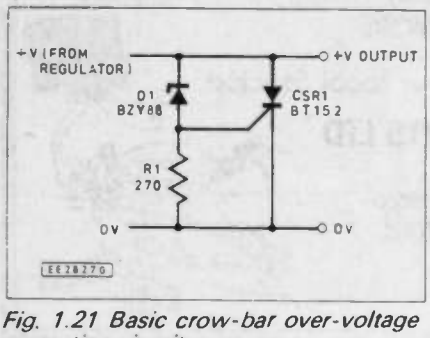


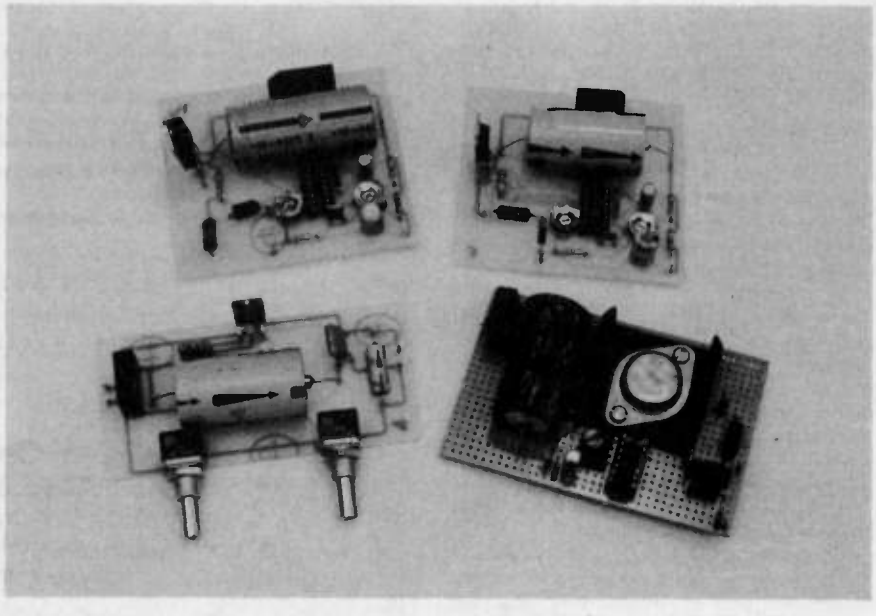
Fig. 1.21 Basic crow-bar over-voltage protection circuit

Current Limit

Most general purpose commercial power supplies are fitted with a current limit (usually variable) which allows the user to adjust the threshold of output current at which the output voltage rapidly falls to zero.

The current limit control is normally adjusted to the maximum current value associated with the circuit which is connected to the power supply. In the event of a fault arising (such as a short-circuit capacitor across the supply rail or short-circuit output transistor), the current trip will operate and protect both the equipment and power supply from the results of an excessive supply current.

Operation of a current trip is usually virtually instantaneous (i.e. within a few microseconds) rather than the milliseconds associated with conventional fuses.



Three prototypes for the 723 power supply modules plus the L200 module.

Failure to set a current trip at a sufficiently high current can sometimes cause rather strange effects including a form of low-frequency instability (in which the equipment is rapidly switched on and off by the current trip repeatedly operating and releasing).

Most bench power supplies are fitted with voltage and current meters which may be either of digital or analogue type. Some instruments use a single analogue meter movement (or digital display) which can be switched to read either voltage or current. In such a case, it is important to ensure that the meter is switched to display voltage (*not* current) before using the power supply and to check that the required voltage is set *before* connecting the equipment on test. Failure to observe such a simple precaution can sometimes result in the destruction of components (just imagine the effect of connecting a 30V supply to a piece of equipment designed for operation on 3V!).

Design Problem

This month's exercise, in common with all of our design problems, is designed for readers who would welcome the opportunity of tackling a little "homework" and, whilst the exercise can be accomplished purely "on paper", some of you may wish to go further by building and testing your solutions. This month's problem arises from the need for a means of calibrating an oscilloscope:

An oscilloscope is to be fitted with an accurate d.c. voltage calibrator. This circuit is to provide fixed d.c. levels of 100mV, 1V and 10V at a front-panel test point. The voltage levels should be accurate to within ±2% and the voltage level should be maintained within this range when the test point is "loaded" by a standard oscilloscope input (equivalent to 1Mohm). Design a suitable circuit arrangement based on a standard voltage regulator operating from an internal +18V rail. Specify all component values required.

Answers to questions in Part One

Question 1	(a) 40V
	(b) +70°C
	(c) pin-12
	(d) 9.5V
	(e) 2.0V
	(f) 0.03% of V_{OUT}
	(g) 65mA
	(h) 50mA
	(i) 600mW
Question 2	0.24V
Question 3	60VA
Question 4	6.25V

Cumulative index to modules

Title	Part	Function/specification
Dual output power supply	1	Dual ±5V, ±12V or ±15V regulated power supply rated at 1A max. output
723 variable power supply	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	1	Single variable output of +2.7V to +35V at up to 2A max. Output voltage and current limit are set by means of variable controls.

Next month: In next month's instalment we deal with transistor and operational amplifier circuits. Our design problem involves a microphone pre-amplifier whilst our practical project involves the construction of an intercom system.

FOR YOUR ENTERTAINMENT

by Barry Fox

Getting Taped

The tape companies continually complain that it is virtually impossible to sell high grade domestic video tape in Britain. People just go for the cheapest price tag. And there is nothing to stop manufacturers putting a "high grade" label onto the lowest grade tape, because there are no agreed technical specifications which define the grades.

The packaging and publicity material is confusing because it usually only talks about performance (e.g. the ratio of wanted signal to unwanted random noise on luminance picture detail and chrominance colour wash) being several dB better than the company's own reference tape. A fat lot of help that is!

Catch a tape maker in an honest mood, and he may just admit that for time-shifting there is really no point in spending extra money on high grade tape if good standard grade is available. This is because there is very little visible benefit when the video signal-to-noise ratio is raised above 40dB. It's a threshold, below which the pictures on screen start to look fuzzy, but above which the couple of extra dB gained from using better tape can only be seen by experts with a trained eye.

The benefit of a signal-to-noise ratio above 40dB becomes apparent when the tape is dubbed through several generations, for instance for editing camcorder movies. That's when it really does pay to pay for high grade tape, which can push s/n ratios out to 44 or even 46 dB.

It's also one of the real advantages of S-VHS, where the luminance performance is improved by the higher carrier frequency for S-VHS, and the colour performance is improved because S-VHS tape is by specification of higher quality and coercivity than standard VHS tape.

It's odd that the tape industry has never got its act together on the need to educate the public over the real benefits of high grade tape. Education is the key, and they just haven't educated us. Could this be because a lot of people selling tape don't understand the first thing about the technology?

Screen Speaker

A couple of neat ideas popped up in patent applications recently. West German company E W D Electronic-Werke is filling patents around the world on a way of improving the sound of a TV set without increasing its size.

E W D proposes that the screen and loudspeaker be combined. This is done by making the loudspeaker from a transparent film of piezopolymer, which overlays the screen.

All piezoelectric materials flex and move when an electric current passes through them. When the current is a fluctuating audio signal, the material vibrates at audio frequencies.

The result should be good sound, because the loudspeaker diaphragm is as large as the TV screen. But there is no addition to the size of the TV set cabinet. An added benefit is that the sound appears to be coming direct from the mouths of actors depicted on the screen.

Mindlink

In 1984, at the Chicago Consumer Electronics Show, Atari demonstrated "Mindlink" a headband that was claimed to control a computer video game "by power of your mind alone". The demonstrator said it sensed electrical signals from the brain. Concentrate hard, they told everyone who tried it.

I reckoned that the headband just sensed any slight change in pressure e.g. from a furled brow. I quickly took mine off during a demonstration and (before being jumped on by the Atari people) found it had three pressure senses that worked just as well if you pressed them with your finger. Predictably, Mindlink soon disappeared without trace.

Now, computer firm Wang of Lowell, Massachusetts is patenting a headband that controls the cursor on the screen of a desktop computer, without the need to move a mouse or keyboard cursor keys. This leaves the user's hands free to do other work or control other functions of the keyboard. It also makes it easier for handicapped workers to operate a computer. The same system could be used to play video games. But there is no nonsense talk of sensing brainwaves.

Wang's patent application shows a band which clips over the top of the user's head, like a pair of personal stereo headphones. The band supports a spherical container, like a tennis ball. The sphere is half filled with liquid in the lower half of the sphere and gas, such as air, in the upper half.

When the user's head is upright, the boundary is horizontal. When the user's head tilts, the boundary changes its angle with respect to the sphere.

The change in boundary angle is sensed by a cluster of light emitting diodes mounted inside the top of the sphere and beaming pencils of light down through the liquid boundary onto photodetector diodes mounted inside the lower part of the sphere, and submerged in the liquid.

When a light pencil is perpendicular to the liquid boundary, it passes through to the diodes unhindered. When the pencil strikes the boundary at an angle, at least some of the light is refracted, so the photo diode senses a drop in light.

There are four pairs of transmitter and receptor diodes, each 90 degrees apart, and each angled at 45 degrees to the fluid boundary. Comparison of the electrical outputs from the four sensors gives an accurate indication of both the direction of rotation of the sphere and the magnitude of rotation. This in turn gives an electrical representation of the position of the computer user's head.

It is a simple step to convert the output signals from the orientation sensors into digital code, which is formatted to simulate the cursor control signals put out by a keyboard or mouse. In this way the user is able to aim a cursor at any part of a TV or computer screen, simply by head movement.

Cycling Computer

Here's a mental challenge, and a neat way of shutting up people who say "computers will soon be able to do even the most complicated things."

Devise a hardware-software system that rides a bicycle through traffic–something that humans do every day, without thinking, or while thinking about something completely different.

The pedalling drive is the easy part, once you have found batteries that can deliver the power needed and recharge on a plate of cornflakes and slice of toast!

Now build a level sensor system with feedback loop which continually adjusts the balance of the load on the two wheel support to stop the whole thing falling over. The adjustments will have to be very fast, and cope with all speeds from stationary to downhill cruising, as well as uphill wobbling, uneven roads and camber on corners.

Don't forget the need for three dimensional vision to detect distances, with side vision to avoid any pedestrians that step off the pavement and peripheral vision to get advance warning of any vehicles coming up close from behind. And you will need sound sensing too, in stereo to pinpoint the direction of cars and horns.

Both the sound and vision systems will of course have to work in the main feedback control loop, judging the speed and relative speed of several objects at the same time, to avoid collisions. Predictive software, based on a memory bank of past experience will be needed to replicate a cyclist's sixth sense feeling that the pedestrian or car ahead may do something wholly unpredictable.

Finally, all this work must be done as background processing, to leave the computer's "mind" clear to think nice thoughts and enjoy the scenery.

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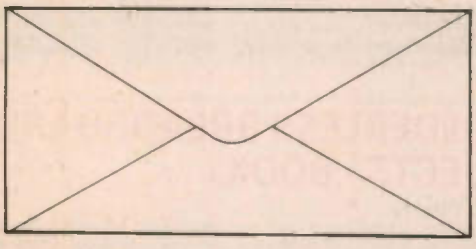

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Book only: 502-102 £3.95
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By Owen Bishop

This well illustrated book was designed for older secondary school pupils. It persues a greater understanding of electronic circuits by means of self assesment questions included in the text. Basic calculations of Voltage and Current are introducedand a large number of practical experiments are carried out on a 0.1 inch pitch solderless breadboard (our K120). All components can be re-used. Pack includes Breadboard, Photocell, Thermistor, Transistors, Capacitors LEDs etc..

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By Tom Duncan

Three types of radio, a parking light, flashing lamp, electronic organ, metronome, wailing siren electronic timer, computer counter and fire alarm are built when following this book. An S DEC breadboard is used so that soldering is not required and all components can be re-used. A batteries are required for this, and all of the other books in this section, these are not included in the pack but should be readily available locally.

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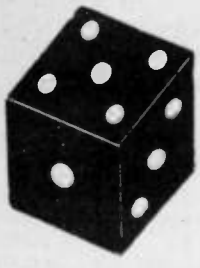


101 ELECTRONIC DICE
E.E. MAR 77
A Row of 6 LEDs one of which stays alight at random after pressing and releasing a push button switch. powered by a PP3 battery, built on stripboard. Easy to build and ideal for beginners. Our first project kit!

263 BUZZ OFF E.E. MAR 83
An improved version of the traditional steady hand game. The player must guide a loop along a bent wire obstacle course. a buzzer is used instead of a bell & an electronic circuit ensures that the buzzer will sound for half a second even if only momentary contact is made.

199 CMOS DIE E.E. SEPT 81
This electronic die has for its display a set of LEDs arranged in the standard die pattern. The circuit is activated by a small 'throw' push button & the score remains displayed for approximately 10 seconds before the circuit switches itself off. PP3 battery provides power.

207 HEADS & TAIL GAMES E.E. OCT 81
This is a very simple project suitable for beginners. two LEDs are fitted in a balanced circuit. When the circuit is switched on only one of them can light - which one lights is determined at random by the noise in the circuit, hence the lamps can be used to similate the tossing of a coin.

260 DOUBLE DICE E.E. JAN 83
A double version of the electronic dice. The display is by means of two sets of LEDs arranged in the shape of a standard dice. A single push button spins both dice together. The numbers are displayed continously until the power is switched off. Operates from a 9V battery.

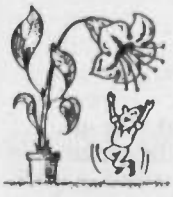
432 GAMES TIMER E.E. JAN 85
A simple timer giving four pre-set switched ranges for timing moves during games etc. Component values can be selected to give times between 5 mins and 30 mins. Battery powered.

571 RANDOM NUMBER GENERATOR E.E. DEC 86
A two digit random number generator which can be switched to select numbers between 1 and 90 (for bingo) and 1 and 55 (for standard pools coupons). Built on stripboard, and powered from 4 x AA cells. numbers occur completely at random, and so may repeat.

770 GAMES TIMER E.E. FEB 88
An adjustable timer which gives delays variable from 0 - 40 seconds, with an alarm which bleeps for a short period as the end of the time approaches, and then sounds a continous tone. Battery powered, built on PCB.

HOBBY KITS

131 SPEED CONTROL FOR R/C H.E. APR 80
Controls speed & direction for electric motors up to 15 amps. uses a single channel of a proportional radio control system. Can be used to replace servo/rheostat control assemblies. Gives excellent control right down to crawl speeds. Includes a heavy duty relay.

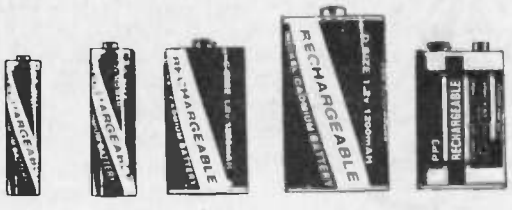


148 SOIL MOISTURE MONITOR E.E. NOV 80
A simple project which provides a reliable wet/dry indication using red & green LEDs. Supplied with probes.

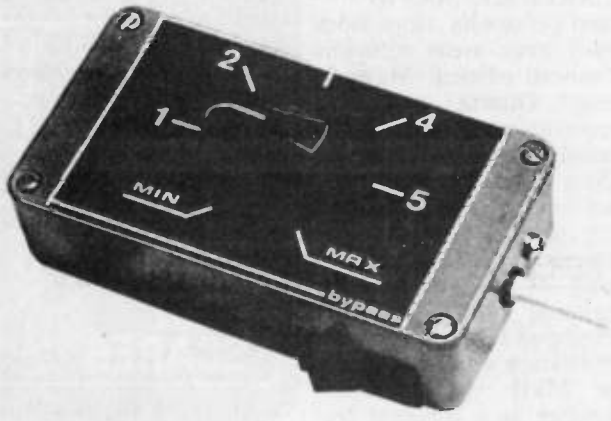
181 SOIL MOISTURE INDICATOR E.E. MAY 81
LED gives 3 indications: flashes - soil dry, glows - soil moist, off - soil wet. Based on a '555' IC. Complete with probes.

242 2 WAY INTERCOM E.E. JULY 82
A simple two way intercom constructed using screw terminal blocks. soldering is not required so the project is ideal as an introductory educational exercise. Using a PP3 battery good performance over 100 metres is achieved.

350 NI-CAD BATTERY CHARGER E.E. MAR 84
A constant current regulator circuit which is designed to be added to a standard car battery charger or similar 12V supply. A small meter indicates the charge current which is set by a control potentiometer. The circuit will charge PP3. HP7, HP11 & HP2 size cells. Up to 12 cells of the same type may be connected & charged in one go.



386 DRILL SPEED CONTROLLER E.E. OCT 84
This power controller allows the speed of standard pistol drills to be varied over a wide range. The circuit incorporates back emf sensing which ensures that full torque is obtainable even at very low speeds. Also suitable for controlling universal AC motors in many other applications.



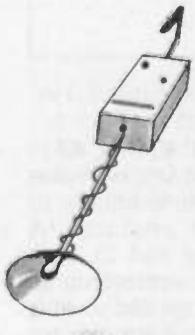
387 MAINS CABLE DETECTOR E.E. OCT 84
A compact unit which helps find concealed mains cables when drilling walls etc. The hand held detector produces a loud buzz when it is held near to live AC mains cables. Built on veroboard. Battery powered.

481 SOLDERING IRON POWER CONTROLLER E.E. OCT 85
A very neat and compact unit that provides variable heat control for soldering irons or other lower power (up to 150 watts) loads. Control of soldering iron temperature extends bit life and makes soldering much easier because it reduces the formation of scale and oxides. A tremendous help for beginners and a must for serious constructors.

514 INTERVAL TIMER E.E. MAR 86
A versatile timer that gives an audible warning after a pre-set period between 30 sec and 15 mins. A twelve position switch allows selection of the required delay. The warning tone can be switched to sound just before or just after the time has elapsed. Battery powered.

529 MINI STROBE E.E. MAY 86
A hand held stroboscope which uses six 'ultra bright' LEDs as the light source. Designed to demonstrate the principles of stroboscopic examination, the unit is also suitable for measuring the speed of moving shafts etc. The flash rate control covers 170 - 20,000 rpm in two ranges. An external sync socket allows the strobe to be synchronised to an accurate frequency souce or, via a suitable pick up, to the machine being viewed.

722 FERMESTAT E.E. JULY 87
For brewers, gardeners, and other users requiring controlled low temperature heating. This circuit uses a thermistor to provide control of mains heating elements (up to 5 amps) for controlling the temperature of a small cupboard for heating a brewing container, incubator, or small greenhouse. A sensitive circuit ensures accurate control via a mains triac. Also can be used with soil heaters and other systems requiring accurate temperature control. Built on a PCB. Mains powered.



719 BUCCANEER I.B. METAL DETECTOR E.E. JULY 87
This metal locator uses the sensitive and versatile I.B. (induction balance) technique. It is an easy to build detector with good sensitivity which rejects iron and foil to a good extent. The output is via a small loudpeaker (or headphones can be plugged in). Kit includes all electronic components, PCB, case, wire for search coils etc., but excludes the search head and handle. These were made from a plastic plate and tubing in the prototype but other materials can be used. A quality design, using interesting circuit techniques.

730 BURST FIRE MAINS CONTROLLER E.E. SEPT 87
A project for reducing the power of the heating elements in soldering irons or similar appliances (up to 500W). The system works by switching the load on and off near to mains zero crossing points, resulting in silent interference free switching. A potentiometer alters the on/off ratio to provide a wide range of control from zero to full power. The circuit is built on pcb and mains powered.

713 VIDEO FADER P.E. JAN 87
A simple fader that allows a complete video signal to be processed when editing video recordings etc. The signal can be faded right down to zero with no loss of synchronisation as the circuit maintains these at a high level even when the video signal is faded away. A compact mains powered unit.

744 VIDEO CONTROLLER E.E. OCT 87
For use with home video recording equipment, this project gives separate facilities to control sound and vision via two adjacent slider controls. It also allows a microphone signal to be mixed with the audio signal so that, for example, a commentary can be added to an existing video track. As well as a stereo output an independent mono output is also provided, and a pan control allows the microphone channel to be positioned anywhere across the sound stage. The circuit is battery powered, and built on a PCB.

740 ACOUSTIC PROBE E.E. NOV 87
A very popular project which picks up vibrations by means of a contact probe and passes them on to a pair of headphones or an amplifier. The probe (which must be constructed following the details in the article) is held in contact with the object to be examined. Sounds from engines, watches, and speech travelling through walls can be amplified and heard clearly. A very useful piece of equipment for mechanics, instrument engineers, and nosey parkers. Battery powered, PCB constructed.

764 DUAL MAINS LIGHT FLASHER E.E. DEC 87
A circuit which independently flashes two sets of mains lights, the flash rate of each can be set individually so that complex changing patterns can be produced. A switch is provided to overide the flashing and fix both channels at full output. The circuit can control up to 100W per channel. Two pairs of special plugs and sockets are provided for the outputs, and the circuit is built in a fully insulated plastic case. Ideal for Christmas lights, shop displays etc.

712 VIDEO ENCHANCER P.E. DEC 86
A combined audio and video processor that allows picture sharpness to be enhanced, or softened according to taste. The audio signal is also processed by a dynamic noise reduction circuit, reducing background noise substantially by means of a voltage controlled filter which is automatically adjusted according to the incoming signal level. Ideal for improving poor video recordings and enhancing good ones. The circuit is mains powered, and operates on composite video signals. It is not suitable for UHF modulated signals or RGB.

784 VIDEO WIPER E.E. JULY 88
Adds a professional touch to Video recordings by enabling the screen to be wiped from top to bottom progressively down (or up) at the end of one scene and up (or down) at the beginning of the next. This is a mains powered unit which also has a passive audio fader built in to allow simultaneous fading with the video signal. Works on standard PAL composite video at 75 ohms impedance and produces jitter free results.

796 SEASHELL SEA SYNTHESISER E.E. NOV 88
A battery powered unit that plugs into a stereo system and produces the relaxing rushing sounds of waves on the beach. The circuit contains digital noise generators and low frequency modulating oscillators to produce a true stereo output. Soothing sounds for the tired businessman/woman and the restless infant.

812 ULTRASONIC PEsT SCARER E.E. MAY 89
Keep pets/pests away from newly sown areas with this advanced efficient Magenta design. Quartz controlled frequency and High Voltage transducer drive give intense pulses of Ultrasound unpleasant to cats and dogs. The unit can be battery powered or powered from a small 9V AC transformer (optional extra). We have developed this project since publication and now supply the MkII version which operates at a different frequency.

814 BAT DETECTOR E.E. JUNE 89
This is an exellent circuit which reduces Ultrasonic frequencies between 20kHz and 100kHz to the audio range. Operating rather like a Radio Receiver the circuit allows the user to Tune-in to the Ultrasonic frequencies of interest. Listening to Bats is a fascinating hobby, and it is possible using this instrument to identify the different types of bat and get some insight into their Ultrasonic RADAR system. The circuit has found other uses as well in industry and laboratories.

815 P.I. TREASURE HUNTER E.E. AUGUST 89
A highly developed and acclaimed Magenta designed easy to build P.I. metal detector with excellent performance and reliability. This kit features a complete hardware package as well as all the electronic components. An advanced Quartz Crystal controlled design with High Voltage MOSFET search head drive and High Slew-Rate DC Coupled amplification. Total absence of Ground Effect enable this detector to work with the search head totally immersed in sea water. Detects a 10p coin at 20cms and larger objects much deeper. The 190mm diameter search coil is easy to wind and gives good area coverage. The advanced design minimises setting up procedures and makes the detector simple to use. Audible output is provided to a pair of stereo headphones.

NOVELTY KITS

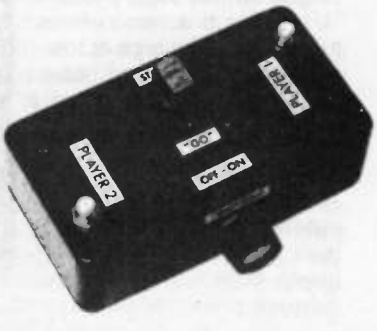
106 WEIRD SOUND EFFECTS GENERATOR E.E. MAR 78
Three tuneable oscillators coupled together. Create your own science fiction 'music' by playing this unit through an amplifier or tape recorder.

117 ELECTRONIC CANARY E.E. JUNE 79
The pleasing twittering sound produced by this simple circuit makes it a novel replacement for the doorbell.

120 TWINKLING STAR E.E. DEC 79
An effective decoration suitable for the Christmas tree, a window or wall etc. Consists of 6 lamps which are positioned on a hardboard star shape - using 2 '555' timer ics the circuit is arranged so that the centre light is always on & the others flash in such a way that the star appears to be 'twinkling'. Requires a 9V 300-400mA power supply. The kit is supplied with a plug in power supply - which can of course be used on its own after Christmas.

226 POCKET TIMER E.E. MAR 82
A simple circuit which lights an LED after an internally pre-set time delay. Components supplied allow up to 3 hours to be achieved. Suitable for use as a parking meter timer etc.

243 REFLEX TESTER E.E. JULY 82
For use by two players. Tests how quickly a button is pressed in response to an LED lighting. After pressing a 'start' button a time delay passes before the 'go' light comes on, after which both players press their response buttons. LEDs indicate which person pressed first.



270 NOVELTY EGG TIMER E.E. APR 83
A timer continously variable from 0 - 8 mins. At the end of the time period a pleasant warbling alarm sounds & two LEDs flash. this kit comes without a case because the original was built to look like an egg - hence the 'novelty' title.

333 NOVEL EGG TIMER E.E. DEC 83
An electronic circuit which makes a good imitation of a cackling chicken when the egg is cooked. The time is variable by means of an internal preset control. 9V battery powered.

455 ELECTRONIC DOORBELL E.E. JUNE 85
A circuit which produces an electronic imitation of a standard doorbell. The circuit is battery powered and uses a piezo ceramic audio transducer to produce the sound.

499 MAINS DELAY SWITCH E.E. JAN 86
A turn-off time delay circuit giving 8 or 20 mins of power after the start button has been pressed. Designed for use with porch lights or similar circuits where power can be wasted by leaving things switched on accidentally. The circuit is designed to be built into a double surface mounting switch box.

548 ELECTRONIC SCARECROW E.E. JULY 86
This circuit provides a 25 seconds burst of 200Hz square waves every 60 seconds. It is designed to be placed in the garden to distrub birds and animals that destroy crops. The circuit requires a source of 6-9V AC which can be supplied from a plug in adaptor or a transformer mounted in the house, garage or shed.

776 LIE DETECTOR E.E. MAR 88
A simple project that causes a line of LEDs to light progressively in response to skin resistance. Fun to use in games and at parties.

LIGHT RIDER

DISCO LIGHTS...LAPEL BADGE...CHASER LIGHT

Three projects that will certainly test the creative eye of the experimenter. You could even create your own version of "Kit" of *TV Knight Rider* fame.

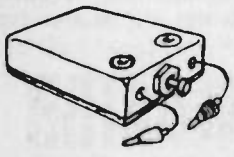
LIGHT RIDER E.E. OCT 86
Three projects under one title - all simulations of the Knight Rider lights from the TV series. The three are a lapel badge using 6 LEDs, a larger unit with 16 LEDs and a mains version capable of driving six mains lamps totalling over 500 Watts.

560 LIGHT RIDER - DISCO LIGHT E.E. OCT 86
An adaptation of the lapel badge circuit to drive 6 banks of mains lamps. Each bank of lamps can be rated up to 500 watts to give a large bright display. A variable speed control allows the effect to be changed over a wide range. The circuit is housed in a plastic box for complete safety and built on a single PCB.

561 LIGHT RIDER - LAPEL BADGE E.E. OCT 86
A very effective compact lightweight unit that gives a continous moving light with realistic fade out and overlap between lights. The circuit uses high efficiency miniature LEDs to give a bright display with long life. The display is clearly visible in daylight and very bright at night.

559 LIGHT RIDER - CHASER LIGHT E.E. OCT 86
A 16 LED version of the effect which can be built into model robots, or cars to add interest and appeal. The circuit is built on a single printed circuit board and powered from a 9V PP3 battery.

TEST GEAR KITS



103 RAPID DIODE CHECK E.E. JAN 78
This very simple device is capable of checking a silicon or germanium diode for polarity in half the time required using a multimeter. In addition to ascertaining whether a diode is in working order, this device also identifies the cathode lead by LED indicators.

108 IN SITU TRANSISTOR TESTER E.E. JUNE 78
Can be used to check a transistor while it is in or out of a circuit. Provides a general guide to transistor condition. Can also be used for quick checks on diodes & rectifiers. Indication by LED.

112 FUSE CHECKER E.E. OCT 78
A handy device for checking all types of household fuses. With test button & LED indication of blown - not blown fuses.

115 TRANSISTOR TESTER E.E. ARP 79
A simple & cheap tester which is, within its limits, accurate. Measures gain. Output is via the crystal earpiece provided.

147 TRANSISTOR TESTER E.E. NOV 80
This battery powered tester allows PNP & NPN transistors to be checked. Also measures current gain (HFE) & leakage. HFE range 5-650 at 2 mA collector current.

153 TRANSISTOR TESTER H.E. NOV 80
Test NPN or PNP transistor quickly & easily with this simple to build project for beginners. Calibrated to give a visual readout of the transistor's gain. Includes a set of test leads.

191 VARIABLE BENCH POWER SUPPLY H.E. JULY 81
An extremely useful power supply unit which provides from 0 to 14 volts at 1 Amp. The voltage is set by means of a calibrated control & a panel meter accurately indicates the output current. Regulation is provided by an excellent I.C. regulator which has full internal protection against overheating & short circuits. The circuit is housed in an attractive PVC coated metal case & is fitted with 4mm screw terminals suitable for connecting either plugs or loose wires.

197 0-12V POWER SUPPLY E.E. SEPT 81
A versatile supply providing an output adjustable from 0-12V at up to 400mA by means of a calibrated potentiometer. The circuit is fully regulated & incorporates three step adjustment of current limiting to prevent damage to circuits being tested. A rotary switch selects 40, 100, or 400mA maximum current. If the set current is reached the current limiting circuit comes into action & an audible alarm sounds. This is very useful feature & eliminates the need for an expensive current meter.

229 SIGNAL TRACER H.E. APR 82
A high impedance probe suitable for tracing signals in radio & audio circuitry. The circuit uses an FET input stage which drives a high gain transistor output stage. The output stage is biased so that A.M. radio signals will be demodulated to produce an audiable output. The output is suitable for connection to a crystal earpiece.

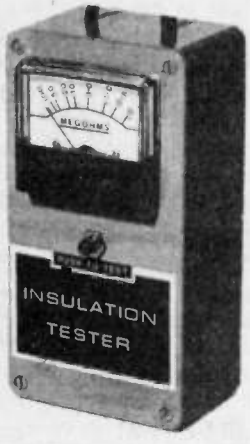
283 TTL LOGIC PROBE H.E. JUNE 83
A very simple logic probe which gives indication of logic '1' or '0' on a two colour LED indicator. Two presets allows the logic high & low thresholds to be set independently. If a high speed pulse waveform is present both led colours will light together & an orange/yellow colour is seen.

330 CONTINUITY TESTER H.E. DEC 83
A compact tester which gives audible indication of low resistances & short circuits. In addition two LED indicators are provided which allow the tester to distinguish between short circuits & 'false' current paths through semiconductors junctions etc.

334 CONTINUITY TESTER E.E. DEC 83
A continuity tester which responds to low resistance with one tone & high resistance with another tone. The current in the probes is very low so the tester will not damage sensitive circuits. Power is provided by a 9V battery.

344 SIGNAL TRACER E.E. FEB 84
This circuit is built in two sections. One section generates an 800Hz signal for injection into the circuit under test. The other section consists of a high impedance probe connected to a high gain amplifier circuit. The amplifier output can drive either a crystal earpiece or high impedance headphones. Suitable for 'trouble shooting' in audio circuitry.

358 FUSE/DIODE CHECKER E.E. APR 84
A simple circuit which gives LED indication of the state of fuses and diodes. Two LEDs indicate conduction in opposite polarities, thus a blown fuse or open circuit give no light, a good fuse or short circuit lights both lamps, & a good diode will light one or other of the lamps depending on which way it is connected.



444 INSULATION TESTER E.E. APRIL 85
A reliable electronic tester which checks insulation resistance of wiring appliances etc at 500 volts. The unit is battery powered simple and safe to operate. Leakage resistance of up to 100 megohms can be read easily. One of our own designs, and extremely popular.

461 CONTINUITY TESTER E.E. JULY 85
This tester produces an audible and visual output when the probes are bridged by any resistance less than 7k ohms or so. The circuit will also check transistor and diode junctions without danger of damaging them. A pair of metal pads on the case of the tester allow fuses and small components to be checked simply without the need for test leads.

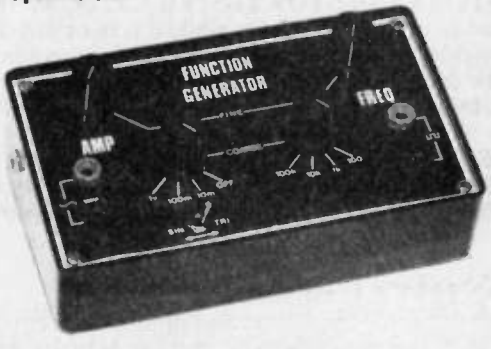
524 VERSATILE P.S.U. E.E. APRIL 86
This power supply can provide 1.2 to 15 volts DC output at up to 1.2 amps. The circuit uses a solid state voltage regulator which is practically indestructable. A feature of the supply is a constant current mode in which the supply can be set to deliver one of six pre-set currents which have been selected for charging the range of NICAD batteries from a PP3 right up to D cells.

493 DIGITAL CAPACITANCE METER E.E. DEC 85
A superb easy to use instrument with five digit direct read-out of capacitance values from 1pf to 1000uf. The circuit has been designed for quick accurate use, even by absolute beginners. calibration is not required as the unit uses a quartz crystal and close tolerance resistors. A special time-out circuit blanks the display after 30 seconds to ensure maximum battery life.

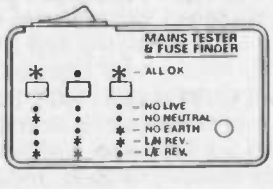
503 FUNCTION GENERATOR E.E. FEB 86
A circuit which provides sine, triangle and square waves from 10hz to 100khz in 4 ranges. The unit is suitable for testing audio circuits, digital logic circuits and computer perpherals such as a to d convertors. The sine and triangle wave output level is variable in 3 ranges covering 0-10mv, 100mv and 1 volt rms. The square wave output is fixed at 10 volts peak to peak from an open collector transistor stage. The circuit features a constant 600 ohms output impedance at all settings and is therefore excellent for testing op-amp circuits when gain often depends on the source impedance. The circuit can be battery powered but an optional mains power unit is also available.

FUNCTION GENERATOR

Produces sine, square and triangular waveforms over the range 0·01Hz to 1MHz at up to 1V output, thus forming a very useful piece of test equipment. The article includes a simple battery eliminator for those that require mains operation.



512 MAINS TESTER & FUSE FINDER E.E. MARCH 86
A handy unit which sounds an audible warning when the mains supply is disconnected and gives visual indication on three neon lamps of the connections to mains sockets. Designed for checking the correct connections of mains wiring and for tracing which socket in the house connects to which fuse in the fusebox. the circuits can detect fault conditions as follows: No live, No neutral, No earth, I/N reversal, I/E reversal.



553 BATTERY TESTER E.E. AUG 86
A tester that applies the correct load to batteries to give meaningful voltage readings. This tester achieves this by means of a push button switch which connects an appropriate load resistor across the battery and gives a voltage reading on a built in panel meter. The meter is specially scaled so that it reads 1-1.5v and 6-10 volts. This gives a very precise reading of voltage which enables the battery condition to be assessed easily.

563 200MHZ DIGITAL FREQUENCY METER E.E. NOV 86
An easy to construct project which measures frequencies from a few Hz to 200mhz. The circuit has an 8 digit led display, and is powered from a 9V plug- in mains adaptor (supplied with the kit). 10Mhz quartz crystal master oscillator ensures high accuracy without any need for calibration. An ideal instrument for CB, and amateur (HF and VHF) use. Also ideal of calibrating audio oscillators, radio tuners I.F. amplifiers etc.

580 VERSATILE PULSE GENERATOR E.E. FEB 87
Another digital trouble shooting project. This unit provides pulses from 1.4 sec to 14u sec in 5 ranges. Pulse width is adjustable from 0.7 to 7u sec and amplitude from 0v to 8v peak. Rise and fall times are 0.5u sec on all ranges. A mains powered project housed in verobox. Built on stripboard.

704 CURRENT TRACER E.E. APR 87
Another of the digital trouble shooting projects. This one detects the voltage drop in short lengths of PCB track and so allows the current to be estimated without actually breaking the circuit. This is a very effective way of tracing faults, especially short circuits, as is allows the current to be followed progressively from the source to the leak. Built on stripboard, battery powered and housed in a verobox.

710 AUDIO LOGIC TRACER E.E. MAY 87
A simple logic tracer that takes pulses from a digital circuit under test and produces an audiable output via a small audio transducer. A very useful simple method of fault finding in logic circuits, which can yield a lot of information very quickly, especially when testing known systems.

745 TRANSTEST E.E. OCT 87
An in circuit tester for transistors and diodes. This circuit works by applying an alternating voltage between two probes which are placed on the diode and transistor under test. Two leds indicate the current flowing in each direction through the circuit indicate the polarity of any diode or transistor junction between them. Neither LED lights for an open circuit, both LEDs light for an short circuit, and either one of the LED lights to indicate a good semi. junction. A simple well designed project.

834 QUICK CAPACITANCE TESTER E.E. FEB 90
A low cost hand held audio/visual unit which can identify short, open, and working capacitors quickly and with a minimum of fuss. Also gives indication of leakage current. Especially useful for electrolytics and for diode and transistor junctions. An ideal kit for beginners. Built on a single circuit board which has large copper areas used as test pads. Only the very minimum of wiring is needed. Output is provided by 2 LEDs and a piezo transducer. The capacitance value is determined by the pitch of the tone and which test pads are being used. Ideal for Bargain Pack sifting.

716 SCOPE STORE P.E. JULY 87
A solid state digital store which enables intermittent and one shot waverforms to be capured and studied on a standard oscilloscope. Sample rate of up to 100,000 per second is obtainable, allowing good accuracy with audio waveforms. For slower waveforms sample rate can be lowered as required. The unit uses a 2k x 8 RAM chip, giving a 2048 x 256 display which shows no sign of stepping at all on the average oscilloscope. Input sensitivity and trigger controls are provided. Manual and automatic triggering may be used, and the input signal may be A.C. or D.C. coupled. A very effective and interesting piece of equipment.

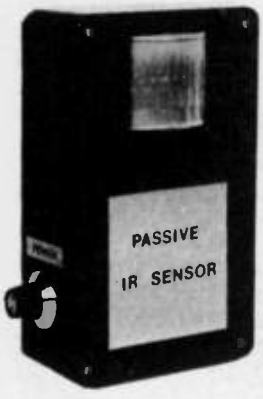
763 AUDIO SIGNAL GENERATOR E.E. DEC 87
A compact reliable and effective source of audio sine waves for checking speakers, amplifiers, peizo sounders etc. This circuit is a Magenta design and provides frequencies from 33hz to 33khz in 3 ranges. Simple to assemble and use, it provides three outputs. The first is up to 1/2 watt into 8 ohms, the second variable from 0 to 6V, the third 0 - 60mV. Operates from a PP3 battery, built on PCB.

769 POWER SUPPLY (MOSFET) E.E. JAN 88
The best power supply project published for some time. This Magenta design gives 0-25V at 0-2.5 Amps output so is capable of powering almost anything. Two panel meters indicate voltage and current. The output is fully protected from short circuits. As well as the usual voltage control, The circuit also has fully adjustable current limit control which allows the supply to work in constant current mode. This is ideal for charging batteries - especially NICADSs. A power MOSFET is used as the output device, and this gives the unit exceptional ruggedness and reliability. Printed circuit board construction. Uses a toroidal power transformer.

785 ISOLINK E.E. JULY 89
An opto-isolated circuit that allows small signals to be passed between its input and output whilst being fully isolated from one another. Ideal for use in BIOLOGICAL experiments where the input signal from electrodes fixed to a person can be connected to a mains powered oscilloscope and other test gear without any danger. Frequency response is DC to 30kHz with very low distortion due to a special opto-isolated feedback loop technique. The circuit has many other uses including the testing of electronic circuits which have sections connected to mains voltages - such as lamp dimmers, motor drives, switch mode power supplies and television receivers.

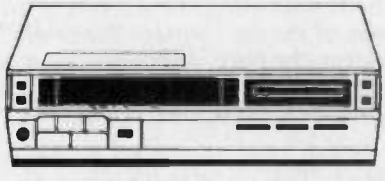
SECURITY KITS

556 INFRA RED BEAM ALARM E.E. SEPT 86
A brokem beam intruder detector module with a range of over 10 metres which is designed for connection into an existing closed loop alarm system. The transmitter and receiver are fitted in to separate boxes and each powered from 4 - HP7 type cells. When the beam is not broken a relay in the receiver circuit is permanently energised. Breaking the beam or failure of either of the batteries will cause the relay to release.



551 PASSIVE INFRA RED DETECTOR P.E. JULY 86
A mains powered module with a relay output that switches in response to the movement of body heat. A pyro-electric sensor is used coupled with a special fresnel lens capable of covering a room up to 4m x 7m. The circuit is designed to switch on a light when the room is entered. An additional photocell is incorporated so that the circuit does not turn on the light during daylight hours. Easily adapted to operate a burglar alarm or warning buzzer.

581 VIDEO GUARD E.E.FEB 87
This novel project provides good anti-theft protection for VHS type video recorders. A small printed circuit board is built into an empty cassette and inserted into the machine. A tilt switch on the board will be activated if the video recorder is picked up or moved, sounding a loud alarm. The circuit is automatically switched on when it is inserted into the recorder, and switched off when it is removed. A simple but very effective anti-theft device. Very long battery life is assured by the low circuit quiescent current.



700 ACTIVE INFRA RED ALARM E.E. MAR 87
An infra red alarm that emits a pulsed beam of radiation and detects the amount of it received by a sensor which can either be placed alongside the emitter (reflective mode), or facing it (beam mode). The circuit is suitable for mounting indoors or outdoors and is powered from a mains transformer in a separate indoor unit. When triggered the alarm closes a relay for a time that can be pre-set from a few seconds up to an hour. The relay contacts can be used to operate an outdoor light, or can be connected to a siren, or other alarm system. Two pairs of change over contacts are available. A special type of synchronous detector ensures that interference effects from mains lighting etc. are ignored.

791 ULTRASONIC BREAKING GLASS ALARM E.E. SEPT 88
This self contained battery powered alarm picks up the high frequency 'sounds' produced when glass breaks. A 40kHz ultrasonic detector is used followed by a filter which rejects any audio frequencies which might cause false alarms. The alarm is set by a key operated switch and produces a whooping sound from a built in speaker when triggered. Pick up range is in excess of 3 metres.

122 UNIBOARD BURGLAR ALARM E.E. DEC 79
A simple but effective circuit which accepts inputs from normally open & normally closed types of contact loops. Battery powered - very low current drain. Test button facility. Includes a buzzer.

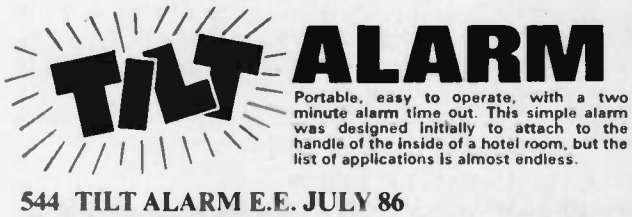
750 INTRUDER CONFUSER H.E. JAN 82
This device is intended to confuse a would be intruder by appearing to be part of a sophisticated alarm system. It steadily flashes an LED day & night. When placed at one side of a window for example, it attracts the attention of the would be intruder who is led to believe that an infra red beam is protecting the property - so he goes elsewhere. The circuit is powered by a single cell that will give at least 7 months continous use.

230 BIKE ALARM H.E. APRIL 82
Protect your bike or other moveable property (camera bag, toolbox etc) with this movement sensitive alarm. The alarm is set by removing a jack plug which contains your own secret resistor. Any movement will trigger the alarm which will continue to sound for 20 seconds. Further movement will retrigger the alarm for a further 20 seconds & so on. The alarm can be instantly silenced by insertion of the special jack plug. The circuit is designed to take very low current & give very long battery life.

262 PUSH BIKE ALARM E.E. FEB 83
An alarm which detects movement by means of a mercury switch. The alarm sounds for approximately 1 minute after it has been triggered, after which it resets. A keyswitch is fitted to turn the alarm on & off. A PP3 battery provides the power.

364 SIMPLE LOOP BURGLAR ALARM E.E. MAY 84
An alarm system designed for use with a loop of wire which is woven around goods to be protected. The unit includes its own alarm speaker & key operated switch for setting.

474 CARAVAN ALARM E.E. JULY 85
A 'loop wire' type alarm for protecting caravan contents and also items outside the caravan through which a loop wire can be passed. The alarm required 12v car battery and an external car horn or other 12V warning device. A 30 second time-out prevents the alarm sounding continously causing a nuisance and discharging the battery.



544 TILT ALARM E.E. JULY 86
This simple tilt alarm was designed to be portable and easy to operate. It can be used in any situation where an attemped theft invloves tilting something e.g. a hotel door handle, toolbox lid, camera case, suitcase etc. The alarm is compact and draws very little current on standby so that it can be left unattended for long periods. An automatic time out circuit stops the alarm from sounding and re-arms the circuit after two mins. The circuit uses a printed circuit board and is powered by a PP3. The alarm sound is a loud high-pitched warble which is very penetrating.

114 CAR ALARM H.E. FEB 79
Easy to build - quick to fit - complex in circuit operation. the circuit detects a voltage drop anywhere in the vehicle's electrical system. Not prone to false alarms. Connect it to any point which is normally live at all times. Alarm is automatically turned off after 45 seconds & reset. Most theives are deterred by knowing an alarm is fitted - so project includes a flashing LED. A reliable effective and popular alarm.

782 DOOR SENTINEL E.E. MAY 88
A low cost security project which allows doors and windows to be monitored using magnetic reed switches in a normally closed loop. The loud alarm tone sounds for two minutes after the circuit has been triggered and then resets. A flashing LED announces that the alarm is in operation and so deters theft. The alarm is set and reset by means of a magnet operating a concealed reed switch.

CAR KITS

735 CARAVAN FRIDGE ALERT E.E. OCT 87
A very good gadget that senses the state of a caravan fridge supply (a fridge of the absorption type). It prevents gas and electricity being connected at the same time (to dual-fuel fridges) and also ensures that current is being drawn by the fridge from the car battery system, sounding an alarm if power fails for some reason. A simple, well though out project.

777 LOW FUEL ALERT E.E. APR 88
Using the existing petrol gauge sensor, this circuit provides an audiable warning of low fuel. Suitable for most negative earth cars. Constructed on stripboard, housed in a small plastic case.

771 CAR LAMP CHECKING SYSTEM E.E. FEB 88
A circuit which checks the current flowing in car brake lights and side/tail lights and indicates a fault in any of them. Panel mounted warning lights give indication. A neat little circuit, built on stripboard. Suitable for negative earth vehicles only and not suitable for caravan/trailers.

783 HEADLIGHT REMINDER E.E. JUNE 88
Simple easy to build unit which sounds a buzzer and flashes an LED if one of the front car doors is opened whilst the headlamps are on. Once fitted it can be forgotten and will constantly guard against flat batteries.

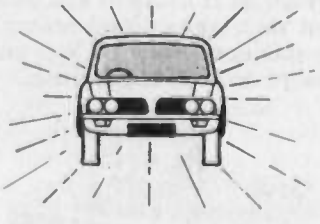
114 CAR ALARM H.E. FEB 79
Easy to build - quick to fit - complex in circuit operation. The circuit detects a voltage drop anywhere in the vehicle's electrical system. Not prone to false alarms. connect it to any point which is normally live at all times. Alarm is automatically turned off after 45 seconds & reset. Most theives are deterred by knowing an alarm is fitted - so project includes a flashing led for mounting in a prominent place. A reliable effective and popular alarm.

173 WINDSCREEN WIPER CONTROL H.E. MAR 81
An easy to build project for the car owner - helps to stop those smeary screens at a flick of a switch. In addition to giving single intermittent wipes this gives several alternative time delays between wipes. Suitable for 12 volt positive or negative earth cars. The wipers are controlled by a pair of normally open relay contacts which are wired across the ordinary wiper switch - so continous operation of the wipers can be obtained in the normal way.

210 ICE ALARM E.E. OCT 82
Detects icy road conditions by means of a thermistor mounted under the front of the car. A flashing warning LED indicates the potential hazard to the driver.

543 WATCHDOG E.E. JUNE 86
A car lights warning circuit which provides an audible indication when the car ignition is turned off whilst the headlights or sidelights are on. An override switch allows the sidelights to be left on when parking.

569 AUTOMATIC CAR ALARM E.E. DEC 86
A fully automatic alarm with entry and exit delays and a buzzer which sounds during the entry delay. The alarm is armed and disarmed by means of the ignition switch which must be turned within 12 seconds of entry. Sensing is by means of the car courtesy light switches. In the event of an alarm, the horn is sounded for a pre-settable period between 1 and 5 minutes, a very well though out alarm with a number of other useful features.

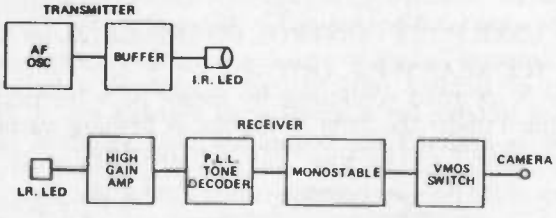


708 FRIDGE ALARM E.E. MAY 87
A low temperature alarm that monitors fridge temperature with a thermistor and sounds a tone if the internal temperature rises above a certain fixed level. Useful for checking caravan fridges etc. A small self contained unit, that comsumes practically no power when in the quiescent state.

PHOTOGRAPHIC KITS

225 CAMERA OR FLASHGUN TRIGGER E.E. MAR 82
This trigger unit enables action photographs to be taken by producing a trigger pulse whenever an infra red beam is broken. Two range settings give up to 2 metres range at maximum setting & 1 metre at minimum with reduced battery drain. The output should trigger any normal electronic flashgun & also most modern SLR cameras fitted with electronic shutter controls or autowind facilities.

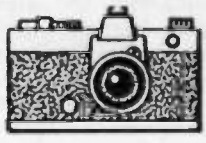
340 INFRA RED CAMERA CONTROL H.E. FEB 84
Designed for use with cameras that have electric remote shutter release and/or autowinder. Provides remote triggering at up to six metres range provided there is a transparent path between the hand held transmitter & the receiver. An indicator on the receiver allows the unit to be set up without connecting a camera.



383 SOUND OPERATED FLASH E.E. SEPT 84
This unit will trigger most standard flashguns in response to sound, enabling many interesting frozen action shots to be taken. The sound is picked up by a crystal microphone.

118 DARKROOM TIMER E.E. JULY 79
A simple battery powered unit with an LED which flashes once per second. Flashes are counted by the operator to give the desired exposure time. Ideal for short printing jobs. Max. accuracy 1/60th of a second.

171 PHOTOGRAPHIC TIMER H.E. MAR 81
Simple to build. The unit has an LED indicator which flashes at one second intervals. Useful in the darkroom etc.



209 PHOTO FLASH SLAVE E.E. OCT 81
Designed to trigger one flash gun in response to the flash from another. The circuit uses a phototransistor to detect the flash. This drives a thyristor which triggers the second flash unit via a diode bridge. Power is derived directly from the slave flashgun.

219 SIMPLE INFRA RED REMOTE CONTROL E.E. NOV 81
A range of about 9 metres is achieved with this remote control circuit. The system is a simple on/off switching type where a pair of relay contacts at the receiver close while a push button switch at the transmitter is pressed. Transmitter & receiver are battery powered. Suitable for the remote control of slide projectors or similar. Alternatively the unit could be mains powered & operate a broken beam alarm.

RADIO KITS

718 3 BAND 1.6-30MHZ RADIO E.E. AUG 87
A three band TRF receiver using modern miniature plug-in coils covering 1.6 - 30mhz in 3 bands. The circuit uses a special i.c. containing 5 matched high frequency transistors to obtain exceptionally smooth control of regeneration (or reaction) and produce a highly sensitive circuit which can by tuned easily by beginners and experienced short wave listeners. The audio output is approx 1/2 watt via a built-in loudspeaker. Another Magenta design, this is one of our 'top kits' and is exceptionally good project to build and use.

808 SUPER FILTER E.E. MARCH 90
A universal filter designed to remove high frequency signals from the power and low frequency connections of HI-FI, CB, Amateur radio and Vehicle Radio/Audio systems. Based on a special filter block which provides 12 feedthrough PI filters.

746 EXPERIMENTAL CRYSTAL SET E.E. NOV 81
A simple crystal set capable of driving a crystal earpiece or high impendence headphones. Wire is provided for four home made coils to cover MW & SW bands.

542 PERSONAL RADIO E.E JUNE 86
A simple compact medium wave radio designed to be used with 'personal stereo' headphones of 30-64 ohms impedance. The circuit is built on a printed circuit board and powered by a PP3 battery. Controls are provided for volume, and tuning. As the circuit is a trf design it does not require alignment and should work satisfactorily from switch on.

362 VARICAP AM RADIO E.E. MAY 84
A compact medium wave TRF radio tuned by varicap diodes. The circuit is battery powered & provides an output suitable for driving high impedance headphones or a crystal earpiece.

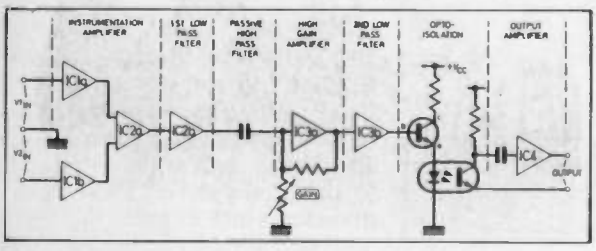
835 SUPERHET BROADCAST RECEIVER E.E. March 90
An up to the minute low cost design using high tech I.C.s. One I.C. is the front end with R.F. amplifier, I.F. amplifier and detector, the other is an audio power amplifier driving a loudspeaker. The circuit uses a ceramic I.F. filter for excellent selectivity and simple alignment. Covers Long and Medium Wavebands. Built in a clear plastic case made from two panels with a simple wooden frame. The drilled panels and a transparent (plain) tuning dial are included.

COMPUTING KITS

337 BIOLOGICAL AMPLIFIER E.E. JAN 84

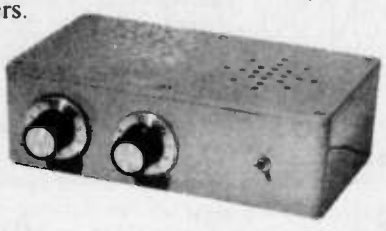
This carefully designed circuit enables the electrical signals produced by muscular, brain, & plant activity to be coupled to a microcomputer. A balanced differential input stage followed by an opto-isolated output stage ensures excellent performance & safety in use. The output is suitable for connection to a range of computer A to D convertors.

Block diagram of the Biological Amplifier.



370 SPEECH SYNTHESISER E.E. JUNE 84

Suitable for all computers which have or are fitted with an 8 bit output port. This circuit uses the SPO256/AL2 IC to generate allophones which can be strung together to produce an unlimited range of speech. The circuit requires a 12V DC supply which may by available from some computers. An audio amplifier & loudspeaker are included. Pitch & volume are variable by means of two potentiometers.



392 BBC MICRO AUDIO STORAGE SCOPE INTERFACE E.E. NOV 84

A fast analogue to digital converter which is connected to the computer user port. A sampling rate 200,000 per second enables audio frequency waveforms to be captured and displayed on the computer monitor. There are four controls, a switched coarse gain control, a fine gain control, sampling speed and D.C. shift control. Maximum sensitivity is 25mV for a full screen waveform.

459 AMSTRAD USER PORT E.E. JULY 85

This add on unit provides all the input/output facilities of the BBC B and VIC 20 Computers for the Amstrad CPC464. The use of a 6522 VIA chip allows most BBC and VIC add-ons to be interfaced to the Amstrad with a little ingenuity. The unit connects to the 25 way double sided expansion slot and is powered from the computer.

568 BBC 16K SIDEWAYS RAM E.E. DEC 86

A versatile add-on providing 16K static 'sideways' RAM for the BBC computer. Built on a small PCB which plugs into one of the ROM slots of the computer. A 'write protect' switch allows the RAM to be used as 'ROM' if required. A software tape containing a number of utilities is included with the kit to accompany the board (or other sideways RAM boards).Easy to install and use, a Magenta designed project which is extremely popular.

246 INTERFACE BOARD H.E. SEPT 82

Suitable for both Sinclair ZX81 & SPECTRUM computers. This is an easy to build unit with gives two independent ports. One is an 8 bit input port, the other is an 8 bit output port. The entire circuitry is built on a single printed circuit board which plugs directly onto the computer user port. The connections to the port are made to four miniature PCB mounted plugs (sockets are provided). Extremely simple programming can be used. PEEK/POKE on the ZX81, & IN/OUT on the Spectrum.

292 USER PORT I/O BOARD E.E. JULY 83

Designed to investigate the facilities offered by a computer user port. This board has 8 buffered LED displays & 8 switches so that each bit of an 8 bit port can be 'written to' or 'read'. Suitable for any computer with a 8 bit port & 5V output.

293 USER PORT CONTROL BOARD E.E. JULY 83

A computer interface board providing 4 independent pairs of isolated relay contact outputs & 4 buffered inputs suitable for connection to switches etc. A fifth input is available for connection to a standard edge sensitive handshake line. Suitable for connection to many of the popular computers that have a user port.

301 STORAGE 'SCOPE INTERFACE FOR BBC MICRO' E.E. AUG 83

This circuit connects to the analogue input socket of the BBC computer. It is designed to convert the amplitude of an audio signal into a varying DC signal which can be analysed & displayed by use of appropriate software. Suitable for displaying ADSR envelope functions & frequency response curves when used with a suitable audio signal generator. Software is available from E.E. on cassette to operate in conjunction with this project, however it is not essential.

322 SPEECH SYNTHESISER FOR THE BBC MICRO E.E. NOV 83

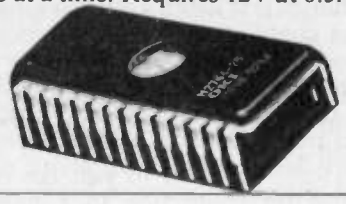
This system uses the GI SPO256 Allophone chip to produce an unlimited range of speech. The circuit connects straight to the user port & produces an audio output suitable for connection to a hi-fi system or small amplifier. Simple programs are given in the article to allow the composition of any speech output by combining the allophones.

360 COMMODORE 64 A TO D CONVERTER E&CM MAY 84

A two channel A to D converter capable of operating at up to 50,000 conversions per second. Suitable for other computers which have an 8 bit user port with two handshake lines such as the VIC20, PET, & BBC Model B. Simple setting up & programming are a feature of this straightforward design which uses the Plessey ZN448/449 chip.

800 SPECTRUM EPROM PROGRAMMER E.E. DEC 88
A single board programmer for the Spectrum computer which allows the most common 2764 and 27128 EPROMS to be programmed. Software is available to accompany this project (directly from the author). The kit includes components for 21V and 12.5V programming, and a ZIF socket for the EPROM. The circuit board mounts directly onto the computer expansion slot, and so is supplied without a case.

790 EPROM ERASER E.E. OCT 88
A safe low cost unit that uses a 12V supply to drive a special ultra-violet tube which will erase all EPROMS in 10 to 30 minutes. Efficient High Frequency inverter circuit gives instant starting and extended lamp life. The use of a 12V supply makes the unit especially safe for Educational applications, and a reed switch and magnet provide an interlock to ensure that the tube cannot be viewed whilst turned on. Erases up to four EPROMS at a time. Requires 12V at 0.5A minimum.



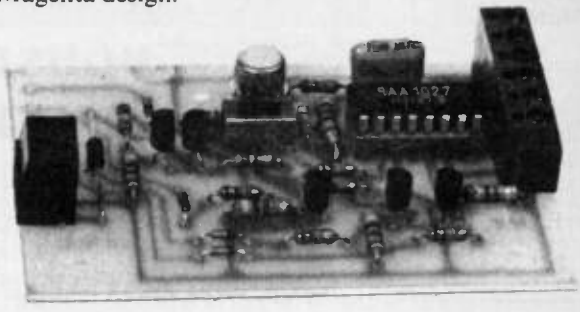
789 AMSTRAD PCW PIO E.E. SEPT 88
An easy to build and effective interface which provides two programmable 8 Bit I/O ports for the Amstrad PCW 8256/512 computers. Supports both memory mapped and I/O operation so allowing a wide range of programming options. Ideal for use with Mallard BASIC the circuit uses a Z80PIO chip on a PCB fitted with a ribbon cable connector terminated at each end with IDC connectors.

799 AMIGA MIDI IINTERFACE
ST/Amiga Format iss. 5
Provides a MIDI interface with In, Thru, and three Out sockets for the Amiga A500, A1000, and A2000 computers. It connects to the serial port and takes its power from the computer. Suitable for use with any programs that use the serial port method of MIDI interfacing. Easy to construct with minimal wiring.

813 ST/Amiga SOUND SAMPLER
ST/Amiga Format
A high speed sound sampler circuit providing fully digitised output for the parallel ports of the ATARI ST and Commodore AMIGA computers. A 5 way DIN connector is provided for the audio input which can be from a Music centre, Tuner, or any other sound source with suitable levels of output. Microphone input is possible but will need some pre-amplification. Originally available in Built or Kit form, but now only supplied as a kit with drilled and printed front panel and plastic case. A very popular and effective project. The circuit can be battery powered but a regulated plug-in power supply is recommended and available as an extra.

818 ATARI ST DISK TRACK INDICATOR ST Format
A compact unit with two digit display indicating which side and track of a disc drive is currently being accessed. Kit is supplied complete with case and special 14 way connector.

464 STEPPER MOTOR INTEFFACE FOR THE BBC COMPUTER E.E. JULY 85
This interface enables 4 phase unpolar stepping motors to be driven from four output lines of any computer user port. The circuit is especially suitable for the ID35/MD35-1/4 motor and our MD200 which are commonly used in buggies and robot arms. The interface is supplied complete with ribbon cable and connector for the BBC user port and a full listing is given in the article to accelerate, run, and decelerate the motor. A 12 volt power supply is required. Screw terminals on the board allow easy connections for the power supply and motor leads. A very popular Magenta design.

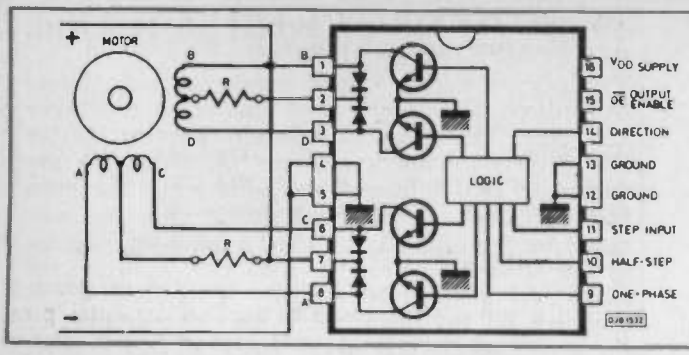


578 SPECTRUM I/O PORT
E.E. FEB 87
A compact and versatile I/O port for the ZX Sspectrum computer. 8 input and 8 output lines are provided simultaneously via a 2 way IDC header. A simple project to construct using a double-sided PCB. The port is I/O mapped and requires only a single IN and OUT instruction to read, or write. The port can be housed in a plastic case, but this is not necessary and is not supplied with the kit. Use with 579 for driving stepping motors and other high current loads.

579 STEPPING MOTOR BOOSTER (FOR ABOVE)
E.E. FEB 87
Use this circuit with our 578 or other computer port to provide high current output for driving a four phase unipolar stepping motor (our ID35 or MD200 types are suitable). A program which provides suitable full and half step drive routines (using 578) is supplied in the article. To keep this circuit as simple as possible it uses screw type terminal blocks for construction.

584 SPECTRUM SPEECH SYNTH E.E. FEB 87
This synthesiser uses the SPO256 AL2 PIO IC. Speech output of up to 1 watt is provided by an LM380 audio amplifier on the board which drives a small speaker. As only 8 lines of the PI0 chip are used for speech, a futher 8 spare I/O lines are available for other purposes. The circuit is built on a single sided printed circuit board. Supplied without a case.

703 EXPERIMENTAL SPEECH RECOGNITION E.E. APR 87
This very interesting circuit splits incoming sounds into four frequency bands and produces four analogue outputs corresponding to the level of each band. A BBC computer program listing is printed in the article to enable words to be learned, recognised and printed, by comparison with a range of stored samples. The unit connects to the computer analogue port.



816 STEPPING MOTOR DRIVER P.E. AUG 89
A refined and adaptable design using the M5804 I.C. to give HALF STEP and FULL STEP drive to any four phase unipolar stepping motor requiring up to 35V and up to 1.25A per phase. All of the Magenta motors are suitable but the MD35 1/4 and MD200 are particularly recommended. A special offer price is provided for purchasers of the interface and MD35 1/4 motors. The interface can be driven directly from any 5V logic system and so is compatible with the BBC computer I/O ports and those of practically all other computers and logic teaching systems.

HOUSEHOLD KITS

240 EGG TIMER E.E. JUNE 82
A pre-set device operated by a touch switch. An LED lights at the start of the time period & stays alight until a buzzer sounds at the end of the set time. The time period can be internally adjusted by means of a pre-set control.

278 MOISTURE DETECTOR E.E. MAY 83
Suitable for use as an overflow warning device, rain detector & many other water sensing jobs. The circuit detects water by sensing the leakage current across a piece of stripboard & sounds a warning alarm.

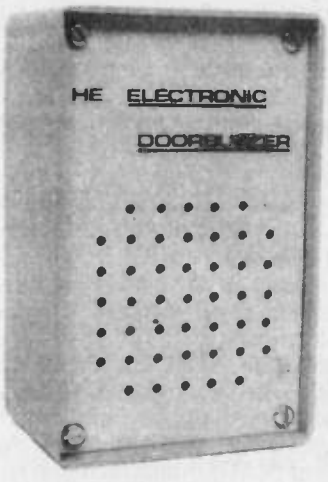
315 HOME INTERCOM E.E. OCT 83
A battery powered two station intercom capable of operating over 200 metres. The circuit uses an IC audio amplifier. Calling is possible from either station without the need to keep the unit switched on. Very long battery life.

497 MUSICAL DOORBELL E.E. JAN 86
This project uses a special I.C. pre-programmed with twenty five tunes and three chimes. A Magenta design, the circuit is battery powered and only draws current whilst producing sounds. Two rotary switches select the tune required. Provision is made for three bell pushes, each of which sound a different tune, so that three points of entry can be identified. A popular project, easy to build and reliable.

417 DOOECHIME E.E. DEC 84
This battery powered doorbell circuit produces an excellent electronic imitation of a chime. Two oscillators are combined via a ring modulator and given a decaying amplitude envelope by a VCA circuit. A 500mW audio amplifier I.C. driving a miniature 8 ohm speaker provides the audio output.

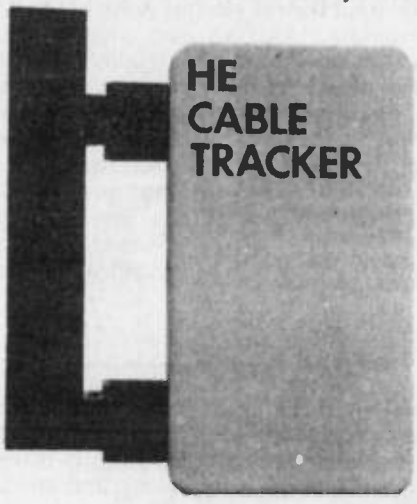
475 FRIDGE ALARM E.E. JULY 85
A simple device which ensures that the fridge or freezer door is closed correctly after use. A photocell is used to detect light from the internal fridge light andfrom light leaking around the door. If light is detected for more than 1.5 mins an audible alarm sounds.

203 TELEPHONE BELL REPEATER H.E. OCT 81
This project picks up the sound from a ringing telephone or doorbell & transmits it along a wire to a remote unit. The remote unit contains an oscillator which drives a loudspeaker, producing a loud beep each time the phone rings. Also in the remote unit is a relay which closes in sympathy with the beep. This can be connected either to a large mains powered alarm bell or to one or more lamps. The lamps flash whenever the phone or doorbell rings & so could attract attention in a noisy area, or be used as a 'doorbell' by a deaf person.

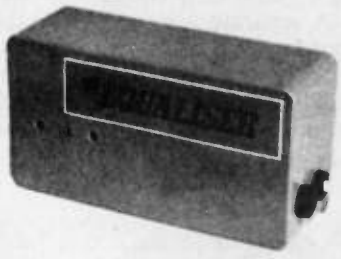


186 ELECTRONIC DOOR BUZZER H.E. JULY 81
A warbling tone oscillator coupled to a miniature loudspeaker which produces a much pleasanter sound than a conventional mechanical buzzer. The circuit uses a '555' timer IC modulated by a unijunction transistor oscillator. Battery drain is very low, a PP3 should last 6 months or more.

236 CABLE TRACKER H.E. MAY 82
Suitable for detecting wiring & piping concealed beneath floors or walls etc. This is sensitive & stable circuit which gives an audible beep whenever metal is approached. The pick up head uses a high 'Q' tuned coil fitted on a ferrite rod. Essential in any serious DIY toolbox.



707 EQUALISER IONISER E.E. MAY 87
A mains powered ioniser with an output of negative ions that give a refreshing feeling to the surrounding atmosphere. Negligible current comsumption, and all-insulated construction ensure that the unit is safe and enconomical in use. easy to build on a simple PCB.



714 ULTRASONIC TAPE MEASURE E.E. MAR 87
An ultrasonic ranging device with digital output which is capable of measuring distances of up to 5 metres. A three digit LED display indicates the range in centimeters. This project is supplied without a case. Battery powered, built on a printed circuit board.

555 FREEZER FAILURE ALARM E.E. SEPT 86
A temperature sensing device with a probe for fitting inside a domestic freezer. If the temperature rises above a pre-settable level an audible warning sounds. Although designed for freezers the circuit has numerous other applications. Its function can be reversed easily so that it sounds the alarm on falling temperature. The circuit is mains powered and housed in a plastic case.

575 HANDS-OFF INTERCOM E.E. JAN 87
A two-way intercom which allows simultaeous speech in both directions. Much easier to use that the usual 'press to talk-release to listen' systems. Full privacy is assured by an on-off switch at each end, which allows the intercom to accept only incoming calls. Battery powered, built on stripboard.

705 BULB LIFE EXTENDER E.E. APR 87
A 'soft start' circuit which produces greatly increased mains bulb life by gently increasing the applied voltage and by running it very slightly under its maximum rating. Ideal for use with modern spotlight fittings and special coloured lamps when can be very expensive to replace. Built on a small PCB. Supplied less case.

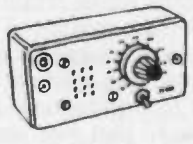
734 AUTOMATIC/MANUAL PORCH LIGHT E.E. OCT 87
A mains powered circuit that switches on and off porch lights at dusk and dawn. A manual overide is provided, and the output is via a relay with 1A mains rated contacts. The project is built on stripboard.

MUSIC KITS

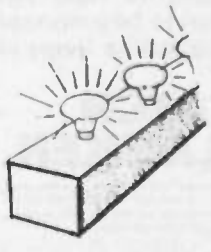
150 THREE CHANNEL SOUND TO LIGHT E.E. NOV 80
500 watts per channel. Independent control for bass, middle & treble. Bridge circuit used to give full wave control. Full mains interference suppression is incorporated. Outputs via PL552 socket & PL551 plug - both supplied. A master control allows all 3 channels to be adjusted simultaneously for different input levels. Input is taken from across the speaker terminals.

174 GUITAR FUZZ BOX H.E. MAR 81
Produce delightful distortion from your electric guitar in a novel way. A simple to build project with foot pedal control. This unit produces a very smooth sound. Circuit is housed in a 'foot pedal case' complete with a pedal to operate an internal switch. Features more controlled distortion & less background noise than most other designs.

180 GUITAR HEADPHONE AMPLIFIER E.E. MAY 81
For personal use with stereo headphones. Ideal for those who want to practice without disturbing others. This unit is small & battery operated & so is completely portable. It can drive a pair of ordinary stereo headphones to more than adequate volume for practice purposes.



105 AUDIBLE VISUAL METRONOME E.E. JAN 78
An aid for music practice that produces an audible timing reference together with a light flashing in step. Beat range is 40 to 210 beats per minute.



111 SOUND TO LIGHT UNIT E.E. SEPT 78
A simple safe and effective one channel sound to light converter. Modulates a light according to the amplitude of the music. Total output 800 watts e.g. 16 x 50 watt bulbs.

124 SPRING LINE REVERB UNIT E.E. JAN 80
Reverberation is the fading echo effect heard in churches, large halls etc, without it music can sound 'flat'. Use for recording or with instruments such as electric guitar, electronic organ etc. Incorporates a master volume control, & mixer for the reverb & straight-through signals. Very effective project.

140 GUITAR PHASER H.E. SEPT 80
Simple to construct. Compares well with far more expensive commercial units. Built in compact diecast box. Overcomes the problem of noise by using bi-fet op amp technology these give low noise & low power comsumption. This phaser uses the Texas TL064 IC. An override footswitch is provided, also a switched jack socket for automatic on/off.

149 GUITAR PRACTICE AMPLIFIER E.E. NOV 80
A self contained mains powered unit delivering a comfortable 5 watts into 8 or 15 ohm speakers. Speaker not included. A separate output socket is provided for headphones listening at reduced power level.

453 GRAPHIC EQUALISER E.E. MAY 85
A mono graphic equaliser with six frequency bands centred at 50Hz, 150Hz, 500Hz, 1.5Hz, 5KHz and 15KHz. This unit gives very good control of the frequency spectrum of P.A. systems etc and is particulary effective with electric guitars and other instruments.

513 BBC MIDI INTERFACE E.E. MARCH 86
A standard Musical Instrument, Digital Interface which will link a BBC Mirco to a keyboard or synthesiser. A compact reliable circuit built on a single printed circuit board which connects to the 1 MHz bus output of the computer. DIN sockets are used for the instrument connections, one input and two outputs are provided. The circuit is powered from the computer.

523 STEREO REVERB E.E. APRIL 86
This reverb effects unit uses a spring line to add 'richness' to music. It is designed to be inserted between a pre-amplifier and power amplifier (most commercial HI-FI systems have suitable sockets). It can be used as a Stereo simulator, Headphone enhancer, or Quadraphonic synthesiser and also as a musical effects unit.

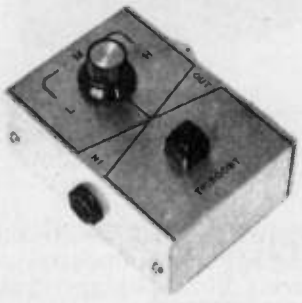
528 P.A. AMPLIFIER E.E. MAY 86
A portable amplifier designed to be powered from a 12V car battery. It will deliver 20 watts rms into 4 ohms, or 10 watts into 8 ohms from a microphone or line input. The circuit uses a low noise IC input stage and incorporates a variable cut off frequency low pass filter on the mic channel. The output stage is protected from short circuits, over voltage, and overheating.

558 SCRATCH BLANKER E.E. SEPT 86
A sophisticated stereo signal conditioner that removes the clicks produced by scratched records whilst retaining the full 20Hz - 20Khz bandwidth of the system. Two CCD delay lines are used so that the scratch signal can be detected and removed before the signal has reached the output. Special techniques are used to differentiate between clicks and high frequency music so that even small clicks are removed without losing sections of music. The circuit is mains powered and is designed to be connected between the pre-amplifier and power amplifier stages of stereo equipment.

562 10 WATT AUDIO AMPLIFIER E.E. OCT 86
Designed to be extremely versatile and useful, this amplifier provides 10 watts rms sine wave output power (20 watts peak) and will accept a wide variety of inputs. There are two 'flat' inputs, one for dynamic and electret microhones, guitar pick-ups and other low signal sources. The other input accepts signals at standard 'line' levels between 100mV and one volt. A third, completely independent input is provided with full disc RIAA equalisation for use with moving magnet pick up cartridges. The input can also be mixed to blend announcements with music etc.

211 FUZZBOX E.E. OCT 81
A compact unit producing the familiar diode clipped fuzz effect. Fitted with a footswitch to remove the effect when not required. The unit is switched on by inserting the guitar lead. Housed in a robust diecast case.

295 TRI BOOST GUITAR TONE CONTROLLER E.E. JULY 83
This project provides switchable gain boost to either low, medium, or high audio frequencies selected by a single rotary switch. A separate filter switch enables a dip in frequency response to be inserted between the area of real base & middle frequencies. This has a very good clarifying effect & reduces the 'boominess' which can often spoil the overall sound. A footswitch allows the effect to be switched in or bypassed.



332 CHILDREN'S DISCO LIGHTS E.E. DEC 83
A safe simple sound to light circuit which flashes a row of coloured lights in response to music. The sound is picked up by a microphone eliminating the need for any external connections. Battery powered for complete safety.

355 DUAL MIC PRE-AMP ES&CM APR 84
An excellent low noise wide dynamic circuit providing two independent channels with pre-settable gain from 10 to 50dB steps. The circuit uses the NE5532 IC to achieve a high level of performance without becoming overcomplicated. Ideal for matching low output pick ups & microphones into line level mixer inputs & effect units. The input may be adjusted to match 50K or 600 ohm sources by means of a single resistor change.

381 GUITAR HEADPHONE AMPLIFIER E.E. SPET 84
A simple battery powered unit which will drive low or high impedance headphones directly from a guitar pick-up. Output power is 0.5 watts into 4 ohms.

361 SPRING REVERB UNIT H.E.MAY 84
A reverberation unit incorporating a standard spring line delay module. Bass & Treble controls operate on the reverberated signal to produce a range of effects & compensate for the losses in the spring line. A master volume control allows the effect to be added in varying proportions to a P.A. system.

473 RIAA PRE-AMP INPUT SELECTOR E.E. JULY 85
A low noise stereo pre-amplifier to match a magnetic cartridge to the auxiliary inputs of an amplifier. A three position selector switch is incorporated which allows two other signal sources to be selected in place of the cartridge.

775 ENVELOPE SHAPER E.E. MAR 88
A sound effects unit for keyboard and guitar use. The circuit is sound triggered, and produces an output of slow attack, sustain, and short delay. A footswitch allows the unit to be put in and out of circuit. Battery powered, housed in a strong discast case and built on a PCB

779 STEREO NOISE GATE E.E. APR 88
A very high quality noise gate device with special 'zero volt' switching arrangements that eliminate clicks as the circuits turns on and off. A variable threshold control allows optimum performance in circuits with differing levels of background noise. Suitable for use with many sound sources, such as musical instruments, keyboards, 78 records (silencing hiss between tracks or at the start and end), PA systems etc. A very effective unit built on a single PCB. Easy to construct and use.

801 DOWNBEAT METRONOME E.E. DEC 88
A Quality Metronome design with Accented Beats, Variable speed, Audio output, and LED output for silent operation when recording. Battery powered and constructed on a single printed circuit board.

813 ST/Amiga SOUND SAMPLER
ST/Amiga Format
A high speed sound sampler circuit providing fully digitised output for the parallel ports of the ATARI ST and Commodore AMIGA computers. A 5 way DIN connector is provided for the audio input which can be from a Music centre, Tuner, or any other sound source with suitable levels of output. Microphone input is possible but will need some pre-amplification. Originally available in Built or Kit form, but now only supplied as a kit with drilled and printed front panel and plastic case. A very popular and effective project. The circuit can be battery powered but a regulated plug-in power supply is recommended and available as an extra.

519 SOUND ACTIVATED SWITCH P.E. APRIL 86
A superb system for switching on a tape recorder or radio transmitter in response to speech without losing the first syllables. This is achieved by a bucket brigade delay line which delays the speech by sufficient time for the switch to have operated. The delay is adjustable from a few milliseconds to around one tenth of a second. Input sensitivity is at microphone level, two outputs provide microphone level and line level. A relay provides the switching output. A 9 volt or 12 volt battery is required.

721 MONOMIX E.E. JULY 87
A four channel mono mixer designed for the video enthusiast. One input channel is at microphone level. The other three are a line (500mV) levels. Outputs from the circuit are also at line level for driving amplifiers, video recorders etc. There are no tone controls, A compact battery powered unit, built on a PCB.

715 MINI DISCO LIGHT E.E. JUNE 87
A single channel sound to light unit which picks up sound using a small loudspeaker as a microphone. A 5A triac coupled via an opto-isolator provides the output. A combination of lamps totaling up to 250W can be driven. The circuit is built on a printed circuit board and housed in a plastic box.

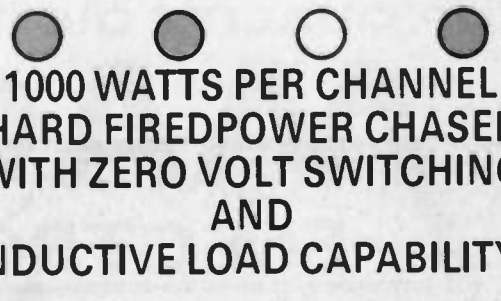
728 PERSONAL STEREO AMP E.E. SEPT 87
A low cost stereo amplifier delivering 2 Watts per channel from a personal stereo player output. The circuit is battery powered and drives two miniature loudspeaker.

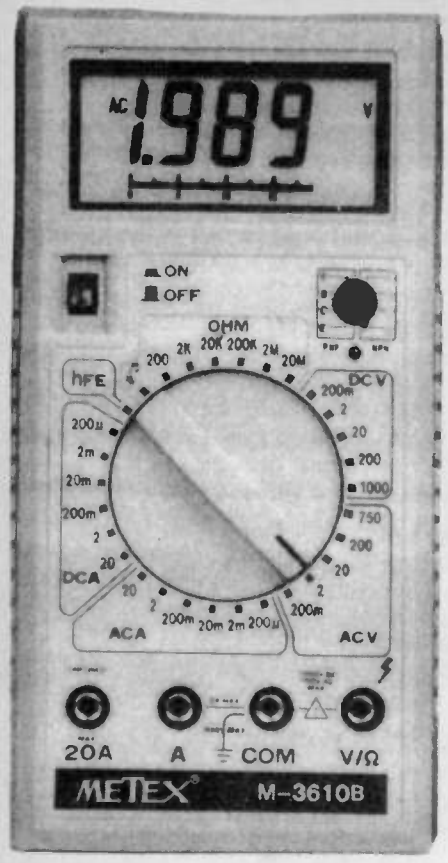
729 NOISE GATE E.E. SEPT 87
For reducing the background noise of a guitar effects system. This noise gate switches on only when the input level exceeds a certain threshold. Below that it mutes the input signal and noise, so that silence prevails. A fast switch on time (2m sec) ensures that no signal is lost, and a slow decay time allows slow decaying signals to die away before they are muted. Mains powered, the circuit is built on a PCB, and mounted in a metal case.

724 SUPER SOUND ADAPTOR E.E. AUG 87
A mono audio signal fed into this unit is processed and converted to a pseudo stereo effect by means of a clever new I.C. which introduces frequency selective phase shifts in the mid audio band, but leaves high and low frequencies unchanged. The result is a very good enhanced mono effect which broadens the sound stage very effectively. Two audio amplifiers (1 Watt) are built in, so the circuit can be used on its own by being connected to the audio line of a T.V. set or video recorder. The unit is mains powered.

739 ACCENTED METRONOME E.E. NOV 87
A well designed circuit that provides an accented beat selectable from every other beat to 1 beat in 10. A 10 LED bargraph display moves along one step each beat and returns to zero on each accented beat. The beat rate is variable from 30 to 300 beats per minute. Built on PCB, battery powered, and housed in a neat case.

833 FOUR CHANNEL LIGHT CHASER
E.E. JAN 90
1000 watts per channel Hard Fired chaser with full inductive load capability. Zero Volt switching ensures low interference levels, and high reliability. Built in microphone and special Beat Seeker circuitry give superior Beat Synchronised chase performance. 3 / 4 channel selector switch, Mic sensitivity control, Free running chase speed control, and full front panel LED mimic complete this comprehensive Magenta designed project. Fitted with standard 8 pin connector. Will drive Rope Lights, Pin Spots and Tungsten-Halogen lamps with or without transformers.



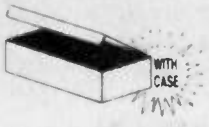


M3610B £59.95

40 point analog bargraph display

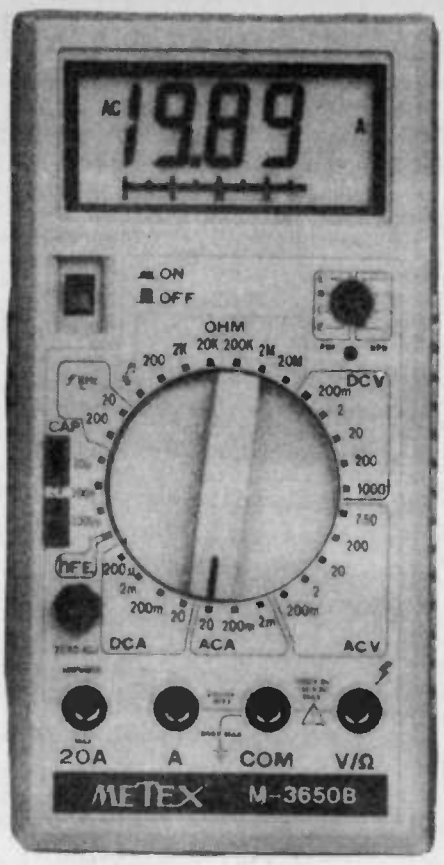
- ★ 3½ digit 17mm LCD display
- ★ 30 ranges including **20A ac/dc**
- ★ Transistor and diode test
- ★ Continuity test with LED indicator and buzzer
- ★ **Built and tested to IEC348**

Fully shrouded test leads, battery, instruction manual and carrying case included.



AC volts	0-200m-2-20-200-750Vac ±0.8%
DC volts	0-200m-2-20-200-1000Vdc ±0.3%
AC current	0-200μ-2m-20m-200m-2A-20Aac ±1.0%
DC current	0-200μ-2m-20m-200m-2A-20Adc ±0.5%
Resistance	0-200-2k-20k-200k-2M-20MΩ ±0.5%
Transistor hFE	0-1000 NPN/PNP
Dims	176 x 90 x 36mm

ALSO — M3610 same but without bargraph £46.95



M3650B £73.95

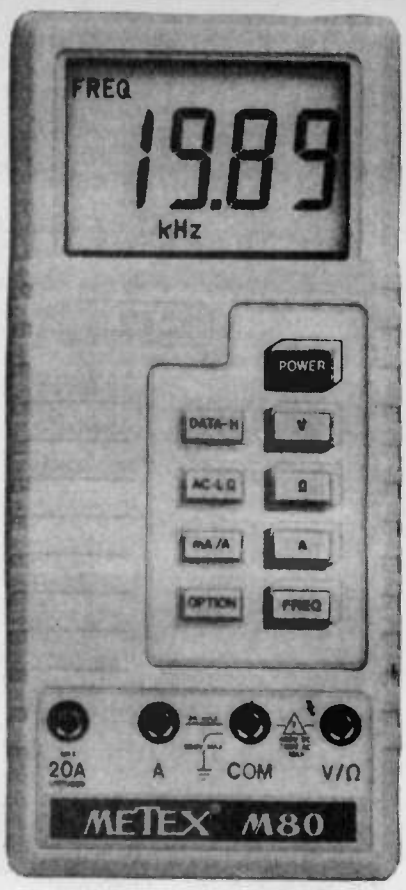
40 point analog bargraph display

- ★ 3½ digit 17mm LCD display
- ★ 30 ranges including **20A ac/dc**
- ★ **Frequency** counter
- ★ Capacitance test with zero adjust
- ★ Continuity test with LED indicator and buzzer
- ★ Transistor and diode test
- ★ **Built and tested to IEC348**

Fully shrouded test leads, battery, instruction manual and carrying case included.

AC volts	0-200m-2-20-200-750Vac ±0.8%
DC volts	0-200m-2-20-200-1000Vdc ±0.3%
AC current	0-2m-200m-20Aac ±1.8%
DC current	0-200μ-2m-200m-20Adc ±0.5%
Resistance	0-200-2k-20k-200k-2M-20MΩ ±0.5%
Capacitance	0-20p-200n-20μF ±2.0%
Frequency	0-20k-200kHz ±2.0%
Transistor hFE	0-1000 NPN/PNP
Dims	176 x 90 x 36mm

ALSO — M3650 same but without bargraph £61.95



M80 £60.95

- ★ **Autoranging volts, ohms, amps and frequency count**
- ★ **Large 21mm 3¾ digit display**
- ★ **20 Amp ac/dc ranges**
- ★ **Data hold function**
- ★ Ruggedised, weatherproof case
- ★ Diode and continuity test
- ★ Auto polarity and zero
- ★ **Built and tested to IEC 348**

Fully shrouded test leads, battery, carrying case and instruction manual included.

AC volts	0-400-700Vac ±1.8%
DC volts	0-400m-4-40-400Vdc ±0.5%
AC current	0-4m-40m-400m-2-20Aac ±1.8%
DC current	0-4m-40m-400m-2-20Adc ±1.2%
Resistance	0-4k-40k-400k-4MΩ ±1.2%
Frequency	0-4k-20kHz ±2.0%
Dims	182 x 85 x 34mm

TOP QUALITY DIGITAL MULTIMETERS FROM:

MAGENTA ELECTRONICS LTD

ANALOGUE MULTIMETERS

ETU2070 20k ohm/Volt

ETU2070 MULTIMETER
A reliable and versatile meter suitable for use in hobby, educational and maintenance fields. Featuring a 3-colour mirrored scale, battery test facility, and a built in continuity buzzer. The movement is protected by diodes and a fuse.19 ranges including 10A dc. Test leads fitted with 4mm plugs. Supplied with batteries and instructions.

AC Volts.....10-50-250-1000Vac
DC Volts.....0.25-2.5-10-50-250-1000Vdc
DC Current.....50µ-5m-50m-500m-10Adc
Resistance.....10k-100k-10MΩ
Continuity Buzzer.....Battery Test 1.5V and 9V

ORDER CODE 420-101 £16.98

HC215 2k ohm / Volt

HC215 MULTIMETER
A handy miniature multimeter with 12 ranges selected by a rotary switch.Test leads supplied with 2mm plugs, battery, and instruction book.Mirrored scale. Suitable for basic testing, fault finding and experimenting. A straightforward meter giving voltage, current and resistance ranges. Diode protected movement
Size 90 x 60 x 30mm

AC Volts.....0-10-50-250-500Vac
DC Volts.....0-10-50-250-500Vdc
DC Current.....0-500µ-50m-250mA
Resistance.....0-1MΩ

ORDER CODE 420-102 £8.98

HC201 20k ohm/Volt

HC201 MULTIMETER
A quality meter with a very clear mirrored scale. Featuring 12A AC and DC ranges. Fuse and Diode protection, 4mm shrouded test leads, and 19 ranges. Supplied with batteries and instructions.
Size 148 x 100 x 42mm

AC Volts.....12-30-60-300-600Vac
DC Volts.....3-12-60-300-600Vdc
DC Current.....60µ-1.2m-12m-120m-12A
Resistance.....1k-10k-1M-10MΩ
AC Current 12A

ORDER CODE 420-104 £18.95

HC2020S 20k ohm/Volt

HC2020S MULTIMETER
A superior meter with large open mirrored scale and 20 ranges. Featuring a Plug-in Transistor and Diode tester, and polarity reversing switch.Test leads fitted with shrouded 4mm plugs. Fuse and diode protection. Batteries and instructions supplied.
Size 150 x 102 x 45mm

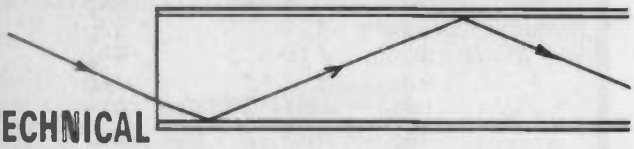
ACVolts.....0-10-50-250-1000Vac
DC Volts.....0-0.1-2.5-10-50-250-1000Vdc
DC Current.....0-50µ-2.5m-25m-250mA-10A
Resistance.....0-2k-20k-2M-20MΩ
Transistor and Diode Tester

ORDER CODE 420-105 £22.95

OPTICAL FIBRES

INTRODUCTION

Plastic optical fibres that conduct visible and near infra-red lightalong their length. Made from high purity polymers on advanced equipment. These fibres areflexible, tough, and can be handled and bent repeatedly.They can be cut with a scalpel or razor blade and their ends can be prepared quickly and easily forr maximum light transmission. Compared with Glass polymer fibres are cheaper, more flexible and lighter.



TECHNICAL

Polymer optical fibres consist of a core of high purity polymethylmethacrylate surrounded by an optical cladding of fluoropolymer with a lower refractive index. This junction of different refractive indices produces total internal reflection at the perimeter of the fibre, preventing light from escaping and giving efficient transmissionalong its length. Excellent performance through the whole visible spectrum and near infra-red is achieved, allowing great potential for colour and decorative displays and short range communications use. Typical attenuation is 1.5 dB (30%) per metre.

APPLICATIONS

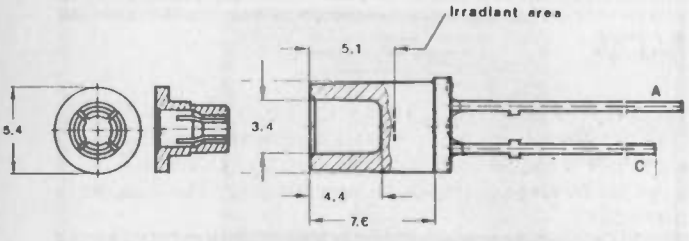
A wide range of applications already exists for optical fibres ,and more are being found constantly. In industry they are used in sensing devices, display panels, instrumentation, simulator panels, and automotive lamp monitoring and dial illumination.
Commercial applications such as eye catching colourfull signs and point of sale displays. Animated advertising signs are made simpler and more effective by using optical fibres.

HOBBY AND EDUCATIONAL USES

Ideal for model railway signals and lighting, doll's house lighting, and decorative lamps. More technical hobby applications include data and voice communications links, optically isolated sensing and control, and image scanners.

LIGHT SOURCES AND SENSORS

Specially made LEDs and PHOTOTRANSISTOR



Red Green and Yellow visible emitters and High Efficiency Infra-Red emitter. Collets for 1, 1.5, and 2mm allow direct fitting of fibres right down to the chip. Phototransistor responds to visible and IR.

TYPE	ORDER CODE	PRICE
RED LED	422-130	48p
GREEN LED	422-131	48p
YELLOW LED	422-132	48p
I.R. LED	422-133	£1.39
PHOTOTRANS.	422-134	£1.89
COLLETS 1mm	422-139	10p
1.5mm	422-139	10p
2mm	422-140	10p

STOCK RANGE

ROUND

- 0.5mm dia.
- 0.75mm dia.
- 1.0mm dia.
- 1.5mm dia.
- 2.0mm dia.
- 2.0 x 0.3mm ribbon
- 1.3 x 0.9mm oval
- 1.0mm with black cladding

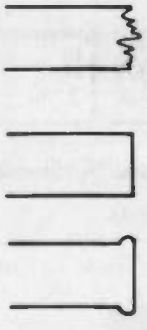
All sizes are supplied in continuous lengths up to 100m.

A mixed trial pack is also available containing 1m each of the unclad fibres and 2m of the 1.0mm black clad type (9 metres in all) Order code 422-120 Price £1.99

TYPE	ORDER CODE	1m	PRICE 10m	100m
0.5mm	422-100	7p	60p	£4.99
0.75mm	422-101	12p	£1.00	£7.99
1.0mm	422-102	16p	£1.40	£10.99
1.5mm	422-103	27p	£2.40	£17.99
2.0mm	422-104	36p	£3.30	£24.00
2.0 x 0.3mm	422-105	24p	£2.00	£16.00
1.3 x 0.9mm	422-106	28p	£2.40	£18.99
1.0mm clad	422-108	60p	£4.99	£38.98

MIXED PACK - 422-120 - £1.99

PREPARATION



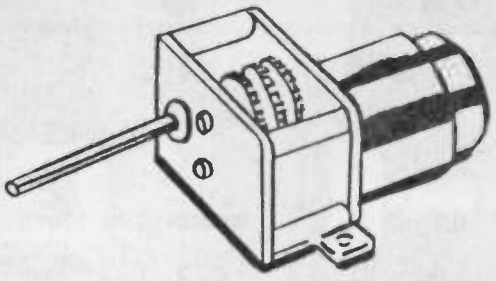
When cut the end of the fibre can be rough, and not ideal for gathering light. It must be smoothed or even polished for better performance. The simplest way is to rub the tip of the fibre over very fine wet-and-dry abrasive paper using water as a lubricant. This should produce the result shown in (B).It is also possible to produce a smooth end by pressing the fibre end onto a heated smooth surface to produce the effect shown in (C).

On the thinner fibres it is possible to obtain a good finish simply by cutting with a sharp, warm, razor blade.

LIGHT SOURCES

Any source of illumination can be used by these fibres. The best sources are the specially made devices which clamp the fibre end in a small ferrule close to an LED source, (or a photo-diode or phototransistor detector). We now stock a range of such devices which give excellent performance at reasonably low cost.
Alternative less efficient but still very effective methods rely on the fact that **holding one end of the fibre near to any light source will cause the other end to light up!**
Filament bulbs with coloured filters, LEDs (visible and infra-fed types), lasers, sparks, flames, and flash tubes all have their uses. The output from the fibres can then be used either for direct vision or to illuminate a range of photo-sensing devices soch as ORP12 photoconductive cells OP500 phototransistors, and BPW41 PIN photodiodes.

D.C. MOTOR/GEARBOX ASSEMBLIES



Ideal for robots and buggies. A miniature plastic reduction gearbox coupled with a 1.5 - 4.5 Volt mini motor. Variable gearbox reduction ratios are obtained by fitting from 1 to 6 gearwheels (supplied) as required. Two types are available, the smaller size has a higher revving motor, the large unit a lower revving but higher torque motor. The output shaft is 75mm long and 3mm diameter. On full reduction there is plenty ot torque to drive a small buggy using 75mm diameter wheels.

Small Unit type MGS
Speed range 3 - 2200 rpm. Size 37 x 43 x 25mm

ORDER CODE	424-100	£3.99

Large unit type MGL
Speed range 2 - 1150 rpm. Size 57 x 43 - 29mm

ORDER CODE	424-101	£4.55

The table below shows the output shaft speeds obtained for various supply voltages and gear ratios for the two types of motor.

NUMBER OF GEARS FITTED	1.5Volts		3.0Volts		4.5Volts	
	MGS	MGL	MGS	MGL	MGS	MGL
6	3	2	5	4	6	6
5	10	5	18	10	24	14
4	32	16	58	32	74	45
3	96	44	180	88	230	125
2	290	150	540	300	700	410
1	900	400	1700	800	2200	1150

MINI MOTORS

Low cost permanent magnet D.C. motors. Ideal for robotics, buggies, models, and toys. These motors are reversible by changing the polarity of the supply.

MM1

MM2

Both of these motors run at approximately 10,000 rpm on a three volt supply with a current of 1A and 10gcm torque. Current consumption is around 200mA when running lightly loaded and rises above 1A when stalled. The spindles are 2mm diameter and 8mm long.

TYPE	ORDER CODE	PRICE
MM1	424-110	29p
MM2	424-111	48p

GEARS AND PULLEYS

A range of low cost pulleys and gears that enable many types of drive to be built.

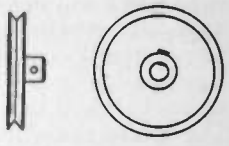
NYLON GEARS

Type G1. A range of gears with brass bushes and steel grub screws. Bush hole size is 3/32 and can be drilled out easily to 3mm.

TYPE Diameter inches	Teeth	ORDER CODE	PRICE
3/8	10	424-130	39p
9/16	20	424-131	50p
13/16	30	424-132	59p
1	40	424-133	72p
1-1/4	50	424-134	81p
1-1/2	60	424-135	91p

NYLON PULLEYS

A range of pulleys with brass bushes and steel grub screws. Bush hole size is 3/32 and can be drilled out easily to 3mm.

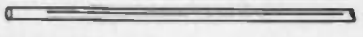


TYPE Diameter inches	ORDER CODE	PRICE
3/8	424-140	38p
1/2	424-141	38p
3/4	424-142	46p
1	424-143	48p

Also available, without brass bushes to be a tight push fit on a 2mm shaft in the following sizes only:
Gear - 3/8 dia 10 teeth. Pulleys - 5/16 dia and 3/8 dia.

TYPE	ORDER CODE	PRICE
Gear-3/8 10t	424-138	16p
Pulley-5/16	424-146	14p
Pulley-3/8	424-147	14p

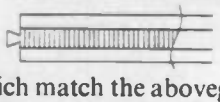
SHAFTING



Lengths of 3/32 dia steel shafting to suit the above pulleys and gears. Supplied in 12 lengths.

ORDER CODE	424-150	38p/length

RACKS



Nylon racks which match the abovegears in pitch. Each rack is a strip 4 long x 5/8 wide with a central toothed section 1/4 wide 50 teeth long. Racks can be fastened together to give continuous long runs using moulded in dovetails.

ORDER CODE	424-154	53p each

RUBBER DRIVE BELTS

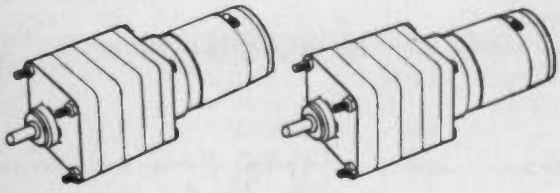
Ideal for models and as replacements in cassette recorders etc. Square section belts with limited stretch. Sizes given are the diameters of the belts when lying in a circle.
19mm, 30mm, 35mm, 46mm, 57mm, 66mm, 70mm, 75.5mm, 83mm, 90mm.

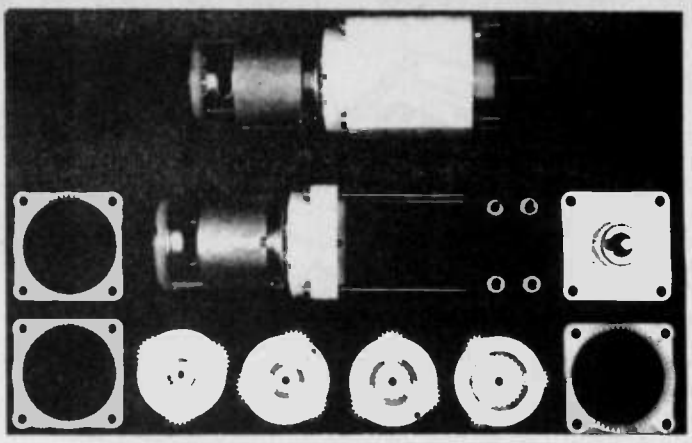
ORDER CODE	425-19mm etc	55p each

100mm, 110mm

ORDER CODE	425-100mm etc	65p each

VARIABLE RATIO EPICYCLIC GEARBOX AND MOTOR





A high quality unit with a high torque 5 pole motor. Four epicyclic gear modulesare stacked onto the shaft as required to produce different gearing. These modules have different ratios: 3 : 1, 4 : 1, 5 : 1, and 6 : 1, and can be assembled onto the motor shaft in any number and combination to give a wide range of reduction ratios between 3 : 1, and 360 : 1.
The motor operating voltage range is from 5V to 15V and this gives an additional method of speed control which combined with different gear ratios gives available speeds from 15 rpm to 4,800 rpm.
An extremely reliable and robust unit.

Motor size: 29mm dia x 38mm long
Gearbox size: 32mm square x 62mm long (inc. shaft)
Shaft size: 4mm dia x 10mm long
Each gearbox section is 8mm thick

Possible reduction ratios are: 3, 4, 5, 6, 12, 15, 18, 20, 24, 30, 60, 72, 90, 120, and 360 to 1

ORDER CODE	424-200	£12.98

Output rpm at different voltages and gear ratios

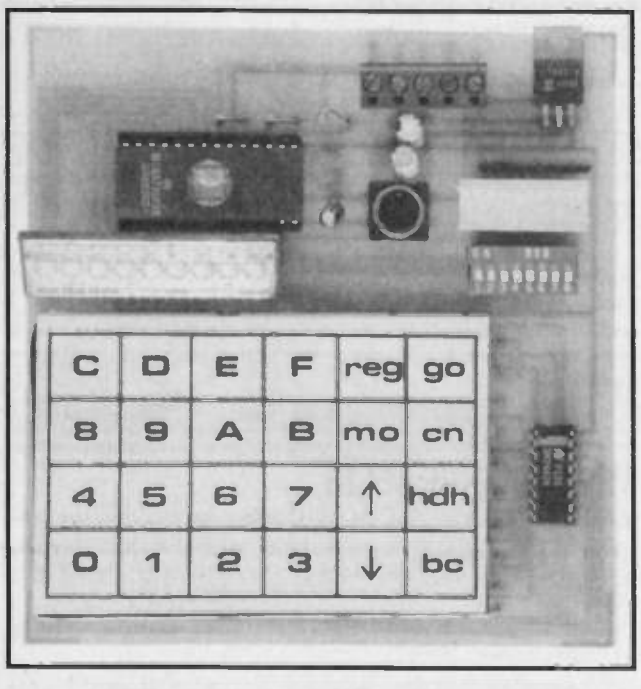
Ratio	6V rpm	9V rpm	12V rpm	15V rpm
3 :1	1400	2250	3000	4000
6 :1	700	1100	1500	2000
18 :1	2390	370	520	660
30 :1	140	220	300	390
90 :1	46	75	100	130
360 :1	11	18	26	33

EXTRA GEARBOX KIT

An additional 4 module gearbox pack that can be added on to the above units to give even higher reduction ratios. Each pack contains one each of the four reduction gearbox stages with ratios of 3 : 1, 4 : 1, 5 : 1, and 6 : 1 and four extra long screws. The maximum ratio now possible is extended to 129,000 : 1 which gives possible output speeds of well below 1 rpm (0.03 rpm with all sections fitted.

ORDER CODE	424-201	£5.90

PICOTUTOR ASSEMBLY LANGUAGE TRAINER



Machine code programs run hundreds of times faster than their BASIC equivalents and take up much less memory space, but they are difficult to write. Assembly language simplifies machine code programming and can be learned and understood by following the exercises in the manual which accompanies this single board stand-alone trainer. This simple low cost microcontroller can also be connected to the outside world via switches and relays and is suitable for developing and running simple control applications.

The Picotutor is a single board computer built around one of the many 'single chip' control oriented microcontroller ICs. It is accompanied by an educational series that covers all aspects of its operation and aims to familiarise the user with the operation and programming of microprocessors at assembly language level.
The kit includes a hexadecimal keypad, a nine digit seven segment display, an octal dil switchbank, and an eight segment bargraph display, all of which are interfaced directly to the IC.
The board requires 5V at 300mA and has a built in voltage regulator to allow operation from supplies between 8 and 15V.
An optional analogue interface board can be connected to provide 8 Bit D/A and A/D functions.
Throughout the manual care has been taken to discuss other microprocessors as well as the Motorola 68705 series so that a broader range of techniques are presented.
The monitor programme which is supplied programmed into the IC contains many subroutines that can be called from the user's own programs. This allows complicated programs to be run without having to enter long sections of standard code.

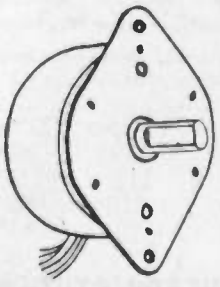
	ORDER CODE	PRICE
Micro-controller KIT	501-625	£44.95
Analogue Interface KIT	501-626	£10.47

STEPPING MOTORS

Three stepping motors suitable for driving a wide range of mechanisms under computer control using simple interfacing techniques. They are electrically similar and may be driven from any interface designed for Four Phase Unipolar operation.
The simplest drive circuit need only consist of four medium power darlington transistors which can be driven directly from most computer output I/O ports.
The motors differ mechanically and so it is on this basis that the most suitable type should be selected.

The MD200 motor is the best motor because it offers higher torque and faster stepping rates, and above all has 200 steps per revolution against 48 steps for the other two. The MD35-¼ motor is very similar to the ID35 motor but has a more convenient spindle diameter of 1/4 with a flat. The MD38 is for applications where space is limited and has lower power than the other two.

MD35-¼



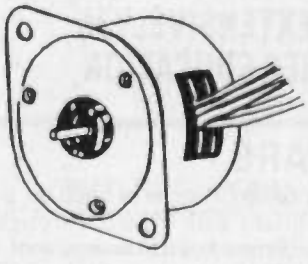
MD35-¼ Permanent Magnet motor - 48 steps per rev

Diameter	55mm	Torque	65mNm
Depth	25mm	Max step rate	180/sec
Fixing Centres	68mm	Inductance per phase	520mH
Shaft Dia	0.25 with flat	Current per phase	330mA
Resistance per phase	36Ω	Rotor inertia	40gcm2
Step angle	7.5°		

Connections

Winding 1 start	red	Winding 2 start	blue
Winding 1 centre	white	Winding 2 centre	white
Winding 1 finish	brown	Winding 3 finish	yellow

MD38



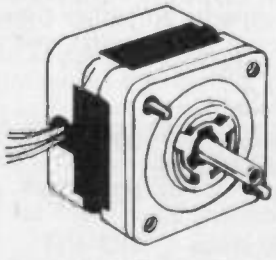
MD38 Permanent Magnet motor - 48 steps per rev

Diameter	42mm	Torque	50mNm
Depth	22mm	Max step rate	320/sec
Fixing Centres	50mm	Inductance per phase	790mH
Shaft Dia	3mm	Current per phase	240mA
Resistance per phase	50Ω	Rotor inertia	13gcm2
Step angle	7.5°		

Connections

Winding 1 start	black	Winding 2 start	orange
Winding 1 centre	red	Winding 2 centre	red
Winding 1 finish	brown	Winding 3 finish	yellow

MD200



MD200 Hybrid motor 200 steps per rev

Width and height	42mm	Torque	90mNm
Depth	34mm	Max step rate	630/sec
Fixing Centres (diagonal)	44mm	Inductance per phase	32mH
Shaft Dia	5mm	Current per phase	320mA
Resistance per phase	34Ω	Rotor inertia	19gcm2
Step angle	1.8°		

Connections

Winding 1 start	red	Winding 2 start	blue
Winding 1 centre	black	Winding 2 centre	white
Winding 1 finish	yellow	Winding 3 finish	orange

STEPPING MOTOR DRIVING INTERFACES

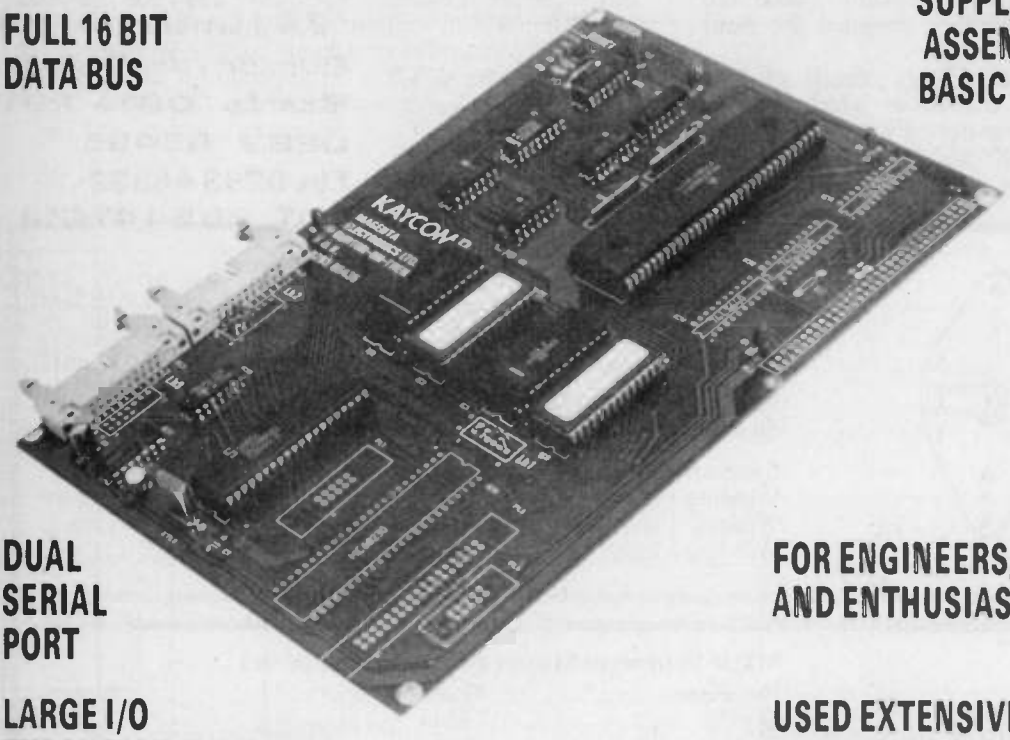
Magenta offer two interfaces that comnnect between a computer output port and any of the above motors. Both interfaces require a separate motor supply which is normally 12V.
Our kit 464 is a simple interface for a single motor which is supplied with a program for the BBC model B user port. This interface has been used extensively in schools and provides bi-directional operation in Full Step mode.
Kit 816 is a more sophisticated (and yet easier to build) interface that provides Half Step and Full Step operation along with a third method called One Phase or Wave Drive. This interface has the ability to handle up to 35V at 1.5A per phase and so can be used with the above motors and series resistors to give enhanced performance by allowing much higher stepping rates with maintained torque

TYPE	ORDER CODE	PRICE
48 step:		
MD35-¼	424-210	£12.70
MD38	424-214	£9.95
200 step:		
MD200	424-218	£16.80

THE MAGENTA 68000 BOARD

FULL 16 BIT DATA BUS

SUPPLIED IN KIT FORM OR ASSEMBLED AND TESTED BASIC SYSTEM KIT £110.00



DUAL SERIAL PORT

FOR ENGINEERS, STUDENTS AND ENTHUSIASTS

LARGE I/O EXPANSION AVAILABLE

USED EXTENSIVELY IN FURTHER EDUCATION

MAGENTA 68000

The Magenta 68000 computer board is a low cost design/evaluation tool for educational and training applications.As it is such a low cost system it can be provided on a one-per-student basis.

PROGRAMS

Programs are developed with an on-board monitor program and an optional line-by-line assembler/disassembler contained in EPROMS. The system is used with a host computer configured as a terminal, usually a BBC model B or a PC. Full details are given of the lead connections, and a short BBC program listing is given. There are many such programs for PCs the most common one being PROCOM.

CROSS-ASSEMBLERS

The board is an ideal target system for use with cross- assembler programs. A particularly low cost approach to this is to use our 68000 cross-assembler program which runs on the BBC computer.

Minimum system with Monitor EPROMS	ORDER CODE	PRICE
KIT	501-600	£110.00
BUILT	501-650	£138.00
With Monitor and Assembler EPROMs		
KIT	501-601	£134.00
BUILT	501-651	£164.00
Add-ons		
PIO/Timer	501-603	£11.88
G64 Interface	501-604	£5.99
16k RAM	501-605	£8.96
64k RAM	501-606	£16.88
Switch mode PSU	501-609	£18.95

HARDWARE

The Magenta 68000 system is built on a top quality double sided board with Plated Through Holes and Solder Mask. Printed with component layout and identification. The system includes a DUART IC which provides serial communications with the host computer and a printer if required. Full RS232 levels are provided. 5V and 12V (pos and neg) supplies are required. Our supply type 501-609 provides this and has ample spare capacity for other connected systems. 8Mhz processor clock crystal, and a separate 3.6864Mhz are included.

DATA PACKS

Operating Manual	501-612	£3.00
Monitor Source Listing and 68000 Data	501-610	£7.20
68681 and 68020 Data	501-611	£4.20

68020

A new option which allows the system to be upgraded to 68020 operation by plugging a daughter board into the 68000 socket. The board is a sophisticated 5 layer one using two PAL devices for the additional logic and resulting in a very compact design which can also accomodate the arithmetic co-processor 68881. The board is supplied with two 27256 EPROMS containing an enhanced operating system.

Price of the add on board does not include the 68020, or 68881 ICs but does include sockets for both and all other components so that the system is ready to go once the chips are inserted

ORDER CODE	501-616	£97.00

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You can order on a separate piece of paper, but using a photocopy of this page will make it easier. Don't forget to fill in your name and address and keep a copy if you can. New order forms will be sent with your order.

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BP191	SIMPLE APPLIC OF THE AMSTRAD CPCS FOR WRITERS	£2.95
BP275	SIMPLE SHORTWAVE RECEIVER CONSTRUCTION	£3.95
BP219	SOLID STATE NOVELTY PROJECTS	£0.85
BP248	TEST EQYIPMENT CONSTRUCTION	£2.95
BP114	THE ART OF PROGRAMMING THE 16K ZX81	£2.50
BP109	THE ART OF PROGRAMMING THE 1k ZX81	£2.50
BP119	THE ART OF PROGRAMMING THE ZX SPECTRUM	£2.50
BP146	THE PRE-BASIC BOOK	£2.95
BP115	THE PRE-COMPUTER BOOK	£1.95
BP62	THE SIMPLE ELECTRONIC CIRCUIT & COMPONENTS BOOK 1	£3.50
BP70	TRANSISTOR RADIO FAULT-FINDING CHART	£0.95
BP234	TRANSISTOR SELECTOR GUIDE	£4.95
BP272	UPGRADING & REPAIRING PCS & COMPATIBLES	£3.95
BP273	USING ELECTRONIC SENSORS	£3.95
BP189	USING YOUR AMSTRAD CPC DISC DRIVES	£2.95

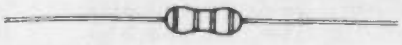
RESISTORS

Carbon Film 5% 0.25 Watt
E12 series: 1, 1.2, 1.5 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8, 8.2, 10 etc.and all decades from 1ohm to 10Meg.

ORDER CODE 100-1R, 100-1k8, 100-470k etc.
all values 2p each or 12p for 10 of 1 value.

Carbon Film 5% 2 Watt
E12 series (as 0.25 W) range 1R to 1Meg

ORDER CODE 101-1R, 101-1k, 101-33k etc.
all values 12p each or 50p for 5 of 1 value.



Metal Film 1% 0.6 Watt
E 24 series: 1, 1.1, 1.2, 1.3, 1.5, 1.6,.1.8, 2.0, 2.2, 2.4, 2.7, 3.0, 3.3, 3.6, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1, 10. and all decades from 4R7 to 1Meg.

ORDER CODE 102-4.7R, 102-16k etc.
all valuues 4p each or 30p for 10 of 1 value

Wirewound 5% 2.5 Watt resin coated
E12 series from 0.1 ohm to 1k

ORDER CODE 103-0.1R, 103 33R etc.
all values 28p each or £1.10 for 5 of 1 value

RESISTOR NETWORKS

SINGLE IN LINE (SIL)
Networks containing 7 or 8 resistors of the same value with a single common connection at one end. Values: 100R, 220R, 470R, 1k, 2k2, 4k7, 10k, 22k, 47k.

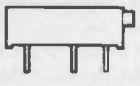
ORDER CODE		
	7 Way	104-100R etc. 20p each
	8 Way	105-100R etc. 22p each

OPEN PRESETS

Miniature Horizontal and Vertical Open Type
0.1 Watt
100R, 220R, 470R, 1k, 2k2, 4k7, 10k, 22k, 47k, 100k, 220k, 470k, 1M, 2M2.

ORDER CODE		
	Vertical	106-100R etc. 14p
	Horizontal	107-100R etc. 14p

MULTITURN PRESETS



Standard 3/4 inch type with
end adjustment
100R, 200R, 500R, 1k, 2k, 5k, 10k, 20k, 50k, 100k, 200k, 500k, and 1M

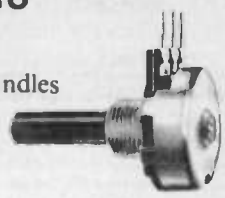
ORDER CODE 116-100R etc. 89p each

10mm Square, top adjustment
Range of values as type 116

ORDER CODE 118-100R etc. £1.20 each

POTENTIOMETERS

Midget Carbon, Single
Standard size pots with 3/8 mounting bushes and 1/4 spindles



LINEAR and LOG Values:
4k7, 10k, 22k, 47k, 100k, 220k, 470k, 1M, 2M2.
Reverse log (antilog) 470R and 470k only

ORDER CODE			
	LIN	108-4K7 etc.	56p each
	LOG	109-4k7 etc.	58p each
REVERSE	LOG	110-470R etc.	98p each

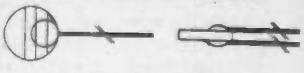
Switched - DPST 2A Mains switch.
values LIN and LOG
4k7, 10k, 22k, 47k, 100k, 220k, 470k, 1M

ORDER CODE			
	LIN	111-4K7 etc.	£1.20 each
	LOG	112-4k7 etc.	£1.22 each

Dual Ganged (Stereo)
LIN and LOG values (both sections the same)
10k, 47k, 100k, 470k.

ORDER CODE			
	LIN	113-10k etc.	£1.56 each
	LOG	114- 10k etc.	£1.58each

THERMISTORS



Disc typr - Negative TC
5mmdiameter disc thermistors for temperature sensing and measurement. Resistance given at 25 and 100 deg.C

R 25	R 100	ORDER CODE	PRICE
300R	40R	115-010	
1k	80R	115-012	
4k7	380R	115-014	
15k	1k2	115-016	all 59p each
33k	2k8	115-018	
100k	9k0	115-021	

Rod type TH3 - Negative TC
Used for sensing and circuit surge protection.

ORDER CODE 115-030 £1.95 each

Glass Vacuum Sealed - R53
For amplitude stabilisation in oscillators

ORDER CODE 115-033 £7.49 each

CAPACITORS

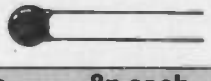
CERAMIC PLATE Sub Min. 50V
2.5 mm pitch, long leads.
2.2pF, 3.3, 4.7, 5.6, 6.8, 8.2, 10, 15, 22 TC NP0; 33, 47, 56, 68 TC N150; 82, 100 TC N750.

ORDER CODE 136-2.2p etc 8p each

150, 180, 220, 270, 390, 470, 560, 680, 1000 (1nF), 2200 (2n2), 3300 (3n3), 4700 (4n7); High K dielectric.

ORDER CODE 138-470p etc. 8p each

CERAMIC DISC 50V
Coupling and decoupling capacitors
High K dielectric. 5mm lead pitch.
10nF, 22nF, 33nF, 47nF, 100nF.

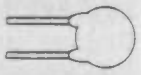


ORDER CODE		
140-10n etc.		8p each
140- 100n only		10p each

COMPONENTS

CAPACITORS

CERAMIC DISC HIGH VOLTAGE



High voltage discs for mains suppression, Voltage multipliers, and contact protection.

1nF 1000V	141-131	18p
4n7 500V	141-132	20p
10nF 1000v	141-136	22pp

POLYSTYRENE

Highly stable 63V 5%. N150 TC
10, 15, 22, 33, 47, 68, 100, 150, 220, 330, 470, 680,

ORDER CODE	142-10p etc	16p each

1nF, 1n5, 2n2, 3n3, 4n7

ORDER CODE	142-1n etc	16p each

5n6, 6n8, 8n2, 10n

ORDER CODE	142-5n6 etc	28p each

MYLAR

General purpose 100V 10% low cost Polyester film. Resin Coated

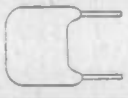
VALUE	ORDER CODE	PRICE
.001uF	148-101	7p each
.0022uF	148-102	8p each
.0047uF	148-104	8p each
.01uF	148-110	9p each
.015uF	148-115	12p each
.022uF	148-122	13p each
.033uF	148-133	15p each
.047uF	148-147	15p each
0.1uF	148-200	16p each

MINIATURE LAYER, PETP

High quality block foil construction
10% tolerance. Compact construction

VALUE		ORDER CODE	PRICE
.01uF	400V	153-101	14p each
.022uF	250V	153-102	14p each
.047uF	250V	153-104	16p each
0.1u F	100V	153-110	16p each
0.22uF	100V	153-120	22p each
0.33u F	100V	153-130	26p each
0.47uF	100V	153-140	34p each
0.68uF	100V	153-160	42p each
1uF	100V	153-200	36p each
2.2uF	100V	153-220	68p each

C368 POLYESTER 250V DC (C280)



Standard resin dipped capacitors
20% tolerance.

VALUE	ORDER CODE	PRICE
.01uF	164-101	9p each
.15uF	164-102	9p each
.022uF	164-103	9p each
.033uF	164-104	9p each
.047uF	164-105	9p each
.068uF	164-106	10p each
0.1u F	164-110	12p each
0.15uF	164-115	14p each
0.22uF	164-120	18p each
0.33u F	164-130	22p each
0.47uF	164-140	28p each
0.68uF	164-160	38p each
1uF	164-200	44p each
1.5uF	164-215	59p each
2.2uF	164-220	86p each

SUPPRESSION CAPACITORS

Class X2 for direct connection across the mains. Radial leads

VALUE	ORDER CODE	PRICE
.022uF	185-102	28p each
.047uF	185-104	32p each
0.1u F	185-110	36p each
0.22uF	185-120	64p each
0.33u F	185-130	78p each
0.47uF	185-140	95p each

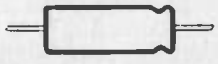
TANTALUM BEAD

Low leakage and series inductance for decoupling and timing circuits

VALUE		ORDER CODE	PRICE
0.1uF	35V	170-101	14p
0.22uF	35V	170-102	14p
0.33uF	35V	170-103	14p
0.47uF	35V	170-104	14p
1uF	35v	170-110	14p
1.5uF	35V	170-115	16p
2.2uF	35V	170-122	20p
3.3uF	35V	170-133	26p
4.7uF	35V	170-147	29p
6.8uF	35V	170-168	30p
10uF	16V	170-210	28p
10uF	35V	170-211	38p
15uF	16V	170-215	39p
22uF	16V	170-222	40p
22uF	25V	170-223	60p
33uF	16V	170-230	80p
47uF	10V	170-240	70p
47uF	16V	170-241	82p
100uF	3V	170-300	80p
100uF	10V	170-301	£1.80

AXIAL ELECTROLYTIC CAPACITORS

Miniature axial lead capacitors.
Polarity indicated by negative signs on sleeve.

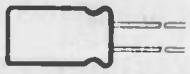


VALUE		ORDER CODE	PRICE
1uF	63V	180-110	10p
2.2uF	63V	180-112	10p
3.3uF	63V	180-113	10p
4.7uF	40V	180-114	10p
10uF	25v	180-120	14p
10uF	63V	180-121	18p
22uF	16V	180-122	14p
22uF	25V	180-222	16p
22uF	63V	180-322	17p
33uF	40V	180-123	16p
47uF	16V	180-124	14p
47uF	25V	180-224	16p
47uF	40V	180-324	16p
47uF	63V	180-424	18p
100uF	16V	180-130	16p
100uF	25V	180-230	18p
100uF	40V	180-330	20p
100uF	63V	180-430	28p
220uF	16V	180-132	20p
220uF	40V	180-232	30p
330uF	10V	180-133	20p
470uF	16V	180-134	28p
470uF	25V	180-234	38p
470uF	40V	180-334	42p
470uF	63V	180-434	54p
1000uF	10V	180-140	38p
1000uF	25V	180-240	50p
1000uF	40V	180-340	65p
1000uF	63V	180-440	80p
2200uF	25V	180-142	78p
2200uF	40V	180-242	84p
2200uF	63V	180-342	90p
4700uF	25V	180-144	£1.22

CAPACITORS

RADIAL ELECTROLYTICS

Miniature radial lead capacitors plastic sleeved. polarity indicated by negative signs on one side



VALUE		ORDER CODE	PRICE
1uF	63V	181-110	8p
2.2uF	63V	181-112	8p
3.3uF	63V	181-113	8p
4.7uF	40V	181-114	8p
10uF	25v	181-120	8p
10uF	63V	181-121	9p
22uF	16V	181-122	8p
22uF	25V	181-222	8p
22uF	63V	181-322	12p
33uF	40V	181-123	14p
47uF	16V	181-124	10p
47uF	25V	181-224	12p
47uF	40V	181-324	16p
47uF	63V	181-424	18p
100uF	16V	181-130	12p
100uF	25V	181-230	14p
100uF	40V	181-330	16p
100uF	63V	181-430	22p
220uF	16V	181-132	16p
220uF	25V	181-232	22p
330uF	10V	181-133	12p
470uF	16V	181-134	18p
470uF	25V	181-234	24p
470uF	40V	181-334	36p
470uF	63V	181-434	44p
1000uF	10V	181-140	26p
1000uF	25V	181-240	29p
1000uF	40V	181-340	34p
1000uF	63V	181-440	60p
2200uF	25V	181-142	72p
2200uF	40V	181-242	80p
2200uF	63V	181-342	86p
4700uF	25V	181-144	£1.14

COMPRESSION TRIMMERS

100-470Pf Rectangular trimmers

ORDER CODE	188-100	72p each

MINIATURE ROTARY FILM TRIMMERS

General purpose compact trimmers for crystal and RFtrimming.

VALUE	ORDER CODE	PRICE
2 -10pF	188-120	36p
2 -22pF	188-121	44p
5.5 - 65pF	188-122	52p

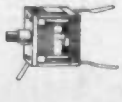
JACKSON C804 TUNING CAPACITORS

Top quality tuning capacitors for short wave construction. 1/4 shaft

VALUE	ORDER CODE	PRICE
10pF	188-130	£5.20
22pF	188-131	£4.89
50pF	188-132	£5.28

MINIATURE TUNING CAPACITORS

Solid dielectric type with
2 - 330pF sections (AM) and
2 - 30pF sections (FM) plus 4 trimmers



ORDER CODE	188-151	£1.24 each

COILS &TRANSFORMERS

FERRITE ROD

3/8 Dia 5 1/2 long rods suitable for MW and LW

ORDER CODE	201-100	69p each

COILS & TRANSFORMERS

FERRITE ROD AERIAL

Our 3/8 Ferrite rod fitted with LW and MW coils. Both coils are wound on paxolin tubes fitted with 4 solder tags and have separate coupling windings.

ORDER CODE	201-102	£1.44 each

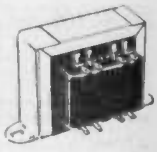
LW COIL AND MW COIL

Long wave and Medium wave coils available separately. fit any 3/8 rod

TYPE	ORDER CODE	PRICE
M.W. coil	201-105	69p each
L.W. coil	201-108	72p each

MAINS TRANSFORMERS

A range of British made transformers with twin primary windings for 120 / 240v operation. Twin secondary windings allow series operation for double voltage or parallel for double current. When series connected the centre link can be used to make 6-0-6V outputs etc.



6 VA Output (3 VA) per winding.
W 45 D 40 H 37mm Regulation 25% Mtg Ctrs 53mm

OUTPUT		ORDER CODE	PRICE
2 x 4.5V	0.6A	204-100	
2 x 6V	0.5A	204-102	
2 x 9V	0.33A	204-105	
2 x 12V	0.25A	204-108	£3.98 each
2 x 15V	0.2A	204-109	
2 x 20V	0.15A	204-112	

12 VA Output (6 VA) per winding.
W 59 D 50 H 50mm Regulation 10% Mtg Ctrs 70mm

OUTPUT		ORDER CODE	PRICE
2 x 4.5V	1.3A	204-200	
2 x 6V	1A	204-202	
2 x 9V	0.6A	204-205	
2 x 12V	0.5A	204-208	£5.20 each
2 x 15V	0.4A	204-209	
2 x 20V	0.3A	204-212	

20 VA Output (12 VA) per winding.
W 68 D 54 H 58mm Regulation 7% Mtg Ctrs 85mm

OUTPUT		ORDER CODE	PRICE
2 x 4.5V	2.2A	204-300	
2 x 6V	1.6A	204-302	
2 x 9V	1.1A	204-305	
2 x 12V	0.8A	204-308	£5.98 each
2 x 15V	0.6A	204-309	
2 x 20V	0.5A	204-312	

50 VA Output (25 VA) per winding.
W 79 D62 H 65mm Regulation 10% Mtg Ctrs 92mm

OUTPUT		ORDER CODE	PRICE
2 x 4.5V	5.5A	204-400	
2 x 6V	4.1A	204-402	
2 x 9V	2.7A	204-405	
2 x 12V	2A	204-408	£8.24 each
2 x 15V	1.6A	204-409	
2 x 20V	1.2A	204-412	

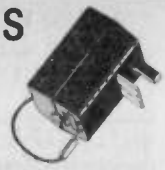
MAINS ISOLATING 12VA

240V - 240V 50mA ideal for testing low powered Mains equipment safely.

ORDER CODE	204-224	£3.98 each

COMPONENTS

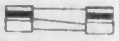
PLUG -IN POWER SUPPLIES

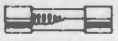


LOW VOLTAGE MULTI-OUTPUT SUPPLIES
Three types available, all have switchable output voltages of 3, 4.5, 6, 7.5, 9, and 12V

OUTPUT	ORDER CODE	PRICE
300mA unregulated	204-500	£3.85
300mA regulated	204-501	£7.98
500mA regulated	204-502	£11.95

FUSES AND FUSEHOLDERS

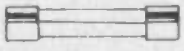




QUICK BLOW and ANTI-SURGE
20 x 5mm glass.
250, 315, 500mA, 1, 1.25, 1.6, 2, 2.5, 3.15, 5, 6.3A

TYPE	ORDER CODE	PRICE
QUICK BLOW	220-250mA etc.	14p
ANTI-SURGE	221-250mA etc.	20p

QUICK BLOW and ANTI-SURGE
1-1/4 x 1/4 glass.
250, 500mA, 1A, 1.25A, 2A, 5A, 10A



TYPE	ORDER CODE	PRICE
QUICK BLOW	224-250mA etc.	20p
ANTI-SURGE	225-250mA etc.	30p

AXIAL THERMAL FUSES
Metal body 250V 15A thermal fuses
72, 98, 121, 141, 169, 184, and 228 deg. C

ORDER CODE	226-72deg. etc.	82p each

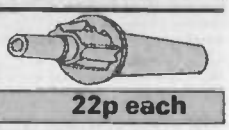
FUSEHOLDERS
Panel mounting fuseholders for 20mm fuses. Finger release. 6A rated.

ORDER CODE	230-100	48p each

OPEN CHASSIS FUSEHOLDER 20mm
Solder tag connections, one hole fixing.

ORDER CODE	230-102	18p each

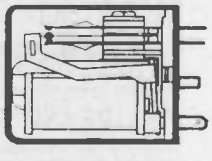
IN - LINE 1-1/4 FUSEHOLDER
For car radio and audio leads.



ORDER CODE	230-112	22p each

RELAYS

MINIATURE CRADLE RELAYS
Plug-in or solder directly. Standard 2 pole changeover relays. Contacts rated 250V AC 1A. Coil: 12V type, 185 ohms 5V type 200 ohms.



TYPE	ORDER CODE	PRICE
12V 185 ohm	240-100	£3.98
5V 200 ohm	240-104	£3.64

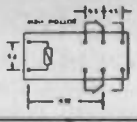
UPRIGHT PCB MOUNTING
10 AMP RELAYS.
SPDT 250V AC, 24V DC 10A rating

TYPE	ORDER CODE	PRICE
12V 280 ohm	240-106	£2.42
6V 70 ohm	240-108	£2.42

UPRIGHT PCB MOUNTING
16 AMP RELAYS
SPDT 250V AC, 16A rating

TYPE	ORDER CODE	PRICE
12V 280 ohm	240-112	£2.94
24V1100 ohm	240-115	£2.94

UPRIGHT PCB MOUNTING
10A RELAYS
DPDT 250V AC 10A contacts
12V 280 ohm coil



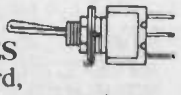
ORDER CODE	240-118	£3.34 each

ECONOMY PCB MOUNTING
10A RELAYS
Enclosed low cost sensitive relays
SPDT 10A 110V AC, 24V DC contacts

TYPE	ORDER CODE	PRICE
6V 100 ohm	240-122	£1.40
12V 4200 ohm	240-123	£1.42
24V 1800 ohm	240-124	£1.68

SWITCHES

MINIATURE TOGGLE SWITCHES
2A 250V AC 1/4 fixing hole. Standard, Centre-Off, and Biased (spring return to centre)



TYPE	ORDER CODE	PRICE
SPST	244-100	79p
SPDT	244-102	89p
DPDT	244-104	95p
DPDT Centre OFF	244-106	£1.05
DPDT Bias one way	244-108	£1.24
DPDT Bias two ways	244-110	£1.30

STANDARD TOGGLE SWITCHES
2A 250V AC 12mm fixing hole.
SPST and DPDT Types.

TYPE	ORDER CODE	PRICE
SPST	242-100	57p
DPDT	244-102	77p

MINIATURE PUSH SWITCHES
Low voltage 1A switches. Push to Make (red top) Push to Break (black top)

TYPE	ORDER CODE	PRICE
Push to Make	246-100	19p
Push to Break	246-102	23p

PUSH ON / PUSH OFF
Single pole 1A screw terminals alternate action

ORDER CODE	248-100	34p each

FOOTSWITCHES
Large chrome plunger, heavy duty SPDT and DPDT types. Low voltage.

TYPE	ORDER CODE	PRICE
SPDT	248-112	£2.60
DPDT	248-114	£2.95

ROCKER SWITCHES
10A AC mains rated black rocker switches. 1/4 spade contacts.
30 x 11mm SP, 30 x 22mm DP.

TYPE	ORDER CODE	PRICE
SPST	248-121	90p
SPDT	248-122	96p
DPST	248-124	£1.08
DPDT	248-127	£1.16

MINIATURE ROCKER SWITCHES
10A SPST and SPDT rocker switches
Black body fits 19.3 x 13mm hole.

TYPE	ORDER CODE	PRICE
SPST	248-130	62p
SPDT	248-131	78p

SWITCHES

MINIATURE KEYPAD SWITCH

PCB mounting push to make.
Positive feel, excellent quality

ORDER CODE	248-140	28p each

PCB MOUNTING PUSH TO MAKE SWITCH.
A high quality upright push to make switch
8mm x 6mm recangular button

ORDER CODE	248-142	29p each

DIL SWITCHES

Switches with standard IC pin layout
4 way SPST (8 pin) 4 way DPDT (16 pin)
8 way SPST (16 pin)

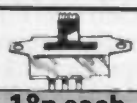
TYPE	ORDER CODE	PRICE
4P SPST	248-200	79p
4P SPDT	248-202	£1.99
8P SPST	248-204	96p

ROTARY HEXADECIMAL DIL SWITCH
BCD coded 16 position rotary switch in 8mm square 5 pin package. 0 to F, screwdriver slot.

ORDER CODE	248-218	£1.48 each

SLIDE SWITCH - SUB MIN PCB
SPST 12 x 5 x 5mm

ORDER CODE	248-224	11p each

MINIATURE SLIDE SWITCH

DPDT Panel mounting type 15 x 8 x 7

ORDER CODE	248-226	18p each

CENTRE OFF SLIDE SWITCH
DPDT 22 x 13 x 8mm 2 - M3 fixings

ORDER CODE	248-228	28p each

1 POLE 3 WAY SLIDE SWITCH
PCB mounting with side acting slider
Gold plated contacts 25 x 7 x 7mm

ORDER CODE	248-230	34p each

MULTIPOLE ROTARY SWITCHES

24V 1A or 240V 150mA. 1/4 spindle
Plastic body, solder tag connections. Adjustable end stop. 3/8 fixing bush.

TYPE	ORDER CODE	PRICE
1Pole 12 Way	248-240	96p each
2Pole 6 Way	248-241	
3Pole 4 Way	248-242	
4Pole 3 Way	248-243	

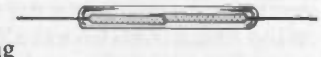
MAINS ROTARY ON/OFF SWITCH
2A mains DPST 1/4 spindle

ORDER CODE	248-246	94p each

MERCURY TILT SWITCHES

Glass tilt switches 1A rating
For burglar alarms and sensors. 20mm long x8mm dia.

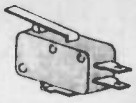
ORDER CODE	248-320	65p each

REED SWITCH

Glass reed switch. 25mm long

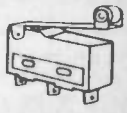
ORDER CODE	248-306	19p each

MAGNET 3 X 3 X 20MM For reed switches

ORDER CODE	248-310	49p each

MICROSWITCHES

Standard size (V3) SPDT 250V 10A
Button, 25mm Lever, and 25mm Lever with Roller.

TYPE	ORDER CODE	PRICE
Button	248-250	94p
Lever	248-251	£1.08
Roller	248-252	£1.16

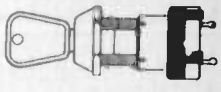
MINIATURE MICROSWITCHES

Miniature (V4) microswitches 5A 250V rating. SPDT 20 x 10 x 6mm
Button, 15mm Lever and 15mm Lever with Roller

TYPE	ORDER CODE	PRICE
Button	248-265	64p
Lever	248-266	80p
Roller	248-267	£1.04

LOCKSWITCH

British made switch with high security lock. 10A 12V, 4A250V DPDT. Key removable in both positions. 19mm panel hole

ORDER CODE	248-300	£4.80 each

LOCKSWITCH

British made switch with high security lock. 1A 12V, 1 pole 3 way. Key removable in all positions. 19mm panel hole

ORDER CODE	248-303	£4.68 each

CABLE & WIRE

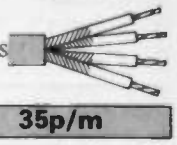
RIBBON CABLE
0.05 pitch standard cable for IDC connectors.Plain grey and rainbow colour coded types. 10, 20, and 40 way. Easily split to narrower sizes.

TYPE	ORDER CODE	PRICE
10 Way Grey	250-010	33p/m
20 Way	250-012	65p/m
40 Way	250-014	£1.32/m
10 Way Rainbow	250-020	64p/m
20 Way	250-022	£1.20/m
40 Way	250-024	£1.99/m

SINGLE SCREENED CABLE

PVC insulated grey 3mm dia.
10 - 0.12mm core, Lapped screen

ORDER CODE	250-032	18p/m

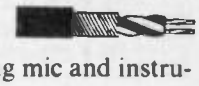
4 CORE INDIVIDUALLY SCREENED

4 x 7 - 0.1mm cores with individual screens
5mm dia. Ideal for HIFI leads etc.

ORDER CODE	250-036	35p/m

TWIN SCREENED FIG 8

Two screened cables bonded side by side
Black. For headphone leads etc.

ORDER CODE	250-040	25p/m

MICROPHONE CABLE

Twin twisted mic cable screened overall
Tough black outer 6mm dia. For trailing mic and instrument leads. Balanced or unbalanced.

ORDER CODE	250-040	60p/m

MULTICORE SCREENED CABLE
15 Core 7 - 0.16mm 7.5mm dia. Braid screen.

ORDER CODE	250-050	68p/m

CABLE & WIRE

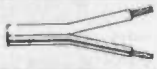
MULTICORE CABLE
Unscreened 7-0.12mm cores
13 way 6mm dia.

ORDER CODE	250-046	34p/m

MAINS CABLE
3 Core white PVC outer.

TYPE	ORDER CODE	PRICE
2.5A	250-061	26p/m
3A	250-062	39p/m
6A	250-063	52p/m
10A	250-064	58p/m
13A	250-065	68p/m

SPEAKER CABLE
Twin fig. 8 marked one side for polarity.



TYPE		ORDER CODE	PRICE
7/0.2	1Amp	250-080	10p/m
13/0.2	2Amp	250-081	15p/m
16/0.2	4Amp	250-082	24p/m
32/0.2	9Amp	250-083	40p/m

CONNECTING WIRE
1/0.6mm solid core wire 1A. Colours: Red, Black, Green, Yellow, Blue, White, Brown, Grey, Pink, Orange, Violet. supplied in multiples of 10m of a colour.

ORDER CODE	250-088/Colour	69p/10m

7/0.2 stranded core 1A. Colours as 1/0.6

ORDER CODE	250-092/Colour	59p/10m

16/0.2 stranded core 4A.
Colours: Red, Black, Green, Blue, Yellow.

ORDER CODE	250-096/Colour	95p/10m

32/0.2 stranded core 9A.
Colours: Red, Black, Green.

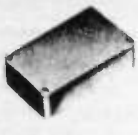
ORDER CODE	250-098/Colour	£1.30/10m

INSULATING SLEEVING
High temperature PVC. 5m lengths.
Colours: Red, Black, Green, Blue, Brown.

TYPE	ORDER CODE	PRICE
1mm Bore	250-110/Colour	55p/5m
1.5mm	250-111/Colour	75p/5m
2mm	250-112/Colour	90p/5m
3mm	250-113/Colour	£1.05/5m
4mm	250-114/Colour	£1.15/5m

CASES

Top quality ABS Cases (Bimboxes)
Black cases with PCB guides around all sides. Metal threaded inserts for lid screws. Cut and drill very well. Polished finish.



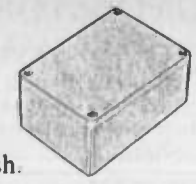
W x L x H	ORDER CODE	PRICE
100 x 50 x 25	252-100	£1.98
112 x 62 x 31	252-101	£2.28
120 x 65 x 40	252-102	£2.56
150 x 80 x 50	252-103	£3.24
190 x 110 x 60	252-104	£4.85

POLYSTYRENE CASE
Low cost good quality case, no PCB guides 112 x 62 x 31.

ORDER CODE	252-108	£1.35 each

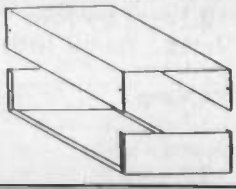
CASES

ABS cases
Black cases with PCB guides.
Brass threaded inserts for lid screws.
Cut and drill very well. Polished finish.



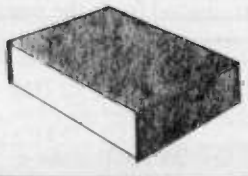
W x L x H	ORDER CODE	PRICE
80 x 62 x 40	252-112	£1.85
102 x 78 x 40	252-113	£2.05
120 x 100 x 45	252-114	£2.20
212 x 126 x 82	252-115	£2.80
220 x 150 x 64	252-116	£3.60

FOLDED ALUMINIUM BOXES
Two piece boxes made from aluminium sheet covered with plastic protection film



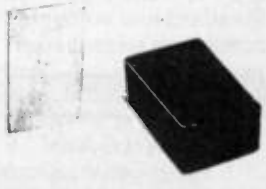
W x L x H	ORDER CODE	PRICE
133 x 70 x 38	252-137	£1.95
102 x 70 x 38	252-139	£1.90
100 x 133 x 38	252-140	£2.26
100 x 64 x 50	252-141	£1.90
75 x 50 x 25	252-142	£1.28
152 x 102 x 50	252-143	£2.75
203 x 152 x 76	252-145	£4.98

ALUMINIUIM / STEEL CASES
Two part cases with textured PVC coated steel tops and plastic protected aluminium bases.
Tops are black except 252-158 which is blue.



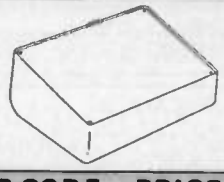
W x L x H	ORDER CODE	PRICE
152 x 102 x 38	252-150	£3.95
229 x 127 x 64	252-152	£5.95
280 x 191 x 89	252-154	£7.95
152 x 178 x 182	252-158	£7.95

ABS CASES WITH METAL LIDS
Black ABS bases with PCB guides.
Grey plastic coated aluminium recessed panels.
Very neat appearance.



W x L x H	ORDER CODE	PRICE
85 x 56 x 29	252-173	£2.25
111 x 76 x 42	252-174	£2.75
161 x 96 x 53	252-175	£3.45

SLOPING TOP CASES
Similar to 252-173 but with sloping top



W x L x H	ORDER CODE	PRICE
161 x 96 x 39 (57)	252-185	£2.85
215 x 130 x 47 (73)	252-186	£4.48

SLOPING TOP CASES
A different type of sloping top case with a metal wrap over panel that is top front and rear. and a flat section on top. Black ABS lower half.

W x L x H	ORDER CODE	PRICE
105 x 143 x 32 (56)	252-190	£3.45
170 x 143 x 32 (56)	252-191	£4.25
170 x 214 x 32 (82)	252-292	£6.45

CONNECTORS

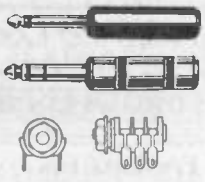
MINIATURE JACK PLUGS AND SOCKETS

Mono and stereo connectors for audio applications. Switched sockets hava a single pole break contact on the tip connection

TYPE	ORDER CODE	PRICE
Plastic plugs		
2.5mm	254.100	18p
3.5mm	254-101	20p
3.5mm stereo	254-106	30p
Metal plugs		
2.5mm	254-108	18p
3.5mm	254-122	29p
3.5mm stereo	254-126	35p
Sockets - Panel mtg		
2.5mm	254-130	19p
3.5mm	254-132	16p
3.5mm stereo	254-134	38p
Sockets - Line		
2.5mm	254-137	30p
3.5mm	254-139	28p
3.5mm stereo	254-142	44p

CONNECTORS

¼ JACK PLUGS AND SOCKETS



Mono and stereo plugs and a variety of switched socket options. Sockets have black nylon fixing nuts and are insulated from the panel

TYPE	ORDER CODE	PRICE
¼ Plugs		
Plastic mono	254.150	33p
Plastic stereo	254-151	48p
Metal mono	254-156	59p
Metal stereo	254-158	79p
¼ Sockets		
Mono Bk-Bk	254-160	27p
Mono Mk-Bk	254-162	29p
Stereo Bk-Bk-Bk	254-164	88p

DC POWER CONNECTORS

Standard low voltage as used in computers,stereos etc.

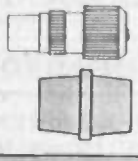
TYPE	ORDER CODE	PRICE
1.3mm plug	254.170	38p
2.1mm plug	254-173	30p
2.3mm plug	254-176	32p
2.1mm panel skt	254-179	36p
2.5mm panel skt	254-179	36p

PHONO PLUGS AND SOCKETS

Plastic and metal plugs and sockets and paxolin type chassis socket.

TYPE	ORDER CODE	PRICE
Plastic plug	254.180	20p
Metal plug	254-181	30p
Plastic line socket	254-186	24p
Metal chassis skt.	254-189	32p
Paxolin chassis skt.	254-191	15p

CO-AX CONNECTORS



Plugs and sockets for TV aerials chassis socket is insulated type. Coupler is Back to Back Sockets.

TYPE	ORDER CODE	PRICE
Metal plug	254-240	30p
Line socket	254-244	44p
Chassis socket	254-245	24p
Coupler (Female)	254-247	20p

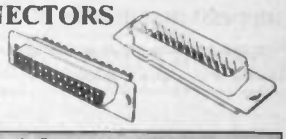
DIN PLUGS AND SOCKETS

Standard round plastic plugs and metal panel sockets - 2 hole fixing.

DIN PLUGS	ORDER CODE	PRICE
2 pin speaker	254-200	12p
3 pin	254-201	18p
4 pin	254-202	26p
5 pin 180 deg	254-203	20p
5 pin 240 deg	254-204	20p
5 pin domino	254-205	38p
6 pin	254-206	40p
7 pin	254-207	42p
8 pin	254-208	50p
13 pin	254-213	£1.99
14 pin	254-214	£2.10

DIN SOCKETS	ORDER CODE	PRICE
2 pin speaker	254-220	10p
3 pin	254-221	22p
4 pin	254-222	28p
5 pin 180 deg	254-223	22p
5 pin 240 deg	254-224	22p
5 pin domino	254-225	34p
6 pin	254-226	24p
7 pin	254-227	26p
8 pin	254-228	52p
13 pin line socket	254-223	£2.44
14 pin line socket	254-224	£2.45

MINIATURE D TYPE CONNECTORS



Standard D connectors, 2 row. Sockets, Plugs and Plastic Hoods. Also 15 pin 3 row type.

TYPE	ORDER CODE	PRICE
9 pin plug	254-250	55p
15 pin plug	254-251	66p
23 pin plug	254-253	£1.15
25 pin plug	254-252	78p
9 pin socket	254-255	59p
15 pin socket	254-256	72p
23 pin socket	254-259	£1.17
25 pin socket	254-257	90p
9 pin cover	254-260	48p
15 pin cover	254-261	55p
25 pin cover	254-262	58p
Note use 9 way cover with 3 row 15 pin types		
15 pin 3 rowPlug	254-265	£1.36
15 pin 3 row Skt	254-266	£1.44

IDC CONNECTORS

20, 26, 34, and 40 way sockets to fit onto ribbon cable. Straight and right angled PCB plugs.

TYPE	ORDER CODE	PRICE
20 pin plug Str.	254-280	95p
26 pin plug ..	254-281	£1.04
34 pin plug ..	254-283	£1.15
40 pin plug ..	254-285	£1.80
20 pin plug 90deg	254-300	98p
26 pin plug ..	254-301	£1.09
34 pin plug ..	254-303	£1.26
40 pin plug ..	254-304	£1.65
20 pin socket	254-290	50p
26 pin socket	254-291	54p
34 pin socket	254-293	58p
40 pin socket	254-295	£1.16

TERMINAL BLOCKS

2A, 5A, and 15A strips of 12. Cut down to size easily.

TYPE	ORDER CODE	PRICE
2A	254-320	00p
5A	254-321	00p
15A	254-322	00p

COMPONENTS

TERMINAL BLOCKS PCB TYPE
Interlocking blocks on 5mm pin spacing

TYPE	ORDER CODE	PRICE
2 way	254-360	32p
3 way	254-361	40p
6 way	254-362	62p

CROCODILE CLIPS
Small insulated clips,

TYPE	ORDER CODE	PRICE
Red	254-370	10p
Black	254-371	10p

CROCODILE CLIP TEST LEADS
10 Leads, 5 colours fitted with small matching insulated clips.

ORDER CODE	254-376	£1.98 each

TEST LEADS WITH PROBES

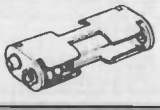
Moulded probes on good quality leads, with different types of plugs. 2mm pins, 4mm plain, & 4mm shrouded

TYPE	ORDER CODE	PRICE
2mm	254-380	£1.10
4mm	254-381	£1.44
4mm shrouded	254-382	£4.95

BATTERY CLIPS
Standard press stud type

TYPE	ORDER CODE	PRICE
PP3 (small twin)	254-390	10p
PP9 (larger)	254-381	14p

BATTERY HOLDERS
A range of types with PP3 type press studs, or solder tags.



TYPE	ORDER CODE	PRICE
1 x AA	254-390	15p
2 x AA	254-391	19p
4 x AA long type	254-392	21p
4 x AA Square	254-393	24p
6 x AA	254-394	29p
8 x AA	254-395	33p
4 x C 2 wide x 2	254-396	36p
4 x D 4 wide x 1	254-397	63p

PANEL METERS
MOVING COIL TYPE
Size 45H x 51W x 34D
Cut out 38mm dia.

TYPE	ORDER CODE	PRICE
100uA	255-100	
1mA	255-110	
1A	255-120	
5A	255-125	£5.98 each
25V	255-130	
100-0-100uA	255-105	

SPEAKERS, MICs, & BUZZERS
Electret, Dynamic and Crystal Mic Inserts

TYPE	ORDER CODE	PRICE
Electret 9mm dia	261-130	65p
Crystal 25mm dia	261-132	70p
Dynamic 22mm dia	261-133	72p

TELEPHONE PICK-UP COIL
For recording phone calls

ORDER CODE	261-135	85p each

ULTRASONIC TRANSDUCERS
40 and 32kHz piezo-ceramic

TYPE	ORDER CODE	PRICE
32 kHz Trans.	261-140	£2.99
32 kHz Rec	261-141	£2.99
40 kHz Trans	261-146	£2.49
40 kHz Rec	261-149	£2.49

MINIATURE LOUDSPEAKERS
Standard miniature speakers for all applications. 100 - 250mW

TYPE	ORDER CODE	PRICE
8 ohm 1.½	260-100	79p
8 ohm 2	260-101	81p
8 ohm 2¼	260-102	82p
8 ohm 2½	260-103	84p
64 ohm 2½	260-120	93p
80 ohm 2½	260-122	95p

PILLOW SPEAKER
8 ohm with lead and 3.5mm plug

ORDER CODE	260-136	£1.40 each

EARPIECES
Crystal (high impedance)
Magnetic 8 ohms

TYPE	ORDER CODE	PRICE
Magnetic	260-130	22p
Crystal	260-141	72p

PIEZO TRANSDUCER PB2720
Plastic housed piezo element used as speaker or pick-up. 2.6kHz resonance

ORDER CODE	261-120	90p each

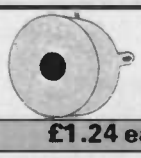
BUZZERS
Miniature Electronic buzzers with low current drain22 x 16 x 15mm

TYPE	ORDER CODE	PRICE
6V	261-101	82p
9V	261-102	84p
12V	261-103	86p

PIEZO BUZZER 3 - 28V
High pitch output30mm dia 12mA at 12V

ORDER CODE	261-104	98p each

HIGH OUTPUT PIEZO BUZZER
100 dB High pitch output
VERY piercing. 20mA at 12V.



ORDER CODE	261-105	£1.24 each

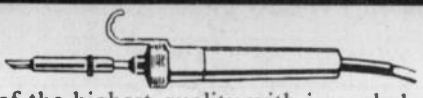
PCB MOUNTING PIEZO BUZZER
3 - 24V23mm dia 5mA

ORDER CODE	261-108	92p each

PIEZO SIREN - HIGH OUTPUT
12V 150mA. Whooping type sound. Very loud. For Burglar alarms.

ORDER CODE	261-110	£7.99 each

SOLDERING



ANTEX IRONS

British made irons of the highest quality with iron clad bits for long life.
Model XS 25Watts. Model C 17 Watts lightweight.

MODEL	ORDER CODE	PRICE
XS 240v	290-100	£8.59
XS 110V	290-101	£8.75
XS 24V	290-102	£9.13
XS 12V	290-103	£9.13
Model C 240V	290-120	£8.37

Spare Bits for Model XS

TYPE	ORDER CODE	PRICE
Small No. 50 3/32	290-110	£1.62
Med No. 51 1/8	290-111	£1.62
Large No. 52 3/16	290-112	£1.62

Spare Bits for Model C

TYPE	ORDER CODE	PRICE
106 1mm	290-130	£1.73
820 2.3mm	290-131	£1.62
821 3mm	290-132	£1.62
822 4.7mm	290-134	£1.62
302 2.3mm cranked	290-135	£1.62
10 0.5mm cone	290-137	£1.62

ANTEX HEAT SINK TWEEZERS

For protecting delicate components

ORDER CODE	290-145	48p/pair

ANTEX ST4 STAND

Suits models XS, C, and many other irons. With Cleaning sponge

ORDER CODE	290-148	£3.24

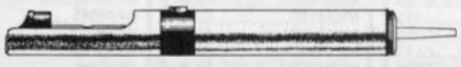
DESOLDER BRAID

Extremely effective solder removal

ORDER CODE	290-150	99p/ reel

DESOLDER PUMP

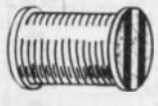
Spring return suction tool with PTFE nozzle



ORDER CODE	290-152	£3.98 each

SOLDER

Flux cored solder 60 tin 40 lead for all electronic assembly 18 swg - standard 22 swg - fine.



TYPE	ORDER CODE	PRICE
100g reel 22swg	290-260	£2.25
500g reel 18 swg	290-164	£6.99
3 yd dispenser 18 swg	290-170	75p
size 10 multicore reel 22 swg	290-172	£4.99
size 12 multicore reel 18 swg	290-174	£4.99

MINI VICE

Suction base plastic vice with metal jaws 85 x 65 x 60mm Lever action base.

ORDER CODE	290-180	£1.48

HELPING HANDS

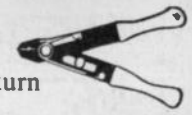
Top quality model with Glass magnifier Heavy metal base and two spring loaded clips.

ORDER CODE	290-182	£5.99

TOOLS

WIRE STRIPPERS AND CUTTERS

BIB adjustable strippers with spring return and pvc coated handles.



ORDER CODE	290-300	£2.99 each

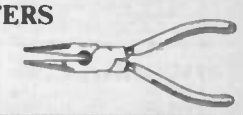
MINI SHEARS

The ideal tool for cropping component leads through PCBs etc Spring loaded PVC coated handles.

ORDER CODE	290-301	£2.85 each

LOW COST PLIERS AND CUTTERS

PVC insulated handles. Pliers have spring return and serrated jaws. 5 long overall.



TYPE	ORDER CODE	PRICE
Pliers	290-302	£1.98
Cutters	290-303	£1.96

TOOL SET & SCREWDRIVER SETS

Popular sets of small tools Screwdriver set has 6 jewellers screwdrivers. Tool sets have 5 spanners 5 nut spinners, 5 allen keys and 4 screwdrivers.

TYPE	ORDER CODE	PRICE
Screwdrivers	290-304	£1.48
Tool set	290-305	£4.49

SPOT FACE CUTTER

For cutting stripboard tracks

ORDER CODE	290-320	£2.20

COMO MINI DRILL

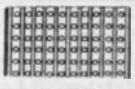
398D Drill with 3 collets. 9 - 18V DC

COMO DRILL STAND

594D New design stand for Vertical and Horizontal use.

TYPE	ORDER CODE	PRICE
398D Drill	290-330	£11.95
594D Stand	290-332	£14.95

STRIPBOARD



0.1 INCH PITCH BOARD

Strips x Holes	ORDER CODE	PRICE
9S x 24H - Pack of 5	290-500	94p / pack
36S x 50H	290-503	£1.95 each
36S x 170H	290-505	£5.98 each

PRINTED CIRCUIT BOARD

Copper clad laminate for making PCBs. Single & double sided Glass Fibre based, and single sided paper based. Supplied in 150 x 200 mm panels 1/16 thick.

TYPE	ORDER CODE	PRICE
SS Paper	290-520	£1.30
SS Glass fibre	290-521	£1.85
DS Glassfibre	290-524	£1.98

FERRIC CHLORIDE CRYSTALS

For etching copper clad board. Makes 1 litre of solution

ORDER CODE	290-530	£1.95 pack

ETCH RESIST PEN

For drawing tracks onto board before etching.

ORDER CODE	290-534	48p

ETCHING KIT

Contains everything to make PCBs including Crystals, Drill bits, Pen, Board, Tray, Transfers,Cleaner, and Instructions

ORDER CODE	290-538	£6.49

SEMICONDUCTORS

Transistors

2N2926	11p
2N2955	£1.12
2N3053	32p
2N3055	79p
2N3702	11p
2N3704	11p
2N3819	52p
2N3820	78p
2N3904	11p
2N3906	11p
2N5457	58p
2N5484	63p
3SK51	£1.18
40673	£1.18
AC128	59p
AC141	48p
AC142	49p
AC176	57p
AD161	66p
AD162	66p
BC107	14p
BC108	14p
BC109	14p
BC109C	15p
BC171	12p
BC177	18p
BC178	18p
BC179	18p
BC182	11p
BC182L	11p
BC183	11p
BC183L	11p
BC184	11p
BC184L	11p
BC212	11p
BC212L	11p
BC213	11p
BC213L	11p
BC214	11p
BC214L	11p
BC440	51p
BC441	56p
BC460	50p
BC461	55p
BC547	12p
BC548	12p
BC549	12p
BC640	38p

BC650	58p
BD131	48p
BD132	49p
BF244B	65p
BFX88	32p
BFY50	35p
BFY51	29p
BFY52	38p
BRY39	78p
BSX20	48p
HPWR6501	£6.78
IRF740	£3.98
IRF840	£4.20
MJE340	62p
MPF102	69p
MPF105	68p
MPSA13	36p
MPSA65	48p
TIP121	64p
TIP122	66p
TIP126	68p
TIP127	96p
TIP141	£2.48
TIP146	£2.56
TIP2955	69p
TIP3055	69p
TIP31A	50p
TIP31C	52p
TIP32A	50p
TIP32C	52p
TIP33A	94p
TIP33C	99p
TIP34A	92p
TIP34C	98p
TIP41C	£1.90
TIP42C	£1.97
TIS88A	68p
TPSA13	35p
VN10KM	69p
VN66AF	£1.62
VN67AF	£1.60
ZTX300	19p
ZTX450	30p
ZTX451	38p
ZTX500	19p
ZTX550	51p
ZTX650	64p

74 Series TTL Logic ICs

7400	38p
7401	38p
7402	28p
7403	28p
7404	36p
7406	64p
7407	62p
7408	35p
7410	28p
74107	63p
74121	78p
74123	73p
74128	94p
7413	82p
74132	79p
7414	85p
74141	£1.90
74150	£1.44
74154	£1.61
7416	48p
74192	98p
74193	£1.24
7420	44p
7427	38p

7430	36p
7432	44p
7440	36p
7441	£1.42
7445	£1.36
7447	£1.48
7451	36p
7454	67p
7470	56p
7472	48p
7473	39p
7474	38p
7475	77p
7476	72p
7480	£1.42
7482	£1.76
7483	72p
7486	61p
7490	86p
7492	72p
7493	71p
7495	82p
7496	76p

74LS Series TTL Logic ICs

LS00	27p
LS02	27p
LS03	27p
LS04	33p
LS05	27p
LS08	27p
LS09	27p
LS123	44p
LS125	48p
LS132	52p
LS138	36p
LS139	44p
LS14	40p
LS161	56p
LS175	38p
LS193	64p
LS20	27p
LS240	86p
LS244	68p

LS245	82p
LS27	27p
LS273	69p
LS30	27p
LS32	30p
LS367	64p
LS373	83p
LS374	58p
LS377	85p
LS42	43p
LS47	£1.67
LS640	£1.38
LS73	28p
LS74	38p
LS75	40p
LS76	36p
LS85	50p
LS86	36p
LS90	44p

CMOS Logic ICs

4000	24p
4001	22p
4001A	39p
4007	39p
4008	98p
40103	£2.46
40106	69p
4011	24p
40114	£3.80
4012	24p
4013	26p
4014	96p
4015	69p
4016	42p
4017	58p
40174	96p
4018	66p
4020	72p
4022	76p
4023	28p
4024	68p
4025	32p

4026	£1.40
4027	48p
4028	82p
4029	98p
4030	56p
4033	£1.68
4035	99p
4040	59p
4041	48p
4042	76p
4043	69p
4046	84p
4047	72p
4049	38p
4050	49p
4051	94p
4053	92p
4060	98p
4066	62p
4068	39p
4069	39p
4069UB	49p

4070	39p
4071	38p
4076	76p
4081	40p
4082	38p
4093	66p
4098	84p
4502	68p
4510	89p
4511	99p
4514	£1.18
4516	99p
4518	99p
4520	99p
4528	96p
4534	£7.13
4553	£4.96
4583	£2.99
4584	34p
4585	96p

Linear & Digital ICs

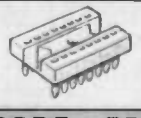
2114	48p
2240	£2.48
27128	£2.42
27128	£4.48
4116	80p
4164	£1.20
555	36p
556	84p
6116	£1.63
6116	£1.64
6264	£1.98
6264	£1.98
723	58p
8038C	£6.46
AD595AQ	£11.65
AD7581JN	£23.63
ADC0844CCN	£13.60
AY3-1350	£4.95
AY3-8912	£5.98
CA3080E	88p
CA3085AE	£1.24
CA3086	88p
CA3130E	96p
CA3140E	69p
CA3240E	£1.67
COP420 SYNTH	£11.98
DAC0800LCN	£3.80
ICL7611	£1.55
ICL7660CPA	£1.98
ICL8069DCSQ	£3.96
ICM7106	£13.61
ICM7216D	£27.95
ICM7217J	£8.40
ICM7555	89p
ICM7556	£1.66
L200CV	£1.80
LA4422	£1.89
LF347N	£2.92
LF351N	69p
LF353N	89p
LF355N	£2.17
LF356N	£2.39
LM13600	£1.98
LM13700	£1.98
LM1830	£2.98
LM2917N8	£4.98
LM301A	78p
LM311N	78p
LM317K	£1.99
LM317T	76p
LM318H	£5.38
LM324	88p

LM334Z	£1.89
LM335Z	£3.50
LM339	82p
LM348N	£1.48
LM358N	£1.02
LM35DZ	£4.96
LM377N	£5.76
LM380N	£1.48
LM381N	£2.38
LM382N	£3.99
LM383T	£4.80
LM384N	£4.99
LM386N	£1.48
LM387N	£2.84
LM389N	£2.95
LM3900	98p
LM3909	£1.67
LM3911	£3.75
LM3914	£4.54
LM3915	£4.55
LM393N	84p
LM394	£8.98
LM567N	£1.98
LM747	98p
LM748CN	74p
LM833	£2.23
M5804	£4.98
MC1301P	60p
MC1455L	£6.86
MC1458N	67p
MC1488	48p
MC1489	48p
MC3302	£1.68
MC3340	£2.99
MC3360P	£2.10
MC3403	£1.48
MC68000P8	£15.95
MC6802P	£3.96
MC6810P	£1.80
MC6821P	£1.98
MC68230P8	£6.99
MC6850P	£2.08
MC68681	£9.60
MC68705P3	£19.98
MF10CN	£5.98
NE5532N	£1.74
NE566	£2.40
NE567	£1.48
NE570N	£4.47
NE571N	£2.36
NE5534N	98p
OM335	£9.92

OM361	£12.66
OPI2252	£1.54
R6522	£6.69
SAA1027	£3.48
SL1640	£6.99
SL560DP	£2.56
SL6270	£3.87
SN76018	£1.20
SN76131	98p
SP8629DP	£2.36
SPO256AL2	£2.98
SSM2040	£1.80
TBA820M	£1.20
TDA2002	£3.50
TDA2006	£3.83
TDA2030	£1.99
TDA7052	£1.48
TDS2004	£4.69
TEA5570	£2.20
TL061	93p
TL064	£1.97
TL430	£1.40
TL497	£3.17
TLO71	49p
TLO72	81p
TLO81	49p
TLO82	76p
TLO83	£1.73
TMS1000-MPO121	£6.48
TMS1000-MPO27	£6.58
TOL84	£1.48
U237B	£1.99
U267B	£2.50
UGN3501	£5.48
ULN2003N	86p
ULN2004	97p
ULN2803N	£1.04
UPD43256-16	£6.80
UPD8255	£2.95
XR2206	£5.98
Z80AP10	£1.60
ZN1034E	£2.97
ZN1040	£5.88
ZN414	£1.20
ZN419-409CE	£2.21
ZN423	£1.76
ZN424P	£1.44
ZN425E8	£6.99
ZN428E8	£8.28
ZN448E	£7.20
ZN449E	£4.85

IC Sockets

IC SOCKETS
low profile standard sockets.



TYPE	ORDER CODE	PRICE
6 pin	254-406	6p each
8 pin	254-407	8p each
14 pin	254-409	10p each
16 pin	254-411	12p each
18 pin	254-414	14p each
20 pin	254-416	18p each
24 pin	254-418	22p each
28 pin	254-421	24p each
40 pin	254-424	32p each
64 pin	254-426	98p each

Diodes and Rectifiers

DIODES

1 AMP RATING:	
1N4001 ..50V	6p
1N4002 ..100V	6p
1N4003 ..200V	6p
1N4005 ..600V	7p
1N4007 ..1000V	8p
3 AMP RATING:	
1N5401 ..100V	18p
1N5402 ..200V	18p
1N5404 ..400V	19p
1N5408 ..1000V	22p
6 AMP RATING:	
MR751 ..50V	94p

SIGNAL DIODES	
1N4148	5p
1N914	5p
LOW LEAKAGE	
BAS45	48p
GERMANIUM	
OA47	18p
OA90/91	19p
TV TYPES	
BYI27 .1250V..1.5A	28p
BY407A	48p
BY206G	44p
VARICAP AM	
KV1236 ..9V..300pF	£1.87

BRIDGE RECTIFIERS

1.5AMP RATING 9mm ROUND TYPE	
W005 ..50V	36p
W04 ..400V	40p
3AMP RATING 15mm SQUARE TYPE	
C30-200 ..200V	68p
C30-800 ..800V	92p
6 AMP RATING16MM SQUARE TYPE	
C80-200 ..200V	£1.10
C80-800 ..800V	£1.24

4 AMP RATING 23mm IN-LINE TYPE	
KBL-02 ..200V	£1.22
KBL-08 ..800V	£1.36
25 AMP RATING 29mm SQUARE TYPE WITH SPADE TAGS, METAL CLAD	
C250-050 ..50V	£2.17
C250-600 ..600V	£2.48

ZENER DIODES

400mW and 1.3W ZENER DIODES in the following range of voltages:
2.4, 2.7, 3.0, 3.3, 3.6, 3.9,4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1, 10, 11, 12, 13, 15, 18, 20, 22, 24, 27, 30, and 33V.

400mW Range BZY79 - etc 12p 1.3W Range BZX85 - etc. 18p
REMEMBER TO STATE VOLTAGE WHEN ORDERING

VOLTAGE REGULATORS

100mA TO92 PLASTIC POSITIVE O/P	
78L05 ..5V	44p
78L12 ..12V	44p
78L15 ..15V	44p
100mA TO92 PLASTIC NEGATIVE O/P	
79L05 ..-5V	52p
79L12 ..-12V	52p
79L15 ..-15V	52p
1A TO220 PACKAGE POSITIVE O/P	
7805 ..5V	59p
7812 ..12V	59p
7815 ..15V	59p
7824 ..24V	64p

1A TO220 PACKAGE NEGATIVE O/P	
7905 ..-5V	69p
7912 ..-12V	69p
7915 ..-15V	69p
7924 ..-24V	74p
ADJUSTABLE REGULATORS	
Positive	
LM317L .. 1.2-37V 100mA TO92	86p
LM317T .. 1.2-37V 1.5A TO220	97p
LM317K .. 1.2-37V 1.5A TO3	£2.79
L200CV .. 2.8-36V 2AT0220 5pin	£2.36
Negative	
LM337T ..- 1.2-37V 1.5A TO220	£1.49

THYRISTORS &TRIACS

DIAC	
BR100	48p
THYRISTORS (SCRs)	
TICV106D ..400V 1A TO92	48p
C106D ..400V 3A TO126	56p
TIC106D ..400V 4A TO220	68p
TIC116D ..400V 8A TO220	£1.14
TIC126M ..600V 12A TO220	£1.26
2N4443 ..400V 5A TO220	98p

TRIACS - NON-ISOLATED TABS	
TAGM9/K9 ..400V 5.5A TO220	94p
TIC226D 400V 8A TO220	£1.23
TRIAC - ISOLATED TAB	
TAGM22 ..8A 400V TO220	£1.36

OPTOELECTRONICS

PHOTOTRANSISTORS	
BPX25 ..TO18	£3.98
TIL81 ..TO18	£2.76
XC500C ..3mm	62p
OP500 ..3mm	65p
TIL78 ..3mm	79p
PHOTODIODES	
MIR10L ..Infra Red	£2.13
BPW41 ..Infra Red	68p
INFRA RED EMITTERS	
TIL38 ..5mm Infra Red	79p
TIL32 ..3mm Infra Red	48p
CQW13R ..Lensed,with Chrome Mount	£2.94
PHOTOCONDUCTORS	
ORP12	99p

OPTOCOUPLERS	
4N25 ..Transistor O/P	48p
CNY17-1	56p
CNY17-3 ..High Efficiency	94p
ISD74 ..Dual	£1.08
ISQ74 ..Quad	£1.68
OPI2252 ..Dual	£1.25
MOC3020 ..TRIAC 400V 100mA	98p
SENSORS	
H21L1 ..Reflective	£4.95
H21A1 ..Slotted	£1.75
TIL139 ..Reflective	£3.20
PASSIVE IR SENSOR FOR BURGLAR ALARMS	
SR02	£9.60

OPTO ELECTRONICS & INDICATORS

LEDs

TYPE		ORDER CODE	PRICE
Standard Diffused			
3mm Red	2mcd	295-100	12p
3mm Green	2mcd	295-101	12p
3mm Yellow	4mcd	295-102	12p
5mm Red	4mcd	295-104	13p
5mm Green	4mcd	295-105	14p
5mm Yellow	4mcd	295-106	15p
Super Bright Diffused			
3mm Red	80mcd	295-107	28p
3mm Green	80mcd	295-108	30p
3mm Yellow	80mcd	295-109	30p
5mm Red	100mcd	295-114	28p
5mm Green	100mcd	295-115	30p
5mm Yellow	100mcd	295-116	30p
Ultra Bright Water Clear			
5mm Red	250mcd	295-124	36p
5mm Green	250mcd	295-125	36p
5mm Yellow	250mcd	295-126	36p

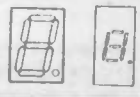
LOW CURRENT LEDs
Optimised for 2mA. Drive directly from ICs

TYPE	ORDER CODE	PRICE
3mm Red diffused	295-130	39p
Sub min - side leads	295-134	34p

LED BAR ARRAY - 10 WAY
10 rectangular red LEDs in DIL 20 pin.

ORDER CODE	295-143	£1.24

SEVEN SEGMENT DISPLAYS - RED
Standard 0.3 and 0.5 displays
Common Anode and Common Cathode.



TYPE	ORDER CODE	PRICE
0.3 Common Anode	295-146	£1.44
0.3 Common Cathode	295-147	£1.40
0.5 Common Anode	295-149	98p
0.5 Common Cathode	295-150	95p

MES FILAMENT BULBS
Standard screw in bulbs.

TYPE		ORDER CODE	PRICE
200mA	3.5V	295-165	all 18p each
60mA	6V	295-167	
150mA	6V	295-169	
150mA	12V	295-170	

MES BATTEN HOLDERS
Screw terminal type.

ORDER CODE	295-190	35p

BREADBOARDS

A range of solderless breadboards into which standard component leads are plugged to build circuits. Especially useful for educational experiments and testing new components and circuit ideas. The S-DEC has70 contacts on 0.3 x 0.6in pitch. The Eurobreadboard has 550 contacts on 0.1in pitch. K10 has 390 contacts on 0.1in pitch, and K12 has 840 0.1in pitch contacts. The K120 is a K12 with added power terminals.

TYPE	ORDER CODE	PRICE
S-DEC	254-610	£4.95
EUROBREADBOARD	254-612	£6.99
BIMBOARD1	254-614	£8.32
K BLOCK-K10	254-617	£2.88
K-BLOCK-K12	254-618	£4.48
K-BLOCK -K120	254-624	£8.44

HAMEG OSCILLOSCOPE HM 203-7

Specification

Vertical Deflection

Operating modes: Channel I or Ch. II separate, Channel I and II; alternate or chopped. (Chopper frequency approx 0.4Mhz)
Sum or**difference** of Ch. I and Ch. II. (channel II invertible).
X-Y Mode: via Channel I and Channel II.
Frequency range: 2 × DC to 20MHz (−3dB).
Risetime: approx. 17.5ns. Overshoot: ≤1%.
Deflection coefficients: 10 calibrated steps from 5mV/div. to 5V/div. in 1-2-5 sequence.
Accuracy in calibrated position: ±3%
Variable 2.5:1 to max. 12.5V/div.
Y-magnification × 5 (calibrated) to **1mV/div.** ±5% (frequency range DC to 3.5MHz, −3dB).
Input impedance: 1MΩ II 25pF.
Input coupling: DC-AC-GD (Ground)
Input voltage: max. 400V (DC + peak AC)
Y-output from Ch. I or Ch. II optional.

Trigger System

With **automatic:** 10Hz-40MHz, ≥0.5div. normal with level control from **DC-40MHz**.
Slope: positive or negative.
ALT. triggering, LED indication for trigger action.
Sources: Ch. I, Ch. II, line, external.
Coupling: **AC** (≥10Hz-15MHz), **DC** (0-15MHz), **LF** (0-≤1kHz), **HF** (≥1,5kHz-40MHz).
Threshold external ≥0.3V.
Active TV-Sync-Separator for line and frame.

Horizontal Deflection

Time coefficients: 18 calibrated steps from 0.2µs/div. to 0.1s/div. in 1-2-5 sequence, accuracy in calibrated position: ±3%.
variable 2.5:1 to max. 0.25s/div.,
with **X-Magnifier x10** (±5%) to ≈ **20ns/div.**
Hold-Off time: variable to approx. 10:1.
Bandwidth X-Amplifier: DC-3MHz (−3dB).
Input X-Amplifier via Channel II, sensitivity see Ch. II specification.
X-Y phase shift: <3° below 220kHz.
Z input optional

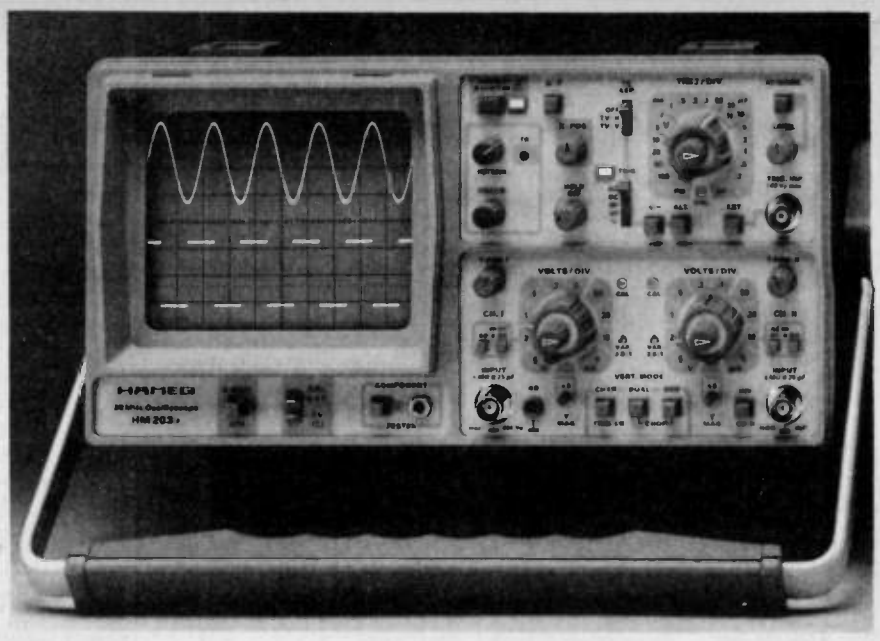
Component Tester

Test voltage: approx. 8.5V_{rms} (open circuit).
Test current: approx. 24mA_{rms} (shorted).
Test frequency: 50-60Hz (line frequency).
Test connection: 2 banana jacks 4mm Ø.
One test lead is grounded (Safety Earth).

General Information

Cathode-ray tube: D14-364 P43/123, or ER 151-GH/-, rectangular screen, intern. graticule, **8x10cm**.
Acceleration voltage: 2000V.
Trace rotation: adjustable on front panel.
Calibrator: square-wave generator ≈ 1kHz for probe compensation. Output: 0.2V and 2V ±1%.
Line voltage: 110, 125, 220, 240V~ ±10%.
Power consumption: ≈ 37 Watt, 50/60/400Hz.
Max. ambient temperature: −10°C...+40°C.
Protective system: Safety Class I (IEC 348).
Weight: approx. 7.5kg. Colour: techno-brown.
Cabinet: **W** 285, **H** 145, **D** 380mm.
Lockable tilt handle.

Subject to change without notice.



20MHz Standard Oscilloscope

2 Channels, max. 1mV/div. sensitivity; Component Tester
Timebase: 0,1s/div. to 20ns/div.; Variable Holdoff; Alternate Triggering;
Triggering: DC-40MHz; TV Sync Separator; Trigger LED

The **HM203-7** is Western Europe's best selling oscilloscope because it responds thoroughly to customer demands for **reliability**, **superior performance**, and **ease of operation**.

The outstanding transient response of the **HM203-7**, particularly when displaying square wave signals, is one of the pre-eminent features of this quality instrument. The integrity of the signals reproduced by this oscilloscope reflect a dedication to engineering excellence normally only found in expensive laboratory instruments. As an aid to ensure the correct polarities when displaying the sum, difference, or video signals, an "invert" control is provided on channel II. Technically advanced triggering circuits enable the user to attain clear, stable displays from **DC to over 40MHz**, with input levels as **low as 0.5 divisions**. The **Holdoff** control enables even complex asynchronous waveforms to be solidly displayed. Trigger action is indicated by an **LED**, which illuminates whenever the trigger threshold point is crossed. And for the display of video signals, the **HM203-7** has a low distortion **active TV sync separator**, which allows for automatic synchronizing with line and frame frequencies. "**Alternate triggering**" mode enables the display of two asynchronous signals simulteneously.

The CRT's 8x10cm internal graticule enhances parallax-free viewing over a wide field. In addition, the **CRT** is fully shielded with **mumetal** to prevent display distortion in the presence of magnetic fields.

As a practical, built-in feature, the **component tester** enables the operator to quickly identify faulty semiconductors and a large variety of individual components, both in circuit and out.

Designed for use in production, service, design, and educational applications. The **HM203-7** is versatile and yet simple to use. A high quality reliable instrument made in West Germany. Outstanding 'build quality' gives this instrument an excellent 'feel' and make it a delight to use.

£338.00 + £50.70 VAT £5.00 NEXT DAY DELIVERY
2 YEARS PARTS + LABOUR WARRANTY

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Accessories supplied: Two 10:1 probes, Line cord, Operators manual

EE REFERENCE LIBRARY

We have specially selected the four books shown here as very high quality reference books. They are all fairly expensive *but* they are all extremely comprehensive; between them they contain over 8,000 pages of information.

We are not suggesting that many people would require all four books, any one of them would be very useful and interesting. Each of them would make an excellent Christmas present. These reference books would be invaluable to any company, electronics club, group of students or anyone involved in teaching electronics etc.

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COLOUR CHANGING CHRISTMAS LIGHTS

MARK DANIELS

A low cost project to add some colour to the festive season

THE ILLUMINATION of Christmas trees has not seen any significant changes for many years. Originally they were lit with candles and more recently with coloured lamps which are sometimes made to flash. But imagine if the lamps themselves were to actually change colour as you watched them. From red to green to yellow and back again.

Obviously this cannot be achieved using ordinary Christmas lights, and in this design the effect is obtained by using bi-colour l.e.d.'s, with an electronic control unit and power supply. The resulting display is very effective and the timing may be adjusted to give numerous different patterns.

BI-COLOUR L.E.D.

As already mentioned this project uses bi-colour l.e.d.s to produce the three colours, red, green and yellow (depending on the l.e.d.s used the yellow may appear as orange). The Bi-colour l.e.d.'s used are packaged in a colourless translucent plastic encapsulation.

The two l.e.d. chips, one red, one green are connected across the two package leadout pins in inverse parallel. Thus when current is passed through the device one or other of the l.e.d's will illuminate. This will give either red or green depending on the direction of current flow.

To obtain the yellow would require both the red and green chips being lit at the same time. This is not really possible since the two l.e.d's require current flow in completely opposite directions!

However, if we were to switch the two chips on and off sufficiently quickly they will appear to be on simultaneously and the eye will perceive this as a constant yellow. Fig. 1a shows the switching waveform that may be used to achieve the three required colours.

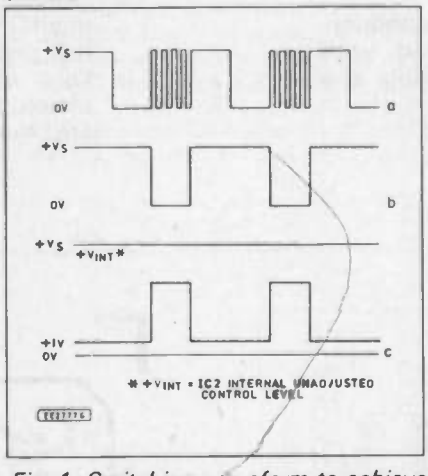


Fig. 1. Switching waveform to achieve the three colours.

CIRCUIT DESCRIPTION

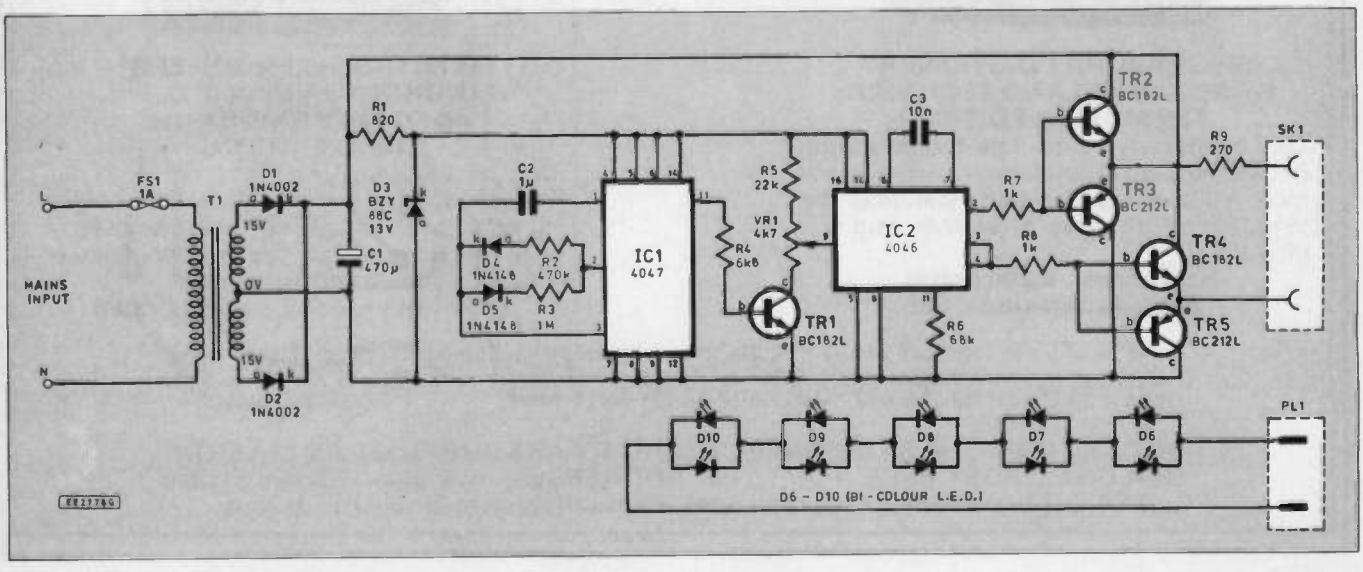
The complete circuit diagram for the Colour Changing Christmas Lights is shown in Fig. 2. Transformer T1 steps the mains voltage down to 15V-0V-15V a.c. This is rectified by diodes D1 and D2 to give a pulsating d.c. which is smoothed by capacitor C1. The smoothed d.c. is then fed into a voltage regulator circuit consisting of resistor R1 and D3, a 13V Zener diode, which provides a constant voltage for the two CMOS i.c.s. IC1 and IC2.

In this application the CMOS multivibrator IC1 is used in its astable mode to give a low frequency square wave output at pin 11, of the form shown in Fig. 1b. It can be seen from the diagram that the high time is approximately twice as long as the low time. This is made possible by using two different timing resistors for the two half cycles. Diodes D4 and D5 direct capacitor C2 charge and discharge currents through two separate resistors of different values in order to achieve this.

The output of IC1 at pin 11 is fed to transistor TR1 base, via resistor R4, and appears inverted at its collector which is connected to the bottom end of a potential divider, made up of VR1 and R5. The adjustable output of potentiometer VR1 provides the control voltage, shown in Fig. 1c, for pin 9 of IC2, a voltage controlled oscillator (VCO).

When VR1 is correctly adjusted the voltage at its wiper will swing between around

Fig. 2. Complete circuit diagram for the Colour Changing Christmas Lights. Fuse S1 is insulated in the mains plug.



one volt with TR1 conducting and a voltage set by the on chip potential divider when TR1 is turned off. The control voltage at pin 9 determines the output frequency of IC2 which changes from about 1Hz with the external control voltage of around one volt to 2kHz when set by the internal potential divider. Resistor R6 and capacitor C3 set the frequency range of the VCO.

The two out of phase outputs of the VCO at pin 2 and pins 3 and 4 are amplified by a pair of simple pull-push amplifier stages having unity voltage gain but a large current gain, so that several chains of series connected bi-colour l.e.d's may be driven. The push-pull amplifier configuration consisting of transistors TR2 to TR5 allows the bi-directional flow of current necessary to achieve the tri-colour states of l.e.d.s D6 to D10.

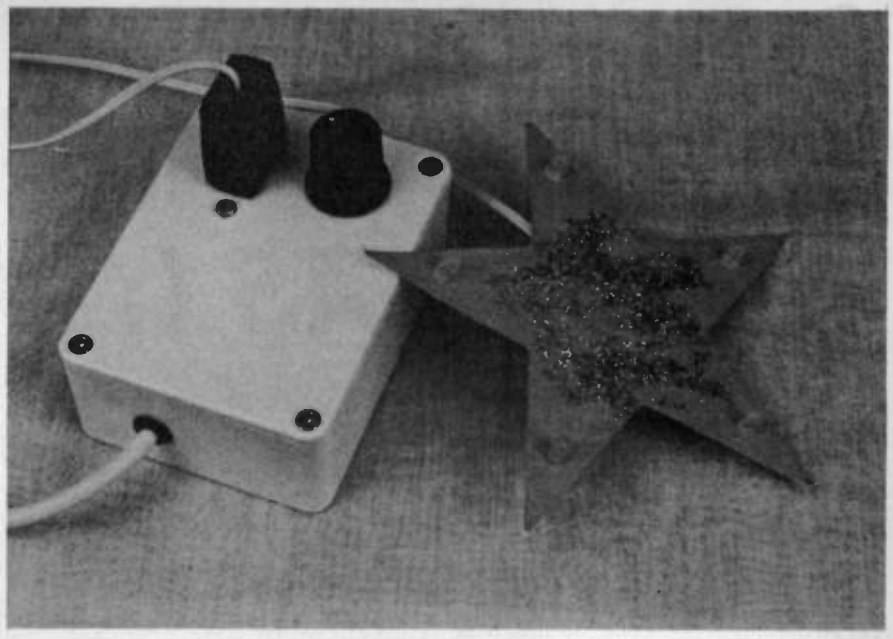
CONSTRUCTION

Most of the components are mounted on a single-sided glass-fibre printed circuit board (p.c.b.), the foil pattern and component overlay for which is shown in Fig. 3. This board is available from the *EE PCB Service*, code EE707.

It is recommended that the resistors and i.c. sockets be fitted first followed by capacitors.

It is suggested that screw terminal blocks be used for the mains connections to the board for reasons of safety (terminal blocks were also used for the l.e.d. outputs on the prototype) and these may be fitted next. Otherwise solder suitable lengths of flexible leads to the board. The three potentiometer connecting leads may be soldered directly into the board or solder pins can be used if preferred. The transformer T1 is fitted last as it makes the board heavy and awkward to work on.

Mount the p.c.b. securely in the bottom part of the case (see Fig. 4), so that it cannot move around. Make suitable holes in the lid of the box to accept VR1, SK1 and a grommet for the mains input lead. Ensure that all lid mounted components will clear the p.c.b. when the box is assembled.



The completed unit showing another suggestion for displaying the bi-colour l.e.d.s.

Pass a length of two core mains cable through the grommet and connect to terminal block TB1. Fasten a cable tie around the mains lead inside the box to prevent its being pulled out. Wire SK1 and resistor R9 to TB2 using thin insulated leads, the polarity is unimportant since the socket is non-polarised. The last connection to be made is between VR1 and the p.c.b. and must be correctly made otherwise the unit may fail to work at all or the control will work in reverse.

IC1 and IC2 may now be fitted in their respective sockets ensuring that they are the correct way round. Note IC2 is upside down compared to IC1. The pins may need some adjustment before they will go into the sockets. Remember these i.c.s are CMOS types and that it is possible for them to be damaged by static electricity, so avoid touching the pins with your fingers until after they have been inserted into their sockets!

Before fitting the lid tie or fasten all loose leads in place and ensure that nothing will foul when the lid is on. A plastic knob should be fitted to VR1 and a 13A plug fitted with a 1A or 3A fuse connected to the mains lead.

The strings of lights may be made up as follows: Trim the leads on five bi-colour

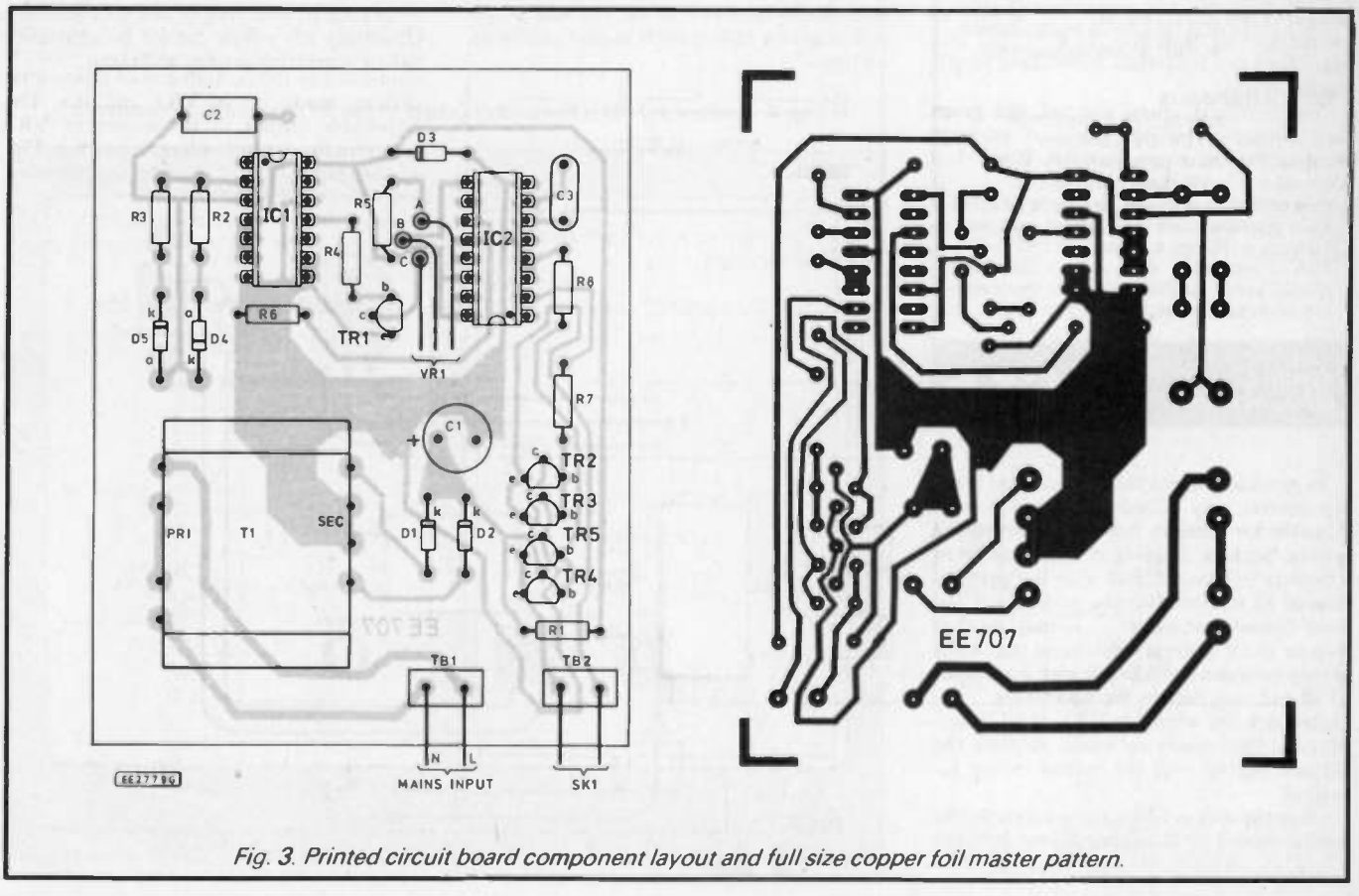
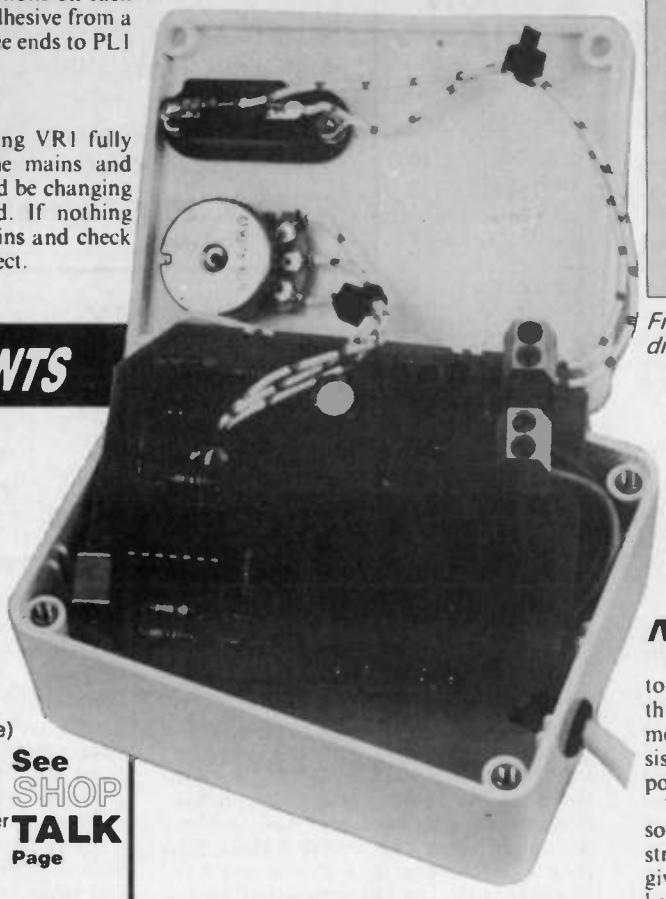


Fig. 3. Printed circuit board component layout and full size copper foil master pattern.

l.e.d's to about 3mm and connect them up in series, observing the polarity of each one, as shown in Fig. 5 using thin single core flex. Insulate the connections on each l.e.d. using Araldite or hot adhesive from a glue gun. Connect the two free ends to PL1 and plug into the main unit.

TESTING

Commence testing by setting VR1 fully anti-clockwise. Plug into the mains and watch the l.e.d.s which should be changing colour about once a second. If nothing happens *unplug* from the mains and check that all internal wiring is correct.



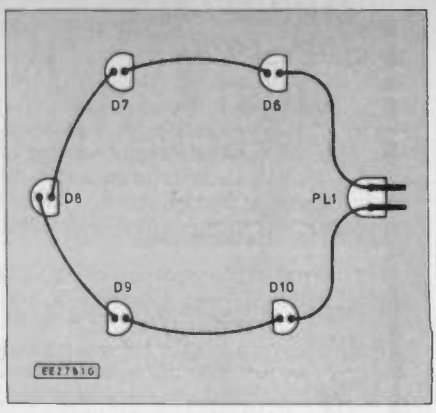


Fig. 5. Wiring up the l.e.d.s to form a display chain.

COMPONENTS

Resistors

R1	820
R2	470k
R3	1M
R4	6k8
R5	22k
R6	68k
R7, R8	1k (2 off)
R9	270

All 0.25W 5% carbon

Potentiometer

VR1	4k7 rotary, lin. (plastic spindle)

Capacitors

C1	470μ radial elec.
C2	1μ polyester layer
C3	10n polyester

See SHOP TALK Page

Semiconductors

D1, D2	1N4002 1A 100V rec. (2 off)
D3	BZY88C 13V Zener
D4, D5	1N4148 signal diode (2 off)
D6-D10	bi-colour 2-pin l.e.d. (5 off)
TR1,TR2, TR4	BC182L *npn* silicon (3 off)
TR3,TR5	BC212L *pnp* silicon (2 off)
IC1	4047B CMOS multivibrator
IC2	4046B phase locked loop

Miscellaneous

T1	Mains 3VA transformer; 15V-0V-15V sec.
SK1/PI1	Non-polarised min. 2-pin plug and socket

Printed circuit board, available from *EE PCB Service*, code 707; platic case, size 100mm x 76mm x 41mm; mains cable; 13A 3-pin plug, with 1A or 3A fuse; plastic knob; rubber grommet; connecting wire, solder etc.

Approx cost guidance only **£15**

In particular check that the i.c.s are fitted the correct way round (it should not be possible for them to have been put in the wrong sockets since they have different numbers of pins). Check also the orientation of all semiconductors, particularly the four output transistors as it may be that two or more of these have been put in the wrong positions which will give no output at all and may destroy the transistors.

Recheck the wiring to VR1. If all is correct the unit ought to work. Replace the lid and secure with the screws before retesting.

Once the unit is functioning correctly the l.e.d.s should be changing colour between yellow and either red or green. To obtain the missing colour turn VR1 slowly clockwise and the third colour should appear.

Turning VR1 further clockwise will increase the flashing rate of the red and green, leaving the yellow unaffected. Further clockwise still and the red and green will alternate fast enough to give yellow at all times.

Due to mains voltage being present on the circuit board, extreme care should be exercised when carrying out work on the unit. In all cases the mains plug must be removed first.

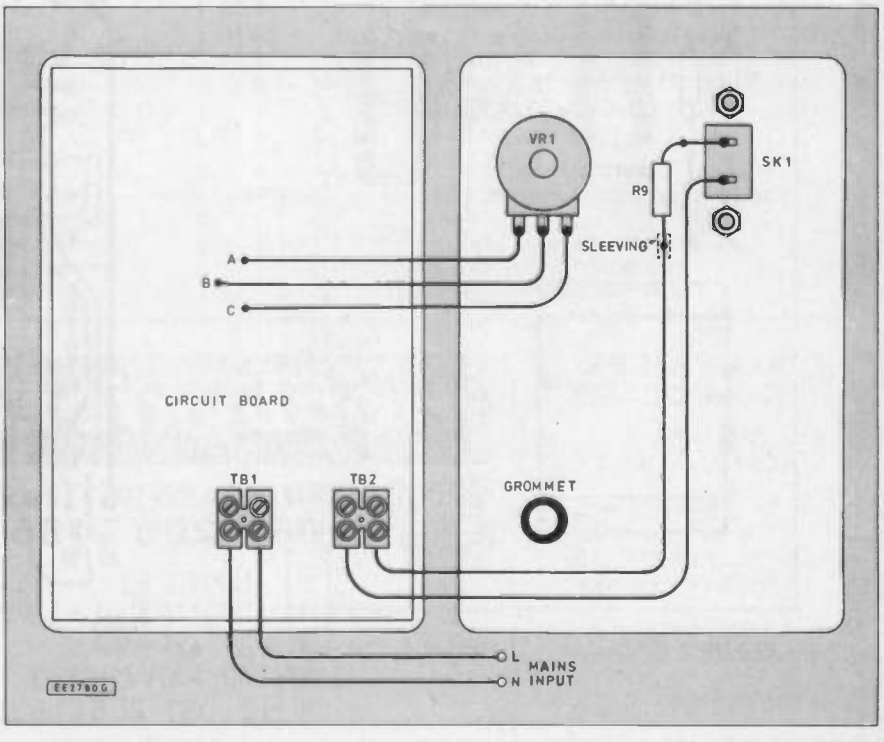
MORE LIGHTS

Duplicating R9, SK1, PL1 and l.e.d.s D6 to D10 is all that is necessary to add up to three or four more strings of lights. Any more than this will require uprating transistors TR2 to TR5 and ultimately a larger power supply will be required.

The value of resistor R9 may need some small adjustment with any number of strings connected and should be selected to give a current of 20mA or so through each l.e.d.

A variation on this circuit would be to use ordinary red and green l.e.d.s in place of the bi-colour ones. Simply connect up two strings of l.e.d.s (one of red, the other green) in the manner shown for the bi-colour set. Connect the two strings in inverse parallel and plug in to the controller. Obviously the yellow cannot be obtained, but an interesting display will result. □

Fig. 4. Interwiring from the circuit board to the lid mounted components.



ROBOT ROUNDUP

Nigel Clark

TWENTY YEARS AWAY

There will be no market for domestic robots for at least 20 to 25 years. There is nothing unusual in that being the view expressed by someone close to the industry. There has always been a body of opinion less optimistic, or more realistic – depending on your view – in its reading of developments in domestic robots.

However when it is expressed by the head of the company which has been given the task of taking the Department of Trade and Industry's domestic robot initiative through its next phases it has more than a good chance of becoming a self-fulfilling prophecy.

Dr Patrick Finlay, head of Fulmar Systems, backs up his view by saying that any devices which could be built today would be so expensive that only the very rich would be able to afford them.

"That will remain the case until the costs come down and the processing power increases."

However, he is not totally negative on the issue. He still thinks that there is work which can be done at the moment to help advance the day when domestic robots will become viable.

DISABLED AID

Fulmar's own suggestion is a mobile robot with an arm which could be an aid for the disabled. One critical element of the device would be that it should operate in any home environment, not requiring the house to be adapted to the needs of the robot.

This idea is now being evaluated by the DTI and Fulmar hopes to get the go-ahead soon to enable the project definition to be completed by Easter next year. The next phase would be the preparation of a demonstration prototype by the end of 1992.

Fulmar's work is taking up where Richard Pawson's Personal Robots Ltd left off when it went into liquidation towards the end of last year. In its final report on the feasibility phase of the DTI initiative it suggested four areas for further study:

- Low-cost single task device for jobs such as lawn mowing, vacuum cleaning, cooking and home security.
- Multi-function domestic robot aimed at the luxury home market.
- Domestic service industry robot.
- Healthcare robot for the handicapped.

If the Fulmar idea gets the OK from the DTI the work of preparing the prototype will be split among the members of the domestic robot initiative. As only 50 per cent of the cost of this stage will be met by the DTI the balance will have to be met from outside sources. It is expected that the initiative members doing the prototype work will fund it themselves. The final stage of producing a commercial product will get no government support at all.

VALIANT FOR CDT

Valiant Technology is determined to make its Roamer mobile an important part of teaching Design in the National Curriculum's Craft, Design and Technology section. For most of this year, since the company decided to design a package around Roamer, Dave Catlin has been working on the project.

"It's turned into a monster." he said, adding that he hoped to have the work finished in the near future. "It's all I'm doing at the moment."

The concept was to show how the design process works, giving it a practical basis by explaining it in relation to customising Roamer, their Smartie-shaped mobile. When he began to get into the subject Catlin quickly realised that a basic idea of creating something to satisfy a need soon expands into defining a solution, creating a design, building and testing. And into those steps are inserted varying constraints such as the technology and materials available and the need to be aware that what might seem old technology could be the most relevant if adapted; for instance power from windmills is now making a comeback.

Catlin commented that, "there are certain logical steps in all this and we are hoping that this package will provide a framework to show how those steps combine to create the final product."

In the meantime Valiant has produced two new packs to enable further customising of Roamer. The light pack contains eight l.e.d.s with four different colours, two lamps and a flasher unit. An activity booklet gives some ideas of models which can be made.

The most obvious is some form of vehicle with headlights, rear lights and indicators which use the flasher unit. This unit is needed because if the flashes are programmed into Roamer they would cause the robot to stop. Another idea is to turn Roamer into a jukebox with the lights programmed to go on and off in time with the notes being played.

The sensor pack contains two touch switches, sound and light sensors and a push button switch, increasing the design possibilities immensely. With careful programming the mobile could be made to appear as if it had a personality, reacting to changes in sound and light. Catlin even suggested it would be possible to create a form of sheepdog reacting to whistles.

Valiant's control console is also now available. Not to be confused with the control box which is added to Roamer to increase its use, the console is a stand-alone controller. It has eight inputs and eight outputs plus two stepper-motor drives and a counter unit.

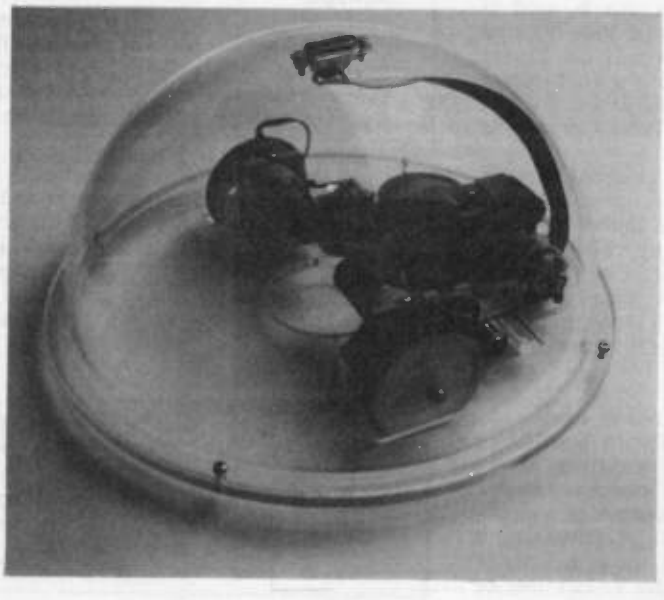
It is an upgrade of the controller on the Roamer with a number of added facilities, one of the most interesting of which is the counter. Catlin gave as an example of its capabilities a mobile which would wait until something like a light flashing on and off had occurred a set number of times before reacting.

TURTLE TRAILS

The Jessop turtle, also known as the Edinburgh turtle, the upturned mixing bowl, has had its capabilities expanded for the first time in many years with the introduction of Turtle Trails. They have been developed by MEU Cymru and are made up of printed floormats and keyboard overlays.

The mats contain routes for the turtles to follow and the overlays for the Concept keyboard enable the children to guide the turtle. As well as the turtle and the keyboard Logotron Logo and a Multiplexer are needed. The pack, which costs about £20, also contains instructions and templates for making other routes. Teachers' instructions and a video help provide ideas.

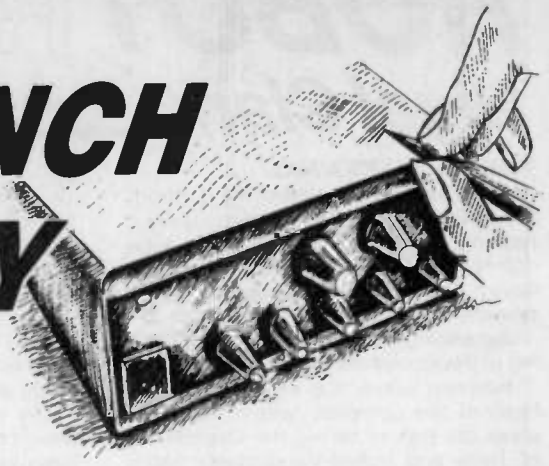
Jessop's turtle was one of the first on the market in this country having been developed by the Artificial Intelligence Department at Edinburgh University. It has sold steadily over the years, finding a new interest with the introduction of the National Curriculum. Costing a little more than £200 there are versions for the BBC series, Nimbus, IBM PC, Commodore C64 and Spectrum. It is driven by two stepper motors, has a retractable pen holder and uses each manufacturer's version of Logo.



The Jessop turtle is claimed to have been one of the first "mobiles" on the UK market and the new expanded version carries a price tag of just over £200.

Teach In '91 Project

VERSATILE BENCH POWER SUPPLY



MIKE TOOLEY BA

The first constructional project to accompany our Design Your Own Circuits, series takes the form of a Versatile Bench Power supply. This unit provides one variable output (3V to 15V) together with two fixed outputs (one of 5V and the other of 12V, both rated at 1A maximum continuous current). 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 RELIABLE bench power supply can be an extremely valuable addition to the range of test equipment available in any electronic workshop. Not only does our versatile bench power supply fulfil a general need but it can also be used to provide the various voltage rails required by the projects described in the Design series. In addition, one of the fixed voltage dual-output modules described in the text can be easily added to further extend the facilities available.

The vast majority of electronic circuits and modules operate from one or more low voltage d.c. supply rails. Indeed, the voltages and currents used by most electronic circuits are usually quite small (often less than 12V and below 1A) and none of the circuits described in our Design series require anything unusual in this respect.

OUTPUTS

Our versatile bench power supply has been designed to satisfy the need for a reliable low-voltage, low-current supply which has accurate fixed as well as variable outputs. The variable output can supply currents well in excess of 1A (its maximum continuous rating) and it has a variable current limit. This useful facility can be instrumental in helping to avoid damage to circuits under test when excessive currents flow due to inadvertent misconnection or failure of individual components.

All three of the power supply outputs are protected against inadvertent short circuit connection though such a condition should not be allowed to persist for more than 60 seconds, or so.

SAFETY

It is worth stating at the outset that this project is ideal for construction by a relative beginner. The circuit is straightforward and uses relatively few components. The components themselves are quite rugged (both electrically and mechanically) and therefore do not require special handling. There is, however, one important proviso; this project derives its power directly from the domestic a.c. mains supply and thus special precautions are necessary since the mains supply (of nominally 240V at 50Hz) **can be lethal if handled incorrectly.** It is, therefore, vitally important that constructors observe the following precautions when building this project:

1. Ensure that the equipment is switched off and the a.c. mains supply lead removed whenever the equipment is

Specifications

Variable output:	
Voltage:	*Variable from* +3V to +15V
Current:	1A maximum continuous
Current limit:	Variable from 5mA to 2A max.
Regulation:	0.15% (typical)
Output resistance:	0.1 ohm (typical)
Hum and noise:	Less than 500μV
Fixed outputs:	
Voltage:	+5V and +12V
Current:	1A maximum continuous (total)
Current limit:	Fixed at 1A (either output)
Regulation:	0.2% (typical)
Output resistance:	0.05 ohm (typical)
Hum and noise:	Less than 250μV
Mains input:	
Voltage:	220V to 240V (see note)
Current:	200mA (typical)
Power:	50VA (maximum)

Note: The mains transformer may also be wired for 110/120V a.c. operation by parallel connecting the two primary windings. In this case the input current will typically be 400 mA.

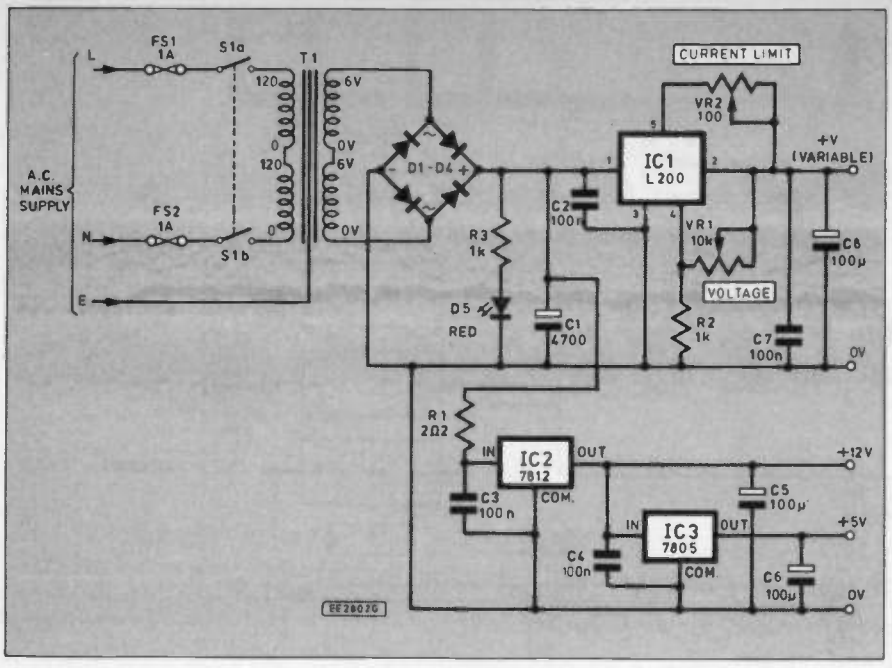


Fig. 1. Complete circuit diagram of the versatile bench power supply.

being worked on and whenever the case is in a dismantled state.

2. Ensure that only correctly rated fuses are fitted to the equipment (as specified in the components list). A standard 3A mains fuse should be fitted to the mains plug.

3. Only use the type of IEC mains lead and connector (which incorporates an earth) specified in the components list. This lead should be disconnected (and the unit switched off) whenever it is necessary to remove power from the equipment during testing and/or fault finding.

4. Do not attempt to apply mains voltage to the equipment until all of the wiring and assembly has been completed and **the wiring has been carefully checked.**

CIRCUIT DESCRIPTION

The complete circuit of the versatile bench power supply is shown in Fig. 1. The circuit is based on an L200 variable voltage regulator (IC1) and two fixed voltage regulators (IC2 and IC3) which respectively provide the fixed +12V and +5V outputs.

A conventional bridge rectifier/reservoir capacitor arrangement is used to provide a source of raw d.c. (approximately 17V off-load falling to 15V on-load) for the regulators. A low-value series resistor is incorporated in the d.c. feed to the two fixed voltage regulators in order to limit the current on full load. All three of the voltage regulators incorporate internal overcurrent and thermal protection.

CONSTRUCTION

The vast majority of the components for the versatile bench power supply are assembled on a single-sided printed circuit board measuring approximately 60 × 130mm. The copper foil layout of the printed circuit board and the corresponding component side layout are shown in Fig. 2.

Components should be assembled on the printed circuit board in the following sequence: p.c.b. headers, resistors, capacitors, variable resistors, bridge rectifier, integrated circuit regulators. As with all of our projects, it is important to ensure that all of the components are correctly located. Furthermore, in the case of the polarised components (such as electrolytic capacitors, bridge rectifier, and integrated circuits) it is absolutely essential to ensure that each component is correctly orientated.

When construction of the printed circuit board has been completed (and before the heatsink is attached) 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 precaution will only take a few minutes to carry out but can be instrumental in preventing much heartache at a later stage!

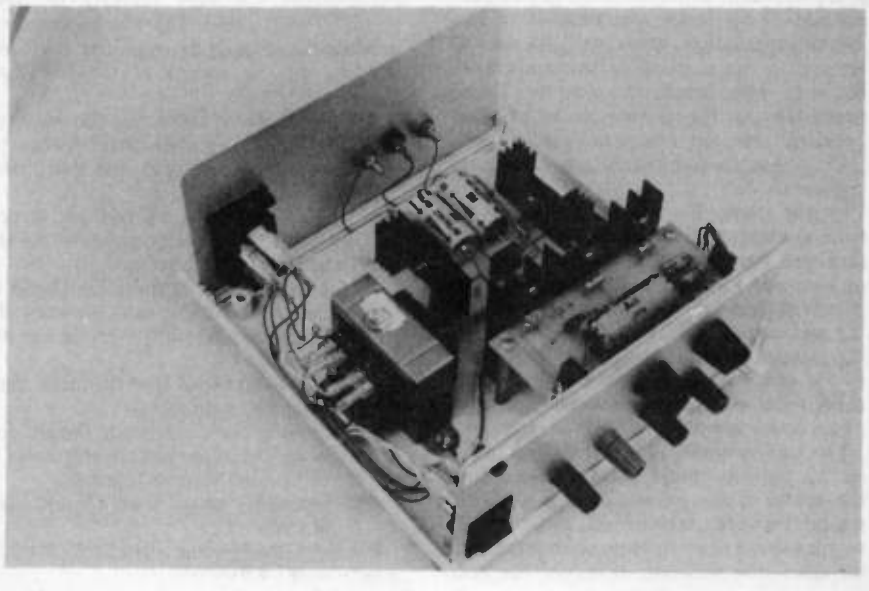
When assembly of the printed circuit board has been completed, the board should be mounted on the front panel by means of the two threaded shafts fitted to the variable resistors. The rear of the printed circuit board is supported above the base of the case by means of two plastic or aluminium alloy mounting pillars. These must be cut to the required length (approximately 49 mm in the prototype unit) and attached by means of self-tapping No. 6 fixing screws.

HEATSINK

In order to avoid premature thermal shut-down (which would severely limit the current output capability), the three regulators require a heatsink of 3.5 degrees C per Watt (or better). This can be achieved by means of a commonly available black finished finned heatsink measuring approximately 75 × 108 × 14 mm. In order to promote effective heat dissipation, the heatsink should be fitted with its fins aligned vertically and, as far as possible, in a region in which free airflow exists.

Having obtained a suitable component, the heatsink should then aligned with the rear of the printed circuit board so that its lower edge rests on the base of the ABS case with the heat-radiating fins aligned in the vertical plane. The heatsink should be marked and carefully drilled to match the mounting holes provided in the metal tabs of the regulators, each of which should be bolted to the heatsink using an M3 nut, bolt and shakeproof washer (insulating washers and bushes are not required since the conductive mounting tabs of all three regulators are connected directly to common 0V). The bottom of the heatsink may then be attached to the base of the case by means of a small L-shaped aluminium bracket. This is also retained by means of two M3 nuts, bolts and shakeproof washers.

In order to improve thermal conductivity between the integrated circuits and the heat sink, a small film of heat sink compound should be smeared onto the rear surface of each device prior to mounting. This film can be instrumental in improving thermal conductivity between the integrated circuits and the heat sink. It is important to note that effective heat dissipation is essential in order to prevent premature thermal shut-down of the regulators. Furthermore maximum load currents can only be achieved if there is effective heat transfer from the regulators to the heat sink.



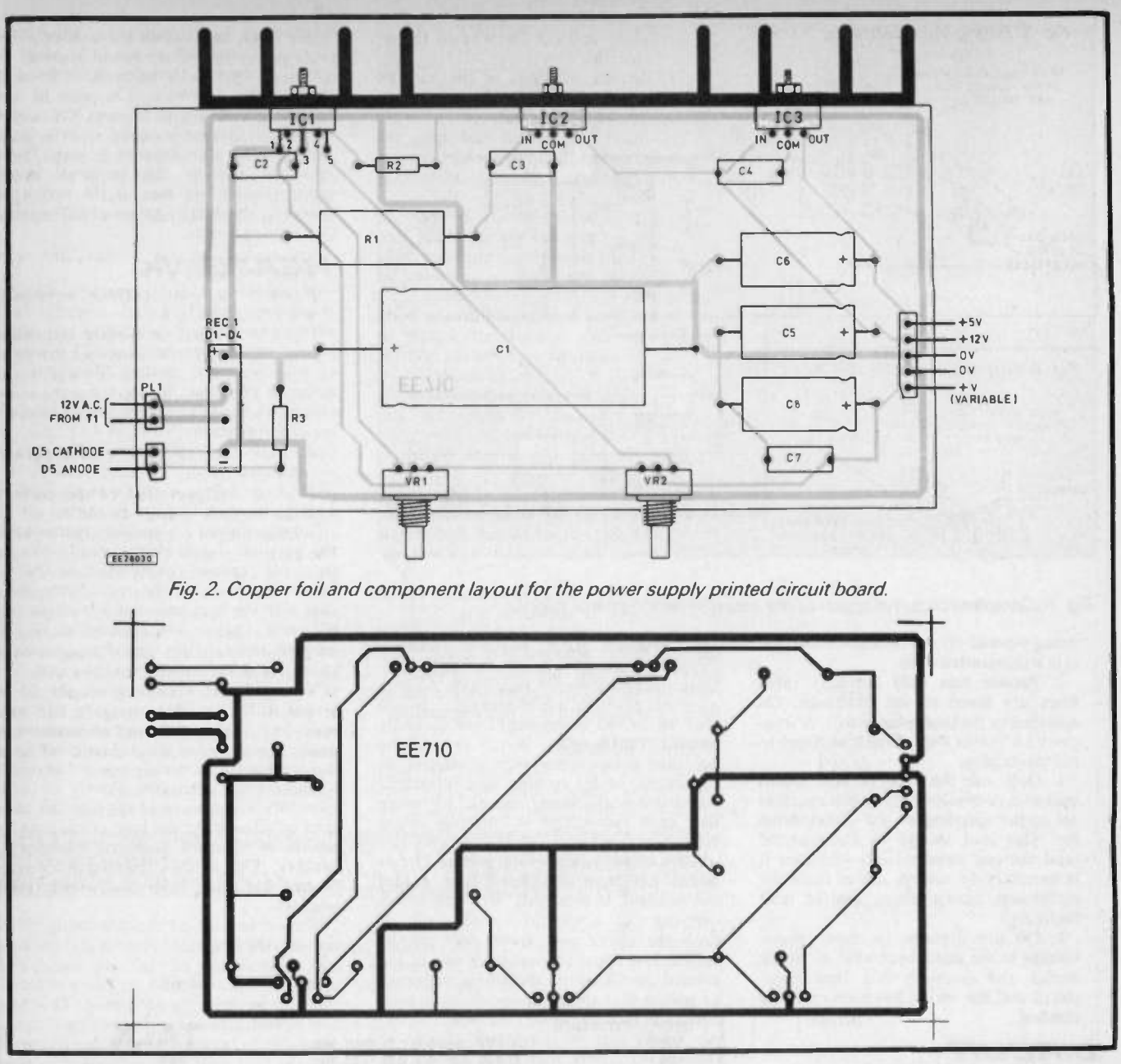


Fig. 2. Copper foil and component layout for the power supply printed circuit board.

CASE

The Versatile Bench Power Supply may be housed in any suitable ABS or metal enclosure which measures approximately 220 × 230 × 105mm or greater. Ventilation is unimportant provided there is sufficient volume of air inside the unit. If in any doubt, ventilation holes can be cut at strategic points in the underside and rear of the unit. This precaution was not found necessary on the prototype which was "soaked" for ten hours at rated output (12V 1A) in an ambient temperature of 30 degrees C.

In any event, the case should be fitted with aluminium front and rear panels to facilitate mounting of the controls, connectors and indicator. The front and rear panels should be marked out before drilling and cutting takes place. There is nothing particularly critical about the layout of the unit and constructors may wish to experiment with the location of the front panel controls and sockets.

The two controls and five output sockets all require round holes to be cut in the metal front panel. This is a fairly straightforward exercise (it is, however, worth using a centre punch so that the drill bit does not wander!) however the rear mounted IEC mains power connector and front-panel mounted mains switch require rectangular mounting holes and are thus not quite so easy to deal with! In production applications, the required holes are normally cut using a rectangular punch but constructors are very unlikely to have access to such a tool. There is, however, no need to panic since the required apertures may be cut by means of the following simple procedure:

(a) Accurately mark out the required apertures on the aluminium front and rear panels using a ruler and sharp pencil.

(b) Carefully drill 6.5 mm (or larger) diameter holes at each corner (within the area of material to be removed).

(c) Cut, using a tension file (fitted in a hacksaw or coping saw) between the four holes and carefully remove the unwanted metal.

(d) Use a flat file to trim the metal back to the marked outline.

For reference, the dimensions (height followed by width) of the rectangular holes in the prototype unit were as follows:

IEC chassis plug and fuseholder: 48.5 × 34.5mm

Rocker-action mains switch: 27.5 × 22.5 mm

In any event, constructors are advised to check the dimensions of the components actually used prior to marking out the front and rear panels.

CONNECTORS

The IEC mains connector specified for use in this project is fitted with integral 20mm fuseholders. In the event that such a component is unavailable, a standard IEC chassis mounting plug can be used in conjunction with two separately mounted 20 mm fuseholders.

All mains connections (i.e. those associated with the IEC mains connector, fuseholders, and mains switch) are made with the aid of shrouded snap-on receptacles. This method of wiring is inherently safe (since all joints are fully insulated) and furthermore it avoids the need for soldering directly to the individual components.

Two sizes of receptacle are be required; 250 (0.25 inch) for the IEC chassis connector and rocker-action mains switch and 110 (0.11 inch) for the fuseholders and transformer connections. The receptacles are assembled as follows:

(a) Select the appropriate wire colour (see below) and cut the wire to the required length.

(b) Prepeare the ends of the wire by

Fig. 3. Fitting the receptacles.

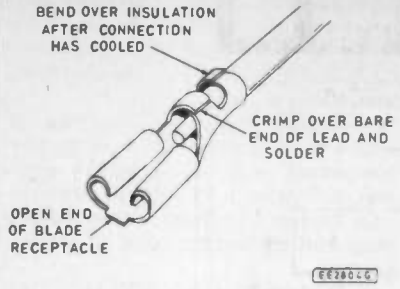
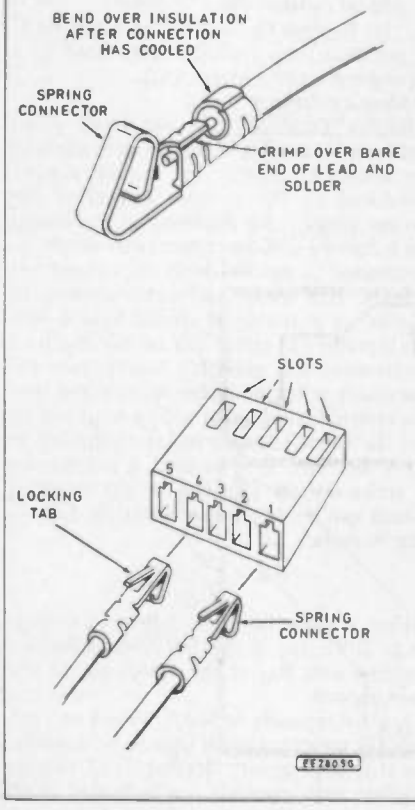


Fig. 4. Fitting the header contacts



stripping back the insulation by 3mm (110 receptacles) or 5mm (250 receptacles), twist and tin the ends.

(c) Fit receptacle covers (of appropriate sizes) to the wires (the larger open end should face towards the tinned end to which the receptacle will be fitted).

(d) Insert the tinned ends into the receptacles. Bend the receptacle to grip the tinned wire and insulation (as shown in Fig. 3).

(e) Apply heat from a soldering iron bit and run a small amount of solder into the receptacle from the open end.

(f) Slide the receptacle cover over the receptacle until it is completely insulated.

The wire used for the mains wiring should be 7/0.2mm or 16/0.2mm stranded equipment wire which conforms to BS 4808. The following colour coding is recommended:

Brown: Mains - line. Blue: Mains - neutral. Green: Mains - earth. Pink: All low-voltage a.c. wiring

Connections to the printed circuit board are made using two 5-way printed circuit board headers.

(a) Select the appropriate wire colour (see below) and cut the wire to the required length.

(b) Prepare the ends of the wire by stripping back the insulation 2.5mm from the end. Tin the end.

(c) Insert the tinned end into the sprung contact. Bend the header contact to grip the tinned end and insulation (as shown in Fig. 4).

(d) Apply heat from a soldering iron and run a small amount of solder into contact from the spring-loaded end (take care to use the absolute minimum of solder!).

(e) Snap the receptacle into the body of the printed circuit board header (it should be gently pushed into the body of the header until it locks into place).

The wire used to make connections to the l.e.d.power indicator and 4mm screw terminals should be 1/0.6mm conforming to BS 4808. The following colour coding is recommended:

LED cathode: Black. LED anode connection: Violet. 0V/common terminals: Black. Variable output (+ve): Red. Fixed +5V output: Blue. Fixed +12V output: Yellow.

The internal wiring of the versatile bench power supply is shown in Fig. 5. It is important to carefully check the wiring of the unit before attempting to connect the power supply to the mains. Particular emphasis should be placed on the mains wiring and mains transformer connections.

TESTING

Insert two 20mm 1A quick-blow fuses into the IEC chassis plug assembly, connect an IEC mains lead (fitted with a 3A mains fuse), and switch the unit on. The l.e.d. power indicator should become illuminated. Set both controls (VR1 and VR2) to the fully clockwise position (i.e. maximum voltage and current). Connect a voltmeter (preferably digital type) to each output in turn (the negative meter lead can be connected to either of the black 0V terminals) and measure the voltages produced. These should be within the following range:

Maximum variable output (red terminal): +15V to +17V

Fixed +5V output (blue terminal): +4.75V to +5.25V

Fixed +12V output (yellow terminal): +11.5V to +12.5V Now set the voltage control (VR1) to minimum and again measure the voltage produced at the variable output (red terminal). This should be in the range:

Minimum variable output (red terminal): +2.4V to +3.2V.

To check the operation of the current trip, the variable output should be set to provide an output of approximately +12V. The current control (VR2) should remain set at the maximum (fully clockwise) position. Now connect a 560ohm 1/2W carbon resistor to the variable output (i.e. between the red and black terminals). Slowly back-off the current control until the output voltage starts to fall rapidly to a low value. If all is well, current limiting should occur at a position which is roughly half-way between the maximum and minimum settings. The output voltage should fall to a very low value as the setting of VR2 current control is further reduced.

If any of the output voltages are not

COMPONENTS

Resistors

R1	2Ω2 2.5W vitreous coated wirewound
R2	1k 0.5W 5% carbon
R3	1k 0.25W 5% carbon

See SHOP TALK Page

Potentiometers

VR1	10k 1W panel/p.c.b. mtg. lin.
VR2	100 1W panel/p.c.b. mtg. lin.

Capacitors

C1	4700µ axial elect. 25V
C2, C3, C4, C7	100n miniature dipped case polyester (4 off)
C5, C6, C8	100µ axial elect. 25V (3 off)

Semiconductors

BR1	200V 1.6A in-line bridge rectifier (e.g. SKB2/02L5A)
IC1	L200
IC2	7812
IC3	7805
D1	Red LED (with mounting bezel)

Miscellaneous

T1	20VA mains transformer with two secondary windings, each rated at 6V 1.6A
PL1, PL3	2-way straight p.c.b. header (0.1in pitch) (2 off)
PL2	5-way straight p.c.b. header (0.1in pitch)
SK1, SK2	5-way socket housing (0.1in pitch) (2 off)
FS1, FS2	20mm 1A quick-blow fuses (2 off)
S1	DPST snap-fit rocker-action mains switch

Heatsink, 3.5deg. C/W finned black heatsink approx. 75 x 108 x 14mm (see text); Enclosure, ABS enclosure (220 x 230 x 105 mm) with aluminium front and rear panels; knobs, Styled grub screw fixing knobs with pointers (2 off); terminals, insulated 4mm terminals (1 red, 2 black, 1 blue, 1 yellow); receptacles, (7 off) 110 (0.11in) receptacles (10 off) 250 (0.25in) receptacle covers (7 off) 110 (0.11in) receptacle covers (10 off); mains plug, double fused snap-in IEC chassis plug; printed circuit board (see text) available from the *EE PCB Service*, order code EE710; pillars plastic or aluminium alloy (see text) with self-tapping No. 6 fixing screws (4 off)

Approx cost guidance only **£30** *plus case*

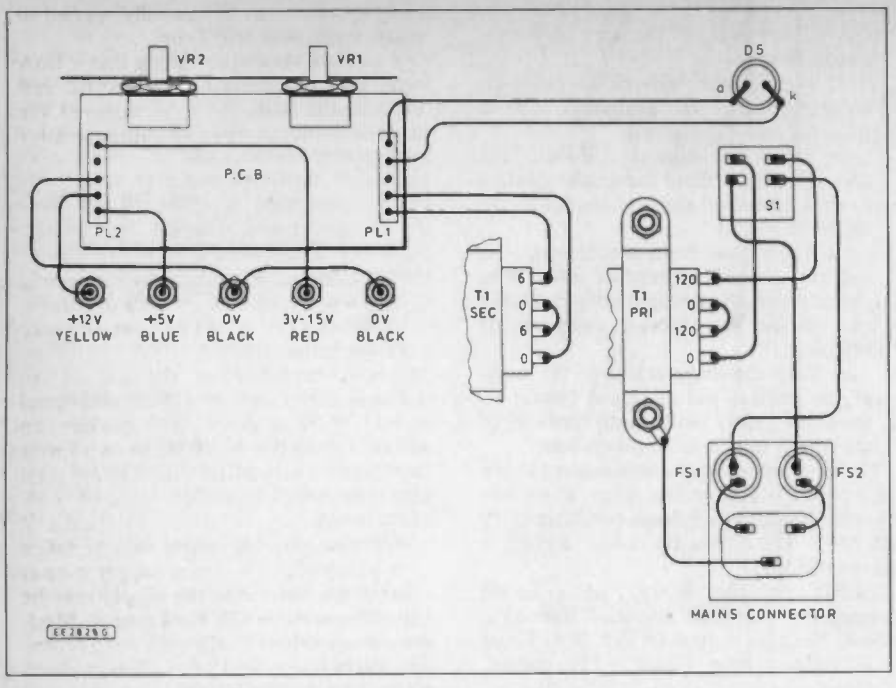


Fig. 5. Internal wiring of the versatile bench power supply.

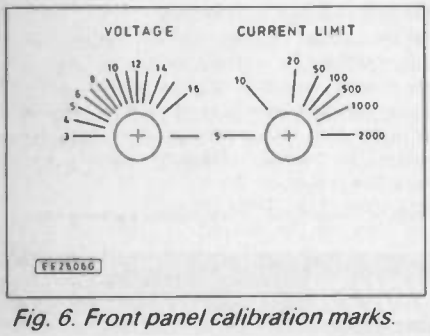


Fig. 6. Front panel calibration marks.

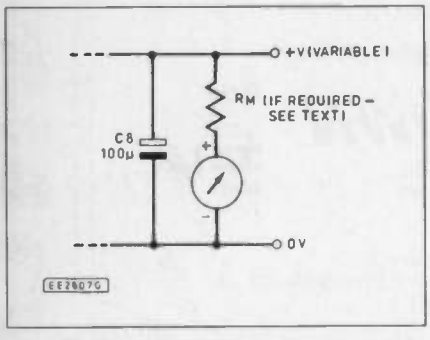


Fig. 7. Connecting a voltmeter to the variable output

within the ranges specified or if the variable output current limit fails to operate as described, it is best to switch off and disconnect the mains power before carefully checking the printed circuit board and internal wiring.

MODIFICATIONS

A number of useful modifications may be made to the basic power supply design. 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.

Additional fixed dual-voltage outputs

The ability to provide dual-voltage outputs (i.e. outputs of identical voltage but of opposite polarity) can be an extremely useful additional facility when dealing with equipment which requires split power supply rails (such as ±5V, ±9V or ±12V). This facility can easily be added to the versatile bench power supply and, in order to support the necessary modification, sufficient space has been left to accommodate a fixed dual-voltage module at the rear of the unit.

The outputs provided by this module can easily be made available via 4 mm screw-terminals fitted to the rear panel whilst the required low-voltage a.c. input (2 × 6V) can be derived from the existing mains transformer (the centre-tap link is taken to the 0V connection on the dual-voltage module). It is important to note that, since the fixed and variable power suppyly modules are not electrically isolated when a common low-voltage a.c. supply is used, the 0V connections should remain separate (i.e. there should be no direct connection between the two modules).

Increased output voltage capability

In some circumstances, the maximum variable output voltage of +15V can be considered something of a limitation. Indeed, under full-load, the output voltage may fall to somewhat less than this value. In order to increase the maximum output voltage to around 22V, the following modifications are required:

(a) Replace the mains transformer, T1, with a suitable rated (30VA, or greater) component with two secondary windings, each rated at 9V 1.6A (or greater).

(b) Replace C1 (4700µ 25V) by a 4700µ axial lead electrolytic rated at 35V (or greater).

(c) Replace C8 (100µ 25V) by a 100µ axial lead electrolytic rated at 35V (or greater).

(d) Replace R1 (2.2ohm 2.5W) by a 4.7ohm vitreous coated wirewound component rated at 6W

(e) Replace the heatsink (3.5 degrees C per Watt) by a similar unit rated at 3 degrees C per Watt (or less).

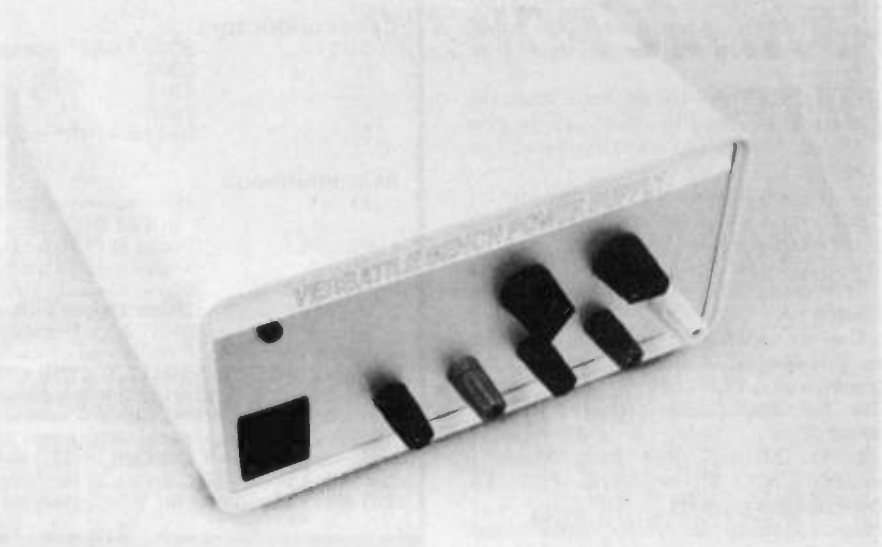
Adding a voltmeter

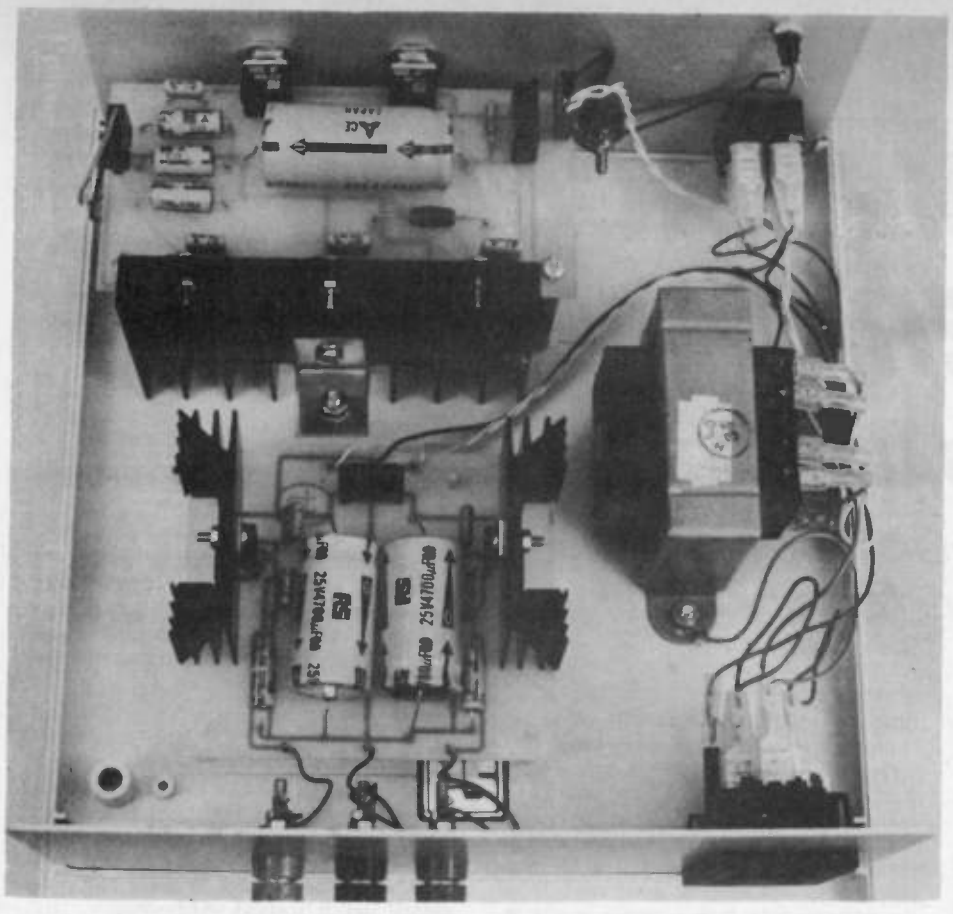
Rather than rely on the front panel calibration marks, a meter can usefully be added to display the output voltage produced by the variable output of the power supply. An analogue meter (based on a moving coil movement) can simply be connected in parallel with the output terminals. If a meter calibrated directly in "volts" is available, it should have a full-scale reading of either 20V or 25V. Such an instrument will generally incorporate the necessary series multiplier resistor and thus no external component will be required. If, on the other hand, a meter calibrated in "µA" or "mA" is to be used, it will require a series resistor (see Fig. 7) the value of which can be determined from the following formula:

$$R = \frac{V}{I_{FS}} - R_M$$

where V is the full-scale deflection voltage (e.g. 20V), I_{FS} is the full-scale deflection current and R_M is the resistance of the moving coil.

I_{FS} will typically be 50µA, 100µA or 1mA and the meter scale will have to be modified so that appropriate increments of voltage (rather than current) are indicated. This is not a particularly arduous task since most meter scales are removable and rub-





An additional ± fixed output board can easily be added as shown above.

down transfers can be carefully applied to produce a professional finish.

As an example and assuming that a 1mA meter movement having an internal coil resistance of 200ohm is to be employed, the required value of series multiplier resistor will be:

$$R = \frac{20V}{1mA} - 200 \text{ ohms}$$

$$\text{thus } R = 20k - 0.2k = 19.8k$$

This value can be realised by connecting an 18k resistor in series with a 1k8 resistor. Both resistors should be close tolerance ± 5% (or better) types.

As an alternative to the use of an analogue meter and at a little additional expense, a digital panel meter module can be used. These are available in two forms with either l.e.d. and l.c.d. displays and require a separate supply voltage of + 5V (l.e.d.) or typically + 7.5V to 15V (l.c.d.).

In the first case, the supply may be taken from the fixed + 5V power supply output whilst in the latter case the supply may be derived from the + 12V fixed output. Modules are usually provided with comprehensive connecting instructions. It is perhaps worth stating that the l.e.d. types offer very much improved readability under poor lighting conditions and thus can readily justify the slightly higher cost.

Front panel mounting of either an analogue meter movement or a digital panel meter module should prove to be reasonably straightforward and an area of no more than about 60 × 46mm (analogue meter) or 72 × 36mm (digital meter module) will be required. □

PCW SOUND GENERATOR

Unispired by your PCW'S "beeping"? This unit gives the PCW three channel stereo sound. The frequency and volume of each channel is software programmable, noise can be added into any or all channels and there is an envelope generator.

TEACH-IN '91 DESIGN YOUR OWN CIRCUITS

The next instalment deals with transistor and operational amplifier circuits. The design problem involves a microphone preamplifier and the Teach-In '91 Project is an INTERCOM SYSTEM.

SPATIAL POWER DISPLAY

An attractive and novel way of monitoring the output from a stereo system. This unit will provide four separate visual displays representing the output from each of the four speakers in a car hi-fi system. It can also be used with other audio equipment.
If you like flashing lights, knobs, whistles and all the gadgets then this is for you!

EVERYDAY ELECTRONICS

JANUARY ISSUE ON SALE 7TH DECEMBER 1990

NEXT MONTH

12V LAMP/VACUUM CLEANER CHARGER

T. R. de VAUX-BALBIRNIE

A lamp or vacuum cleaner charger for the family on the move

SMALL rechargeable lamps and vacuum cleaners of the Black & Decker "Dustbuster" type are very popular. These contain nickel-cadmium batteries which are kept charged from the mains using a small plug-in unit. Such lamps and vacuum cleaners are useful for general jobs inside the car, caravan or boat. However, on trips away from home where no mains supply is available, they are of limited use. This is because the operating time available from one charge is quite short.

OPERATION

The present circuit temporarily replaces the existing mains unit and enables charging to be effected from a 12V d.c. source (car battery). The appliance may then be kept charged from the car system or from a caravan or boat supply. The lamp or vacuum cleaner may then be used just as it is at home.

The unit may be used to charge lamps, vacuum cleaners or other appliances operating from up to 8 cells (nominally 9.6V). It may also be used as a "straight" general purpose nickel-cadmium battery charger. No modification is made to the lamp or vacuum cleaner itself – apart from fitting an additional socket – so mains charging may be resumed at any time.

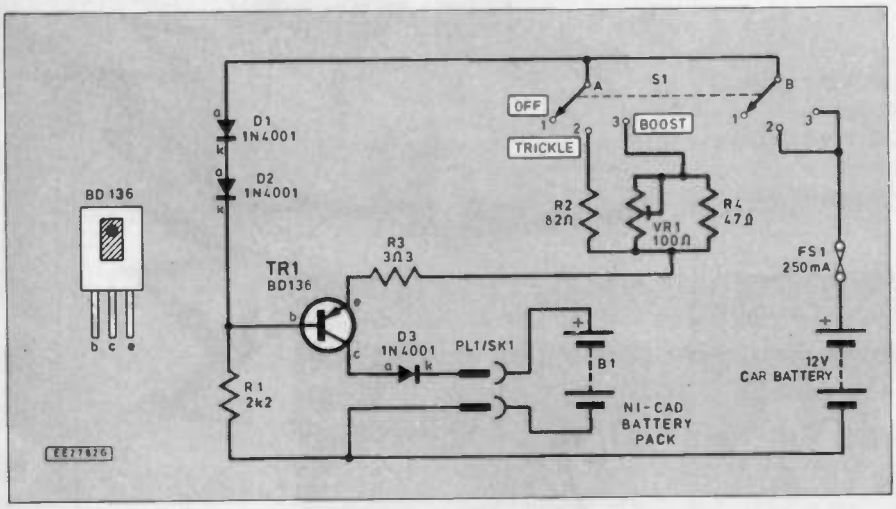
The 12V Lamp/Vacuum Charger is very straightforward to construct but note that a milliammeter (or multi-tester) will be needed at the setting-up stage. This can probably be borrowed if one is not owned – an inexpensive one will be quiet good enough for the purpose since high accuracy is not required. Since the metal case is connected to the negative supply, the device is **suitable for negative-earth systems only.**

The charger has a three-position switch providing "off", "trickle" and "boost" charging. The "boost" setting will bring totally discharged batteries back to full charge in approximately 16 hours. No harm will result if the switch is left in this position continuously but this practice is thought to reduce the life of the batteries somewhat and wastes power.

The "trickle" setting will normally be used for continuous charging. The load of 10mA approximately here imposes negligible drain on the charging battery. The circuit is fitted with a fuse which will guard against circuit failure accompanied by gross overcharging.

Nickel-cadmium batteries (Ni-Cads) require constant current charging. The circuit must therefore be designed to provide a steady output current despite quite wide variations in the operating voltages. Thus, as the terminal voltage of the nickel-cadmium cells rises or when the input voltage changes, correct charging will be maintained.

Fig. 1. Complete circuit diagram for the 12V Lamp/Vacuum Cleaner Charger.



CIRCUIT DESCRIPTION

The circuit for the 12V Lamp or Vacuum Charger is shown in Fig. 1. S1 is a 4-pole 3-position slide switch but only two poles are used in this application – poles A and B. It would be possible to use a two-pole rotary switch instead. Alternatively, two two-position slide switches – one to select charging mode and the other for on-off switching could be used. In this circuit, pole B is responsible for on-off switching while pole A provides circuit changes for trickle/continuous settings.

With S1 in position 1 (OFF), the supply positive feed is disconnected from the rest of the circuit. In position 2 (TRICKLE) and 3 (BOOST), pole B connects the supply. Current now flows through diodes D1 and D2 connected in series and through resistor, R1. Since a forward biased silicon diode develops 0.7V approximately between its ends, there will be 1.4V appearing between the base of transistor TR1 and the positive supply line.

Note that TR1 is a *pnp* transistor rather than the more usual *npn* type. The emitter of TR1 has resistor, R3, and either resistor, R2, or the network consisting of fixed resistor R4 connected in parallel with preset, VR1, connected to the positive supply line according to whether S1 is in position 2 (TRICKLE) or 3 (BOOST).

With TR1 carrying base current via R1, the transistor is biased on and approximately 0.7V will appear between base and emitter. There will therefore be approximately 1.4V – 0.7V = 0.7V appearing between TR1 emitter and the positive supply line. By selecting suitable values for R2, R3, R4 and VR1 the current flowing may be controlled.

The emitter current is the sum of the collector current and base current but since the base current is small, the collector and emitter currents are virtually the same. The nickel-cadmium battery pack, B1, is connected in the collector circuit through plug and socket, PL1/SK1, so its charging current is practically the same as the emitter current. Diode, D3, prevents current possibly draining from the nickel-cadmium cells into the rest of the circuit if S1 is switched off.

CHARGING CURRENT

Suppose a charging current of 120mA is required (a typical value) with the circuit on BOOST. Using Ohm's Law for the emitter resistance: $R = V/I = 0.7/0.12 = 6$ ohms approximately. Since R3 is fixed at 3Ω3, VR1 will need to be adjusted to 3 ohms approximately. The meter referred to earlier will be needed to get this figure right since the predicted value may vary by a small margin from the theoretical one. The value of resistor, R2, sets the trickle current to 8mA approximately and no adjustment is allowed for here since its value is not critical.

The predicted current will flow through B1 so long as its total nominal voltage over that of the supply is developed between TR1 collector and emitter. For example, suppose the battery pack is rated at nominal 4.8V (four cells) and the supply is 12V. 0.7V appears across the emitter resistor as explained previously. A further 0.7V is developed across D3 and 4.8V across the battery pack itself. The total excess voltage is therefore $12 - (0.7 + 0.7 + 4..8) = 5.8$V. This will appear between TR1 collector and emitter and will vary during the course of charging to maintain a stable operating current. This will take account of the terminal voltage of B1 rising as the cells charge and variations in the supply voltage.

Transistor TR1 will dissipate power as the product of the voltage between collector and emitter and the current flowing. This will appear as heat. Even if the output terminals were short-circuited, the current as calculated would still flow but now the maximum excess voltage (nominally 10.6V) would appear between collector and emitter. More heat would therefore be produced. TR1 is of a type normally used for audio amplifier applications – in some ways the present circuit behaves like an amplifier with the transistor operating somewhere between cut-off and saturation.

COMPONENTS

Resistors

R1	2k2
R2	82
R3	3Ω3
R4	47

All 0.25W 5% carbon.

See SHOP TALK Page

Potentiometer

VR1 100 sub-miniature horiz. preset.

Semiconductors

TR1 BD136 *pnp* silicon
D1 to D3 1N4001 silicon (3 off)

Miscellaneous

S1 4-pole 3 position slide switch – (see text)
FS1 20mm chassis fuseholder and 250mA quick-blow fuse to suit.

Stripboard 0.1 in. matrix, size 13 strips x 11 holes; aluminium box size 76 x 51 x 25mm; T0126 mounting kit; rubber grommets (2 off); adhesive fixing pads; 2.1mm power in plug and socket to suit; two-core stranded wire; "rainbow" ribbon cable; self-adhesive plastic feet (4 off).

Approx cost guidance only **£7**

PRE-CONSTRUCTION CHECK

Before commencing construction of the main unit, the appliance must be partly dismantled to fit the power-in socket. It is also necessary to determine the number and type of cells inside. This is usually a simple matter of removing a few self-tapping screws which hold the two halves of the case together. Any number of cells up to eight is satisfactory four being common.

While inspecting the cells, take note of their size (height and diameter) and whether any additional circuitry exists inside the case. If there is additional circuitry, apart from the lamp motor and on-off switch, it will be as well to abandon the project. However, it may be possible to use the "break" contacts on the power-in socket to isolate it when the plug is inserted. A typical arrangement is shown in Fig. 2.

Look for a free space for the power-in socket (perhaps in the handle as in the prototype – see photograph), drill a hole and mount it. Note that the single hole mounting type gives a neater appearance than the two-hole fixing variety. Check that the internal batteries are connected direct to the mains charger connector and connect the new socket direct to these using light-duty twin stranded wire. Alternatively, make the connections direct to the solder tags on the batteries themselves.

Take note which connection is the positive one so that the new charger will be connected with the correct polarity later. This is essential as damage will be caused if it is connected to the nickel-cadmium cells in the wrong sense. When this work has been checked, the unit may be re-assembled.

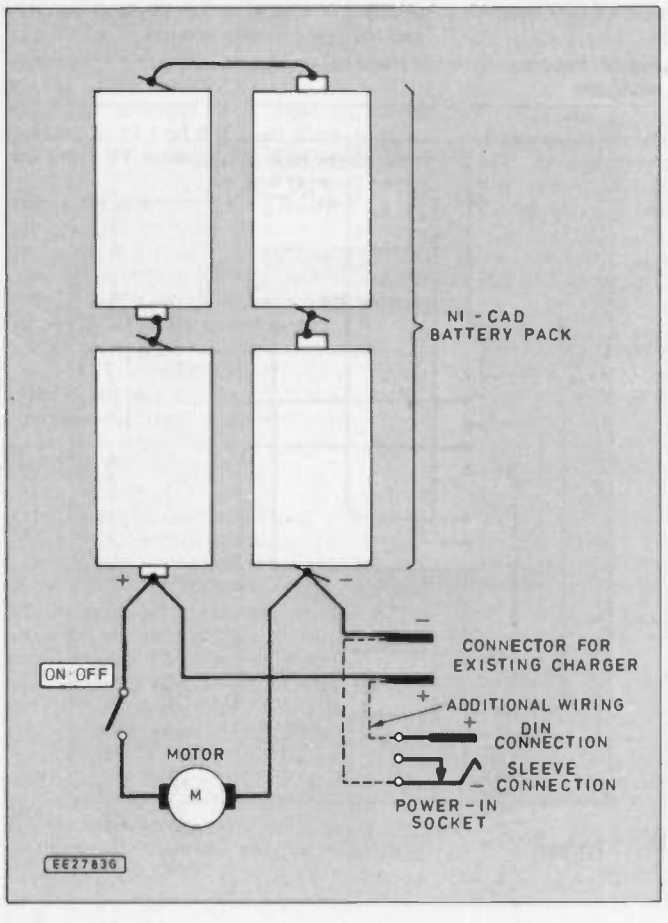
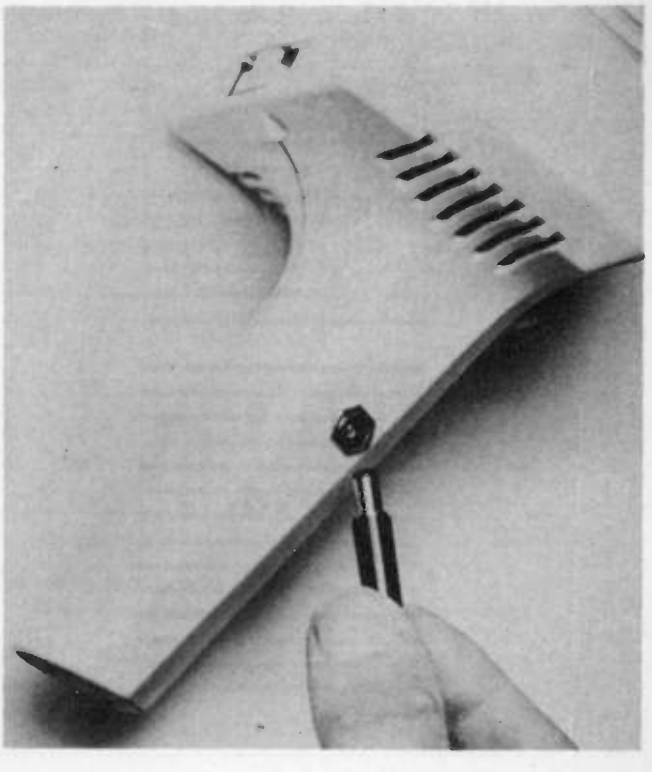


Fig. 2 (left). Adding a power-in socket to the existing low voltage vacuum cleaner.

(below). The power-in socket installed in the handle of the appliance.



CONSTRUCTION

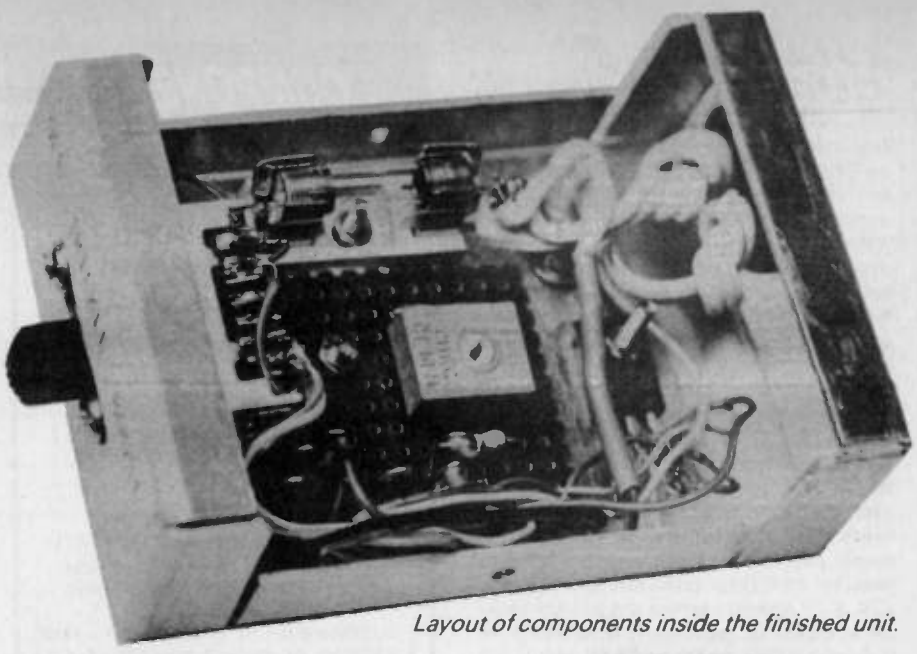
The circuit is built chiefly on a piece of 0.1 in. matrix stripboard, size 13 strips x 11 holes (see Fig. 3). Begin by cutting this to size, drilling the single mounting hole and make the track breaks and inter-strip link. After a careful check for errors, the soldered on-board components should be added. Take care over the polarity of the three diodes. Solder 8 cm pieces of light-duty stranded connecting to wire copper strips *A, C, D, E, F, G, I* and *L* as indicated. Using different coloured wires e.g. "rainbow" ribbon cable here will help in avoiding wiring errors.

Note: Since the case is used as a heatsink for transistor TR1, an aluminium box must be used.

Drill holes in the box for input and output leads also for S1, FS1, TR1, circuit panel and solder tag mounting. Fit rubber grommets in the input/output lead holes. Mount S1 – some packing will be needed between the body and case so that the plastic slider does not protrude too far on the outside.

Mount all remaining components but do not attach the circuit panel yet. Complete the internal wiring (see Fig. 4) noting that TR1 must be attached using a mounting kit. This will isolate it from the metalwork electrically yet allow the free flow of heat. Note that S1 wiring refers to the particular type of switch used in the prototype unit. This may need to be modified to suit the particular switch or switches being used.

Input and output leads consist of pieces of light-duty twin stranded wire. Figure-of-8 loudspeaker wire is ideal since one wire is striped and this may be used to denote the positive one. Put strain relief clamps on the input and output leads inside the case to prevent them from pulling free in service. Note the connection between the wire leading from strip *F* on the circuit panel and the positive output lead. This joint must be properly sleeved to prevent short-circuits.



Layout of components inside the finished unit.

Place three or more adhesive fixing pads on the copper strip side of the circuit panel. These will keep all connections well clear of the metalwork when it is in position. Attach the panel securely using an 8BA fixing through the hole drilled for the purpose. Insert the fuse into its holder. Note that all components are mounted on the base section of the box with nothing on the lid. Fit the base of the case with self-adhesive plastic feet. Switch S1 "off" and leave VR1 adjusted fully anticlockwise.

TESTING

Make a basic test by connecting the output wires direct to the miliammeter observing the polarity. If a multitester is being used for this purpose, it should be set to a d.c. current range of not less than 250mA full-scale deflection. Connect the input wires to the supply, again, observing the polarity. For this test, a 9V PP9 battery in good condition will do.

Switch S1 to "TRICKLE". A current in the region of 10mA should be indicated. Now switch to "BOOST". The meter should read about 10 to 20mA which may be increased by rotating VR1 clockwise. Do not exceed 200mA – although it may be impossible to reach this figure anyway. Set the current to the correct value.

If "C" size cells are used (27mm high x 49mm diameter) then 150 to 200mA would be correct. Sometimes specialist sizes are used – the Dustbuster uses so-called "RR" cells 42mm high x 23mm diameter) and here 100 to 120mA would be appropriate. Where "AA" cells are used (50mm high x 14mm diameter) then 30-40mA is suitable.

Solder the output wires to the power-in plug. Fit the input wire with a plug appropriate to the existing installation. The switch may now be labelled, the case assembled – checking for trapped wires – and the unit put into service. □

Fig. 3. Stripboard component layout and details of breaks in the underside tracks (not to scale).

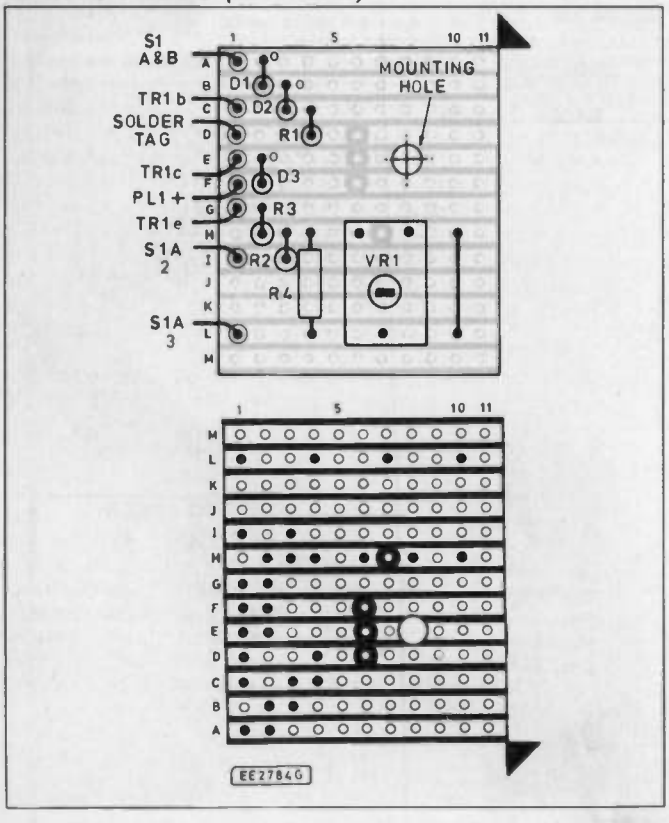
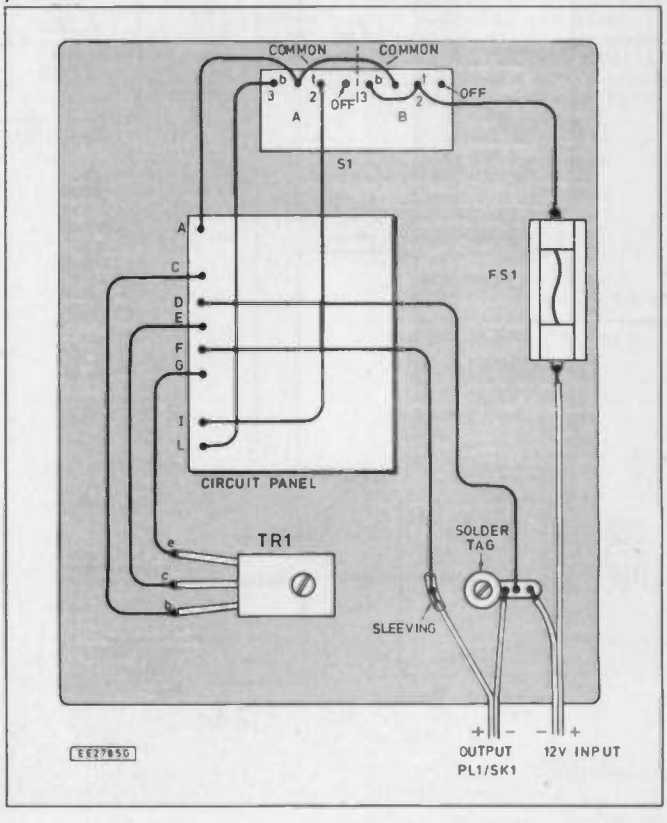


Fig. 4. Interwiring from the circuit boad to all off-board components.



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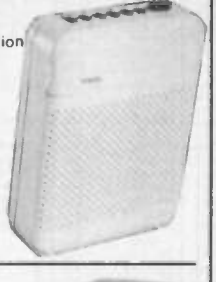

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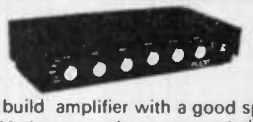

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AF124	50p
AF125	50p
AF126	50p
AF127	50p
AF139	30p
AF239	30p
AF379	45p
BA145	10p
BA148	10p
BA154	6p
BA157	12p
B8105B	18p
B8205B	24p
BC107	8p
BC108	8p
BC109	8p
BC109C	10p
BC115	10p
BC118	11p
BC140	20p
BC141	20p
BC142	20p
BC143	20p
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BC637	20p
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BC640	20p
BCY32	200p
BCY33	200p
BCY34	200p
BCY70	16p
BCY71	16p
BCY72	16p
BD115	30p
BD124P	50p
BD124	110p
BD131	25p
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BD826	50p
BD828	50p
BD875	50p
BD897	50p
BD899	50p
BD901	50p
BD977	50p
BDX32	100p
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BDX53	60p
BDX65	80p
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BDY20	100p
BDY92	100p
8F137	35p
BF154	25p
BF167	30p
BF173	40p
BF178	30p
BF180	16p
BF181	18p
BF183	20p
BF185	20p
BF194	7p
BF195	7p
BF196	8p
BF197	10p
BF198	10p
BF199	8p
BF200	16p
BF225	30p
BF240	16p
BF245	25p
BF254	15p
BF255	12p
BF256	18p
BF257	18p
BF258	18p
BF259	18p
BF262	25p
BF263	25p
BF270	18p
BF273	15p
BF311	21p
BF324	25p
BF336	20p
BF337	20p
BF338	20p
BF355	28p
BF362	30p
BF367	13p
BF371	17p
BF392	18p
BF420	16p
BF421	18p
BF422	21p
BF423	25p
BF450	20p
BF455	14p
BF458	19p
BF459	19p
BF461	60p
BF462	52p
BF469	30p
BF470	28p
BF471	28p
BF472	28p
BF479	30p
BF493	18p
BF494	16p
BF495	16p
BF506	25p
BF595	16p
BF596	16p
BF615	30p
BF617	30p
BF757	40p
BF758	41p
BF759	40p
BF760	40p
BF763	40p
BF869	22p
BF870	22p
BF871	22p
BF872	23p
BF960	38p
BF961	35p
BF963	40p
BF964	38p
BF966	40p
BFR40	25p
BFR79	25p
BFR90	52p
BFR91	99p
BFT37	130p
BFT42	30p
BFT43	30p
BFT84	30p
BFW92	35p
BFX29	20p
BFX84	20p
BFXB5	20p
BFX87	15p
BFX88	15p
BFX89	60p
BFY17	30p
BFY18	40p
BFY50	14p
BFY51	14p
BFY52	14p
BFY56	25p
BFY64	25p
BFY90	45p
BLY48	85p
BR100	14p
BR101	43p
BR103	37p
BR303	85p
BRY39	55p
BRY49	38p
BRY56	33p
BS574	33p
BSX20	15p
BSX26	18p
BSX29	19p
BT100A	70p
BT106	180p
BT109	90p
BT116	80p
BT119	100p
BT138	60p
BT146	99p
BT151	58p
BTY79	140p
BU100A	110p
BU104	100p
BU105	80p
BU108	100p
BU109	100p
BU110	110p
BU111	140p
BU124	60p
BU126	70p
BU180	150p
BU184	100p
BU204	75p
BU205	70p
BU206	100p
BU208	70p
BU208D	80p
BU209	140p
BU225	190p
BU226	190p
BU312	120p
BU325	55p
BU326	75p
BU406	85p
BU406D	95p
BU407	60p
BU407D	95p
BU408	85p
BU408D	95p
BU409	95p
BU426A	75p
BU500	110p
BU508A	85p
BU508D	90p
BU536	150p
BU526	80p
BU546	140p
BU608	150p
BU626	150p
BU636	150p
BU801	95p
BU806	80p
BU807	75p
BU902	130p
BU903	130p
BU920	130p
BU921	130p
BU922	130p
BU930	130p
BUT11A	90p
BUT56A	250p
BUX80	180p
BUX82	180p
BUX84	50p
BUX85	50p
BUY69A	200p
BUY71	300p
C106D	28p
MEO411	38p
MEO414	125p
ME3001	12p
ME4103	12p
ME6001	12p
ME6002	15p
ME8001	15p
ME9021	12p
MJ802	350p
MJ900	200p
MJ1000	200p
MJ1001	200p
MJ10012	300p
MJ15001	325p
MJ15002	300p
MJ15003	325p
MJ15004	370p
MJ15022	400p
MJ2501	110p
MJ2955	55p
MJ3000	115p
MJ3001	115p
MJE29A	30p
MJE30A	30p
MJE340	25p
MJE350	80p
MJE520	30p
MJE2955K	90p
MP8111	40p
MP8112	45p
MP8113	55p
MP8512	50p
MPS65781	20p
MPS9012	20p
MPS9013	20p
MPS9014	20p
MPS9015	20p
MPSA05	15p
MPSA06	15p
MPSA13	15p
MPSA20	15p
MPSA42	15p
MPSA43	15p
MPSA65	25p
MPSA66	25P
MPSA70	15p
MPSA92	20p
MPSA93	20p
MR510	35p
MR856	36p
OC28	250p
OC29	250p
OC35	250p
OC36	250p
OC45	50p
OC71	30p
OC72	50p
OC200	180p
OT121	120p
R2008B	100p
R2010B	100p
S2800D	52p
S2800M	72p
T2800D	52p
T2800M	72p
TIP29	15p
TIP29A	22p
TIP29C	25p
TIP30	25p
TIP30C	30p
TIP31A	24p
TIP31C	30p
TIP32	24p
TIP32A	24p
TIP32C	28p
TIP33	50p
TIP33C	60p
TIP34	50p
TIP34C	60p
TIP35C	65p
TIP36C	65p
TIP41A	22p
TIP41C	25p
TIP42A	22p
TIP42C	25p
TIP47	40p
TIP48	40p
TIP49	45p
TIP50	60p
TIP51	120p
TIP52	120p
TIP53	120p
TIP54	140p
TIP105	65p
TIP106	65p
TIP107	65p
TIP110	47p
TIP111	50p
TIP112	40p
TIP115	45p
TIP116	45p
TIP117	50p
TIP120	43p
TIP121	46p
TIP122	47p
TIP125	47p
TIP126	56p
TIP127	56p
TIP130	30p
TIP131	30p
TIP132	30p
TIP141	90p
TIP142	90p
TIP145	65p
TIP146	90p
TIP147	100p
TIP150	90p
TIP151	90p
TIP2955	42p
TIP3054	45p
TIP3055	42p
TIS44	40p
TIS61	15p
TIS90	15p
TIS91	18p
VK1010	88p
VN10KM	60p
VN66AF	100p
VN88AF	115p
ZTX107	11p
ZTX108	11p
ZTX109	12p
ZTX212	27p
ZTX300	13p
ZTX301	16p
ZTX302	16p
ZTX303	24p
ZTX304	17p
ZTX320	29p
ZTX500	13p
ZTX501	13p
ZTX502	18p
ZTX503	18p
ZTX504	25p
ZTX550	24p
2N 696	26p
2N 697	22p
2N 698	40p
2N 706	22p
2N 708	22p
2N 914	28p
2N 930	18p
2N 1131	28p
2N 1132	28p
2N 1613	24p
2N 1711	24p
2N 1893	30p
2N 2102	50p
2N 2218A	24p
2N 2219	24p
2N 2221	23p
2N 2222	23p
2N 2369	15p
2N 2484	20p
2N 2646	40p
2N 2904	20p
2N 2905	20p
2N 2906	18p
2N 2907	18p
2N 2926	8p
2N 3019	28p
2N 3053	18p
2N 3054	40p
2N 3055	38p
2N 3055H	50p
2N 3440	58p
2N 3442	85p
2N 3583	90p
2N 3585	120p
2N 3702	9p
2N 3703	9p
2N 3704	9p
2N 3705	9p
2N 3706	9p
2N 3707	9p
2N 3708	9p
2N 3710	12p
2N 3711	12p
2N 3771	85p
2N 3772	90p
2N 3773	110p
2N 3799	18p
2N 3819	29p
2N 3866	68p
2N 3903	11p
2N 3904	11p
2N 3905	11p
2N 3906	11p
2N 4031	25p
2N 4036	25p
2N 4037	25p
2N 4062	12p
2N 4064	100p
2N 4401	12p
2N 4403	12p
2N 4443	76p
2N 5061	20p
2N 5088	20p
2N 5163	45p
2N 5192	50p
2N 5241	500p
2N 5245	45p
2N 5294	30p
2N 5296	30p
2N 5320	90p
2N 5321	60p
2N 5366	25p
2N 5401	12p
2N 5448	12p
2N 5496	80p
2N 6107	40p
2N 6109	40p
2N 6254	110p
2N 6292	40p
2N 6384	120p
2N 6385	120p
2N 6403	160p

DIODES RECTIFIER DIODES

BY100	40p
BY103	32p
BY126	6p
BY127	8p
BY133	8p
BY164	40p
BY179	35p
BY184	32p
BY196	20p
BY206	11p
BY207	11p
BY208	18p
BY210	22p
BY225	120p
BY226	18p
BY227	19p
BY228	32p
BY296	20p
BY298	26p
BY299	28p
BYX10	15p
BYX55/350	30p
BYX55/600	30p
BYX70/500	32p
BYX70/800	36p
OA91	8p
OA200	7p
OA202	7p
IN 914	2p
IN 4001	4p
IN 4002	4p
IN 4003	4p
IN 4004	4p
IN 4005	4p
IN 4006	4p
IN 4007	5p
IN 4148	2p
IN 5400	9p
IN 5401	10p
IN 5402	10p
IN 5403	11p
IN 5404	11p
IN 5405	12p
IN 5406	13p
IN 5407	13p
IN 5408	13p
SKE4F2/06	50p
SKE4F2/08	70p
SKE4F2/10	90p

I.C. SOCKETS

8 PIN	6p
14 PIN	8p
16 PIN	9p
18 PIN	12p
20 PIN	14p
22 PIN	16p
24 PIN	18p
28 PIN	20p
40 PIN	25p

ZENER

400 MV BZY88 RANGE
2V7 TO 39V 6p
1.3W
BZX61 RANGE
2V7 TO 39V 12p

VOLTAGE REGULATORS

7805	35p
7806	35p
7808	35p
7812	35p
7815	35p
7818	35p
7824	35p
7905	35p
7906	40p
7908	40p
7912	40p
7915	40p
7918	40p
7924	40p
78L05	28p
78L08	28p
78L12	28p
78L15	28p
78L18	28p
78L24	28p
79L05	40p
79L08	40p
79L12	40p
79L15	40p
78T8KC	100p
7824KC	100p
LM309K	100p
LM317K	220p
LM317T	180p
LM323K	420p
LM723	40p
78HGKC	570p
78H05KC	800p
78H12KC	700p
78GU1C	190p
79GU1C	215p
79HGKC	800p

L.E.D.'S

LED 3MM RED	5p
LED 3MM	
YELLOW	10p
LED 3MM	
GREEN	10p
LED 5MM RED	5p
LED 5MM	
YELLOW	10p
LED 5MM	
GREEN	10p

RECTANGULAR L.E.D.'S

RED	10p
GREEN	15p
YELLOW	15p

LINEAR IC's

LF-347	110p
LF-351	45p
LF-353	48p
LF-355	60p
LF-356	60p
LF-357	70p
LF-398	300p
LM-301	26p
LM-307	42p
LM-308CN	70p
LM-311	35p
LM-318	120p
LM-319	165p
LM-324	35p
LM-334Z	115p
LM-335Z	120p
LM-337	250p
LM-339	37p
LM-348	55p
LM-358	45p
LM-377	220p
LM-380	100p
LM-381	150p
LM-382	130p
LM-384	130p
LM-386	85p
LM-387	100p
LM-392	100p
LM-393	55p
LM-709DIL	30p
LM-710	45p
LM-711	85p
LM-723	40p
LM-733	60p
LM-741DIL	18p
LM741MET	45p
LM-747	58p
LM-748	35p
LM-1458	33p
LM-1889	400p
LM-3900	40p
LM-3909	80p
LM-3911	160p
LM-3914	250p
LM-3915	255p
LM-3916	290p
MB-3515	240p
MB-3614	180p
MB-3712	140p
MB-3713	130p
MB-3714	270p
MB-3715	250p
MB-3722	310p
MB-3730	200p
MB-3731	300p
MB-3756	230p
MB-3759	200p
MB-8719	360p
MC-1310P	130p
MC-1455	45p
MC-1458	33p
MC-1469	290p
MC-1488	65p
MC-1489	65p
MC-1496	65p
MC-3302	70p
MC-3401	45p
MC-3403	60p
MC-3423	75p
NE-531	115p
NE-544	170p
NE-555	20p
NE-556	40p
NE-565	110p
NE-566	130p
NE-567	115p
NE-570	360p
NE-571	290p
NE-592	85p
NE-5532P	140p
NE-5534P	110p

74 SERIES

7400	20p
7401	16p
7402	18p
7403	20p
7404	35p
7405	10p
7406	36p
7407	36p
7408	25p
7409	20p
7413	30p
7414	45p
7416	40p
7417	32p
7420	22p
7421	25p
7425	15p
7430	25p
7437	28p
7438	32p
7442	38p
7447	60p
7450	22p
7451	10p
7454	25p
7470	30p
7473	35p
7474	35p
7475	25p
7481	90p
7482	60p
7485	28p
7486	28p
7489	75p
7490	35p
7492	45p
7493	35p
7495	48p
7497	80p
74107	30p
74111	52p
74116	85p
74119	85p
74122	40p
74123	20p
74125	40p
74126	45p
74132	42p
74141	55p
74145	70p
74153	45p
74155	45p
74157	45p
74160	50p
74164	50p
74167	35p
74173	50p
74174	60p
74175	65p
74176	45p
74180	50p
74182	45p
74192	40p
74196	40p
74197	45p
74393	70p

74LS SERIES LOW POWER SCHOTTKY T.T.L.

74LS00	12p
74LS01	12p
74LS02	12p
74LS03	12p
74LS04	12p
74LS05	12p
74LS08	12p
74LS09	14p
74LS10	12p
74LS11	12p
74LS12	12p
74LS13	20p
74LS14	24p
74LS15	14p
74LS20	14p
74LS21	14p
74LS22	14p
74LS24	35p
74LS26	14p
74LS27	14p
74LS28	14p
74LS30	14p
74LS32	15p
74LS33	15p
74LS31	15p
74LS38	15p
74LS40	15p
74LS42	25p
74LS47	52p
74LS48	48p
74LS51	13p
74LS54	13P
74LS55	15p
74LS73	24p
74LS74	18p
74LS75	24p
74LS76	24p
74LS78	24p
74LS83	37p
74LS85	37p
74LS86	25p
74LS90	26p
74LS91	55p
74LS92	32p
74LS93	26p
74LS95	41p
74LS96	52p
74LS107	28p
74LS109	28p
74LS112	28p
74LS113	28P
74LS114	28p
74LS122	35p
74LS123	35p
74LS124	85p
74LS125	30p
74LS126	30p
74LS132	30p
74LS133	30p
74LS136	30p
74LS138	28p
74LS139	28p
74LS145	65p
74LS147	90p
74LS148	75p
74LS151	27p
74LS153	31p
74LS154	78p
74LS155	36p
74LS156	36p
74LS157	22p
74LS158	27p
74LS160	38p
74LS161	38p
74LS162	38p
74LS163	36p
74LS164	36p
74LS165	50p
74LS166	55p
74LS168	60p
74LS169	55p
74LS170	68p
74LS174	30p
74LS175	32p
74LS190	47p
74LS191	43p
74LS192	41p
74LS193	41p
74LS194	41p
74LS193	44p
74LS196	45p
74LS197	42p
74LS221	45p
74LS240	45p
74LS241	42p
74LS242	43p
74LS243	50p
74LS244	40p
74LS245	40p
74LS247	40p
74LS248	40p
74LS249	70p
74LS251	24p
74LS253	36p
74LS256	52p
74LS257	32p
74LS258	35p
74LS259	50p
74LS260	30p
74LS266	22p
74LS273	44p
74LS279	33p
74LS280	88p
74LS283	51p
74LS290	26p
74LS293	26p
74LS365	26p
74LS366	31p
74LS367	28p
74LS368	30p
74LS373	45p
74LS374	45p
74LS375	46p
74LS390	42p
74LS393	37p
74LS399	68p
74LS629	95p
74LS641	88p
74LS642	105p
74LS644	105p
74LS645	105p
74LS670	62p
74LS674	310p
74LS687	250p

COMPUTER IC'S

2114	200p
2532	330p
2716	200p
2732	280p
2732A	300p
2764	240p
27C64	550p
27128	310p
27256-25	400p
41256-15	240p
4116	75p
4164-15	150p
6116	150p
6264-12	300p
6502	300p
6502A	400p
65C02	930p
6503	570p
6520	170p
6522	330p
6532	460p
6545	880p
6551	530p
6800	210p
6802	220p
6803	800p
6808	500p
6809	600p
6810	150p
6818	380p
6820	140p
6821	140p
6840	310p
6845	620p
6850	110p
8080A	400p
8085A	300p
8086	500p
8088	500p
8155	360p
8156	300p
81LS95	120p
81LS96	130p
81LS97	130p
81LS98	130p
8224	240p
8226	240p
8243	250p
8250	850p
8251	270p
8253	230p
8255	200p
8256	1200p
8257	220p
8259	280p
8271	3400p
8279	270p
8284	440p
8288	650p
8748	1100p
8755	1400p
AY3-1015	290p
SP0256AL2	500p
Z80ACPU	150p
Z80BCPU	400p
Z80ADMA	500p
Z80AP10	220p
Z80BP10	340p
Z80ACTC	200p
Z80BCTC	320p
Z80AS10	460p
Z80AS10-1	580p
Z80AS10-2	580p
Z80ADART	500p

SPECIAL OFFER ORAMS

4164-15	150p
4164-12	175p
41256-10	260p
41256-12	240p
41256-15	220p
41464-12	360p
41464-10	430p
256KX4	1000p
1MBRAM-B	1080p
1MBRAM-10	1000p

SIPP

256KX9-10	3000p
256KX9-8	3800p
256KX9-7	5200p
256KX9-6	6500p

SRAMS

6264LP15	250p
6264LP12	280p
6264LP10	300p
32KX8-12	800p
62256-12	800p
27512	580p

SIMMS

1MX9-10	9500p
1MX9-8	9800p
1MX9-7	10500p
2MX9-10	39000p
4MX9-80	78000p

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DOWN TO EARTH

George Hylton

SIMPLE VOLTAGE CHANGING

WHILE on holiday we bought a car accessory called a Seven-Output DC/DC converter. It plugged into the cigar lighter socket (i.e to the 12V car battery). A switch enabled it to be set up for outputs of 1.5V, 3V, 4.5V, 6V, 7.5V, 9V and 12V d.c.

The outputs were taken to a cable terminated in one of those hydra-headed jacks capable of being plugged into almost any d.c. power socket on a radio, tape recorder, etc.. The stated output was 500mA max. Handy; but how did it work?

PERFORMANCE

The circuit diagram is given in Fig. 1 (omitting a l.e.d. and a polarity-reversal switch, irrelevant here). The performance, when powered by a 12.2V d.c. supply is given in Fig. 2.

The mode of operation is simple enough. The chain of resistors R1 to R7 forms a voltage divider (see Fig 1). The voltage-selecting switch S1 picks off one of the preset voltages and applies it to the base of TR1 (a small silicon power transistor, type unknown).

The transistor is connected as an emitter-follower and passes on a voltage to the output. With an ideal "follower" this would be the same as the selected input. In practice it is lower by about 0.7V, the base-emitter voltage (V_{BE}) of TR1.

Because of this base-emitter drop it is necessary to apply voltages to the base about 0.7V higher than the nominal output voltages. If the input voltage were exactly 12V, if the resistances were exactly as shown, and if the transistor drew no base current then the divider voltages would have the values shown in brackets.

These are all above the nominal outputs but not by equal amounts. However, it must be remembered that the actual terminal voltage of a charged 12V car battery is a variable quality. For a fully charged car battery it is typically 12.6V but may rise to 14V or even more when the battery is on charge.

On the other hand, in cars with sealed batteries, where it would be dangerous to reach high voltages, automatic controls may restrict the voltages to somewhere close to the nominal 12V. And, should the battery get exceptionally run down, the voltage may be less than 12V.

Clearly, the designer must compromise by choosing a plausible battery voltage to give the best compromise on voltage accuracy. To get an output of 1.5V it is necessary to apply about 2.2V to TR1, which is why resistor R7 is higher than the other resistances. From 1.5V, the outputs rise in steps of 1.5V so the flow through the divider chain ought to provide increments of 1.5V.

BASE CURRENT LOADING

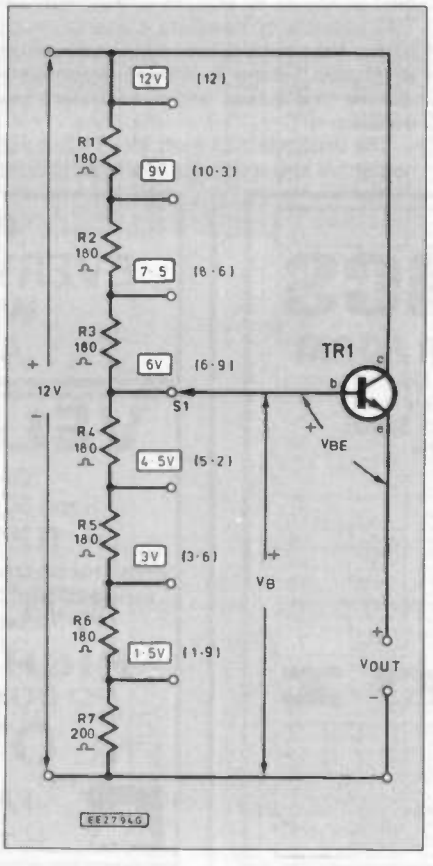
From the measured performance with the 12.2V input I used, the output voltages up to 9V are close to their nominal values when the output current is 400mA. The 12V output setting is less, but on this range the circuit doesn't really work, because the base and collector are connected together and the transistor behaves as a diode.

The designer has to allow for the effect of base current. This increases the voltage drop in all resistors above the tap point, and so pulls the output down a little.

How much? The base current depends on the current gain of the transistor. To make the circuit operate consistently the current gain should be precisely known. In practice, of course, it is variable.

A good compromise is to bleed as much current as is reasonable through the divider and to use a high gain transistor. This way the effect of base current is minimised and, provided the divider passes several times the maximum base current the effect of variations is small.

Fig. 1. Car Voltage Converter circuit diagram.



VOLTAGE VARIATIONS

The performance curves (Fig.2) show, however, that variations are not negligible. On the 6V range, for example, the output is about 7V at low loads, falling to about 5.7V at maximum load. These voltages must suffer further variations as the car battery charges up or runs down.

With the car battery at 14V the voltage settings will all go about 15 per cent higher. At 11V, all go about 10 per cent lower. Thus, there seems to be some risk that equipment powered by such a converter may sometimes receive uncomfortably high voltages, and sometimes voltages too low for corrected operation.

It all depends on how tolerant the equipment is. Fortunately, much battery powered equipment is quite tolerant.

Can we do better? Of course we can, if extra complexity and expense are permissible. Instead of a simple emitter follower a proper variable voltage stabiliser could be used. But can we do better at minimal extra cost and complexity?

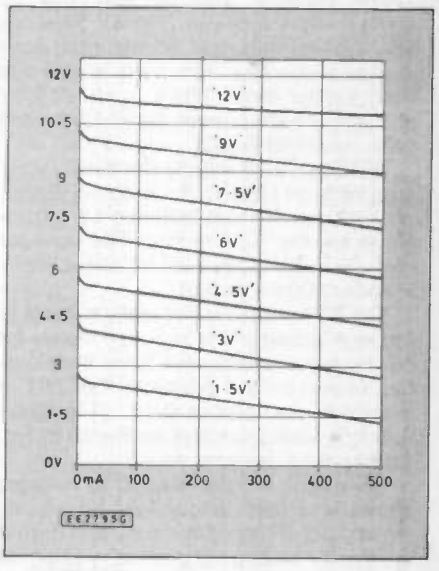


Fig. 2. Car converter circuit outputs.

DARLINGTON OUTPUT

The effect of base current variations can be made negligible by using a compound emitter follower such as the Darlington stage (TR1, TR2) in Fig. 3. Here the effective current gain is the product of the gains of TR1 and TR2. This can easily be several thousand.

The base current of TR1 is very small and imposes little loading on the divider chain. However, it is still necessary for a few milliamps to flow through the divider. Some economy in standby drain can be obtained by using this current to light an indicator l.e.d. D1.A red l.e.d. runs at about 1.6V and the addition of a resistor can bring this up to a suitable voltage to drive the 1.5V output.

Since there are two V_{BE} drops between input and output of the Darlington "pair" the output is about 1.4V less than the input, which must be about 2.9V for 1.5V output. Each resistance above the "1.5V" tap must add 1.5V, until the "9V" tap, which requires 10.4V. Resistor R1 must drop 1.6V if the input is exactly 12V. (The "12V" output has been abandoned in Fig. 3).

Although the effect of base curren: loading is eliminated, the output voltage

of the Darlington circuit still drops as the current drawn is increased. For my test circuit the outputs at 500mA were down by about 0.5V on the low-load value.

The reason is that V_{BE} varies with the base current. If the Darlington has a current gain of 1000 then TR1's current must be 0.5mA at maximum output current, falling to virtually zero for small currents. Transistor TR2's base current varies from nearly zero at low output current to perhaps 10mA-20mA at maximum.

These are wide variations and the V_{BE} drops are bound to change. The effect is quite serious at low output voltages, where a 0.5V change is large in percentage terms.

The effect can be reduced by connecting resistances R8 and R9 (shown dotted). These allow small collector currents to flow even when there is no load, so the base currents don't change from zero to maximum but from a certain amount to maximum.

TRIPLE FOLLOWER

The situation can be improved by using a triple follower (Fig 4). This has very high current gain, so the input base current is very low. Also there is only one base-emitter drop (TR1's – about 0.6V at the low base current drawn) between base input and output.

With my 12.2V supply the output voltages were all close to the required values, after resistor R7 was trimmed by resistor R8 to set the 1.5V output. The voltages for 1.5V to 9V output fell by about 0.25V at about 400mA output.

The 12V output is not really subject to follower action and is included merely for convenience; resistor R9 limits base current to prevent the destruction of TR1 in the event of an output short., (The omission of a corresponding resistance in Fig. 1 looks like a designer error.)

The circuit can be adapted to voltages above or a little below 12V by adjusting resistor R1 to obtain a correct output on the 9V setting. The other resistances are then the same, with the proviso that resistor R7 may need trimming to obtain a correct 1.5V (One could use a 2.2 kilohm preset potentiometer in place of resistors R7 and R8).

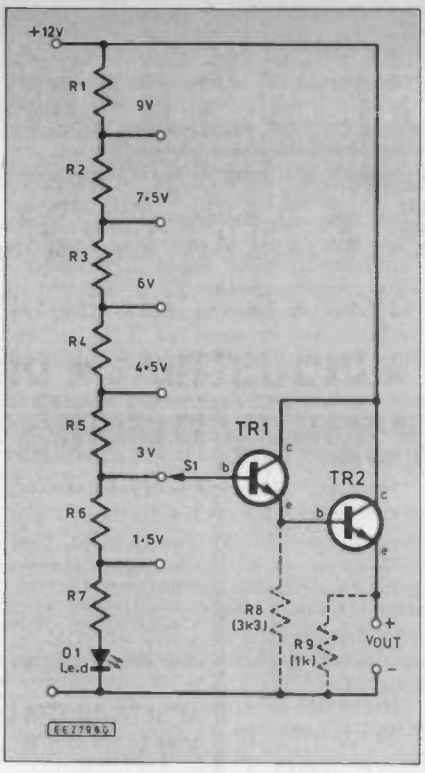


Fig. 3. Using a Darlington transistor output stage.

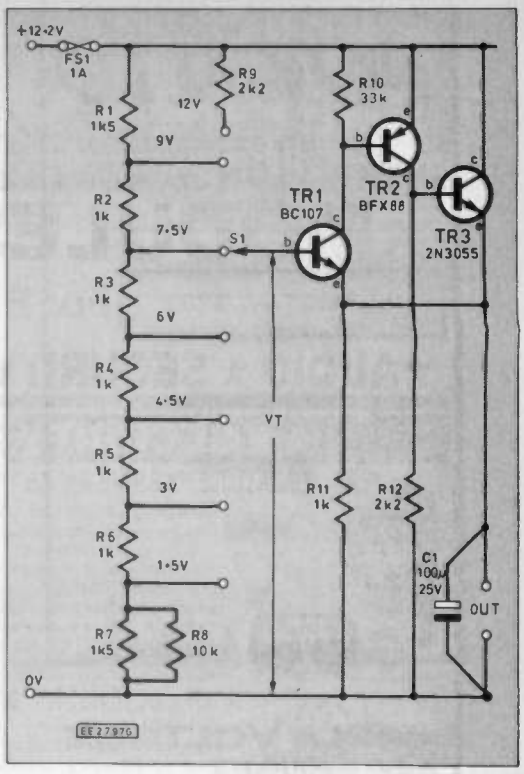


Fig. 4. Triple Follower. Only TR1's base-emitter drop comes between the tap voltage V_T and the output. Capacitor C1 is included to reduce the risk of instability.

DISSIPATION

The problems of "energy" or "heat" dissipation in the circuit of Fig. 4 is greatest at low output voltages because the transistors then have to absorb most of the battery voltage. Assuming 12.6V input and 1.5V output there is 11V across TR3. At 500mA output it must dissipate nearly 5.5W and a heatsink is essential.

Under shorted-output conditions the dissipation can be very high and the best policy is to choose a transistor for TR3 capable of handling currents much higher than needed and to include a fuse as shown. There is then a reasonable chance that a fuse will blow before the transistors.

The dissipation in transistor TR2 is not negligible and a small power type should be used. Dissipation in TR1 is low except under fault conditions.

You may well feel that, in view of the complexity of a triple follower, it would be cheaper and better to buy a variable i.c. stabliser. These are now relatively cheap and can provide short-circuit protection and stablisation against input voltage variations.

All a follower can do is provide constant voltage when the load varies, which stabilisers do too. If you have suitable transistors in the spares box, however, it might be attractive.

Triple followers are used in the output stages of some audio amplifiers. The advantage there is that they make little current demands on the driver stage.

INTERFACE

Robert Penfold

INTERFACE is a new series which, as explained more fully in last month's issue of *Everyday Electronics*, will cover interfacing to any microcomputer that is currently quite popular. Other technical topics may also be covered, such as programs that are of particular interest to *Everyday Electronics* readers. Here we are talking about programs such printed circuit design, circuit simulation, etc., not the latest in "zap" everything in sight games!

Expansion

I think it is fair to say that most of the modern microcomputers have less scope for home-made add-ons than do most of the computers from a few years ago. With computers such as the VIC-20, Commodore 64, and BBC model B there are user ports which can very easily be used to control motors, l.e.d.s, etc., or to read digital signals.

There is nothing similar on most of the computers currently on offer. In some cases there is a printer port that can be used in a similar way to a user port, but in most systems this port will be occupied by the printer.

Another problem is that most modern computers do not have anything that is strictly comparable to the expansion ports of the popular 8 bit computers. The expansion ports of the ZX81, Spectrum, BBC computers, etc. have their peculiarities, but still offer a fairly simple route to massive expansion. In fact the maximum possible expansion is so great with these computers that there is little likelihood of ever occupying more than a few percent of the available addresses. Producing DIY add-ons for these ports is reasonably straightforward.

Expansion ports on more recent computers tend to be large, inaccessible, and relatively difficult to use. In some cases there seems to be no proper expansion port at all. It is probably possible to add your own peripheral devices to any current computer, but in some cases this task will be less than straightforward. In some cases the degree of expansion possible may be rather limited by the standards of the past.

Slot Machines

I should imagine that the IBM PCs and the various "compatibles" from Amstrad etc. are the most popular computers so far produced. The success of these computers is largely based on their widespread acceptance in the business world. I produce the text and drawings for *Everyday Electronics* articles on a PC AT compatible, and on reaching the EE offices they are processed using more IBM compatibles. Although the "PCs" (as IBMs and compatibles are popularly known) are the standard business computers, in recent years they have also sold well as home computers.

In some respects they are perhaps something less than ideal for home use. The graphics capabilities of the early models were either limited or non-existent, but with the much improved EGA and VGA graphics boards now being commonplace, the displays of most modern PCs are really excellent. The same is not true of the sound generator, which remains rather weak even by 8 bit computer standards. The PCs are quite powerful computers, and are backed-up by masses of software of just about every conceivable type. These days, this includes much software of interest to home users.

PC Add Ons

For the add-on enthusiast the PCs offer excellent potential. All PCs and true compatibles have about eight expansion slots within the main system unit. Unlike most other microcomputers, expansion boards fit within the computer, rather than externally on the rear of the unit. If the board must connect to the outside world, this is achieved via connectors mounted on the rear of the board which can be accessed via cutouts in the rear of the computer's case.

The number of expansion slots varies somewhat from one type and make of PC to another, but any modern PC that is a true compatible should have around six to eight slots. Some of these are occupied by essential pieces of hardware, such as the display adaptor, disk controller, and serial/parallel ports. Typically there would still be something like three or four spare expansion slots, leaving plenty of scope for specialised add-ons.

The easy approach to interfacing to a PC is to fit it with a few specialised interface cards, such as analogue to digital and digital to analogue converter boards, and parallel interface boards. Temperature sensors, relay drivers, etc. are then easily connected up to these boards and used with the computer. This method has definite attractions, but suitable interface boards are relatively difficult to obtain, and can be quite expensive.

It is much cheaper to build your own interface boards, including on the board some or all of the additional circuitry for your particular applications if desired. Interfacing to a PC, from the electronics point of view, is more simple than you might expect. Quite simple address and control line decoding will usually suffice, and in this respect interfacing to the PCs is more straightforward than interfacing to the buses of many eight bit computers.

There is an awkward aspect to PC interfacing in that a double-sided printed circuit board is needed to fit into the expansion slot, and it must be made quite accurately if everything is to fit into place and operate properly.

With eight bit computers it is quite common to have add-ons connected to the computer via a suitable connector and a length of ribbon cable. Due to the higher clock speeds involved with PCs, and the minimal latitude in the timing of most signals, this method is not a very practical one. It can be used, but only if the ribbon cable is kept very short indeed. This is a feasible method for testing prototype circuits, but is not a very practical one for the final units.

8 Bit Bus

There are several types of PC expansion bus. The latest IBM machines and a few compatibles use the MCA (micro channel architecture) type, which is a very modern high speed bus. A few compatibles use the EISA (Extended Industry Standard Architecture) type, which is a form of 32 bit bus. This is based on what I suppose would have to be considered the standard PC bus, which is the ISA (Industry Standard Architecture) type. It is actually the 16 bit version of the ISA bus, with some extra connections to take the extra data lines etc.

The original PC bus is an eight bit type, and it is the one still used on the 8088 and 8086 based PCs (the XT type). The ATs and compatibles (including most 80386 based PCs) have a 16 bit bus, but this is the original 8 bit variety with an extra connector to carry the eight extra data lines plus some extra control lines. This method means that there is good compatibility between the XT and AT machines, with most 8 bit cards operating perfectly well in either type of computer.

Of course, a 16 bit card cannot operate properly in a machine that only has 8 bit expansion slots, although some 16 bit cards can be switched to 8 bit operation or will automatically switch to this mode if necessary.

As far as most user add-ons are concerned, they only need the basic 8 bit bus. Unless you have some form of AT compatible, you are obviously restricted to 8 bit expansion cards anyway. For the time being we will only consider the basic 8 bit bus. Fig.1 shows the normal method of pin numbering for the 8 bit expansion slot, which is a 2 x 31 way 0.1 inch pitch edge connector. This is a list of all the lines present on an 8 bit expansion slot:-

Many of these lines are familiar microprocessor types.

The eight data lines (D0 to D7) and the

Terminal No.	Function	Terminal No.	Function
A1	-I/O CH CK	B14	-IOR
A2	D7	B15	-DACK3
A3	D6	B16	DRQ3
A4	D5	B17	-DACK1
A5	D4	B18	DRQ1
A6	D3	B19	-DACK0
A7	D2	B20	CLK
A8	D1	B21	IRQ7
A9	D0	B22	IRQ6
A10	I/O CH RDY	B23	IRQ5
A11	AEN	B24	IRQ4
A12	A19	B25	IRQ3
A13	A18	B26	-DACK2
A14	A17	B27	TC
A15	A16	B28	ALE
A16	A15	B29	+5V
A17	A14	B30	OSC
A18	A13	B31	GND
A19	A12		
A20	A11		
A21	A10		
A22	A9		
A23	A8		
A24	A7		
A25	A6		
A26	A5		
A27	A4		
A28	A3		
A29	A2		
A30	A1		
A31	A0		
B1	GND		
B2	RESET		
B3	+5V		
B4	IRQ2		
B5	-5V		
B6	DRQ2		
B7	-12V		
B8	Reserved		
B9	+12V		
B10	GND		
B11	-MEMW		
B12	-MEMR		
B13	-IOW		

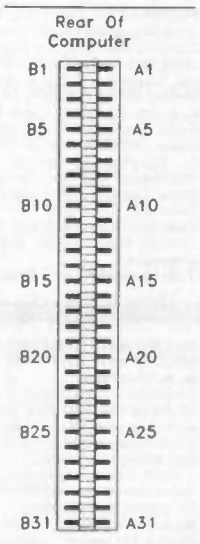


Fig. 1. The numbering used for the IBM 8-bit bus. The connector is a 2 x 31-way 0.1 inch pitch edge type.

twenty address lines (A0 to A19) should require no further explanation. Neither should the ground and various supply rail connections. One point worth making is that not all the address lines are used for input/output devices. Normally the lower 16 address lines are used, giving a massive 64K address space. In the PCs only the ten least significant address lines are used though, giving the reduced (but still substantial) address space of 1K.

Read/Write

The 8088 series of microprocessors have the same origins as the Z80, and some of the control lines are similar to Z80 types. In particular, the 8088 series have separate input/output and memory maps, with two sets of read/write lines for the two types of access.

The read/write lines for memory accesses are –MEMR and –MEMW, while –IOR and –IOW perform the same functions when input/output devices are accessed. These are all negative active lines (as denoted by the "-" signs). User add-ons would normally go into the input/output map. Therefore, –IOR and –IOW are important lines which will normally need to be decoded by user add- ons.

AEN (address enable) is another important line for user add-ons. This indicates whether DMA (direct memory access) or processor bus cycles are taking place. Add-ons should only be activated during processor cycles, when AEN is low.

The lines mentioned so far are the only ones that are essential to most PC interfacing, but we will briefly consider the other lines. ALE is a timing output which can be used as an aid to synchronising events to processor bus cycles.

Inputs DRQ1 to DRQ4, outputs –DACK0 to –DACK3, and TC (the terminal count output) are concemed with direct memory access. IRQ0 to IRQ7 are active high interrupt request lines, but note that IRQ0 and IRQ1 are not available on the expansion bus. These are used by the system for the time of day clock and the keyboard. Some of the interrupt lines that are accessible are likely to be used by standard expansion cards such as the serial and parallel ports, mouse interface card, etc.

Clock

Two clock signals are available on the bus. These are CLK and OSC. The former is the system clock, which has a 2 to 1 duty cycle and is at 4.77MHz on the original PCs and some compatibles. On ATs and XTs used in the "turbo" mode this clock will be at a higher frequency. The OSC signal is a 14.318MHz signal which is apparently intended mainly for use with the CGA graphics card.

RESET is an output which is active low, and which provides a pulse at switch-on that can be used to reset circuits on expansion cards. I/O CH RDY is an input which is normally high, but which can be taken low by a slow peripheral circuit in order to insert additional wait states. Most user add-ons are fast enough to avoid the need for inserted wait states.

I/O CH CK is a normally high input which can be pulled low if a parity error is detected (and a non-maskable interrupt is then generated). This can be used with input/output or memory circuits, but is mainly used with the latter.

Next month we will consider suitable spots for user add-ons in the input/output map, and address decoder circuits.

SHOP TALK

with David Barrington

12V Lamp/Vacuum Cleaner Charger

We cannot foresee any purchasing difficulties for the components required to build the *12V Lamp/Vacuum Cleaner Charger.*

Some readers may experience problems locating a local source for the 4-pole 3-position slide switch. As only two poles are used, it may prove easier to buy and use two, two-position slide switches as indicated in the article.

Versatile Bench Power Supply

Most of the components required for the *Versatile Bench Power Supply,* the first of the *Teach-In '91* back-up projects for the *Design Your Own Circuit* series should be available generally. We understand that some of our advertisers are making up kits for this series and a look through the advertisement pages should produce a local source.

8-Channel Microcontroller Light Sequencer

The MLS1A programmed i.c. used in the *8-Channel Microcontroller Light Sequencer* is a special item and only available from **Magenta Electronics**. The chip, pre-programmed and ready to run, costs £14.95 plus post and packing.

A full kit of parts (less only the battery and solder) including the printed circuit boards, programmed i.c., heatsink block, punched and labelled case is available from Magenta for the sum of £55.95 including VAT plus £2 postage and packing. All parts are available separately.

For case drilling templates and i.c. programmed light sequences send a large stamped addressed envelope to **Magenta Electronics, *Dept EE, 135 Hunter Street, Burton on Trent, Staffs, DE14 2ST. (☎ 0283 65435).***

The two printed circuit boards for this project are obtainable from the *EE PCB Service,* codes EE708 and EE709.

Colou. Changing Christmas Lights

The bi-colour l.e.d.s used in the *Colour Changing Christmas Lights* project now seem to be recognised as standard stock lines by most component advertisers and should not cause any sourcing problems. The rest of the components should also be readily available.

The small printed circuit board for this project is available from the *EE PCB Service,* code EE707.

As there is mains voltage on the p.c.b. and, due to the nature of this project which likely to attract the attention of the younger members of the family, extreme care should be taken when working on this unit.

It would certainly be advisable to use *nylon* nut and bolts to secure the board and "display lights" sockets in the case. You could also consider sealing the case lid, covering the fixing screws, with insulating tape.

Electronic Dipstick

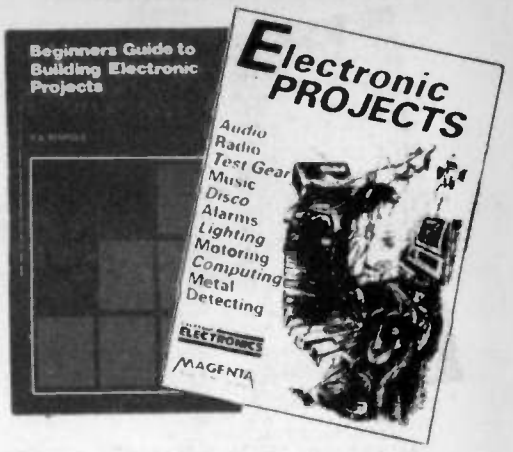
We do not expect any component buying problems to be encountered by constructors of the *Electronic Dipstick,* this month's *Pocket Money Project.* Most of our advertisers stock the 10-way l.e.d. display. You could, if you wish, use the individual stackable types if the single package type is hard to come by.

The rest of the components are standard "off-the-shelf" items. It might prove cheaper to buy a single large piece of stripboard and cut this to size for the two small boards.

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 details are given on the last book page.

For another selection of books see next month's issue.



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Full details on registering for C&G assessment, details of assessment centres, components required and information on the course in general are given.

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COMPUTING

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E. A. Parr, B.Sc., C.Eng., M.I.E.E.
This book is intended for people who wish to progress beyond the stage of BASIC programming to topics such as machine code and assembly language programming, or need hardware details of a Z80 based computer.

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COMPUTERS AND MUSIC — AN INTRODUCTION
R.A. Penfold
Computers are playing an increasingly important part in the world of music, and the days when computerised music was strictly for the fanatical few are long gone. Computer-based music systems in the past have tended to be either horrendously expensive, very crude, or both! These days, prices are much more modest and the potential of the equipment is much greater. Consequently a lot of musicians are being tempted into the unfamiliar territory of computer music systems.

If you are more used to the black and white keys of a synth keyboard than the QWERTY keyboard of a computer, you may be understandably confused by the jargon and terminology bandied about by computer buffs. But fear not, setting up and using a computer-based music making system is not as difficult as you might think.

This book will help you learn the basics of computing, running applications programs, wiring up a MIDI system and using the system to good effect, in fact just about everything you need to know about hardware and the programs, with no previous knowledge of computing needed or assumed. This book will help you to choose the right components for a system to suit your personal needs, and equip you to exploit that system fully.

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A CONCISE INTRODUCTION TO MS-DOS
N. Kantaris
This guide is writen with the non-expert, busy person in mind and, as such, it has an underlying structure based on "what you need to know first, appears first". Nonetheless, the guide is also designed to be circular, which means that you don't have to start at the beginning and go to the end. The more experienced user can start from any section.

The guide covers versions 3.0, 3.1 and 3.2 of both PC-DOS and MS-DOS as implemented by IBM and other manufacturers of "compatible" microcomputers, including the AMSTRAD PC's. It covers both floppy disc-based systems and hard disc-based systems.

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THE ART OF PROGRAMMING THE ZX SPECTRUM
M. James, B.Sc., M.B.C.S.
It is one thing to have learnt how to use all the Spectrum's commands and functions, but a very different one to be able to combine them into programs that do exactly what you want them to. This is just what this book is all about—teaching you the art of effective programming with your Spectrum.

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AUDIO & MUSIC

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Ian Sinclair
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Every aspect of Hi-Fi, from pickup cartridges to loudspeakers, has been covered, and the emphasis has been on explaining design aims. Cassette systems have been given considerable prominence, including the more modern Dolby C and dbx noise reduction systems. The CD record has been covered in detail so that *you* can find out just why this system of sound reproduction is so superior.
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V. Capel
This book explores the various features, good points and snags of speaker designs. It examines the whys and wherefores so that the reader can understand the principles involved and so make an informed choice of design, or even design loudspeaker enclosures for him or herself. Crossover units are also explained, the various types, how they work, the distortions they produce and how to avoid them. Finally there is a step-by-step description of the construction of the *Kapellmeister* loudspeaker enclosure.
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MUSICAL APPLICATIONS OF THE ATARI ST's
R. A. Penfold
The Atari ST's are now firmly established as *the* computers to use for electronic music applications. The range and sophistication of these applications are much greater than most people may realise, but there are still a lot of misconceptions about just what can and cannot be achieved. This book will help you sort out the fact from the fallacy and to get the most musically from the ST's.
A wide selection of topics are covered, including the internal sound chip; MIDI; applications programs such as sequencing and score writing, etc; simple but useful add-on projects and MIDI programming.
90 pages **Order code BP246** **£5.95**

PRACTICAL MIDI HANDBOOK
R.A. Penfold
The Musical Instrument Digital Interface (MIDI) is surrounded by a great deal of misunderstanding, and many of the user manuals that accompany MIDI equipment are quite incomprehensible to the reader.
The Practical MIDI Handbook is aimed primarily at musicians, enthusiasts and technicians who want to exploit the vast capabilities of MIDI, but who have no previous knowledge of electronics or computing. The majority of the book is devoted to an explanation of what MIDI can do and how to exploit it to the full, with practical advice on connecting up a MIDI system and getting it to work, as well as deciphering the technical information in those equipment manuals.
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HOW TO IDENTIFY UNMARKED ICs
K. H. Recorr
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A. Michaels
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320 pages **Temporarily out of print**

RADIO AND ELECTRONIC COLOUR CODES AND DATA CHART
B. B. Babani
Although this chart was first published in 1971 it provides basic information on many colour codes in use throughout the world, for most radio and electronic components. Includes resistors, capacitors, transformers, field coils, fuses, battery leads, speakers, etc. It is particularly useful for finding the values of old components.
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C. E. Miller
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R. A. Penfold
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RADIO, TV, SATELLITE

AN INTRODUCTION TO AMATEUR RADIO
I.D. Poole
Amateur radio is a unique and fascinating hobby which has attracted thousands of people since it began at the turn of the century.
This book gives the newcomer a comprehensive and easy to understand guide through the subject so that the reader can gain the most from the hobby. It then remains an essential reference volume to be used time and again. Topics covered include the basic aspects of the hobby, such as operating procedures, jargon and setting up a station. Technical topics covered include propagation, receivers, transmitters and aerials etc.
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INTERNATIONAL RADIO STATIONS GUIDE
P. Shore
Provides the casual listener, amateur radio DXer and the professional radio monitor with an essential reference work designed to guide him or her around the ever more complex radio bands. This new edition has been completely revised and rewritten and incorporates much more information which is divided into the following sections:
Listening to Short Wave Radio; ITU Country Codes; Worldwide Short Wave Radio Stations; European, Middle East and North African Long Wave Radio Stations; European, Near East and North African Medium Wave Radio Stations; Canadian Medium Wave Radio Stations; USA Medium Wave Radio Stations; Broadcasts In English; Programmes for DXers and Short Wave Listeners; UK FM Radio Stations; Time differences from GMT; Abbreviations; Wavelength/Frequency Conversion.
320 pages **Order code BP255** **£4.95**

AERIAL PROJECTS
R. A. Penfold
The subject of aerials is vast but in this book the author has considered practical aerial designs, including active, loop and ferrite aerials which give good performances and are relatively simple and inexpensive to build. The complex theory and mathematics of aerial design have been avoided.
Also included are constructional details of a number of aerial accessories including a pre-selector, attenuator, filters and tuning unit.
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F.A. Wilson
As a definitive introduction to the subject this book is presented on two levels. For the absolute beginner or anyone thinking about purchasing or hiring a satellite TV system, the story is told as simply as such a complex one can be in the main text.
For the professional engineer, electronics enthusiast, student or others with technical backgrounds, there are numerous appendices backing up the main text with additional technical and scientific detail formulae, calculations, tables etc.
There is also plenty for the DIY enthusiast with practical advice on choosing and installing the most problematic part of the system—the dish antenna.
104 pages **Order Code BP195** **£5.95**

COMMUNICATION
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
A look at the electronic fundamentals over the whole of the communication scene. This book aims to teach the important elements of each branch of the subject in a style as interesting and practical as possible. While not getting involved in the more complicated theory and mathematics, most of the modern transmission system techniques are examined including line, microwave, submarine, satellite and digital multiplex systems, radio and telegraphy. To assist in understanding these more thoroughly, chapters on signal processing, the electromagnetic wave, networks and transmissions assessment are included, finally a short chapter on optical transmission.
256 pages **Order Code BP89** **£2.95**

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I. D. Poole
This book covers the essentials required to gain the most from using the VHF and UHF bands. As such it will be of use to both the newcomer and more experienced operator alike.
Topics included in this book include propagation, descriptions of the bands with outlines of the bandplans and channels, aerials, receivers, transmitters and a special chapter on scanners. In addition to this repeater and mobile operation are included as well as DXing and data modes together with a section on packet radio.
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COMPUTERS AND MUSIC

— see computer section

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PCB SERVICE

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

Boards for some older projects – not listed here – can often be obtained from Magenta Electronics, 135 Hunter St., Burton-on-Trent, Staffs DE14 2ST. Tel: 0283 65435 or Lake Electronics, 7 Middleton Close, Nuthall, Nottingham NG16 1BX. Tel: 0602 382509.

NOTE: While 90% of our boards are now held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail. Please check price and availability in the latest issue before ordering. We can only supply boards listed in the latest issue. Boards can only be supplied on a payment with order basis.

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INCORPORATING ELECTRONICS MONTHLY
ABC
The No 1 Magazine for Electronic & Computer Projects

JANUARY 1990 TO DECEMBER 1990

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CONSTRUCTIONAL PROJECTS

SPECIAL SERIES

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SPECIAL OFFERS AND SERVICES

HIGHGRADE *Christmas* COMPETITION

We've gone completely loopy this year: we're giving away up to £1000! Yes, the winner of our Christmas Competition will receive a voucher for *ten times* the value of the order that accompanies the entry, up to a maximum of £1000! The voucher can be exchanged for any components offered by Highgrade in 1991—you choose what to buy with it. If that's not enough for you, every single competition entry entitles you to a gift, whether you get the answers right or not! Are you ready? Here we go.

Win up to £1,000 worth of components!

In the Highgrade lab we've been experimenting with a special recognition circuit. To test it out, the system is connected to a printer: we speak into the microphone and it prints what it thinks we said. Sad to say, there are still a few bugs in the system. For instance, when I said into the microphone 'Can you recognise speech?' the printer came back with—Can you wreck a nice beach?! Here are some of the mistakes it made when read it a list of television programs. What should it have printed?

1) Colliders Cope should have been _____
2) Casual Tea should have been _____
3) Cora Nation's Treat should have been _____
4) Stale Ucky should have been _____
5) Start Wreck should have been _____
6) Woe Gun should have been _____

Right now we're working on a nudie vice for hoe moaners—sorry, I must remember to turn off the speech circuit. A new device for home owners is what I meant to say, of course. Anyway, now you've filled in your answers you can choose any one of the gifts below!

EVERY ENTRY WINS A PRIZE!

1) Special blade for cutting grooves and notches
2) Mini biofeedback monitor kit
3) Secret circuits file—things the authorities would rather you didn't know!

The competition winner will be chosen by draw from all completely correct entries received by the closing date: December 20th 1990. I'd like to say that some famous celebrity will make the draw, but in reality fair play will be supervised by our not very famous solicitor. The winner will be notified early in January 1991. If you have any queries about the competition, please tel: 0600 3715.

SUPER *Christmas* COMPONENT BARGAINS

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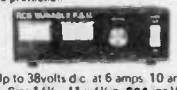

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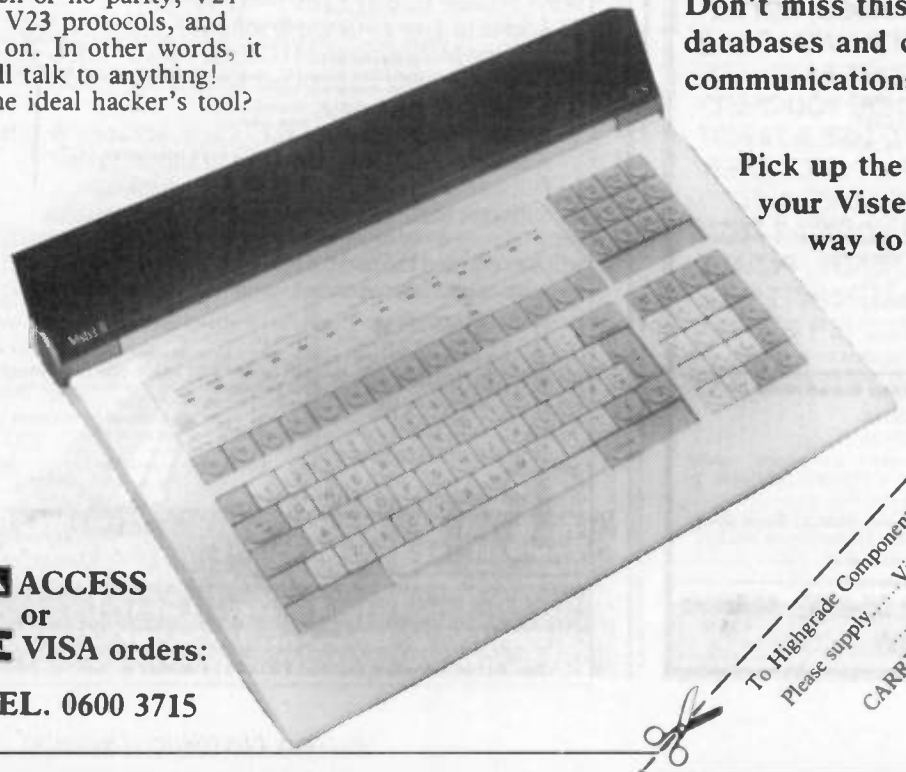

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Model Number:	**AA12531**
Input:	115/230V, 50/60Hz
Outputs:	+5V 5A +12V 0.15A
Total Wattage:	50W
Price:	**£6.95**

Also still available: An Astec 'bare board' model. The PCB is standard Eurocard size, 160 x 100mm. Inputs & Outputs are on right angled PCB pins. This is a very compact model offering excellent value for money.

Specification:

Model Number:	**AC8151-01**
Input:	115/230V, 50/60Hz
Outputs:	+5V 2.5A +12V 2A −12V 0.1A
Total Wattage:	40W
Price:	**£12.95**

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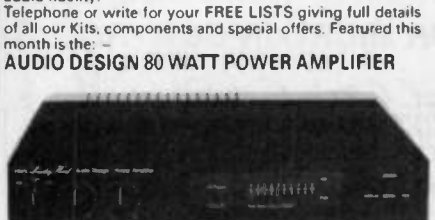
AUDIO DESIGN 80 WATT POWER AMPLIFIER



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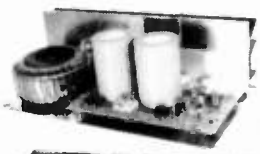

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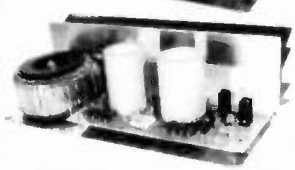

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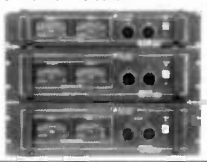

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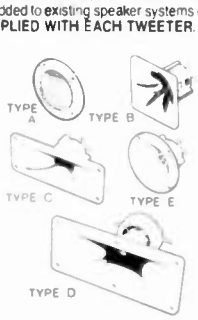

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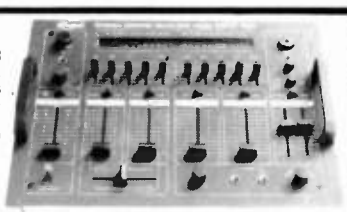

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