EVERYDAY ELECTRONICS

DECEMBER 1987

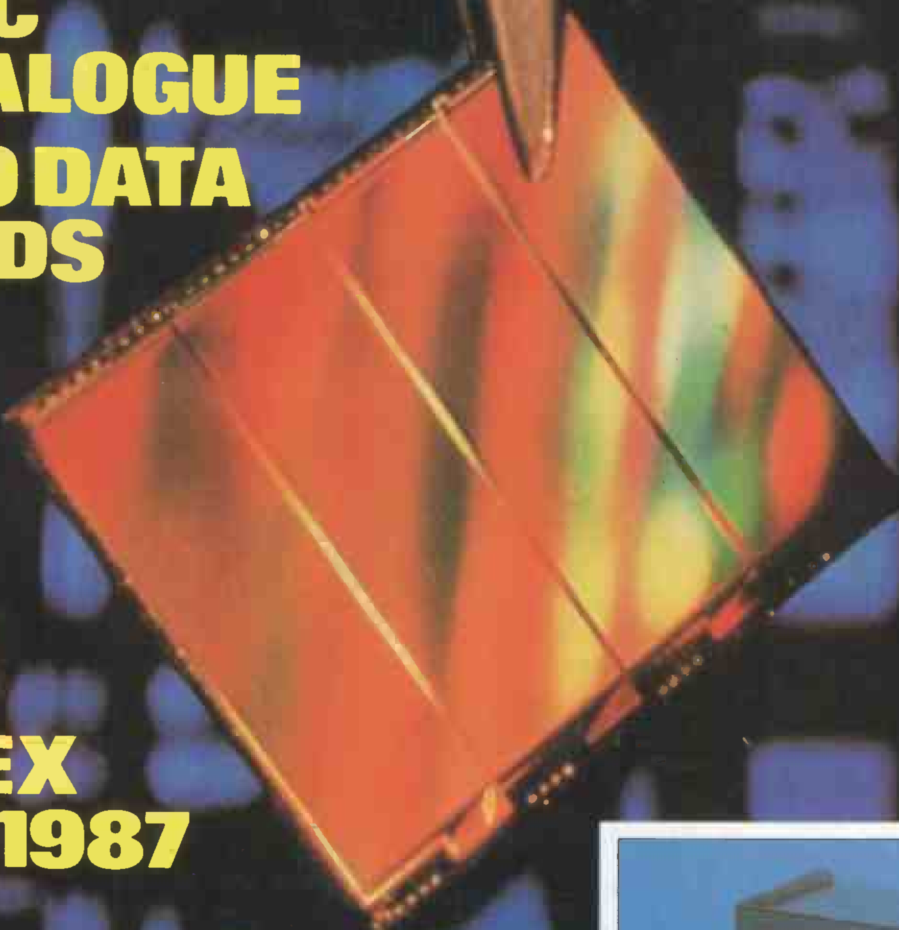
INCORPORATING ELECTRONICS MONTHLY

£1.20

FREE INSIDE

RTVC CATALOGUE

TWO DATA CARDS



PLUS

INDEX FOR 1987

AUDIO SIGNAL GENERATOR

PSEUDO ECHO UNIT

XMAS TREE LIGHTS

The Magazine for Electronic & Computer Projects

£1 BAKERS DOZEN PACKS

Price per pack is £1.00.* Order 12 you may choose another free. Items marked (sh) are not new but guaranteed ok.

1 – 5 13 amp ring main junction boxes
2 – 5 13 amp ring main spur boxes
5 – 3 flush electrical switches
7 – 4in flex line switches with neons
8 – 2 80 watt brass cased elements
9 – 2 mains transformers with 6V 1A secondaries
10 – 2 mains transformers with 12V ½ A secondaries
11 – 1 extension speaker cabinet for 6½" speaker
12 – 5 octal bases for relays or valves
13 – 12 glass reed switches
14 – 4 OCP 70 photo transistors
16 – 4 tape heads, 2 record, 2 erase
17 – 1 ultrasonic transmitter and 1 ditto receiver
18 – 2 15000 mfd computer grade electrolytics
19 – 2 light dependent resistors
20 – 5 different micro switches
21 – 2 mains interference suppressors
22 – 2 25 watt crossover units 2 way
23 – 1 40 watt 3 way crossover unit
28 – 1 6 digit counter mains voltage
30 – 2 Nicad battery chargers
31 – 1 key switch with key
32 – 2 humidity switches
34 – 96 x 1 metre lengths colour-coded connecting wires
36 – 2 air spaced 2 gang tuning condensors
37 – 2 solid diaelectric 2 gang tuning condensors
38 – 10 compression trimmers
41 – 6 Rocker Switches 10 amp mains SPST
43 – 5 Rocker Switches 10 amp SPDT Centre Off
44 – 4 Rocker Switches 10 amp DPDT
45 – 1 24 hour time switch mains operated (s.h.)
46 – 1 6 hour clock timeswitch
48 – 2 6V operated reed switch relays
49 – 10 neon valves – make good night lights
50 – 2 x 12V DC or 24V AC, 4 CO relays
51 – 1 x 12V 2C O very sensitive relay
52 – 1 12V 4C relay
55 – 1 locking mechanism with 2 keys
56 – Miniature Uniselector with circuit for electric jigsaw
57 – 5 Dolls' House switches
60 – 5 ferrite rods 4" x 5/16" diameter aerials
61 – 4 ferrite slab aerials with L & M wave coils
62 – 4 200 ohm earpieces
63 – 1 Mullard thyristor trigger module
64 – 10 assorted knobs ¼ spindles
65 – 5 different themostats, mainly bi metal
66 – Magnetic brake – stops rotation instantly
67 – Low pressure 3 level switch
69 – 2 25 watt pots 8 ohm
70 – 2 25 watt pots 1000 ohm
71 – 4 wire wound pots – 18, 33, 50 and 100 ohm
73 – 4 3 watt wire wound pots 50 ohm
77 – 1 time reminder adjustable 1-60 mins
78 – 5.5 amp stud rectifiers 400V
85 – 1 mains shaded pole motor ¾" stack – ¼ shaft
86 – 2 5" ali fan blades fit ¼" shaft
87 – 2 3" plastic fan blades fit ¼" shaft
88 – Mains motor suitable for above blades
89 – 1 mains motor with gearbox 1 rev per 24 hours
91 – 2 mains motors with gearbox 16 rpm
93 – 4 11 pin moulded bases for relays
94 – 5 B7G valve bases
95 – 4 skirted B9A valve bases
96 – 1 thermostat for fridge
98 – 1 motorised stud switch (s.h.)
101 – 1 2½ hours delay switch
103 – 1 6v mains power supply unit
104 – 1 4½ V mains power supply unit
105 – 1 5 pin flex plug and panel socket
107 – 1 5" speaker size radio cabinet with handle
109 – 10¼" spindle type volume controls
110 – 10 slider type volume controls
112 – 1 heating pad 200 watts mains
114 – 1 1W amplifier Mullard 1172
115 – 1 Wall mounting thermostat 24V
118 – 1 Teak effect extension 5" speaker cabinet
120 – 2 p.c.b. with 2 amp full wave and 17 other recs
122 – 10 mtrs twin screened flex white p.v.c. outer
132 – 2 plastic boxes with windows, ideal for interrupted beam switch etc
155 – 3 varicap push button tuners with knobs
188 – 1 plastic box, sloping metal front, 16 x 95mm, average depth 45mm
241 – 1 car door speaker (very flat) 6½" 15 ohm made for Radiomobile
243 – 2 speakers' 6" x 4" 15 ohm 5 watt made for Radiomobile
266 – 2 mains transformer 9V ½ A secondary split primary so OK also for 115V
267 – 1 mains transformers 15V 1A secondary p.c.b. mounting
330 – 2 6V 0.6V mains transformer .3a p.c.b. mounting
350 – 40 double pole leaf switches
365 – 1 7uf 660V 50hz metal cased condenser
453 – 2 2¼ in 60 ohm loudspeakers
454 – 2 2¼ in 8 ohm loudspeakers
463 – 1 mains operated relay with 2 sets c/o contacts
464 – 2 packets resin filler/sealer with cures
465 – 3 5A round 3 pin plugs will fit item 193
466 – 4 7 segment l.e.d. displays
470 – 4 pc boards for stripping, lots of valuable parts
480 – 1 3A double pole magnetic trip, saves repairing fuses
498 – 4 1000uf 25V axial electrolytic capacitors
504 – 1 Audax PM 8" speaker 15 ohm 5 watt rating
515 – 100 4BA 1½" cheesehead plated screws and 100 4BA nuts
541 – 1 pair stereo tape head as in cassette recorder/players
546 – 1 bridge rectifier 600V international rectifier ref 3SB100
548 – 2 battery operated relays (3-6v) each with 5A c/o contacts 2 pairs
553 – 2 lithium 3V batteries (everlasting shelf life)

TELEPHONE BITS

Master socket (has surge arrestor – ringing condenser etc) and takes B.T. plug	£3.95
Extension socket	£2.95
Dual adaptors (2 from one socket)	£3.95
Cord terminating with B.T. plug 3 metres	£1
Kit for converting old entry terminal box to new B.T. master socket, complete with 4 core cable, cable clips and 2 B.T. extension sockets	£11.50
100 mtrs 4 core telephone cable	£8.50

COMPACT FLOPPY DISC DRIVE EME-101

The EME-101 drives a 3" disc of the new standard which despite its small size provides a capacity of 500k per disc, which is equivalent to the 3½" and 5¼" discs. We supply the Operators Manual and other information showing how to use this with popular computers: BBC, Spectrum, Amstrad etc. All at a special snip price of £27.50 including post and VAT. Data available separately £2, refundable if you purchase the drive.

MULLARD UNILEX AMPLIFIERS

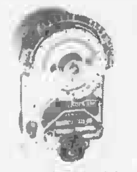
We are probably the only firm in the country with these now in stock. Although only four watts per channel, these give superb reproduction. We now offer the 4 Mullard modules – i.e. Mains power unit (EP9002) Pre amp module (EP9001) and two amplifier modules (EP9000) all for £6.00 plus £2 postage. For prices of modules bought separately see TWO POUNDERS.

CAR STARTER/CHARGER KIT

Flat Battery! Don't worry,you will start your car in a few minutes with this unit – 250 watt transformer 20 amp rectifiers, case and all parts with data case £17.50 post £2.

THIS MONTH'S SNIP

is a 2½ kW tangential heater, metal box to contain it and 3 level switch to control it. Special price £7.50 post pald.



Ex-Electricity Board. Guaranteed 12 months.

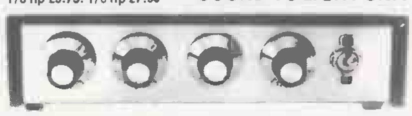
VENNER TIME SWITCH

Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only £2.95 without case, metal case – £2.95, adaptor kit to convert this into a normal 24hr time switch but with the added advantage of up to 12 on/offs per 24hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is £2.30

12 volt MOTORS BY SMITHS

Made for use in cars, etc. these are very powerful and easily reversible. Size 3½" long by 3" dia. They have a good length of ¼" spindle – 1/10 hp £3.45 1/8 hp £5.75. 1/6 hp £7.50

SOUND TO LIGHT UNIT



Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four pin plug and socket facilitate ease of connecting lamps. Special price is £14.95 in kit form.

9" MONITOR

Ideal to work with computer or video camera uses Philips black and white tube ref M24/306W. Which tube is implosion and X-Ray radiation protected. VDU is brand new and has a time base and EHT circuitry. Requires only a 16V dc supply to set it going. It's made up in a lacquered metal framework but has open sides so should be cased. The VDU comes complete with circuit diagram and has been line tested and has our six months guarantee. Offered at a lot less than some firms are asking for the tube alone, only £16 plus £5 post.

LIGHT BOX

This when completed measures approximately 15" x 14". The light source is the Philips fluorescent 'W' tube. Above the light a sheet of fibreglass and through this should be sufficient light to enable you to follow the circuit on fibreglass PCBs. Price for the complete kit, that is the box, choke, starter, tube and switch, and fibreglass is £5 plus £2 post. order ref 5P69.

TANGENTIAL HEATERS

We again have very good stocks of these quiet runnng instant heat units. They require only a simple case, or could easily be fitted into the bottom of a kitchen unit or book case etc. At present we have stocks of 1.2kw, 2kw, 2.5kw, and 3kw. Prices are £5 each for the first 3, and £6.95 for the 3k. Add post £1.50 per heater if not collecting.
CONTROL SWITCH enabling full heat, half heat or cold blow, with connection diagram, 50p for 2kw, 75p for 3kw.

FANS & BLOWERS

5" £5 + £1.25 post. 6" £6 + £1.50 post
4" x 4" Muffin equipment cooling fan 115V £2.00
4" x 4" Muffin equipment cooling fan 230/240V £5.00
9" Extractor or blower 115V supplied with 230 to 115V adaptor £9.50 + £2 post.
All above are ex computers but guaranteed 12 months.
10" x 3" Tangential Blower. New. Very quiet – supplied with 230 to 115V adaptor on use two in series to give long blow £2.00 + £1.50 post or £4.00 + £2.00 post for two

TELEPHONE LEAD

3 mtrs long terminating one end with new BT, flat plug and the other end with 4 correctly coloured coded wires to fit to phone or appliance. Replaces the lead on old phone making it suitable for new BT socket. Price £1 ref BD552 or 3 for £2 ref 2P164.

POWERFUL IONISER

Generates approx. 10 times more IONS than the ETI and similar circuits. Will refresh your home, office, shop, work room etc. Makes you feel better and work harder – a complete mains operated kit, case included. £11.50 + £3 P&P.

J & N BULL ELECTRICAL

Dept. E.E., 250 PORTLAND ROAD, HOVE, BRIGHTON, SUSSEX BN3 5QT

MAIL ORDER TERMS: Cash, P.O. or cheque with order. Orders under £20 add £1 service charge. Monthly account orders accepted from schools and public companies. Access & B/card orders accepted. Brighton (0273) 734648 or 203500.

NEW ITEMS

Some of the many described in our current list which you will receive with your parcel.

£2 POUNDERS*

2P122 1 30a rotary switch, surface mounting with pointer knob
2P123 1 25a rotary switch, surface mounting, cover engraved, high, medium low and off
2P124 1 28kv 001 mfd block condensor
2P129 1 10rpm motor 115V so supplied with adaptor for 230V
2P131 1 Crouzet motor 230V fits the Crouzet gearbox
2P132 1 ceiling heat-stat for fire warning or protection
2P133 1 Circuit breaker 20a, Crabtree ref C50
2P134 1 9V 500mA psu, plugs into 13a socket
2P135 10m 10 conductor intercom cable
2P136 1 2½ kw element made for tangential blowers
2P137 1 Thermo couple, stainless steel tipped for measuring internal heat
2P138 1 Mains transformer 20V 0 20V 1a upright mounting
2P141 1 rechargeable battery D size (4 AH) solder tag ended
2P142 10m 4 pair intercom cable White PVC outer
2P144 1 mains operated relay with 4 · 8a c/o contacts
2P146 1 7,800 uf 150C d.c. smoothing capacitor
2P148 1 Technical Information on 3" FDD refundable if you buy ldd
2P149 5 diff battery operated model motors
2P150 1 PSU chassis with all components for 24V 2A d c unwired
2P151 1 Metal box 14½ · 14 × 4 with lid add £2.00 post
2P152 1 Motor start capacitor 80uf 250V
2P153 1 Two station intercom unused but line reject
2P154a 1 Nicad charger plug into 13a socket 5.2V .7UA output
2P154b 1 Nicad charger plug into 13a socket 6V .9VA output
2P155 1 Mains transformer giving 16, 17, 18 & 20V 60W
2P158 1 Oven thermostat with temp calibrated knob
2P159 1 9V 500ma cased with mains lead and output lead
2P160 1 13a plug adaptor fused takes 3 · 3a plugs
2P161 1 6" diagonal side cutters
2P162 1 Stereo Matrix PCB mounting deemphasis K35
2P163 1 AC Working capacitor 12uf 660V AC or 1500V dc
2P154 3 Phone leads 3 mtrs long tags one end B T plug other end

£3 POUNDERS*

3P7 1 DC voltage, doubler or halver for 12V to 24V 12 to 6V 24 to 12V
3P8 1 24hr time switch Sangamo, new condition Guaranteed 1 year
3P9 12V 500mA psu plugs in 13a socket regulated
3P10 1 Mains transformer 50V 2A with 6.3 pilot light winding, upright mounting, fully shrouded plus £1 post
3P13 1 Noise filter to fit in mains lead of appliance up to 25a
3P15 1 waterproof case will take 150 watt transformer
3P16 1 signal box, 3 lamps on face plate of metal box size 5½ · 3½
3P17 1 choke and starter to work 8' fluorescent tube at 125W
3P18 1 22V 3a mains transformer with bridge rect fitted on top panel
3P20 1 0-5a ammeter 3½ ac dc ex equipment
3P21 1 power factor correction condenser 35uf 350ac
3P22 1 200va auto transformer 230 to 115V torroidal encapsulated £1.50 post
3P24 1 3" floppy disc for Amstrad etc
3P25 1 7" Electricians pliers

£4 POUNDERS*

4P12 50m low loss co-ax 75ohm + £1 post
4P13 3 Horstmann time and set switches 15amp
4P14 1 150w mains transformer "c" core 43V 3.5A secondary
4P15 1 powerful motor 2" stack fitted with gearbox final speed 60rpm mains operated, could operate door opener etc
4P17 1 Uniselector 3 pole 25W, 50V coil standard size
4P18 1 Volt meter with digital display (DIGIVISOR)

COMPUTERS

The Acorn 'Electron' as used in many schools for games and serious jobs. Works into colour or Black and White TV. Proper price was £199, our Price, tested and working £45 + £3 post, tested but slightly faulty £36 + £3 post and lastly tested but not working £20 + £3 post, all are new and complete with mains P S U 300 page handbook TV lead and starter cassette. Full range of Software also in stock at very low prices

£5 POUNDERS*

5P86 1 Transformer upright mounting 230/240V primary 2 · 100 1a secondary
5P88 1 Transformer in waterproof metal box 24V 5A add £2 post
5P89 1 4 bank heating element each 2kw ideal convector heater
5P90 1 18" long tangential blower with motor at one end
5P91 1 14" blower, motor in middle
5P92 10m Audio co-ax double screened 75ohm super low loss for TV
5P93 1 6" Alarm bell 24V dc or ac
5P94 1 Current transformer 14V out with 1a dc input
5P95 1 Vintage photo cell
5P97 1 Impedance matching transformer 0 4 5-8 160 ohm 100 add £1.50 post
5P98a 1 0-90a ammeter for mounting outside control panel
5P98b 1 0-180a ammeter for mounting outside control panel
5P99 1 Mains operated blower centrifugal output size app 5" · 1½
5P100 1 Mains splitter 45a switch 3 × 15a fused circuits
5P101 1 Model motor 1 rpm from 6V reversible

£7 POUNDERS*

7P1 1 Instant heat solder gun mains with renewable tip and job light

£8 POUNDERS*

8P1 1 Charger transformer 10a upright mounting 230/240 primary 16v 10a secondary
8P2 1 6" underdome alarmbell suitable for a fire alarm or burglar alarm mains operated.
8P3 1 heat sink big powerful so ideal for power transmitter
8P6 1 24hr time switch 2 on offs 16a c/o contacts 3" · 3" · 1½
8P7 1 Silent sentinel invisible ray kit
8P8 1 Papst fan 3½ · 3½ · 1½ 230V metal bodied

£10 POUNDERS*

10P14 1 100a time switch 1 on/off per 24hr extra triggers £1 per pair
10P15 1 Max demand meter 230 ac mains
10P16 1 powerful air mover 2 small type blowers with motor in middle
10P18 1 mains operated klaxon
10P19 1 12V alarm bell really loud, mains operated, in iron case · £5 post
10P22 1 sensitive volt meter relay
10P23 1 fruit machine heart 3 fruit wheels each stepper motor operated add £3 post
10P24 1 big panel meter face size 4¾ · 2½ 200uA movement scaled 1-10
10P30 1 instrument psu on pcb has 4 outputs 12V 5V 6A 12V 5A/5V .5A
10P31 1 7 day time switch 16a c/o contacts sep switches for each day
10P32 1 68 rpm 1/6th hp motor reversible

£15 POUNDERS*

15P1 1 kit for 115W hi fi amp
15P2 1 kit for psu to supply one or two 15P1 amps
15P3 1 time switch battery or mains operated 16a c o contacts, 7 day programmable has 36hr reserve

LIGHT CHASER KIT motor driven switch bank with connection diagram, used in connection with 4 sets of xmas lights makes a very eye catching display for home, shop or disco, only £5 ref 5P56.

VOL 16 No.12 DECEMBER '87

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

ABC

The Magazine for Electronic & Computer Projects

ISSN 0262–3617

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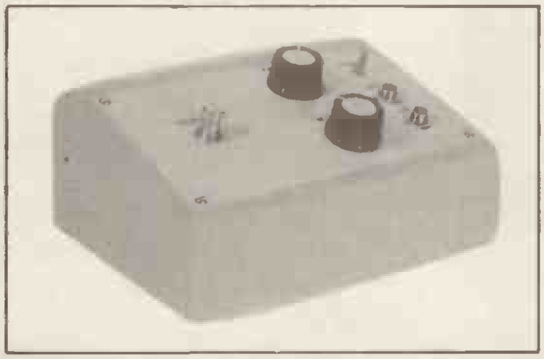
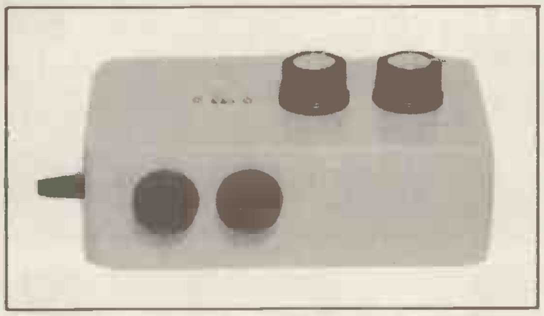
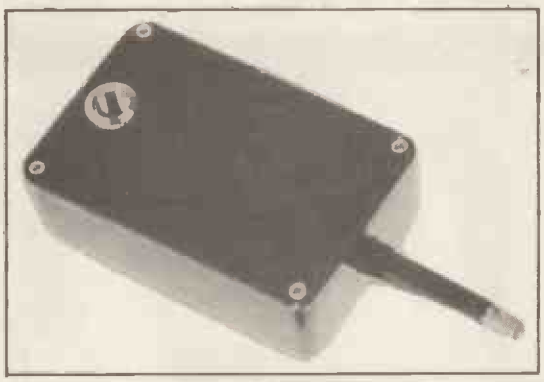
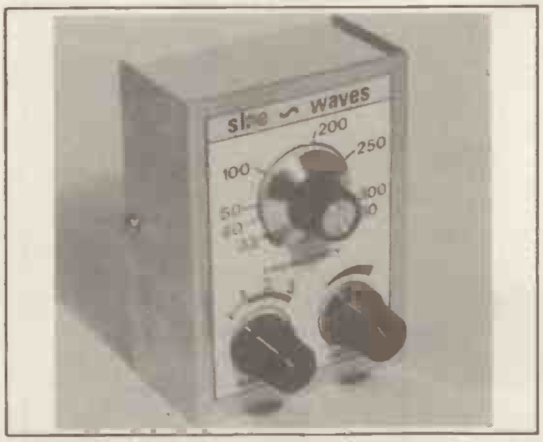
COMMENT . . . POPULAR FEATURES . . .









Projects

DUAL MAINS LIGHTS FLASHER by Andy Flind — 640
Create your own festive light show

AUDIO SIGNAL GENERATOR by Mark Stuart — 644
Gives a sine wave output up to 6V peak-to-peak. Frequency 33Hz-33kHz

LIGHT-OPERATED COUNTER — 658
An Exploring Electronics project

PSEUDO ECHO UNIT by Robert Penfold — 662
Improve your sounds with this easy-build project

TWINKLING STAR by G. Calland — 674
Add some sparkle to your Christmas tree

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Make a clean sweep with this low cost controller

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EVERYDAY ELECTRONICS
INCORPORATING ELECTRONICS MONTHLY

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Please reserve/deliver a copy of **Everyday Electronics** for me each month.

Signed ....

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EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

The Magazine for Electronic & Computer Projects

VOL 16 No. 12 **December '87**

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DORSET BH21 1JH
Phone: Wimborne (0202) 881749

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

Advertisement Offices
EVERYDAY ELECTRONICS ADVERTISEMENTS
4 NEASDEN AVE., CLACTON-ON-SEA, ESSEX
CO16 7HG. Clacton (0255) 436471

DATA

ANOTHER free catalogue this month, plus two free data cards – the first of a series of cards – you will get one data card free with each issue for the next few months. We have also added an extra eight pages to our normal issue size and expect to continue at this new size for some time.

The cards each give information on a microprocessor plus general data, they are designed so that two or more cards can be shown one way up to cover microprocessors or the other way to provide more general data, conversion tables, etc. We hope you find them of value.

TEACH-IN

This issue also carries an advertisement (page 657) for our new *Electronics Teach-In* book. This book is a direct result of demand for our Teach-in series (published in 85/86). The series has been updated where necessary and put together to form a comprehensive introduction to electronics. Since it also carries *eight* constructional test gear projects it will be invaluable to just about everyone involved in electronics as a hobby, student, apprentice, teacher, technician or those in various industries that now require knowledge of electronic principles.

This book represents excellent value for money at just £1.95 for a complete, highly acclaimed, course in electronics plus the projects.

SPIN-OFFS

It is the first time that *EE* has produced such a spin off. This will be closely followed by a book based on our *Digital Troubleshooting* series – soon available through the *EE Book Service*. These two totally different publications will test the market for others we expect to sell over the next few years, forming a wide range of information on electronics in general.

Mike Kenward

SUBSCRIPTIONS

Annual subscriptions for delivery direct to any address in the UK: £14.00. Overseas: £17.00 (£33 airmail). Cheques or bank drafts **(in £ sterling only)** payable to Everyday Electronics and sent to EE Subscriptions Dept., 6 Church Street, Wimborne, Dorset BH21 1JH. **Subscriptions can only start with the next available issue.** For back numbers see below.

BACK ISSUES & BINDERS

Certain back issues of EVERYDAY ELECTRONICS are available price £1.50 (£2.00 overseas surface mail) inclusive of postage and packing per copy. Enquiries with remittance, made payable to Everyday Electronics, should be sent to Post Sales Department, Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH. In the event of non-availability remittance will be returned. *Please allow 28 days for delivery.* **(We have sold out of Sept. Oct. & Nov. 85, April, May & Dec 86, & Jan 87.)**

Binders to hold one volume (12 issues) are available from the above address for £4.95 (£9.00 overseas surface mail) inclusive of p&p. *Please allow 28 days for delivery.*

Payment in £ sterling only please.

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READERS' ENQUIRIES

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

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

COMPONENT SUPPLIES

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

OLD PROJECTS

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

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

ADVERTISEMENTS

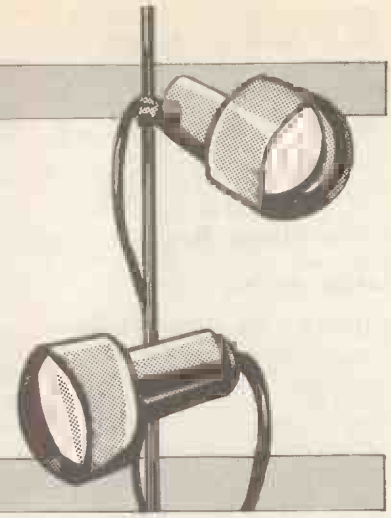
Although the proprietors and staff of EVERYDAY ELECTRONICS take reasonable precautions to protect the interests of readers by ensuring as far as practicable that advertisements are *bona fide*, the magazine and its Publishers cannot give any undertakings in respect of statements or claims made by advertisers, whether these advertisements are printed as part of the magazine, or are in the form of inserts.

The Publishers regret that under no circumstances will the magazine accept liability for non-receipt of goods ordered, or for late delivery, or for faults in manufacture. Legal remedies are available in respect of some of these circumstances, and readers who have complaints should address them to the advertiser or should consult a local trading standards office, or a Citizen's Advice Bureau, or a solicitor.

TRANSMITTERS

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

The law relating to this subject varies from country to country; overseas readers should check local laws.



DUAL MAINS LIGHTS FLASHER

ANDY FLIND

A festive light show for Christmas. Can safely drive up to 100W per channel

ATTRACTIVE as they are, many people consider the fairy lights on the Christmas tree are more effective if they flash on and off. This is usually done with a special "flasher" bulb containing a bi-metallic switch assembly that is heated, during the "on" cycle, by the lamp filament.

Although simple, these bulbs have some disadvantages. The switch mechanism is delicate, and may be erratic in operation and short-lived.

Simple on-off flashing is not very attractive to look at; after all, the lights are off half the time, and the constant switching of a mains-voltage circuit often produces annoying mains-borne r.f. interference. This simple project, whilst costing more than a bulb, effectively overcomes all these problems.

DUAL OPERATION

One of the advantages of this circuit is that it will drive two sets of lights. This greatly increases the odds of at least one set being "on" at any given moment, for a far more attractive display. The flash rates are independently adjustable and by judicious choice of speeds produces an amazingly "random" effect, whilst the controls also give the kids something novel to play with!

As the unit is entirely sold-state there is nothing to wear out, so reliability is almost guaranteed. All switching takes place at *zero-crossing points* of the mains waveform, virtually eliminating r.f. interference.

Finally, if the flashing becomes tiresome, the lights can be simply switched to "continuous" – you can't do that with a flasher bulb!

HOW IT WORKS

At the heart of the circuit are two D-type flip-flops, connected as slow-running oscillators with their switching points synchronised to mains zero-crossings. A simplified diagram of one oscillator, Fig. 1, shows how this is done.

Each flip-flop has a "clock" terminal, an input "D" and two complementary outputs "Q" and "$\overline{Q}$". The input to D decides the state of the outputs, but they only change at the instant when the "clock" input goes positive.

To understand the oscillator action, assume that the D input is positive and a positve clock transition has just taken place. This will have caused the Q output to go positive, pulling D further towards positive through capacitor *C*.

At the same time $\overline{Q}$ has gone negative and is discharging the D side of the capacitor through resistor R1. When it falls below half the supply, the next clock pulse will reverse the outputs and *C* will start charging in the opposite direction. Until this happens though, the clock pulses will not have any effect.

So long as the clock is fast relative to the main oscillation, the output frequency will be determined by *C* and R1. If the clock is synchronised with the mains, all output switching will take place only at zero-crossing points.

The purpose of resistor R2 may puzzle some readers; in some circumstances the input to "D" will exceed the supply rails in each direction after switching. If this happens, internal protection diodes conduct, taking the charge from capacitor *C* and upsetting the timing. Resistor R2 prevents this by restricting current flow to D. In the full circuit, the frequency is made adjustable by attenuating the voltage from Q before supplying it to *C*, as will be seen.

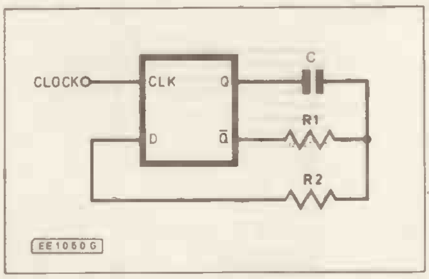


Fig. 1. Simplified oscillator circuit diagram.

TRIAC DRIVING

At this point, a few comments on triac driving may be worth while. At first sight this would appear to be simple; just apply a suitable gate current, of either polarity, and the triac turns on, right? Well, not always!

On closer inspection, firing triacs appears to be something of a black art. Load current, mains polarity at firing time and device temperature all play a part.

After a couple of problems with positive gate firing of C206Ds, experiments were conducted with half a dozen of them, firing with adjustable gate pulses which could be all positive, all negative, in phase with the mains or antiphase (reversed). Results showed that the C206D is more sensitive to negative gate drive, regardless of main circuit polarity.

COMPONENTS

Resistors

R1	390 1W
R2	1M 1W
R3	270k 1W
R4, R13-R20	10k (9 off)
R5,R7	4M7 (2 off)
R6,R8	10M (2 off)
R9-R12	22k (4 off)
R21,R22	1k5 (2 off)

All 0.6W metal film. 1% except where stated otherwise.

Shop Talk
See page 679

Potentiometers

VR1,VR2	100k lin carbon (2 off)

Capacitors

C1	0µ47 250V mains suppression type
C2,C3	470µ axial elec. 25V (2 off)
C4,C5	1µ polyester layer (2 off)

Semiconductors

D1,D4,D5	1N4007 silicon (3 off)
D2,D3	BZY88C8V2 Zener diode, 8.2V 500mW (2 off)
D6,D7	1N4148 silicon (2 off)
CSR1,CSR2	C206D Triac 400V 3A (2 off)
TR1,TR3,TR5	BC184L *npn* silicon (3 off)
TR2,TR4	BC214L *pnp* silicon (2 off)
IC1	4013B CMOS dual D-type flip-flop

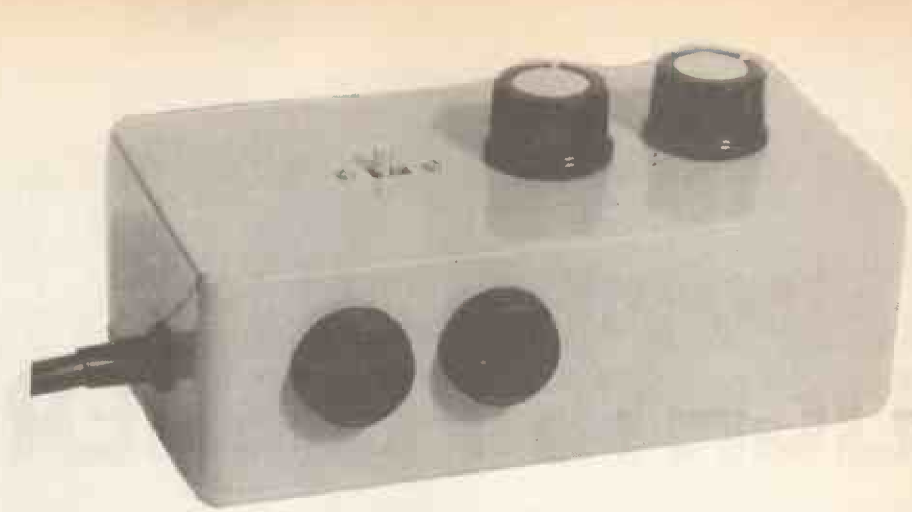
Miscellaneous

Printed circuit board, available from the *EE PCB Service*, code EE587; VDR1 mains transient suppressor; case, ABS box, 150 × 80 × 50mm; 14-pin d.i.l. socket; switch, s.p.s.t. slide switch; miniature mains chassis sockets (2 off), plugs (2 off) to suit; mains lead, plug and strain relief device; knobs (2 off); connecting wire; nylon screws for S1, etc.

Approx. cost Guidance only **£18**

This probably doesn't apply to all triacs as a single C226D tested showed equal sensitivity to either polarity. However, for this design negative gate drive has been incorporated.

Incidentally, if you have a problem with an earlier design using positive gate drive to a C206D triac, it will usually manifest as firing on positive half cycles only. A lamp connected to the circuit will be slightly dimmer with a noticeable flicker. The cure is to replace the triac, since most do in fact operate quite satisfactorily from positive gating.



CIRCUIT DESCRIPTION

Having covered some of the problems of triac firing, the full circuit diagram of the Dual Mains Light Flasher, Fig. 2, can be described. Starting with the low-voltage power supply, this is derived from capacitous mains dropper C1.

On positive half cycles capacitor C2 is charged, with maximum voltage set by Zener diode D2. On negative half cycles capacitor C3 is charged in the same way, to produce the auxiliary negative supply.

Resistor R2 discharges C1 when the unit is unplugged, to prevent shocks being delivered from the pins of the plug! Capacitive mains droppers are cheaper, lighter and simpler than transformers, also they neither hum nor get hot. Unused current (that not used to actually charge capacitors C2 or C3) is purely reactive and will not cause your electricity meter to rotate.

The clock input is generated by transistor TR1. Current from resistor R3, during positive half-cycles, flows through the base-emitter junction of TR1, turning it on. During negative half cycles it flows through diode D5, and TR1 is turned off.

The voltage at the collector is thus a square-wave, in opposite phase to the mains but accurately in time with it, and this is used to drive the two clock inputs of IC1. Two of the D-type flip-flops described earlier are contained in the integrated circuit IC1.

The feedback networks which control the two oscillators are connected as follows: pins 1 and 13 are the Q outputs; pins 2 and 12 are the $\overline{Q}$s, and pins 5 and 9 the Ds. The only difference between these networks and that shown in Fig. 1 are that the capacitors, C4 and C5, are not connected directly to the Qs, they are fed from attenuating potentiometers VR1 and VR2, which have their other ends effectively connected to half-supply through impedances of about one tenth of their value.

This gives an adjustment range of around ten to one, or a cycle length of about one to ten seconds with the values shown. This can easily be changed by altering the values of resistors R5 and R7 if desired.

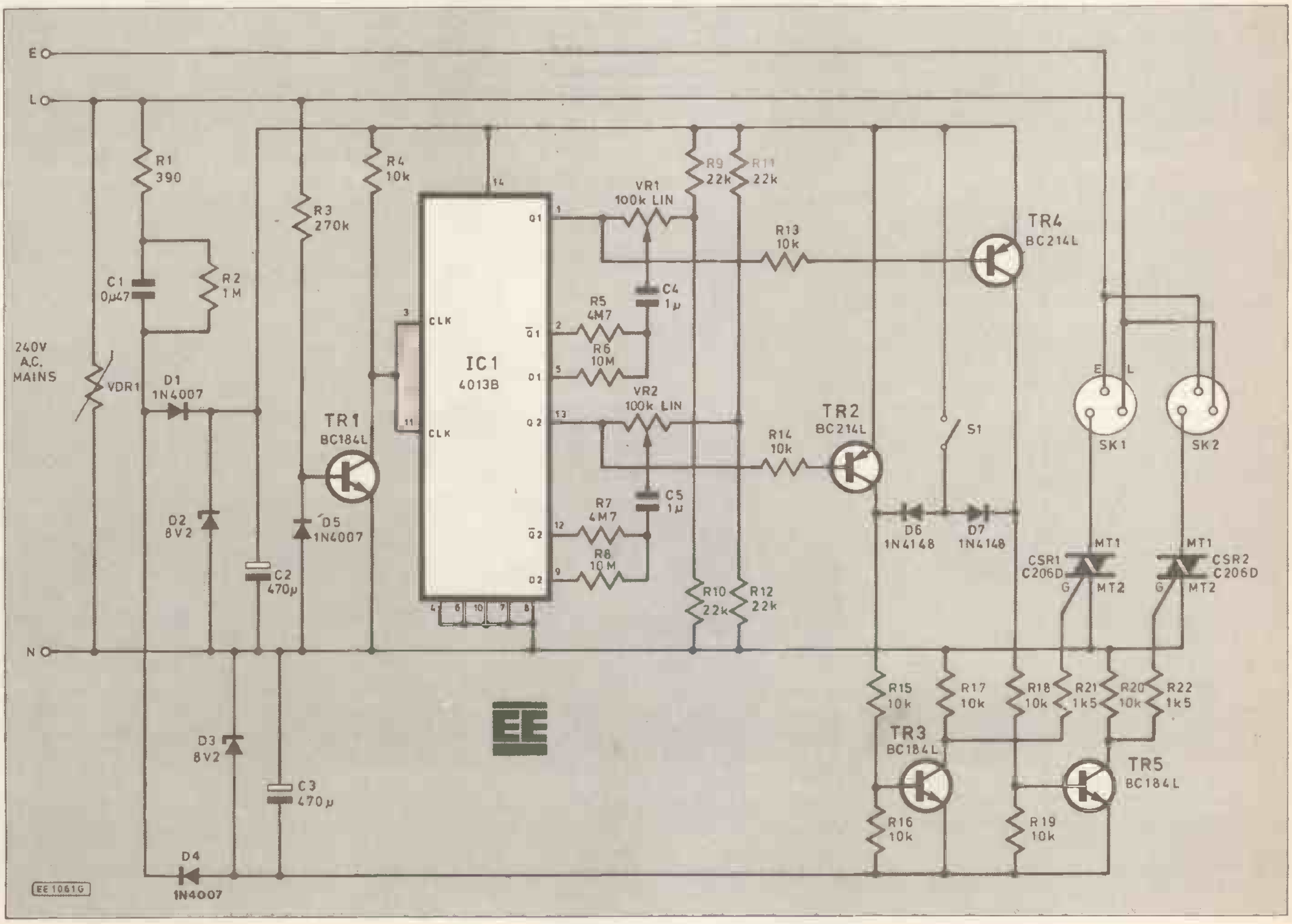
Output taken from the Q outputs is applied to transistors TR2 and TR4. These in turn drive TR3 and TR5, which supply negative gate current to triacs CSR1 and CSR2.

Closing S1 applies drive to the last two transistors for continuous output, useful when the flashing effect becomes tiresome, or when checking that all the bulbs are still working. Constant drive is applied when the triacs are supposed to be on, ensuring they remain operated even if the load current drops below the "holding" value, as may happen with light loads.

Since all switching takes place at zero-crossings and the load is resistive, the circuit is inherently interference-free and no r.f. suppression components are needed. Triacs can easily be destroyed by sudden high voltage transients though, which sometimes occur on the mains supply.

The use of a mains transient suppressor VDR1 is a precaution against this; normally

Fig. 2. Full circuit diagram for the Dual Mains Light Flasher.



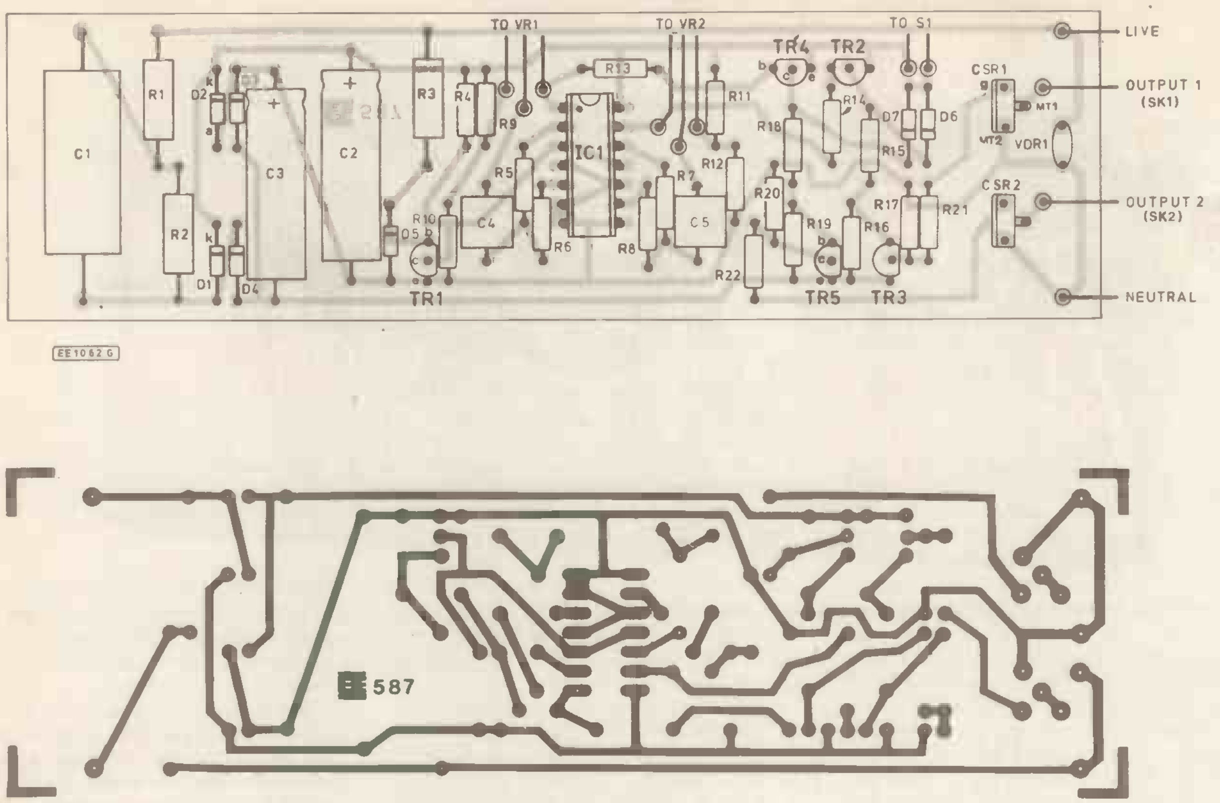


Fig. 3. Full size printed circuit board master foil pattern and component layout. It is recommended that IC1 be mounted in a 14-pin d.i.l. socket on the board.

open circuit, it will conduct and "soak up" spikes of excessive voltage. A blown triac, incidentally, usually goes short-circuit, delivering continuous power to the load.

Although few Christmas light sets are equipped with earth connections, the earth lead has been wired through to the output sockets in this design as it may be desirable in some other applications.

CONSTRUCTION

The component layout and full size printed circuit board foil master pattern is shown in Fig. 3. The small printed circuit board is available from the *EE PCB Service*, Code EE587.

Construction of this project has been kept as simple as possible. It should, in fact, be suitable for relatively inexperienced enthusiasts, providing extreme care is taken to avoid shock whilst testing.

Resistors R1, R2 and R3 are 1 watt types, all the rest are 0.6 watt one per cent types, but none of the values are critical and five per cent will do just as well. Capacitor C1 MUST be rated for continuous 240V use, the type specified is listed by the suppliers as an "IS" (interference suppression) component. Capacitors C4 and C5 are the small, silver-coloured polyester layer type, which are not polarity conscious.

A d.i.l. socket is recommended for IC1. Lastly, the potentiometers *MUST* have plastic shafts, and plastic knobs that cover their bushes should also be used to ensure safety for the finished project.

Check the p.c.b. for fit in the case before starting to fit the components. The positioning of these can be seen in the component layout diagram, Fig. 3.

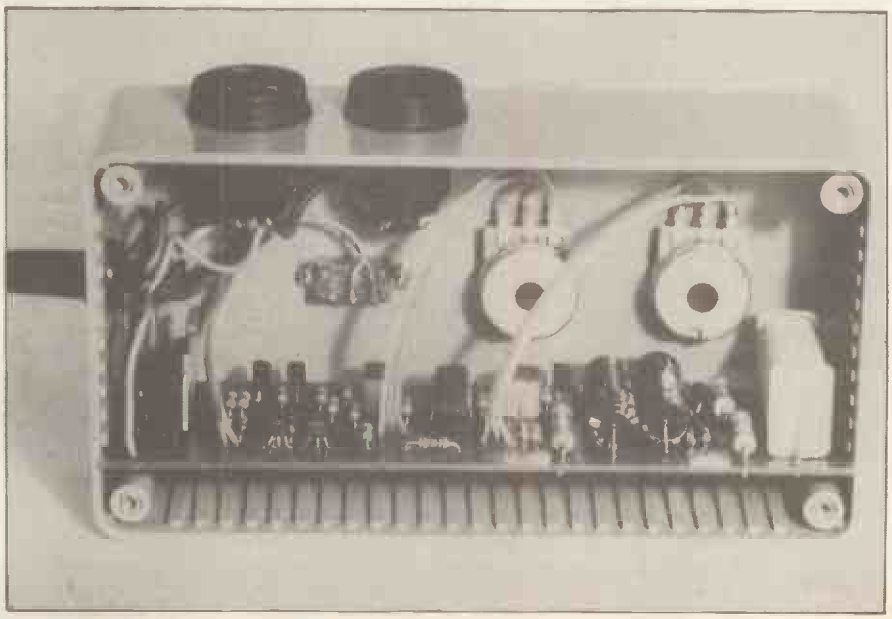
The components are probably best fitted in "height order", that is, resistors and diodes first, then the i.c. socket, then the smaller capacitors and transistors, etc. The only point to note is that capacitors C2 and C3 may be a slightly tight fit between diodes D1 and D4 to their left and D5 to the right, so when fitting these diodes tweak the leads sideways a little, away from the capacitors.

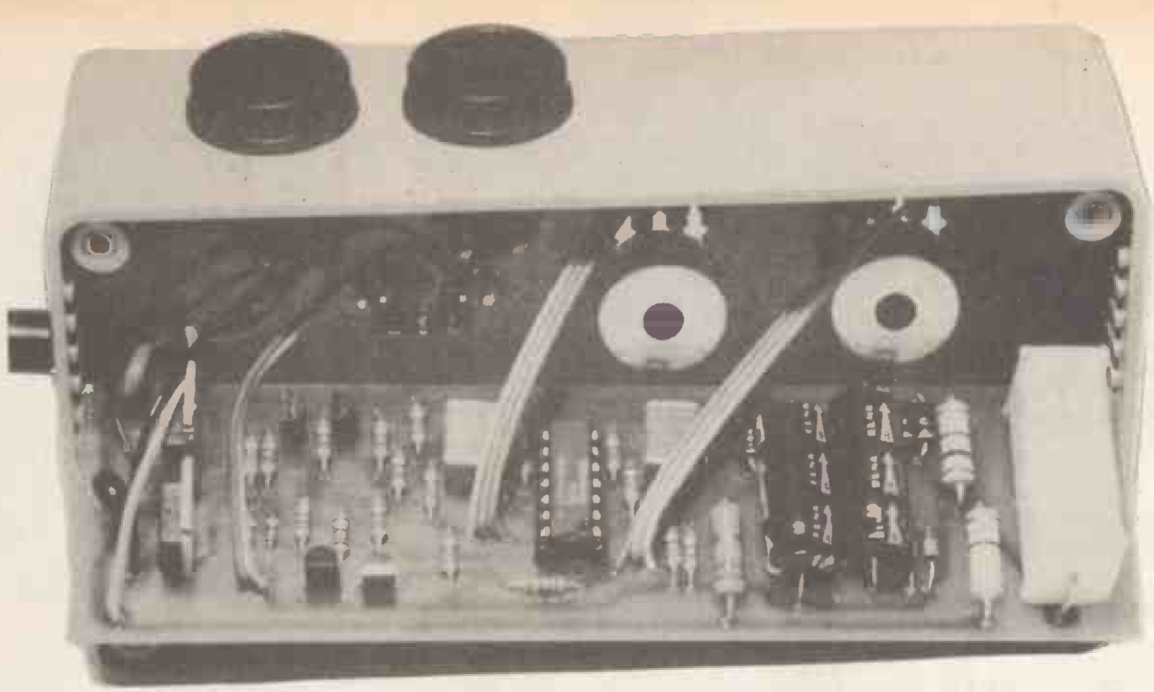
BOARD TESTING

The testing that can be carried out is somewhat limited as most of the circuit will not operate without the mains connected to operate the clock inputs. *AS THE CIRCUIT WILL THEN BE CONNECTED DIRECTLY TO THE MAINS IT MUST ALL BE TREATED AS "LIVE"* and it is obviously unwise to touch unless you know *EXACTLY* what you are doing! In view of this, check the completed board very carefully.

It is probably worth testing the positive and negative supplies before plugging in IC1; this can be done by hooking a voltmeter across capacitors C2 and C3 in turn, THEN connecting to the mains supply. It would also be possible to check operation of transistor TR1 by looking at the average collector voltage, which should be somewhere close to half the positive supply, about 4.1V.

The completed unit showing the board slotted into the case side grooves.





The completed unit. The two potentiometers must have plastic spindles for added safety.

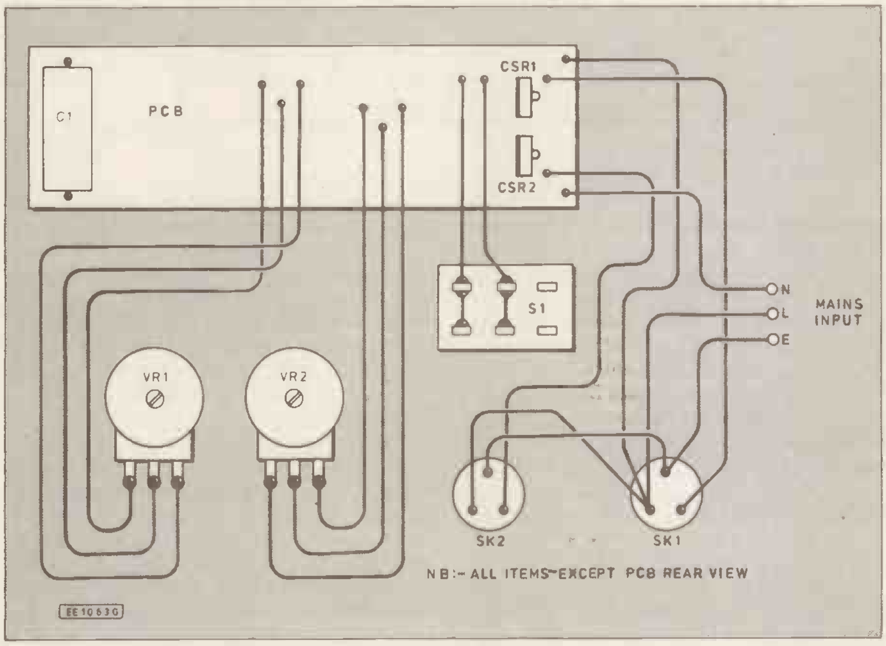


Fig. 4. Interwiring from the circuit board to the case mounted components. The mains lead should be held in position by a suitable plastic clamp.

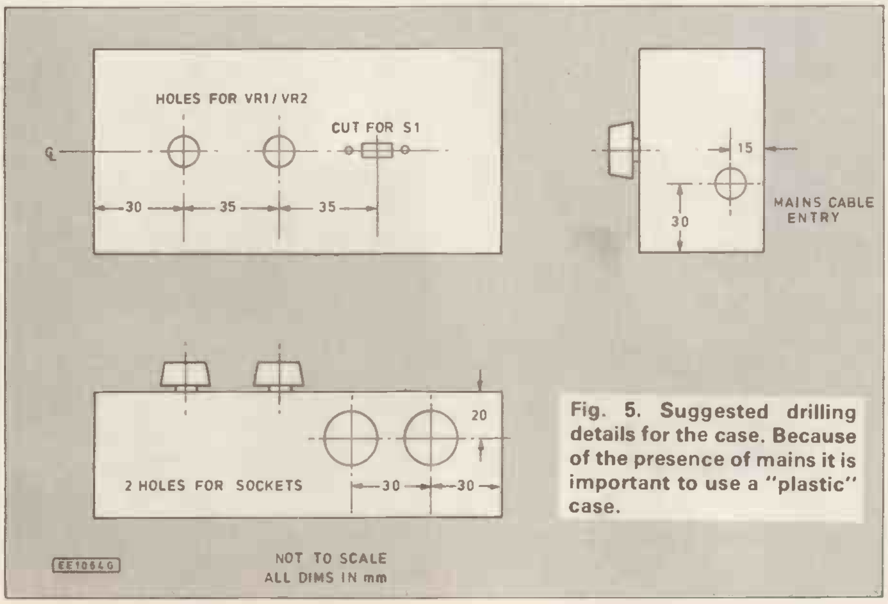


Fig. 5. Suggested drilling details for the case. Because of the presence of mains it is important to use a "plastic" case.

This is about all the testing that can be done without the potentiometers and loads (lights) connected, so the project can be assembled and wired into the case for final checking. Fig. 4 shows all the interconnections needed; a few lengths of ribbon cable make for a neat job. Check the wiring carefully when complete.

To ensure adequate clearance between all components details of drilling for the case are given in Fig. 5, this being a standard grey ABS box with p.c.b. mounting slots, available almost everywhere. Switch S1 was actually a two-pole two-way switch, the two poles were wired in parallel for additional reliability.

Christmas lights, as many readers will know, are designed to fail "short circuit". This prevents the whole set going out if a bulb blows, and enables easy identification of the fault. The drawback with this arrangement is that each failed bulb increases the load on the rest, with a corresponding risk of destruction of the entire set should enough blown bulbs remain unnoticed for a time.

To overcome this failing a special "fuse bulb", more delicate than the others, is generally fitted, often with a white-painted top for identification. At switch-on, the extra surge in this bulb can be clearly seen and it might be expected that it would not last very long if driven by a flasher unit.

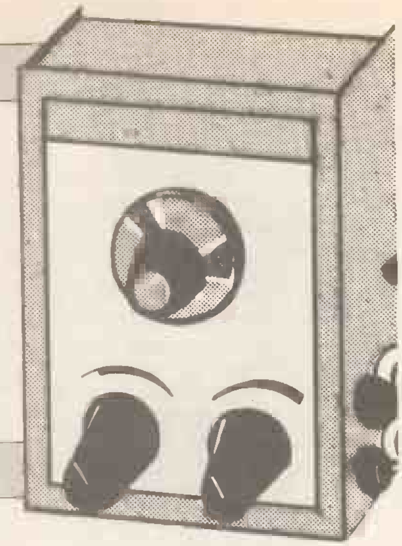
As a test, the author's lights, which have survived at least two Christmases on the tree and are slightly blackened as a result, were driven continuously for twenty-four hours, and all bulbs including the fuse survived. The problem would not, then, appear to be that serious.

However, it would be possible to remove the fuse bulb and fit two 20mm cartridge fuse-holders to the unit so that suitable fuses, say 250mA for 36W lamp sets, can be used. The choice is left to the individual constructor. In any case, the use of a fused mains plug with a 2A or 3A fuse is *strongly* recommended.

FURTHER USES

This project may well find other uses apart from driving the tree lights. Although designed for low loads it can safely drive up to 100W per channel, the limit being set mainly by the lack of heatsinks on the triacs.

It could obviously be used to generate eye-catching displays for shops, exhibitions and the like, and could provide attractive "disco light" shows at parties. The uses are limited only by the user's own imagination, and the simple, inexpensive construction allows more than one unit to be built if required. □



AUDIO SIGNAL GENERATOR

MARK STUART

A low cost, versatile audio signal generator providing up to 6V output.

THIS simple low cost audio generator is extremely useful to have around. The output is a sine wave of up to six volts peak to peak and the frequency can be varied from 33Hz up to 33kHz. Two output sockets give variable outputs of 0-60mV, and 0-6 volts. A third socket gives a constant six volts output which can drive loads as low as eight ohms directly at up to 0.5 watts. This high power output level is ideal for checking loudspeakers and associated wiring. The compact construction makes the unit perfect for the tool box or pocket.

CIRCUIT

The circuit diagram of the oscillator is shown in Fig. 1. A single audio amplifier i.c. the LM386N-1 does everything. The frequency of oscillation is set by the dual variable control VR2a and VR2b, in conjunction with whichever pair of capacitors is selected by S1b and S1c. Capacitors C1 and C4 give the low frequency range of 33Hz to 330Hz, C2 and C5 give 330Hz to 3.3kHz, and C3 and C6 give 3.3kHz to 33kHz.

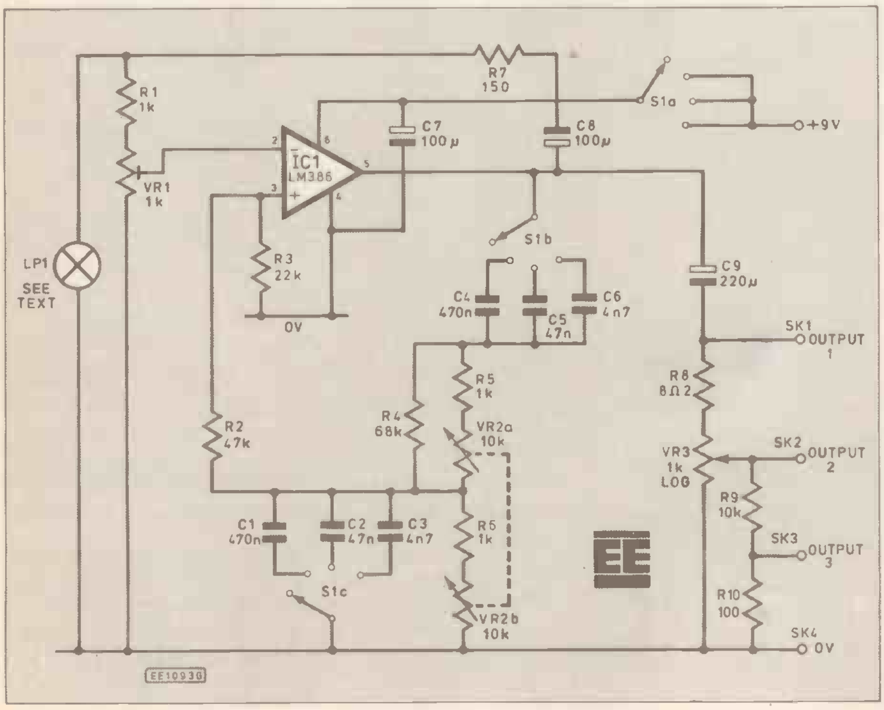
The components together form a frequency selective network known as a Wein Bridge. At the frequency of oscillation the circuit has its maximum voltage "gain" of one third. Above or below this frequency the "gain" falls away. Unlike the sort of tuned circuits used in radio receivers which can have very sharp peaks, this circuit has only a gentle "hump" in its frequency response. Its big advantage is that it does not use inductors (which would be very large for low frequencies) and that the frequency can be varied by changing just the two resistor values. Feedback via this network is passed from the output of IC1 (pin five) to its non-inverting input (pin three) via R2 and R3. If the amplifier gain is exactly three the losses of the feedback network are made up and the whole circuit will oscillate as required. The problem in a practical circuit is that a gain of exactly three is impossible to achieve. If the gain is only slightly less than three the circuit will never oscillate and if the gain is slightly more than three the oscillations will go on increasing in level until the amplifier is driven into clipping and the output is no longer a sine wave.

What is needed is a means of measuring the output level and increasing or decreasing the gain as the output voltage falls or rises. Many elaborate circuits have been designed to do this, some of which are very sophisticated and are used in top class audio measuring instruments. One of the most common methods is to use a pair of diodes or Zener diodes in the feedback network to introduce a controlled form of clipping and to set the gain to slightly over three. This method introduces a small amount of distortion but is quite adequate for some applications.

THERMISTOR

An alternative is to use a thermistor which is driven by some of the output signal and as a result increases in temperature and changes resistance. This change in resistance is arranged to affect the feedback signal so that if the output rises and the thermistor gets hotter the gain is automatically reduced and vice-versa. In this way the gain is constantly controlled and sets itself to exactly three. Low distortion and

Fig. 1. Complete circuit diagram of the Audio Signal Generator.



simple circuitry are the merits of this method, the only drawback being the cost of the thermistor. As this has to be heated by a very small signal it has to be physically small and contained inside an evacuated glass envelope. The RA53 type usually used costs around £6.00 which is rather expensive when a simple, cheap circuit is required. In this circuit the thermistor method has been used but instead of a standard thermistor a small cheap filament lamp is employed.

LAMP CHARACTERISTICS

It is generally known that the resistance of a filament lamp changes as it heats and cools. What is probably less well known is exactly how much. To get some idea of the figures involved a small bulb of 12 volts 60mA rating was tested. The voltage across it was varied and the current measured at different voltages from 25 millivolts upwards. The resulting curve is plotted in Fig. 2. A normal resistor would produce a straight line as shown by the dotted line for a 200 ohm resistor. The shape of the curve shows that initially the current increases rapidly for only a small increase in voltage but gradually increases less and less as the voltage gets higher.

At very low current and voltage (1mA,25mV) the slope of the curve shows the resistance to be around 25 ohms. At higher currents the effective resistance rises becoming 355 ohms at 12 volts. This has very interesting implications from the point of view of switch-on surges. In this case a 60mA bulb will actually look like a 25 ohm resistor at switch-on and will draw a current of 500mA. If the power

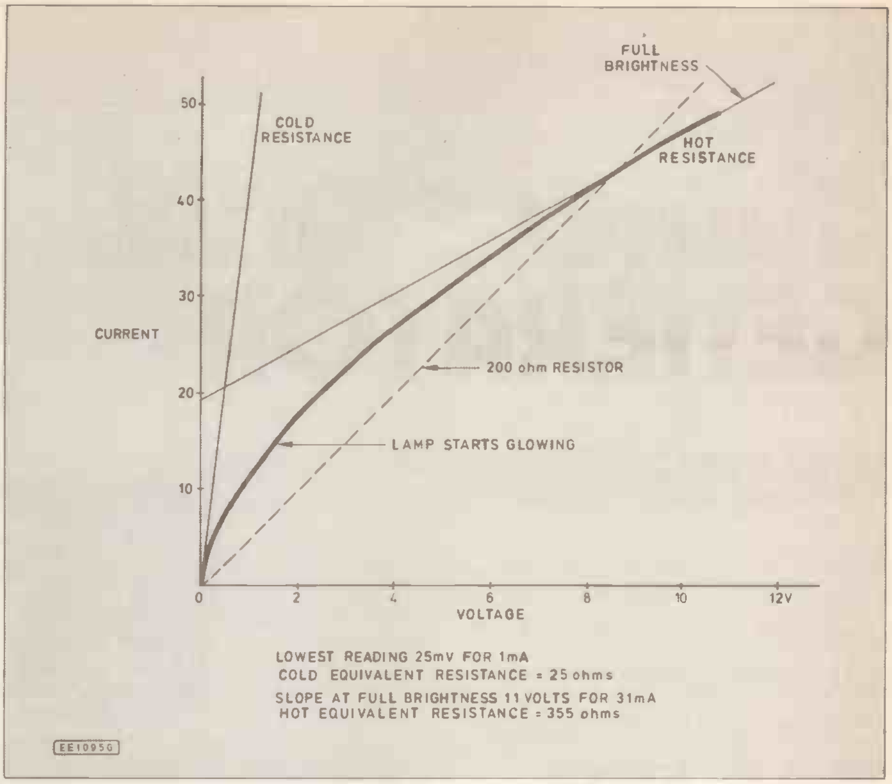


Fig. 2. Lamp resistance variation.

supply can only provide 250mA then a voltage dip will occur which could result in numerous undesirable circuit effects. If it is assumed that all bulbs behave similarly it indicates that a car headlight bulb rated at 48 watts or four amps will draw an initial surge current at switch-on of around 35 amps! The headlamp switch must therefore be able to handle regular 70 amp current surges.

Getting back to the original purpose of all this, it is clear that the bulb filament can be used in the same way as a thermistor to control the gain of the oscillator circuit. The bulb resistance increases as the power in it increases and this must be arranged so that it causes a decrease of circuit gain.

SECOND FEEDBACK LOOP

The arrangement shown in Fig. 1 achieves the necessary control by introducing a second feedback loop around IC1. This loop is from the output to the inverting input so is negative feedback. The output signal is coupled via C8 and R7 to the lamp LP1. The voltage across the

COMPONENTS

Resistors

R1,R5,R6	1k (3 off)
R2	47k
R3	22k
R4	68k
R7	150
R8	8Ω2
R9	10k
R10	100

Shop Talk
See page 679

Potentiometers

VR1	1k min. horizontal preset
VR2	10k dual reverse log.
VR3	1k log.

Capacitors

C1,C4	470n 100V min. polyester 10%
C2,C5	47n polyester 10%
C3,C6	4n7 polystrene 5%
C7,C8	100µ radial elect. 16V
C9	220µ radial elect. 16V

Semiconductors

IC1	LM386N-1 amplifier

Miscellaneous

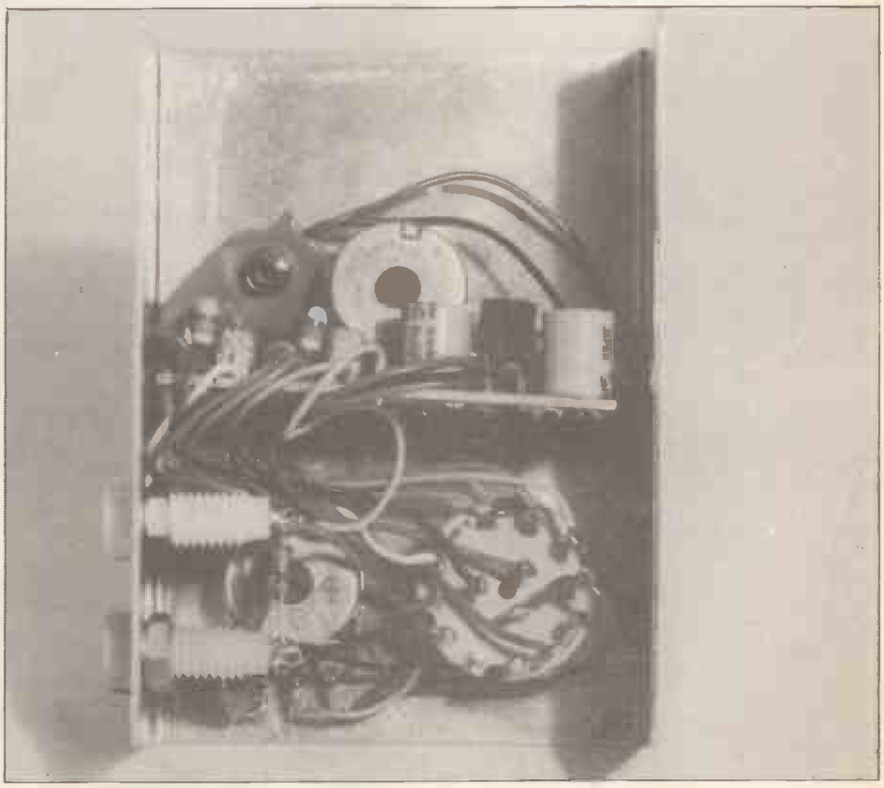
LP1, 12V 60mA min. wire ended lamp.

S1, 3pole 4way rotary switch.

SK1 to SK4, 4mm panel sockets.

Knobs, 2 miniature, 1 with metal skirt; i.c. socket, 8 pin; PP3 battery clip; p.c.b., available from the *EE PCB Service*, order code EE589; metal case – size 75 × 100 × 40mm; wire; case feet.

Approx. cost Guidance only £13



lamp is tapped off via R1 and VR1 and fed to pin two of IC1. Operation is as follows: Initially when the circuit is switched on LP1 is cold and so has a very low resistance. Any feedback via R7 is therefore shunted away and has little effect. Without negative feedback the circuit has high gain and so oscillation commences and builds up.

As LP1 is heated by the increasing output signal, its resistance increases and so the voltage across it also increases. This causes more negative feedback to be applied to the circuit which reduces its gain. This stabilises the oscillations at a level which then can be pre-set by means of VR1. The result is a good stable sine wave output of 6V peak to peak.

Although the final circuit is very simple the actual design of the negative feedback stabilisation loop is quite difficult. The thermal inertia of the lamp puts a delay into the circuit which can cause the stabilisation to overshoot. This means that the output level can have a tendency to bounce up and down as the frequency is varied. Careful design is necessary to reduce this effect to a minimum.

OUTPUTS

Three outputs are available from the circuit. One is straight from the i.c. output via C9, and is capable of driving a speaker at up to 0.5 watts. The second output is variable by means of VR3 from zero to six volts. R8 protects this output from short circuits. The third output is divided by 100 by R9 and R10 and so is suitable for use with sensitive input circuits.

POWER

The circuit can be powered either by 9 or 12 volts. A PP3 battery will give adequate power for intermittent use. A mains adaptor should be used if the unit is in use for longer periods for example during bench testing. A section of S1 (S1a) is used as the on-off switch.

CONSTRUCTION

The whole circuit is built on a small printed circuit board which is shown in Fig. 3, the copper track pattern is also shown. Assemble the board as shown taking care to get C7, C8 and C9 the right way round. A socket should be used for IC1. The board should be fitted with flexible wire leads for the connections to VR3 and S1. These leads are best fitted directly to the board by stripping approximately 6mm of insulation and passing the bare ends through from the component side and soldering on the track side.

Refer to the wiring diagram of Fig. 5 for all of the necessary off-board connections. Switch S1 has all of its tags numbered or lettered for ease of identification. If different switches are used it may be necessary to make changes to this. The lamp LP1 should be secured to the board with a small blob of adhesive. **It is important that the correct lamp is used for the stabilisation circuit.**

SETTING UP

The circuit only requires adjustment of VR1 to be up and ready to use. Fortunately this adjustment is quite simple. Ensure that a fresh battery is fitted, select the lowest frequency range and set the dial to give approximately 50Hz. Connect a multimeter set to a.c. volts between 0V and "Output 1". Adjust VR1 to give a reading of 2.1 volts, and that's it. The calibration of VR2 can be done by borrowing a frequency meter or oscilloscope, or in a slightly more primitive way by comparison with musical instruments.

The scale and panel label shown in the photographs can be copied, stuck on and protected by self adhesive transparent film. □

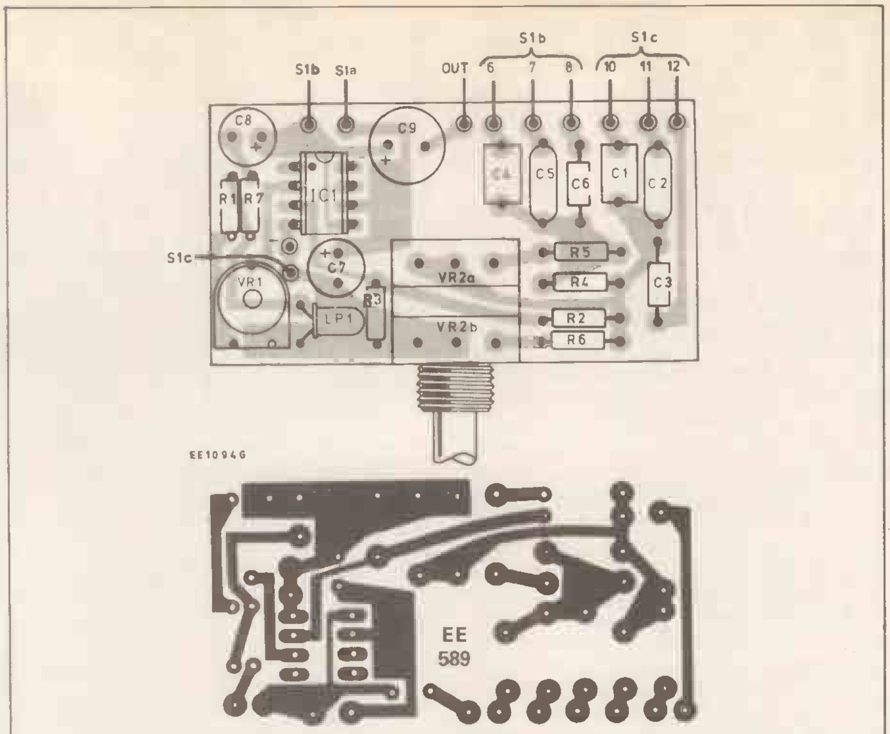


Fig. 3. Printed circuit board layout and wiring.

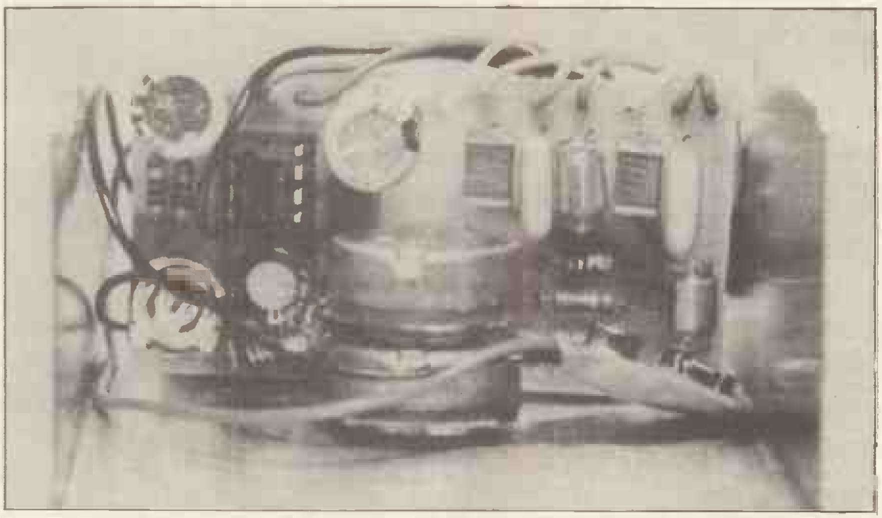
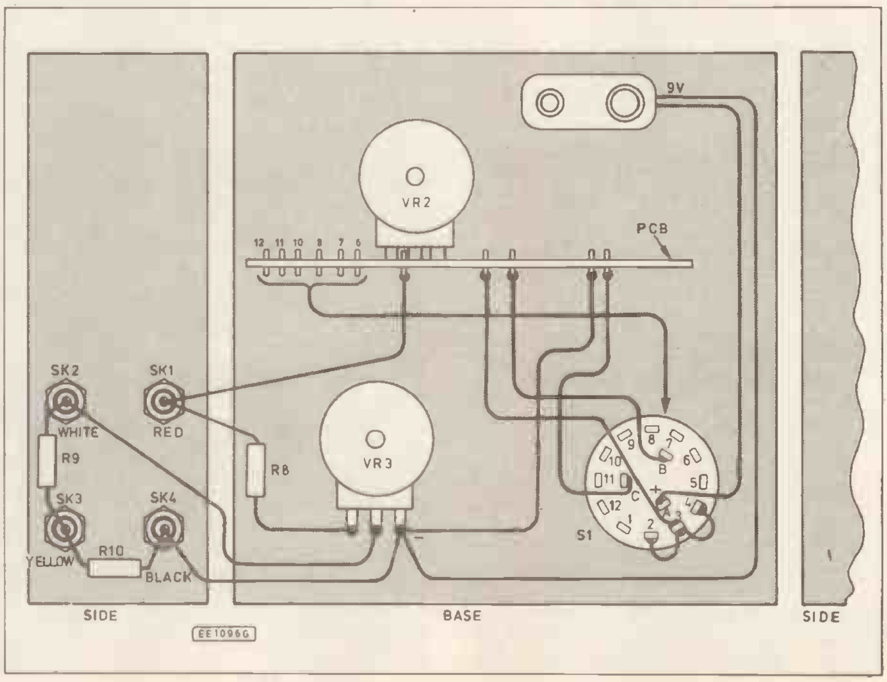


Fig. 4. Interwiring details.



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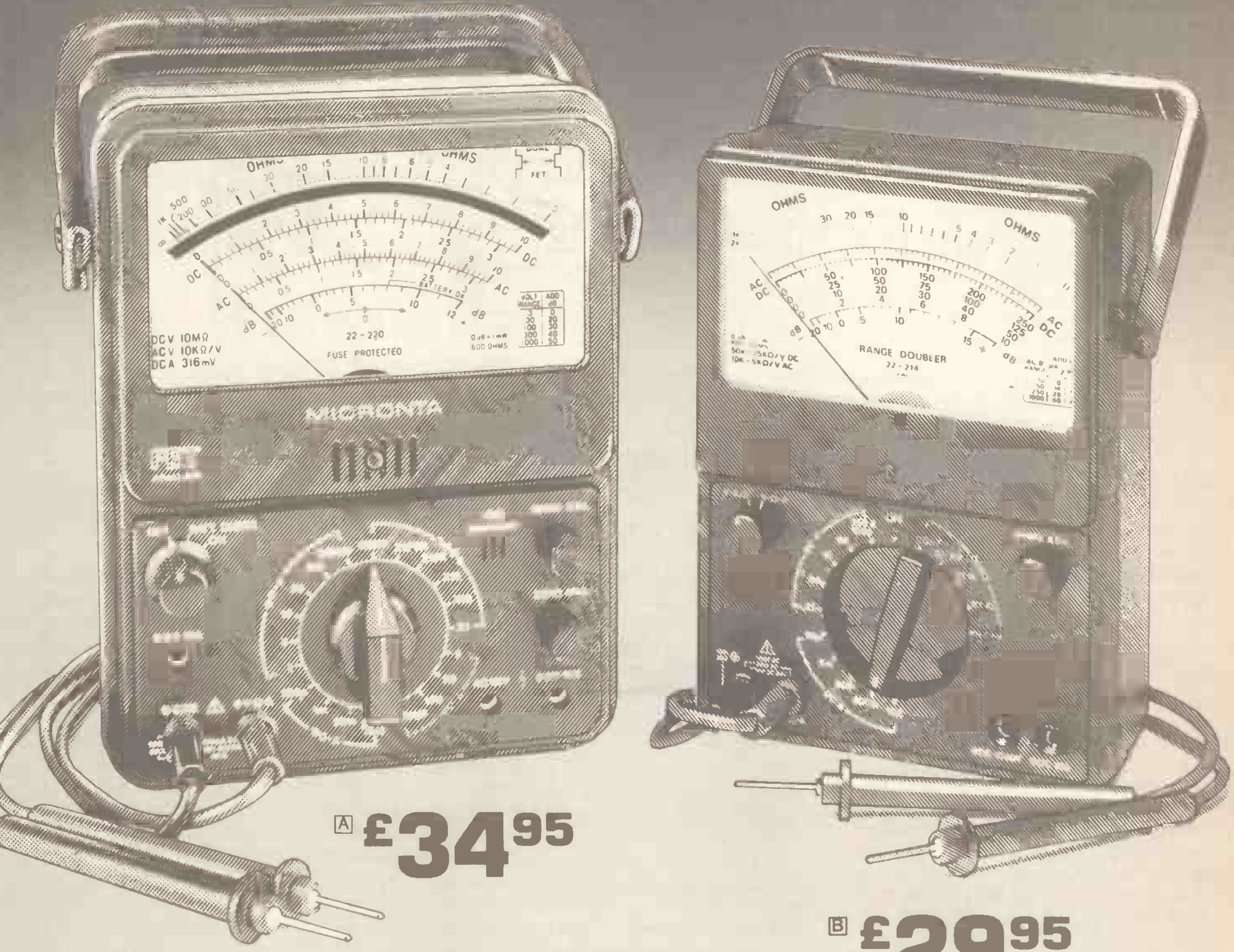

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INTRODUCING MICROPROCESSORS

MIKE TOOLEY B.A.

Part 2

MICROPROCESSORS

In Part 1 we set the scene for our nine part series and introduced readers to the architecture and terminology of microcomputer systems. In this part we shall be revealing some of the innermost secrets of the prime mover within a microcomputer system, the microprocessor.

LEARNING OBJECTIVES

The general learning objectives for part two of *Introducing Microprocessors* is that readers should be able to:

(a) draw a block diagram showing the internal architecture of a representative 8-bit microprocessor and state the function of each of the principal internal elements (2.1)

(b) state and explain the function of each of the principal external connections of a representative 8-bit microprocessor (2.1)

(c) explain the need for a clock and state typical frequencies and periodic times for microprocessor clocks (2.1)

(d) make appropriate use of manufacturers' data sheets (2.1)

(Note: City and Guilds module document reference numbers are shown in brackets.)

The specific objectives for this part are as follows:

2.1 INTERNAL ARCHITECTURE OF A MICROPROCESSOR

2.1.1 Draw and interpret a block diagram showing the internal architecture of a representative 8-bit microprocessor.

2.1.2 State and explain the function of each of the principal internal registers of a representative 8-bit microprocessor.

2.1.3 State and explain the function of each of the principal external connections of a representative 8-bit microprocessor.

2.1.4 Explain the need for a clock and distinguish between external and internal microprocessor clocks.

2.1.5 State the range of typical clock frequencies and periodic times for common 8-bit microprocessors.

2.1.6 Use manufacturers' literature to determine the supply voltage, pin-out, and internal features of any common 8-bit microprocessor.

MICROPROCESSORS

In Part 1 we briefly mentioned that a microprocessor performs the functions of a central processing unit (CPU) within a microcomputer. We also stated that the microprocessor provides control and synchronisation signals for the rest of the system. From this, it should be obvious that the microprocessor is the single most important component within any microcomputer system.

The basic internal elements of a microprocessor are as follows:

(a) registers for temporary storage of instructions, data, and addresses

(b) an arithmetic logic unit (ALU) able to perform a variety of arithmetic and logic functions

(c) control logic which accepts and generates external control and supervisory signals (such as RESET and READ/WRITE) and synchronizes data transfers within the system.

Registers

Internal registers can be thought of as arrangements of pigeon holes into which data (in binary form) can be placed during processing. Some registers are directly accessible to the programmer (i.e. he can set or read their contents at will) whilst others are reserved for the machine's own use. Registers may also be classified as "dedicated" (i.e. they have a specific purpose such as pointing to a memory location or holding the results of an ALU operation) whilst others are described as "general purpose".

In the case of an 8-bit microprocessor, most of the general purpose registers will be capable of storing eight bits. Furthermore, since each of the bits may be either 0 or 1, there will be a total of 256 possibilities for the contents of such a register, ranging from 00000000 to 11111111. Registers used for "pointing" to memory locations, on the other hand, will generally be capable of holding sixteen bits and consequently their contents may range from 0000000000000000 to 1111111111111111 (i.e. 0 to 65535 decimal).

The data bus lines in an 8-bit microcomputer are labelled D0 to D7. The most significant data bit (i.e. that with the greatest binary weight) appears on D7 whilst the least significant bit (i.e. that with the least binary weight) appears on D0. In the case of a 16-bit address bus, the lines are labelled A0 to A15 and the most and least significant address bits are respectively those which appear on address lines A15 and A0. The most and least significant bits are often referred to as the MSB and LSB respectively. Note that it is conventional to write binary numbers with the MSB first and the LSB last (see Part 1).

Unfortunately, there is some considerable variation in both the internal architecture and terminology used by

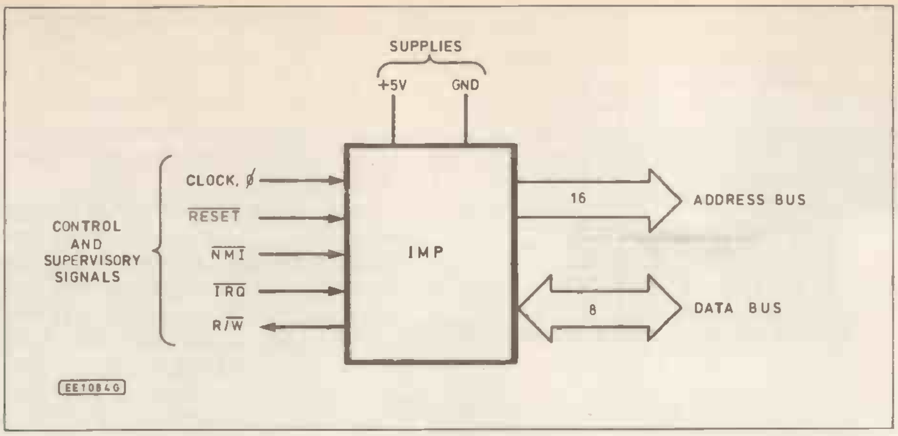


Fig. 2.1 IMP's external connections. N.B. A bar (¯) over a particular signal indicates that it is active-low (i.e. logic 0 when asserted).

different microprocessor manufacturers. Despite this, there are a number of common themes. The major microprocessors families, for example, tend to retain a high degree of upward compatibility both in terms of internal architecture and the software "instruction set" and this is clearly an important consideration in making a new product attractive to the equipment manufacturer.

INTRODUCING IMP

IMP stands for introductory microprocessor, a hypothetical device which we shall be using to explain some of the fundamental concepts of microprocessors. We have chosen to follow this route, rather than tailor our description to a real microprocessor, in order to keep the explanation as simple as possible. IMP contains many of the features found in a real 8-bit microprocessor without favouring the architecture of any particular processor family. By this means, we hope to provide readers with a gentle introduction to microprocessors avoiding superfluous or processor specific information which may otherwise serve only to confuse the newcomer.

Important differences between IMP and real microprocessors will be discussed as we progress but readers who require detailed information on particular microprocessors need not worry as we shall be presenting this information in the current series of Data Cards. These cards will feature all of the most popular 8-bit microprocessors (6502, 6800, 8085 and Z80) and will build to provide a useful library of microprocessor related data.

IMP has an 8-bit data bus, 16-bit address bus and five control and supervisory signal lines. Like most 8-bit microprocessors, IMP has a 40-pin d.i.l. package and operates from a +5V supply. IMP's connections with the outside world are shown in simplified form in Fig. 2.1.

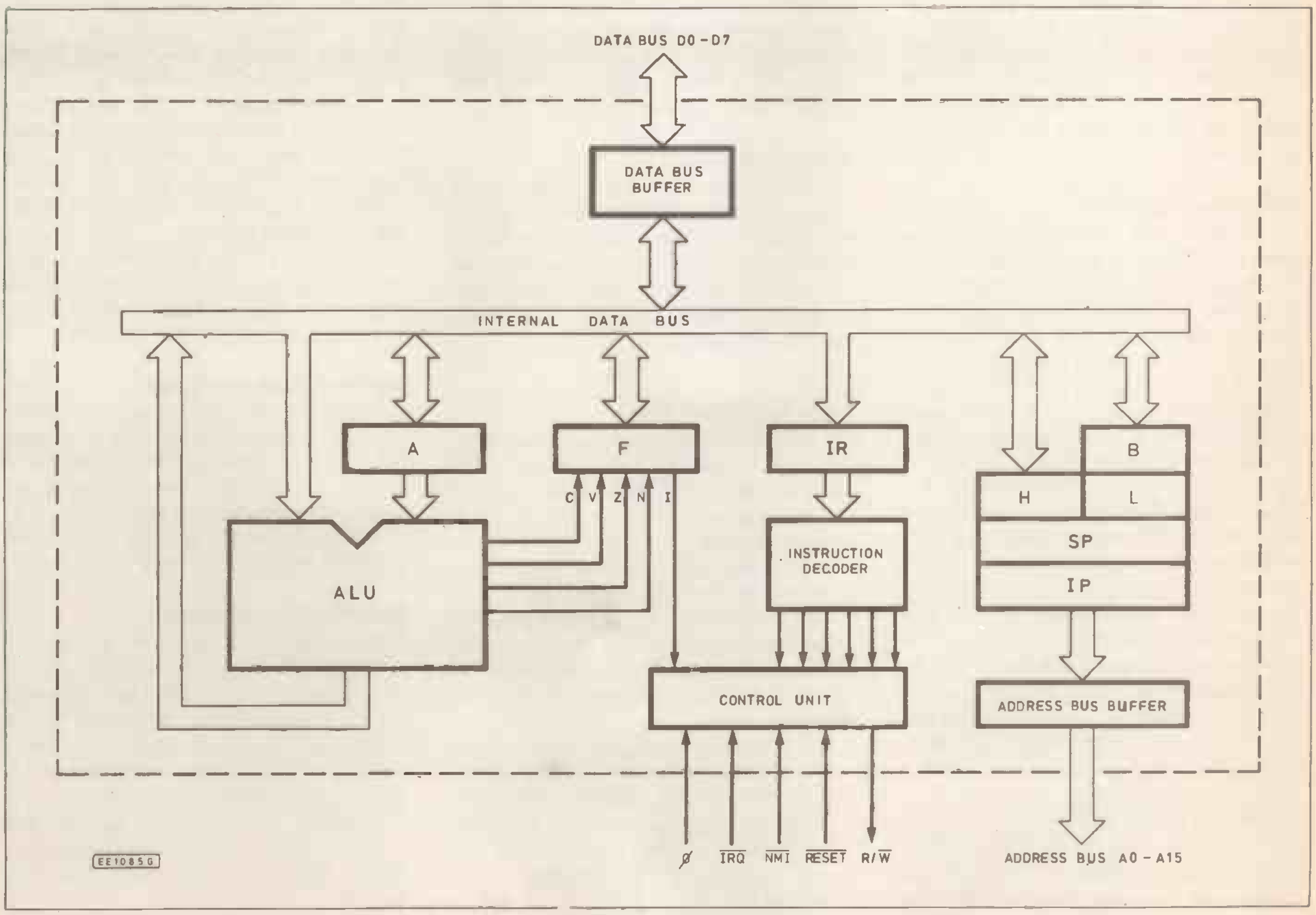
Internal architecture

The internal arrangement (architecture) of the IMP is shown in Fig. 2.2. At first sight this diagram may look rather complex so we will spend some time explaining each individual feature and how it relates to the working of the unit as a whole.

The majority of IMP's internal registers are linked together by means of an internal data bus. This bus can be thought of as a highway along which bytes are transferred from one register to another. Since we are dealing with an 8-bit microprocessor, the internal data bus is naturally eight bits wide. Fig. 2.3 shows how two 8-bit registers (A and B) are coupled to the internal bus. Separate lines from the control unit (not shown on

N.B. A bar (¯) over a particular signal indicates

Fig. 2.2 IMP's internal architecture



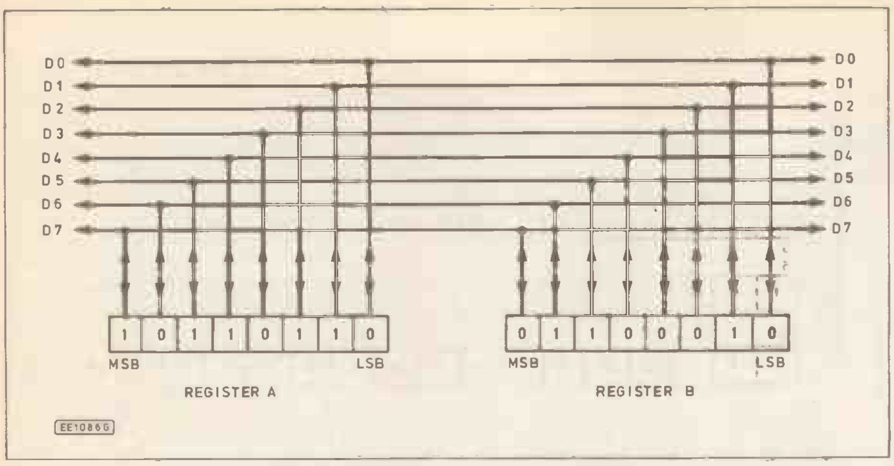


Fig. 2.3 Connections to the internal data bus

either Fig. 2.2. or Fig. 2.3) are used to determine whether:

(a) the contents of the register are to be made available on the bus (so that it may be copied elsewhere),

or (b) the data currently present on the bus is to be latched into the register (replacing whatever was there before),

or (c) the register is to be isolated from the bus (preserving its contents for future use).

Now, consider the process of copying data from register A to register B. We would need to make the data in register A available on the bus (case (a) above), latch the data into register B (case (b) above), and ensure that every other register connected to the bus was currently isolated (case (c) above). If this is beginning to sound rather complex, there is no need to worry as the generation of the necessary internal control signals is both implicit in a particular instruction and entirely automatic.

Data Bus Buffer

The data bus buffer separates the internal data bus from the external data bus and it incorporates eight individual bi-directional current amplifiers. The buffers may be made to receive data from the external bus or transmit data to the external bus in response to control signals (not shown in Fig. 2.2). The buffer helps regularise the logic levels received by the microprocessor and provides a reasonable amount of current gain for "driving" the external bus. The data bus buffer thus provides a means of isolating the microprocessor from the harsh world outside!

[Some microprocessors allow the microprocessor to isolate itself from the data bus by placing the data bus buffer in an open-circuit (i.e. disconnected) or "tri-state" condition. This allows other "intelligent" devices to place information on the data bus.]

Address bus buffer

The address bus buffer behaves in a similar fashion to that of the data bus buffer. It is, however, important to note that the individual address bus buffers are unidirectional since address information is only generated by the microprocessor and not received by it.

[Some microprocessors allow the microprocessor to isolate itself from the address bus by placing the address bus buffer in an open-circuit (i.e. disconnected) or "tri-state" condition. This allows other "intelligent" devices to place information on the address bus.]

Instruction Pointer (IP)

The instruction pointer is a 16-bit register which contains the address of the next instruction byte to be executed. The contents of the register is thus said to "point" to the next instruction byte. The contents of the instruction pointer is automatically incremented each time an instruction byte is fetched.

[Note: Many microprocessors refer to this register as a Program Counter (PC)]

Accumulator (A)

The accumulator is an 8-bit register which functions both as a source and destination register; not only is it the source of one of the data bytes required for an ALU operation but it is also the location in which the result of an ALU operation is placed.

Flag Register (F)

The flag register contains information on the internal status of the microprocessor and, in particular, signals the result of the last ALU operation. It is important to note that the flag register is not a register in the conventional sense; it is simply a collection of bistable latches which can be "set" or "reset" depending upon the result of an ALU operation. The output of each bistable can be considered to act as a "flag". IMP has the following flags:

CARRY (C) – set to 1 when the last ALU operation has produced a carry

OVERFLOW (V) – set to 1 if the last ALU operation resulted in an overflow

ZERO (Z) – set to 1 if the result of the last ALU operation was a zero

NEGATE (N) – set to 1 when subtraction has taken place, otherwise reset to 0

INTERRUPT (I) – set to 1 when interrupts are disabled (in this state the microprocessor is unable to accept an "interrupt request" generated by an external device).

The composition of IMP's flag register is shown in Fig. 2.4. It is important to note that, once changed, the various flag bits remain either set or reset until a further change occurs. The programmer is only able to directly affect the state of the CARRY and INTERRUPT flags. The others change state indirectly as a result of program execution.

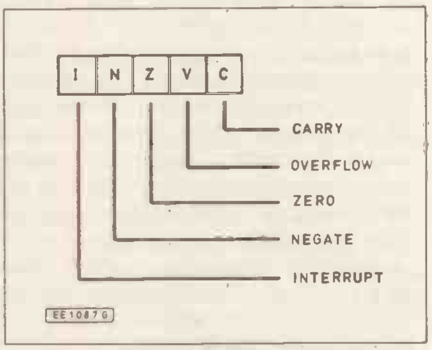


Fig. 2.4 IMP's flag register

Stack Pointer (SP)

IMP needs to have access to an external area of read/write memory (RAM) which permits temporary storage of data. This area of memory is known as a "stack" and it may typically occupy between 16 and 256 bytes of memory. (Note, however, that the stack is a dynamic structure and its size varies continuously during processing.)

The stack operates on a "last-in first-out" (LIFO) basis; data is "pushed" onto the stack and later "pulled" off it. The "stack pointer" keeps track of the extent of the stack by holding the address of the last used stack location.

[Note: Some popular microprocessors (e.g. 6809) have two independent stack pointers; a "system stack pointer" (SSP) and a "user stack pointer", (USP).]

Instruction register

The instruction register is a temporary storage location which is used to contain the current instruction byte whilst it is decoded. The instruction register is not directly accessible to the programmer (i.e. it cannot be loaded directly nor can its contents be copied to other locations).

Instruction decoder

The instruction decoder, a complex arrangement of logic gates with outputs which are fed to the control unit, operates on the instruction currently held in the instruction register. The instruction decoder informing the control unit of the actions demanded by the current instruction (e.g. the need to take the R/W line low and latch the contents of the HL register pair into the address bus buffer).

Control Unit

The control unit generates internal control signals (not shown in Fig. 2.2) which determine the direction, source and destination of internal data transfers, activates external control lines when required, and responds to external signals which arrive on the control bus. The control unit is also responsible for internal synchronisation.

General purpose registers

Apart from the accumulator (A), IMP has three 8-bit registers which may be classed as "general purpose". These are B, H and L. Register B is often used as an "alternative accumulator", results which appear in the accumulator being regularly transferred to and from register B. The H and L registers can be used as individual 8-bit registers and may also be used "end-on" to provide a 16-bit general purpose register (referred to as the "HL register pair"). In this mode, HL can be used as a pointer to data stored in memory (i.e. the 16-bits in HL form an address at which data is to be stored or from which data is to be fetched). The HL register pair can thus be used as an "address pointer" and, in this context, the H register contains the "high" (most significant) byte of the address whilst the L register contains the "low" (least significant) byte of the address.

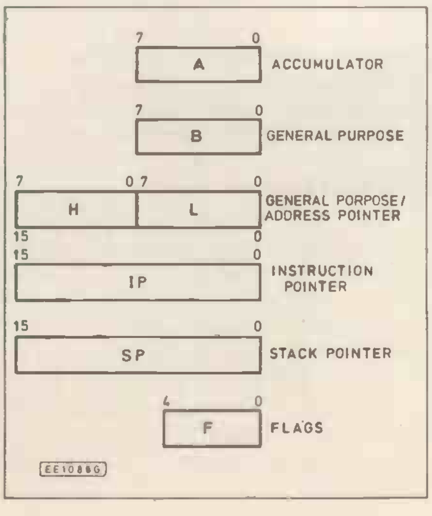
Register model

Whilst Fig.2.2 provides us with some idea of IMP's internal arrangement, it is unnecessarily complex from the point of view of the programmer. The programmer is neither concerned with the links between registers nor need he/she be aware of internal features over which he/she has no direct control. In this context, the "register model" depicted in Fig. 2.5 provides a more useful representation of IMP and this merely shows the registers which are directly accessible to the programmer and over which the programmer has control.

Problem 2.1

Fig. 2.6 shows the state of IMP's internal registers at a particular point in the execution of a program. The MSB of each register (with the exception of the flag register) appears on the left and the layout follows that shown in the register model of Fig. 2.5.

Fig. 2.5 IMP's register model



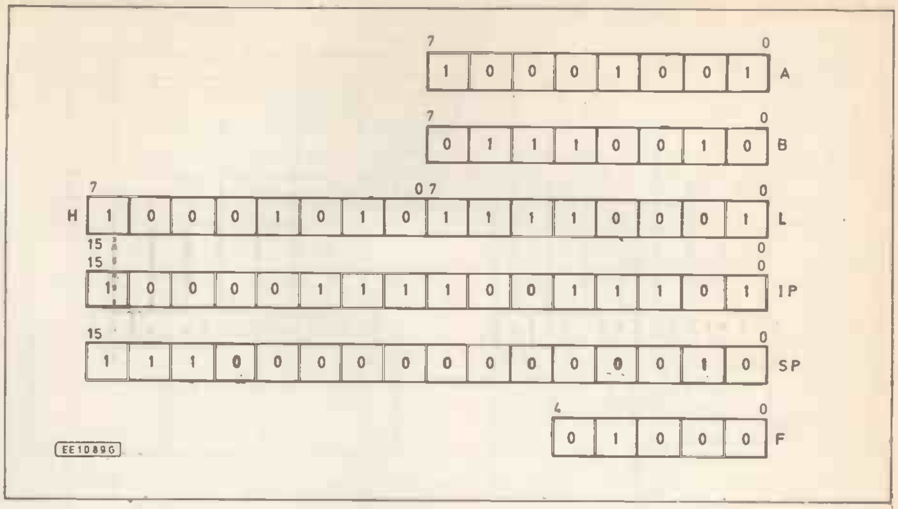


Fig. 2.6 State of registers for problem 2.1

(a) What is decimal value of the data in the accumulator?
(b) What is the hexadecimal value of the data in the accumulator?
(c) Which one of the three 8-bit general purpose registers has the GREATEST value?
(d) What hexadecimal address is pointed to by the Instruction Pointer?
(e) What decimal address is pointed to by the Stack Pointer?
(f) In which of the 8-bit registers is the MSB set?
(g) In which of the 8-bit registers is the LSB set?
(h) Which of the flags is set?
(i) Which of the flags is reset?
(j) If the HL register pair is currently being used as an address pointer, what hexadecimal address is it pointing to?
(k) Are interrupts currently enabled or disabled?

CONTROL SIGNALS

IMP has five control bus signals. Four of these are inputs and one is an output. We shall briefly discuss the function of each:

Read/Write ($R/\overline{W}$)

(output)

This line is taken low (i.e. to logic 0) when IMP is performing a "write" operation (e.g. when data is to be transferred from one of IMP's internal registers to an address in RAM). IMP takes the line high (i.e. to logic 1) when a "read" operation is being carried out. [NB: Some microprocessors (e.g. Z80) have separate READ and WRITE lines.]

Interrupt request ($\overline{IRQ}$)

(input)

This line serves as an input to the microprocessor and is taken low by an external device wishing to signal the fact that it requires attention. Provided the "interrupt flag" is reset (i.e. logic 0) this request will be honoured and the microprocessor will cease normal processing and execute the required "interrupt service routine". The interrupt line is said to be "active-low" (i.e. it is taken to logic 0 when asserted).

Non-maskable interrupt ($\overline{NMI}$)

(input)

As we have seen, the response to an ordinary interrupt ($\overline{IRQ}$) is determined by the interrupt status flag and thus the interrupt may be "masked". Instructions may be placed within the program which "set" or "reset" the interrupt flag hence disabling or enabling interrupts. This technique provides us with a flexible method of responding to interrupts; we can accept them or reject them at will! There are, however, some situations in which it is desirable that an interrupt should be serviced regardless of what else is going on. Hence a separate "non-maskable interrupt" line is provided. When this line is taken low, normal program execution is interrupted regardless of the state of the interrupt flag (i.e. regardless of whether interrupts are currently enabled or disabled).

Reset ($\overline{RESET}$)

(input)

This active low input to the microprocessor is used to initialise the system into a known state prior to normal execution of the program. When the $\overline{RESET}$ line is taken low, the program counter (PC) is placed in a defined state (by loading it with zero) and interrupts are disabled.

Clock (Ø)

(input)

IMP requires an accurate and stable square wave clock having a frequency of typically 2MHz. The clock is used to provide an accurate time reference for the control unit (see below).

[Many microprocessors have internal clock oscillators and merely require that a quartz crystal of appropriate resonant

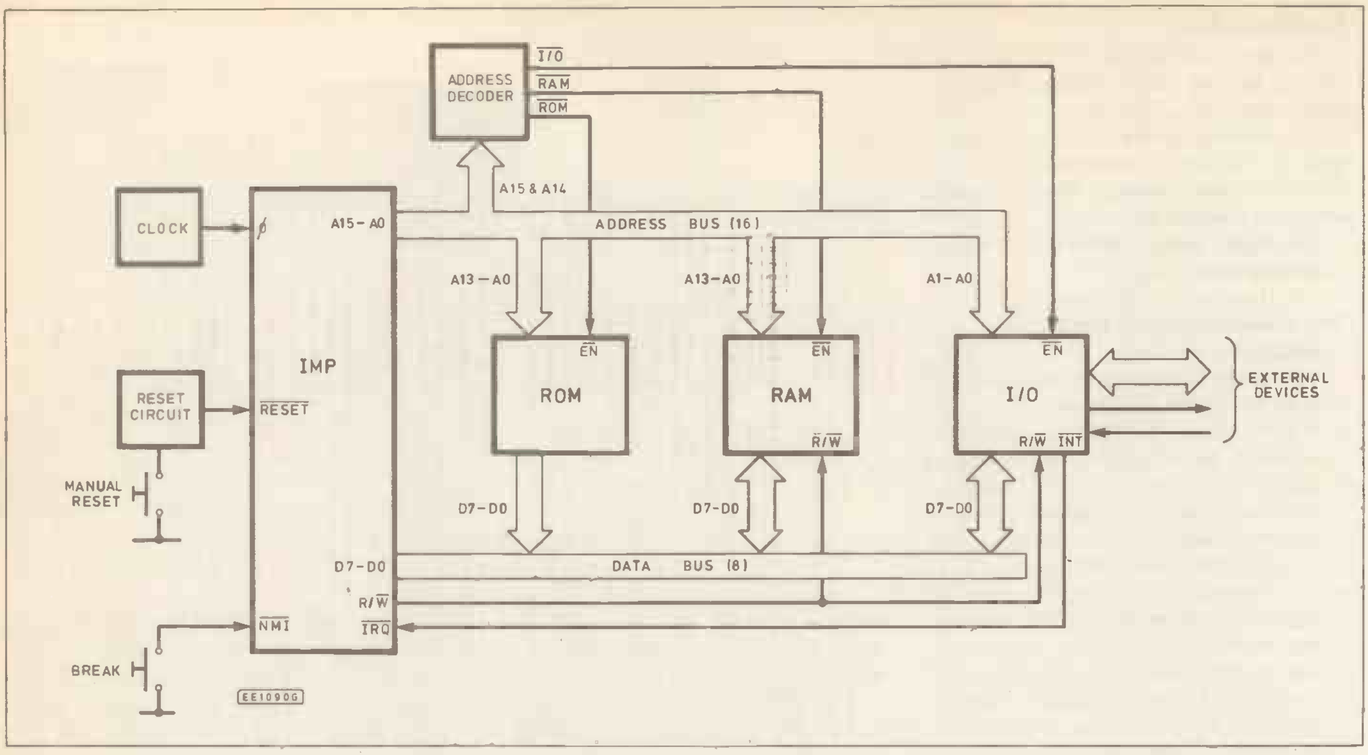


Fig. 2.7 Architecture of a simple IMP-based system

frequency be connected to two of the microprocessor's pins. The vast majority of 8-bit microprocessors operate with clock frequencies between 1MHz and 8MHz.]

A COMPLETE IMP MICROCOMPUTER SYSTEM

Fig. 2.7 shows the internal architecture of a complete microcomputer based on the IMP. Since this diagram is somewhat more complicated than that in Fig. 1 of Part 1, we shall attempt to justify the additional features which have appeared.

The reset circuitry is designed to take IMP's $\overline{RESET}$ input low for a short time (typically 20ms) when the power is first applied to the system or when the manual reset button is pressed. This ensures that the system initialises itself in an orderly fashion as IMP always commences program execution from address 0000H when its $\overline{RESET}$ input is taken low.

In order that data flow within the system is orderly and that there is no uncertainty as to whether the data present is valid or not, it is necessary to synchronise all data transfers using a reference clock signal. This signal, a symmetrical square wave, is generated by an external oscillator. For accuracy and stability, the clock is crystal controlled and functions at a fixed frequency of 2MHz.

The relationship between the frequency and periodic time (period) of a microprocessor clock is given by:

$$f = \frac{1}{t} \quad \text{or} \quad t = \frac{1}{f}$$

Where f is the frequency (in Hz) and t is the periodic time (in seconds). In practice, it is often more convenient to work in terms of MHz and µs, and the same formula will apply. As an example, suppose the clock in Fig. 2 operates at 2MHz. Its periodic time (period) will be 1/2 µs (i.e. 0.5µs or 500ns) and its idealised waveform is shown in Fig. 2.8.

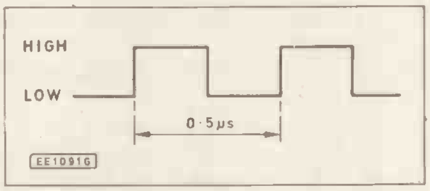


Fig. 2.8 Idealised 2MHz clock signal

The clock cycle (often known as a T-state) is the fundamental timing interval used by the microprocessor. A "machine cycle" (M-cycle) is the smallest indivisible unit of microprocessor activity and usually comprises between three and five T-states. An instruction cycle (i.e. that associated with fetching an instruction, decoding and executing it) normally requires between one and five M-cycles.

To put this into context, suppose that IMP is operating at its maximum clock frequency of 4MHz. The periodic time of the clock (T-state) will be 250ns. A machine cycle (M-cycle) will then occupy from 0.75µs to 1.25µs whereas an instruction cycle will require some 1.25µs to 6.25µs depending upon its complexity. To put this another way, IMP is capable of executing between 160,000 and 800,000 instructions every second!

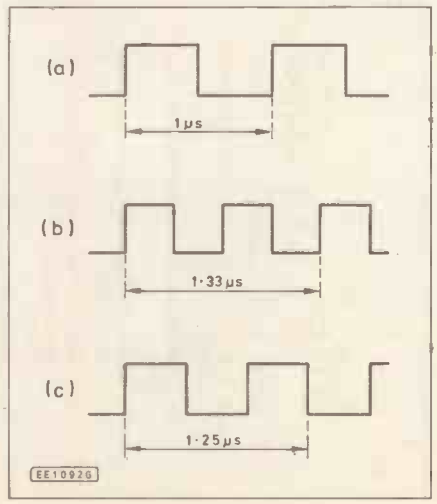
The two most significant address lines are fed to an address decoder which generates active low signals to enable the ROM, RAM and I/O devices (more of this in Part 5). At this stage it is merely necessary for readers to understand that ONLY one of these devices is enabled (i.e. linked to the data bus) at any particular time.

The all-important "break" key is connected to IMP's non-maskable interrupt ($\overline{NMI}$) input. This allows the user to regain control WITHOUT having to reset the system (and erase the data and/or program currently present in RAM). The general topic of interrupts is outside the scope of *Introductory Microprocessors* and therefore readers need not at this stage concern themselves with the action which takes place when an interrupt is received.

Problem 2.2

What is the frequency of each of the microprocessor clock signals depicted in Fig. 2.9?

Fig. 2.9 Clock waveforms for problem 2.2



Problem 2.3

The data sheet in Fig. 2.10 relates to the Intel 8080A microprocessor. Read the data sheet carefully (don't worry if you don't understand all of it!) and answer the following questions:

(a) How many address lines are provided?

(b) How many addresses are available for input/output?

(c) What pin number is used for the RESET input?

(d) What pin number is used for the INTERRUPT input?

(e) How many clock inputs are required?

(f) Are the clock inputs TTL compatible?

(g) What supply voltages are required?

(h) Is the WRITE line "active-high" or "active-low"?

(i) What is the logical state of the WRITE line when a write operation is being carried out?

(j) From what address does execution commence when the RESET input is activated?

intel®

8080A/808A-1/8080A-2
8-BIT N-CHANNEL MICROPROCESSOR

- TTL Drive Capability
- 2 μs (—1:1.3 μs, —2:1.5 μs) Instruction Cycle
- Powerful Problem Solving Instruction Set
- 6 General Purpose Registers and an Accumulator
- 16-Bit Program Counter for Directly Addressing up to 64K Bytes of Memory
- 16-Bit Stack Pointer and Stack Manipulation Instructions for Rapid Switching of the Program Environment
- Decimal, Binary, and Double Precision Arithmetic
- Ability to Provide Priority Vectored Interrupts
- 512 Directly Addressed I/O Ports
- Available in EXPRESS — Standard Temperature Range
- Available in 40-Lead Cerdip and Plastic Packages

The Intel® 8080A is a complete 8-bit parallel central processing unit (CPU). It is fabricated on a single LSI chip using Intel's n-channel silicon gate MOS process. This offers the user a high performance solution to control and processing applications.

The 8080A contains 6 8-bit general purpose working registers and an accumulator. The 6 general purpose registers may be addressed individually or in pairs providing both single and double precision operators. Arithmetic and logical instructions set or reset 4 testable flags. A fifth flag provides decimal arithmetic operation.

The 8080A has an external stack feature wherein any portion of memory may be used as a last in/first out stack to store/retrieve the contents of the accumulator, flags, program counter, and all of the 6 general purpose registers. The 16-bit stack pointer controls the addressing of this external stack. This stack gives the 8080A the ability to easily handle multiple level priority interrupts by rapidly storing and restoring processor status. It also provides almost unlimited subroutine nesting.

This microprocessor has been designed to simplify systems design. Separate 16-line address and 8-line bidirectional data busses are used to facilitate easy interface to memory and I/O. Signals to control the interface to memory and I/O are provided directly by the 8080A. Ultimate control of the address and data busses resides with the HOLD signal. It provides the ability to suspend processor operation and force the address and data busses into a high impedance state. This permits OR-tying these busses with other controlling devices for (DMA) direct memory access or multi-processor operation.

NOTE:
The 8080A is functionally and electrically compatible with the Intel® 8080.

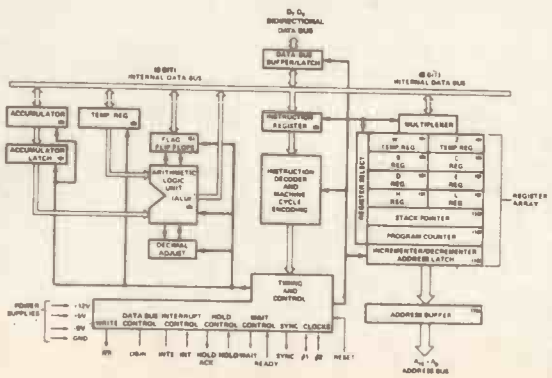


Figure 1. Block Diagram

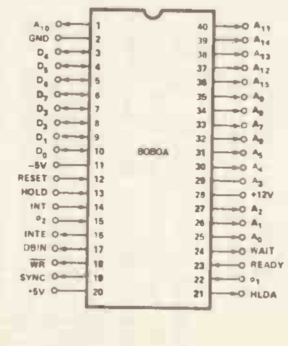


Figure 2. Pin Configuration

Table 1. Pin Description

Symbol	Type	Name and Function
A_{15}-A_0	O	**Address Bus:** The address bus provides the address to memory (up to 64K 8-bit words) or denotes the I/O device number for up to 256 input and 256 output devices. A_0 is the least significant address bit.
D_7-D_0	I/O	**Data Bus:** The data bus provides bi-directional communication between the CPU, memory, and I/O devices for instructions and data transfers. Also, during the first clock cycle of each machine cycle, the 8080A outputs a status word on the data bus that describes the current machine cycle. D_0 is the least significant bit.
SYNC	O	**Synchronizing Signal:** The SYNC pin provides a signal to indicate the beginning of each machine cycle.
DBIN	O	**Data Bus In:** The DBIN signal indicates to external circuits that the data bus is in the input mode. This signal should be used to enable the gating of data onto the 8080A data bus from memory or I/O.
READY	I	**Ready:** The READY signal indicates to the 8080A that valid memory or input data is available on the 8080A data bus. This signal is used to synchronize the CPU with slower memory or I/O devices. If after sending an address out the 8080A does not receive a READY input, the 8080A will enter a WAIT state for as long as the READY line is low. READY can also be used to single step the CPU.
WAIT	O	**Wait:** The WAIT signal acknowledges that the CPU is in a WAIT state
$\overline{WR}$	O	**Write:** The $\overline{WR}$ signal is used for memory WRITE or I/O output control. The data on the data bus is stable while the $\overline{WR}$ signal is active low ($\overline{WR}$ = 0).
HOLD	I	**Hold:** The HOLD signal requests the CPU to enter the HOLD state. The HOLD state allows an external device to gain control of the 8080A address and data bus as soon as the 8080A has completed its use of these busses for the current machine cycle. It is recognized under the following conditions: • the CPU is in the HALT state. • the CPU is in the T2 or TW state and the READY signal is active. As a result of entering the HOLD state the CPU ADDRESS BUS (A_{15}-A_0) and DATA BUS (D_7-D_0) will be in their high impedance state. The CPU acknowledges its state with the HOLD ACKNOWLEDGE (HLDA) pin.
HLDA	O	**Hold Acknowledge:** The HLDA signal appears in response to the HOLD signal and indicates that the data and address bus will go to the high impedance state. The HLDA signal begins at: • T3 for READ memory or input. • The Clock Period following T3 for WRITE memory or OUTPUT operation. In either case, the HLDA signal appears after the rising edge of ϕ_2.
INTE	O	**Interrupt Enable:** Indicates the content of the internal interrupt enable flip/flop. This flip/flop may be set or reset by the Enable and Disable Interrupt instructions and inhibits interrupts from being accepted by the CPU when it is reset. It is automatically reset (disabling further interrupts) at time T1 of the instruction fetch cycle (M1) when an interrupt is accepted and is also reset by the RESET signal.
INT	I	**Interrupt Request:** The CPU recognizes an interrupt request on this line at the end of the current instruction or while halted. If the CPU is in the HOLD state or if the Interrupt Enable flip/flop is reset it will not honor the request.
RESET[1]	I	**Reset:** While the RESET signal is activated, the content of the program counter is cleared. After RESET, the program will start at location 0 in memory. The INTE and HLDA flip/flops are also reset. Note that the flags, accumulator, stack pointer, and registers are not cleared.
V_{SS}		Ground: Reference.
V_{DD}		Power: +12 ±5% Volts.
V_{CC}		Power: +5 ±5% Volts.
V_{BB}		Power: −5 ±5% Volts.
ϕ_1, ϕ_2		**Clock Phases:** 2 externally supplied clock phases. (non TTL compatible)

Fig. 2.10 Data sheet for problem 2.3

NEXT MONTH: we shall be considering the means by which a microprocessor fetches and executes instructions and shall introduce readers to the facilities offered by a system monitor.

BACKGROUND READING

The following background reading is suggested for this month:

(a) Chapter 3 (Software and Programming) of ***Beginner's Guide to Microprocessors*** *by E.A. Parr (a Newnes Technical Book published by Heinemann-Newnes) ISBN 0 408 00579 3. Available from the* EE Book Service – *see page 656.*

(b) Chapter 2 (The Central Processing Unit) of ***Microelectronic Systems 2 Checkbook*** *by R. Vears (published by William Heinemann Ltd) ISBN 0 434 92194 7. Available from the* EE Book Service – *see page 656.*

CORRESPONDENCE

Comments and queries from readers should be sent directly to the author at the following address: Department of Technology, Brooklands Technical College, Heath Road, Weybridge, Surrey, KT13 8TT.

Please include a stamped addressed envelope *(and be prepared to wait a little!)* if you require an individual reply. General queries will be dealt with in *Readers Forum* which will appear in Parts 4 and 9 of the series.

GLOSSARY FOR PART TWO

Accumulator
One or more registers associated with the ALU which temporarily store the results of ALU operations.

Arithmetic Logic Unit (ALU)
One of the essential elements of a CPU. The ALU performs various forms of addition, subtraction and logical operations.

Buffer
A hardware device which provides isolation between two parts of a circuit and which usually increases the drive capability of a signal. In the context of software, the word refers to a contiguous area of memory used for temporary storage of data when performing I/O.

Clock
The clock provides a reference timing source within a microcomputer system. The output of a clock comprises regular pulses of accurately defined frequency and period.

Flag
A bit contained within a flag (or status) register which indicates the internal status of the microprocessor or which signals the outcome of an ALU operation.

Instruction
A single command within a program. A complete sequence of instructions constitutes a program.

Interrupt
A signal generated by an external device which requires the services of the microprocessor or which needs to alert the microprocessor to a particular condition (such as imminent power failure).

Stack
The stack is a contiguous area of read/write memory that is accessed on a last-in first-out (LIFO) basis by the microprocessor and used for temporary storage of data and addresses.

Please Note: Cricklade College, Andover, Tel: (0264) 63311 have notified us that they are an approved centre for 726 courses.

The telephone number given for Charles Keene College, Leicester should have been (0533) 516037.

ANSWERS TO PROBLEMS

2.1	(a)	137
	(b)	89
	(c)	L
	(d)	879D
	(e)	57346
	(f)	A, H and L
	(g)	A and L
	(h)	N
	(i)	C, Z, V and I
	(j)	8AF1
	(k)	enabled
2.2	(a)	1MHz
	(b)	1.5MHz
	(c)	1.2MHz
2.3	(a)	16
	(b)	256 for input and 256 for output
	(c)	12
	(d)	14
	(e)	2
	(f)	no
	(g)	+5V, +12V and -5V
	(h)	active-low
	(i)	0
	(j)	0 (0000H)

BOOK SERVICE

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DATA AND REFERENCE

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F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Bridges the gap between complicated technical theory, and "cut-and-tried" methods which may bring success in design but leave the experimenter unfulfilled. A strong practical bias—tedious and higher mathematics have been avoided where possible and many tables have been included.

The book is divided into six basic sections: Units and Constants, Direct-current Circuits, Passive Components, Alternating-current Circuits, Networks and Theorems, Measurements.
256 pages **Order Code BP53** **£2.95**

ESSENTIAL THEORY FOR THE ELECTRONICS HOBBYIST
G. T. Rubaroe, T.Eng (C.E.I.), Assoc.I.E.R.E.
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128 pages **Order Code 228** **£2.50**

MICROPROCESSING SYSTEMS AND CIRCUITS
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
A truly comprehensive guide to the elements of microprocessing systems which really starts at the beginning. Teaches the reader the essential fundamentals that are so important for a sound understanding of the subject.
256 pages **Order Code BP77** **£2.95**

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.
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AUDIO
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Analysis of the sound wave and an explanation of acoustical quantities prepare the way. These are followed by a study of the mechanism of hearing and examination of the various sounds we hear. A look at room acoustics with a subsequent chapter on microphones and loudspeakers then sets the scene for the main chapter on audio systems—amplifiers, oscillators, disc and magnetic recording and electronic music.
320 pages **Order Code BP111** **£3.50**

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K. H. Recorr
Shows the reader how, with just a test-meter, to go about recording the particular signature of an unmarked i.c. which should enable the i.c. to then be identified with reference to manufacturers' or other data. An i.c. signature is a specially plotted chart produced by measuring the resistances between all terminal pairs of an i.c.
Chart **Order code BP101** **£0.95**

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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CHART OF RADIO, ELECTRONIC, SEMICONDUCTOR AND LOGIC SYMBOLS
M. H. Banani, B.Sc.(Eng.)
Illustrates the common, and many of the not-so-common, radio, electronic, semiconductor and logic symbols that are used in books, magazines and instruction manuals, etc., in most countries throughout the world.
Chart **Order Code BP27** **£0.95**

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320 pages **Order code BP85** **£2.95**

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Section 1: Covers component markings, codings and standards, as well as explaining the symbols used.
Section 2: Tabulates in alpha-numeric sequence the comprehensive specifications of over 1400 devices.
Section 3: Tabulates the devices by case type.
Section 4: Considers particular limits to the electrical parameters when compiling the tables.
Section 5: Illustrates package outlines and leadouts.
Section 6: Consists of a surface mounting device markings conversion list.
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R. Vears
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By Michael Tooley BA and David Whitfield MA MSc CEng MIEE

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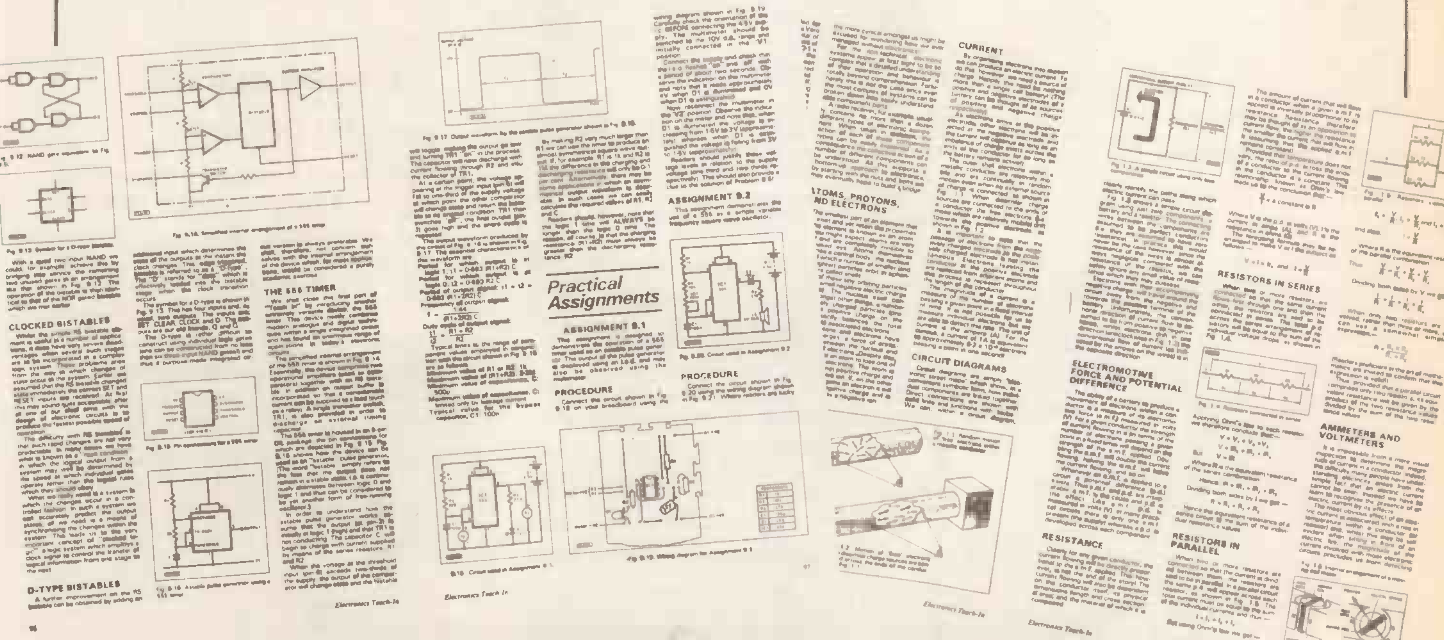
The book includes details of eight items of related test gear giving full constructional information and diagrams for each one. The items of test gear described are: Safe Power Supply; Universal LCR Bridge; Diode/Transistor Tester; Audio Signal Tracer; Audio Signal Generator; RF Signal Generator; FET Voltmeter; Pulse Generator.

This book is an excellent companion for anyone interested in electronics and will be invaluable for those taking G.C.S.E. electronics courses.

Electronics Teach-In from the publishers of **Everyday Electronics** price **£1.95.**



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exploring electronics

OWEN BISHOP

This series is designed to explain the workings of electronic components and circuits by involving the reader in experimenting with them. There will not be masses of theory or formulae but straightforward explanations and circuits to build and experiment with.

Part 18 Binary Counting

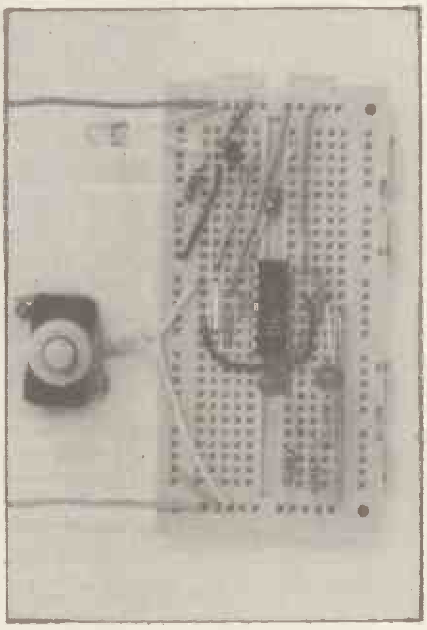
THIS month we continue to investigate counting circuits and take a closer look at "binary" counting. Also, in keeping with the festive time of year, we offer a simple Christmas project which uses binary counting to give a seasonal effect.

INVESTIGATION ONE LIGHT-OPERATED COUNTER

Last month we saw how we can use the J-K flip-flop to build a counting chain. An application of this is shown in the circuit diagram for a Light-Operated Counter, Fig. 18.1. It uses two flip-flops, both contained in a single i.c., the 7473 (dual J-K Flip-Flop).

The phototransistor TR1 receives light from a lamp or a nearby window. When the light beam is broken the voltage at the collector of TR2 rises; it falls when the beam is restored. This "low-going" pulse triggers the first flip-flop, and the event is registered as a count of "01".

The next time the beam is broken, the output of Flip-Flop 1 becomes low again,



Completed "test-bed" for the Light-Operated Counter.

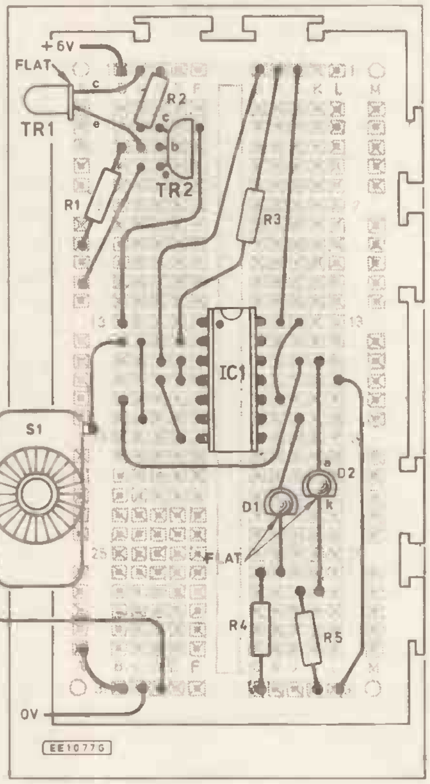


Fig. 18.2. Demonstration breadboard component layout for the Light-Operated Counter.

Fig. 18.1. Circuit diagram for a Light-Operated Counter using the 7473 dual J-K flip-flop i.c.

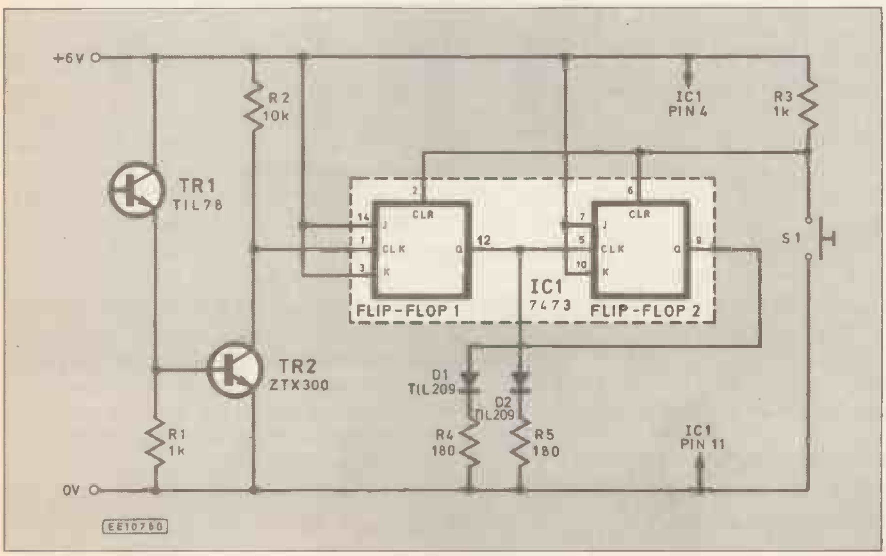
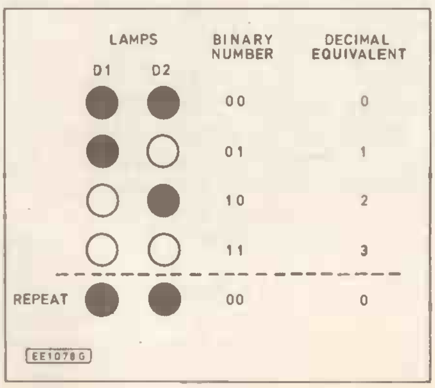
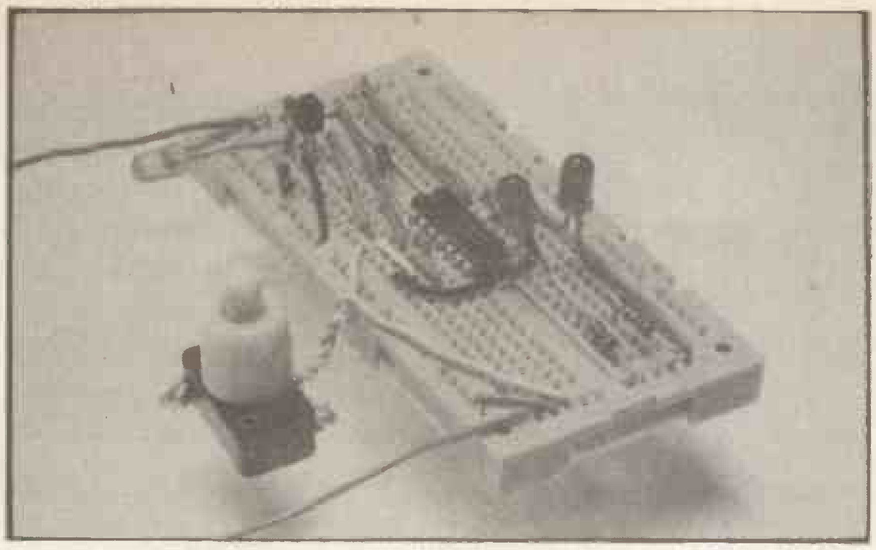


Fig. 18.3. The sequence of l.e.d. operation for the counter.





COMPONENTS

LIGHT OPERATED COUNTER

Resistors

R1,R3	1k (2 off)
R2	10k
R4,R5	180 (2 off)

All 0.25W 5% carbon

Shop Talk

See page 679

Semiconductors

D1,D2	TIL 209 l.e.d. or similar (2 off)
TR1	TIL78 phototransistor
IC1	7473 dual J-K flip-flop

Miscellaneous

S1 Push-button push-to-make switch
Breadboard (e.g. Verobloc); 6V battery and battery case; connecting wire, etc.

CHRISTMAS LIGHTS

Resistors

R1	27k
R2	33k
R3-R7	180 (5 off)

All 0.25W 5% carbon

Capacitor

C1	4μ7 elec.

Semiconductors

D1-D5	TIL209 l.e.d. or similar (5 off)
IC1	555 timer
IC2	7493 4-bit binary counter

Miscellaneous

Breadboard (e.g. Verobloc) or stripboard, size 0.1in matrix 11 strips × 30 hole; 6V battery and battery case; connecting wire, etc.

Approx. cost Guidance only **£5 each**

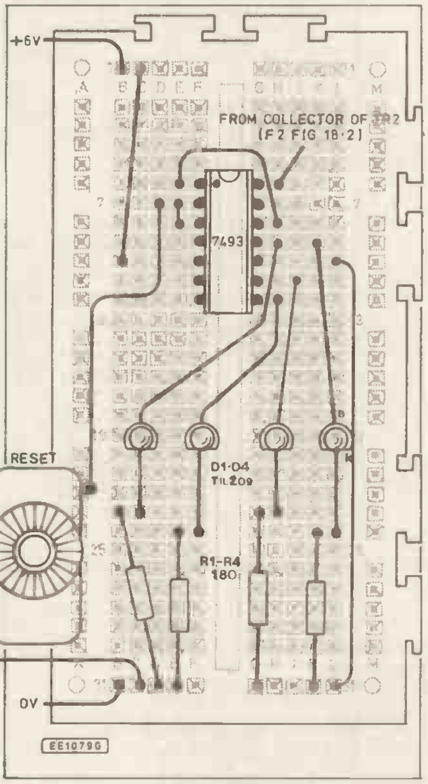
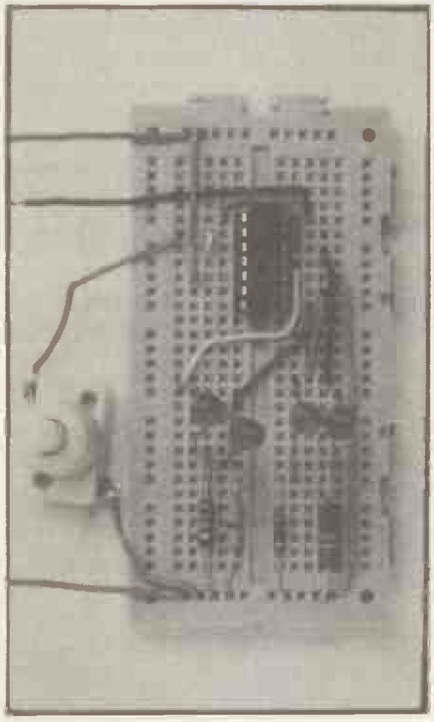


Fig. 18.4. Using the 7493 i.c. as a 4-bit counter.



Breadboard component layout for the 4-bit counter. To save bending the l.e.d. leads too far apart, causing possible fracture, link wires have been used to complete the wiring to the i.c.

This "low-going" pulse triggers Flip-Flop 2, making its output go high.

The count is now "10". When the beam is broken again, the output of Flip-Flop 1 becomes high. This does not affect Flip-Flip 2 since flip-flops are triggered only by "low-going" pulses.

The count is now "11". The sequence of counts is 00,01,10,11 which, in decimal, is equivalent to 0,1,2,3.

Each time the beam is broken and restored the count indicated by the l.e.d.s is increased by 1. The push-button switch S1 clears both flip-flops.

CONSTRUCTION

The demonstration breadboard component layout and wiring is shown in Fig. 18.2.

Commence construction by building the counter system IC1 first. Next assemble the light-triggering system TR1/TR2 and join it to the "clock" input, pin 1, of Flip-Flop 1.

Arrange a beam of light to strike the phototransistor. Place your hand in the beam; nothing should happen. Take your hand away; Flip-Flop 1 should change state. Try flashing a finger, then two fingers and then three fingers quickly through the beam.

This counter is able to work at very high speeds. The lamps (l.e.d.s) run through the sequence shown in Fig. 18.3.

VARIATIONS

The Light-Operated Counter registers up to three counts only: at the fourth count (100 in binary) both lamps go out and you are back to zero again. To count to larger numbers, add another 7473 i.c. which provides two more flip-flops.

The output of each flip-flop is connected to the clock input of the next, i.e. pin 9 of the first 7473 is connected to pin 1 of the next. You can now count up to 15 (1111 in binary).

Instead of using an extra 7473, you can use an i.c. that has four flip-flops in it. In the 7493 (4-bit binary counter), three of these are flip-flops already connected to make a counting chain. You can connect the fourth flip-flop to this chain, as shown in the demonstration breadboard component layout Fig. 18.4.

Now you can count up to 15 using a single i.c. or, if you add your 7473 to the chain, up to 63 (111111), in binary.

NEXT! A SIMPLE CHRISTMAS PROJECT

PROJECT ONE CHRISTMAS LIGHTS

By using a little ingenuity you will be able to make a fascinating and decorative item for the Christmas tree.

HOW IT WORKS

The circuit diagram Fig. 18.5 is simply a 555 timer oscillator followed by a 4-stage counting chain. The five l.e.d.s run through the binary numbers from 0 to 11111 (31, in decimal) over and over again.

If the l.e.d.s are arranged decoratively, a continually changing pattern of twinkling lights creates a very seasonal effect.

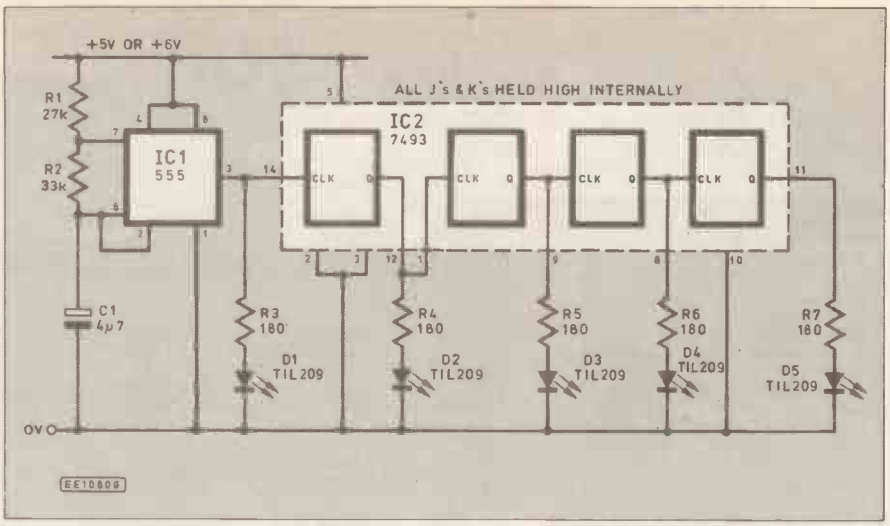


Fig. 18.5. Using a 555timer and a 4-stage counting i.c. to produce a Christmas Lights "sequencer"

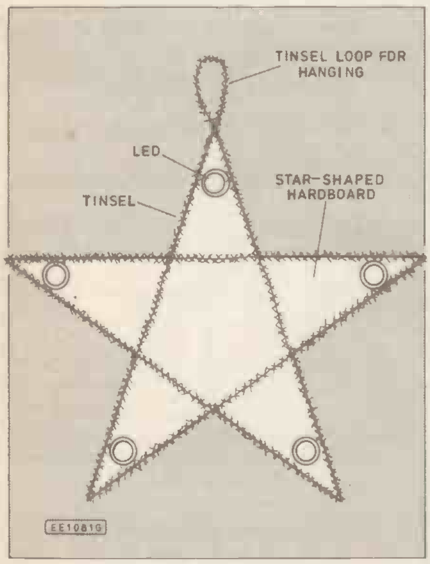


Fig. 18.6. One suggested arrangement is to mount lights in a star formation. Other shapes will no doubt be tried. One possibility would be to glue a Christmas card scene on a piece of hardboard and place the lights at strategic points to enhance the picture.

CONSTRUCTION

It is best to try the circuit on a breadboard layout first and it can even be put on the tree in this form. Just cover everything except the l.e.d.s with coloured paper or Christmas wrapping paper. But it looks better if the l.e.d.s are mounted on a suitably shaped piece of hardboard, such as a star shape (see Fig. 18.6).

Once the breadboard circuit layout has been finalised it can be built on stripboard and mounted behind a hardboard cutout, see Figs. 18.7 and 18.8. To add to the effect you can decorate it with strips of tinsel to reflect the light from the l.e.d.s.

You can also use "aluminium" kitchen foil to reflect the lights, but beware of causing short-circuits! The battery can also be mounted on the tree — put it in the fork of one of the larger branches and run a pair of wires to the circuit board.

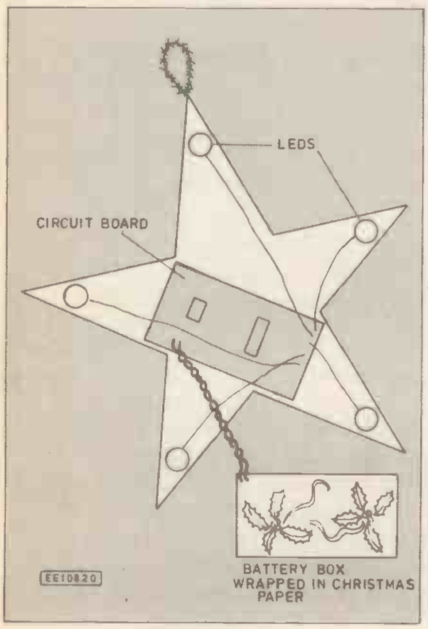
You can vary the rate at which the display changes by altering the value of capacitor C1. With four HB2 cells there should be enough current to last the whole Christmas season.

VARIATIONS

Light emitting diodes, l.e.d.s, are available in several different colours — red, green, yellow and orange, so there is plenty of scope for the imaginative use of colours. You could also extend the circuit to flash more l.e.d.s by adding a 7473 (flip-flop i.c.) or another 7493.

Next Month: Introducing high speed logic plus a Simple Reaction Timer project.

Fig. 18.7. Rear view of the Christmas Star. The battery holder can be wrapped in decorative paper and form part of the tree decoration.



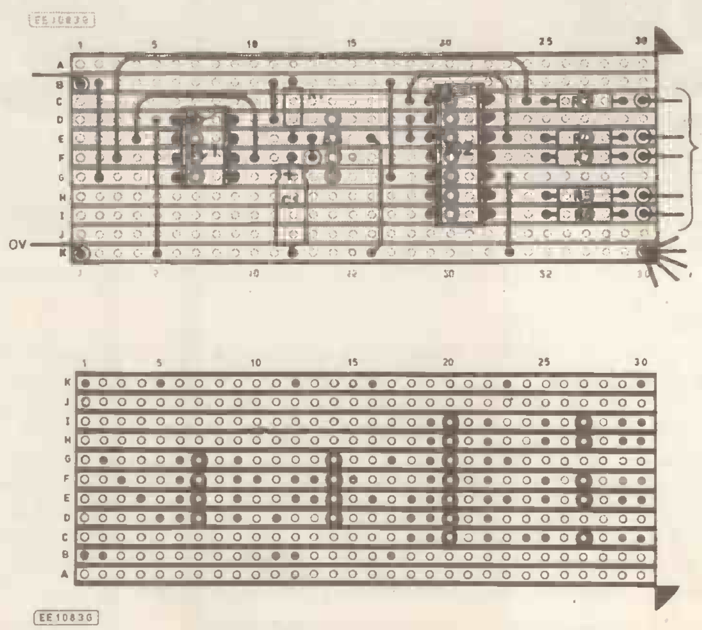
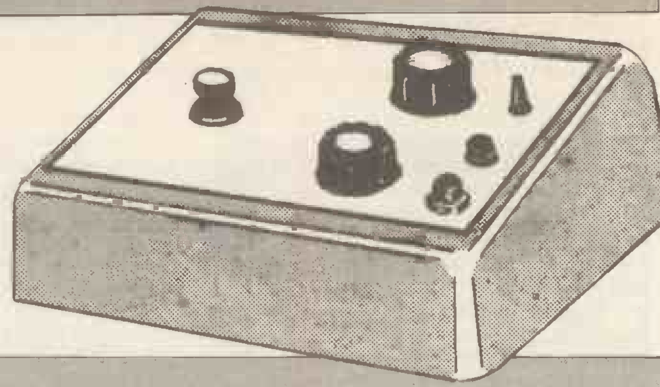


Fig. 18.8. Stripboard component layout for the Christmas Lights project. It would be a good idea to use i.c. holders for mounting IC1 and IC2 on the board.

PSEUDO ECHO UNIT



ROBERT PENFOLD

Produce realistic echo effects at a realistic price.

THIS DEVICE is really a form of tremolo unit, but when used with an instrument (such as a guitar) which has a fast attack and slow decay, it provides an effect which is much more like an echo effect than a conventional tremolo type. The unit differs from a standard tremolo unit in that the modulation signal is a pulse type rather than the more usual sinewave or triangular signal.

The effect of a normal tremolo unit is much the same as manually varying the volume up and down at a rate of (typically) a couple of times per second, and this effect can be generated manually via a swell pedal. The effect of this unit is to switch the signal on and off with no in-between state. This can be used as a rather harsh and extreme form of tremolo, but it is probably most effective when used on a suitable signal to give a pseudo echo effect.

There are limitations to this way of doing things, and the main one is that it only works properly with a signal that has a suitable envelope shape, and which remains essentially the same throughout its duration. With most instruments there is no problem in either case, but the obvious exception is a voice signal which is unsuitable in both cases.

Another problem, and one which is most troublesome when using a low modulation frequency, is that of the start of a note occurring during an "off" period. This can seriously effect the timing of the music, and by eliminating the important attack period of the signal it can drastically alter its sound.

The Pseudo Echo Unit described here has a simple synchronisation facility which can be switched in when using low modulation frequencies, so that the unit is forced to commence an "on" phase at the start of each new note. This seems to totally eliminate the "off" period problem.

ZERO SWITCHING

A third problem with this very harsh form of amplitude modulation is that it tends to produce "click" sounds as the signal is gated on and off. This happens because the unit will usually switch the signal on or off when it is not synchronising the modulation signal with the input signal in such a way that the signal gate only switches state as the input signal passes through 0V. This gives an output signal of the type shown in Fig. 2b, with only sets of complete half cycles present.

SYSTEM OPERATION

The block diagram of Fig. 3 shows the general arrangement used in Pseudo Echo Unit. A buffer stage is used at the input of the unit, and the main signal path is through the sample and hold circuit to the output socket.

The sample and hold circuit is a form of signal gate, and it allows the input signal to pass straight through to the output when it is supplied with a "high" control signal. Switching the control input "low" blocks the signal path, and the output is maintained at whatever level it happened to have at the instant when the signal was cut off. It is important that the output is not simply allowed to drift as this could result in unwanted "clicks" and other noises on the output signal.

The modulation signal is generated by a triangular waveform generator which feeds into a voltage comparator. The other input of the comparator is fed from a variable reference

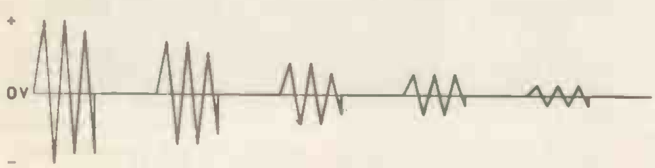


Fig. 1 (above). A combination of the signal's natural decay characteristic and the "chopping" effect of the unit gives an "echo" effect output signal.

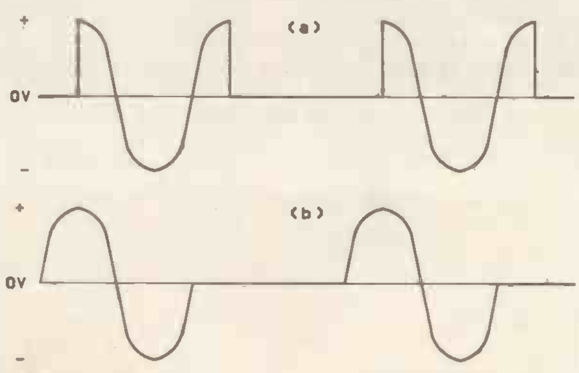


Fig. 2 (right). The waveform of (a) is the result of a simple "chopping" process. (b) is the result of incorporating zero point switching in the process.

The waveform of Fig. 1 shows how this effect is obtained. The input signal must be a type having a fast attack with a much slower decay time if the right effect is to be produced. The output from an electric guitar is in this category, and synthesisers and most other electronic instruments can provide a suitable signal.

The effect of the unit is to chop up the signal into short bursts, and the output from the unit is therefore a series of signal bursts that start at a high level and gradually decay. The sound this gives is very much the same as if a short burst of signal was to be fed into an echo effects unit.

at zero volts. This gives a sudden change from whatever level the signals happen to have at the instant of switching, to the zero volts level. Under worse case conditions a waveform of the type shown in Fig. 2a is obtained, where the signal switches from its peak level to zero volts on each transition of the signal gate.

There are ways of reducing or eliminating the problem, and in this circuit zero point switching is used. This is very effective indeed, and it permits quite high switching frequencies to be used without any significant switching glitches being generated at all.

The method used is very simple in essence, and it avoids the switching glitches by

voltage, and this combination constitutes a conventional variable pulse generator.

The output signal can be continuously varied from narrow positive "needle" pulses through a 1 to 1 squarewave and on to the point where narrow negative pulses are produced. In terms of the modulation effect, this can be varied from the point where the signal is switched off for the vast majority of the time and is only gated on for short bursts, through to a setting where the signal is almost continuously switched on and is only blanked out for very short periods.

The pulsed modulation signal is fed to the sample and hold circuit via some control circuitry which must prevent changes in the signal from taking effect until the input signal passes through zero volts. Two voltage comparators monitor the output from the buffer amplifier, and they are arranged in such a way that they both provide a high output level only when the signal is very close to the 0V level. The voltage comparator outputs, together with the modulation signal, are fed to the inputs of two logic gate circuits.

A simple S/R (set/reset) flip/flop provides the control signal for the sample and hold circuit. The flip/flop must be supplied with a high input signal to its "set" input in order to switch on the sample and hold circuit, and a high input level is then needed at the "reset" input in order to take the sample and hold circuit back to the "hold" mode.

Once switched on the sample and hold circuit remains in this state until the flip/flop is reset, and the second gate is designed to provide the reset pulse when the outputs of the comparators are both high, but the modulation signal is low. Thus, when the output of the pulse generator goes low the signal path is broken, but not until the voltage comparators detect that the signal is close to the 0V level.

Some of the output signal from the buffer stage is fed to an amplifier, and the amplified signal is rectified and smoothed. This gives a d.c. signal that is roughly proportional to the amplitude of the input signal.

For the synchronisation to work properly the input signal must be a type which has a fast attack time with a reasonably rapid initial decay characteristic. Guitars and signals with

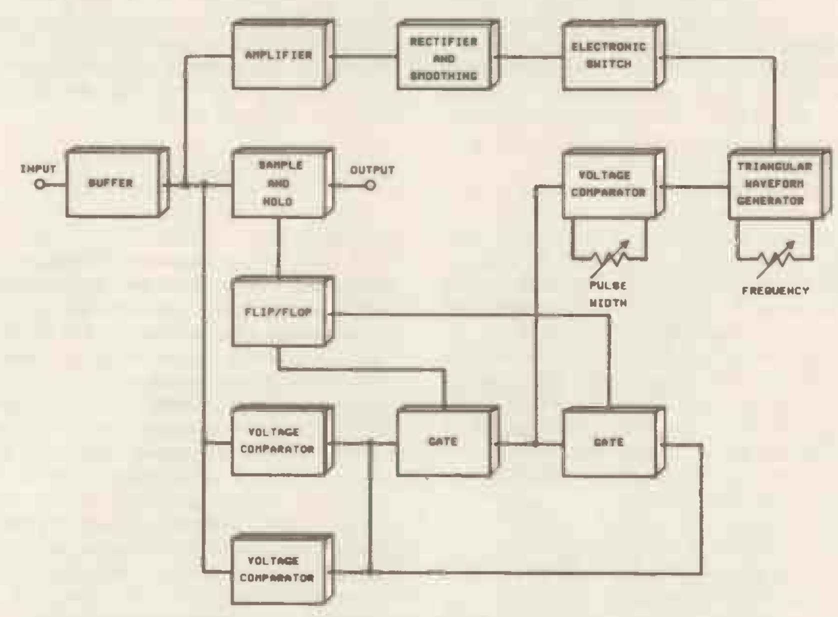
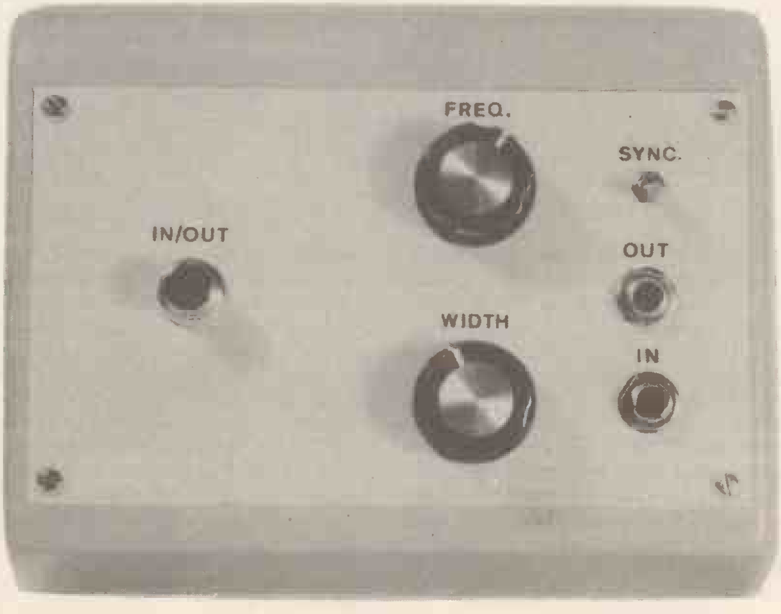


Fig. 3. The block diagram for the Pseudo Echo Unit.

The gates provide these input signals, and the one feeding the set input is configured in such a way that it provides the set pulse when all three inputs go high. In other words, the signal is switched through to the output when the modulation signal goes high, and the voltage comparators detect that the signal is close to the 0V level.

the classic ADSR envelope shape fall into this category, as do all but the most exotic of envelope shapes.

With a suitable input signal the output from the smoothing circuit is something like a ramp signal, and this is used to drive an electronic switch. The circuit is set up so that the switch is only activated on the peak of the ramp waveform, and the electronic switch is turned on briefly each time a note is played. The switch is connected to the biasing circuit of the triangular waveform generator, and it has the effect of forcing the start of a new cycle each time the switch is closed, thus giving the required synchronisation effect.



COMPONENTS

Resistors

R1,R2,R15	100k (3 off)
R3,R10,R16, R17,R18,R22 R23	10k (7 off)
R4,R5,R11, R12	4k7 (4 off)
R6,R9	1M (2 off)
R7,R8,R21	2k2 (3 off)
R13	220k
R14	47k
R19,R20	15k (2 off)

All ¼W 5% carbon

Shop Talk

See page 679

Potentiometers

VR1	47k lin
VR2	1M lin
VR3	100k sub-min hor. preset

Capacitors

C1,C5	100µ radial elec. 10V (2 off)
C2,C6	470n polyester layer (2 off)
C3	10n polyester layer
C4	10µ radial elec. 25V
C7,C9	2µ2 radial elec. (2 off)
C8	1µ radial elec. 63V

Semiconductors

D1 to D8	IN4148 silicon signal diode (8 off)
TR1	BC547 *npn* silicon
IC1	LF351 bifet op. amp.
IC2	4016BE CMOS analogue switch
IC3	CA3140E MOS op. amp.
IC4	4001BE CMOS quad 2-input NOR gate
IC5,7	1458 dual op. amp. (2 off)
IC6,8	741C op. amp. (2 off)

Miscellaneous

SK1	Standard jack, with DPDT switch contacts
SK2	Standard jack socket
S1	Heavy duty locking push button switch
S2	Part of SK1
S3	Miniature SPST toggle switch

Case, sloping front type about 165 × 70 × 125mm; printed circuit board, available from *EE PCB Service*, code EE586; two control knobs; B1, six HP7 size cells in plastic holder; battery connector (PP3 type); 8-pin DIL i.c. socket (6 off); 14-pin DIL i.c. socket (2 off); pins, wire, solder, etc.

Approx. cost Guidance only £19.50

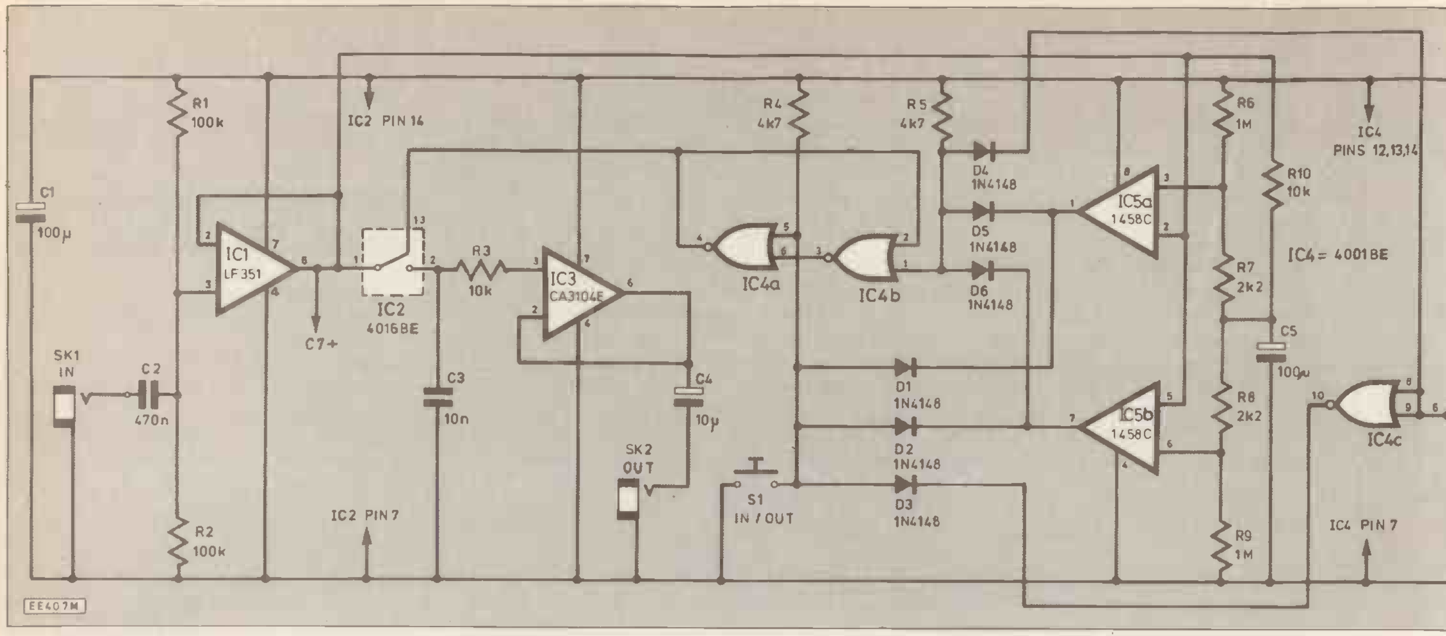


Fig. 4. The main circuit diagram for the Pseudo Echo Unit.

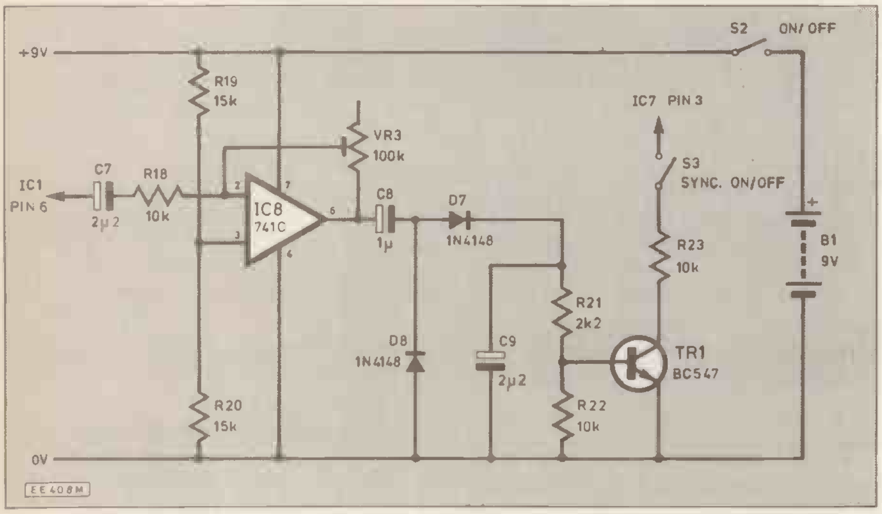


Fig. 5. Circuit diagram for the synchronisation stage.

CIRCUIT OPERATION

The main circuit diagram for the Pseudo Echo Unit appears in Fig. 4, but the synchronisation circuit is shown separately in Fig. 5.

The buffer amplifier IC1 provides an input impedance of about 50k. IC2 is a CMOS analogue switch, and in conjunction with charge storage capacitor C3 it forms a basic sample and hold circuit.

A buffer amplifier (IC3) at the output ensures that there is no significant discharging of capacitor C3 during the "hold" periods. The CA3140E specified for the IC3 position is a MOS input type which gives an input impedance of over one million megohms. Note that there are actually four switches in IC2, but in this circuit only one is used and there are no connections to the other three.

The triangular waveform generator is based on IC7, and the two operational amplifiers in this device are connected as a conventional oscillator of the Schmitt trigger/Miller integrator type. Potentiometer VR2 provides a frequency range of about 0.5Hz to 10Hz. IC6 is the voltage comparator, with VR1 providing the variable reference voltage and acting as the pulse width control.

IC5 provides the two operational amplifiers which act as the voltage comparators in the zero crossing detector circuit. Resistors R6 to R10 and capacitor C5 provide two reference voltages just marginally either side of the "0 volt" level. Of course, it is not strictly accurate to call this circuit a zero crossing detector, as it is actually detecting the signal crossing through the quiescent bias voltage, which is about half the supply voltage and not 0V.

The flip/flop is a conventional CMOS R/S type which is formed from two cross coupled 2-input NOR gates (IC4a and IC4b). The two gates are simple 3-input AND types, each formed from a pull-up resistor and three diodes.

However, the one which drives the reset input of the flip/flop is driven from the pulse generator by way of IC4c which is connected to operate as an inverter. This gives the desired action with the reset pulse being produced when the output of the pulse generator is "low" (and the output of the inverter is "high"). Closing switch S1 holds the flip/flop in the "set" state, and therefore switches out the effect. Note that one gate of IC4 is left unused.

SYNC CIRCUIT

Turning our attention to the synchronisation circuit Fig. 5, the amplifier stage is based on IC8, and this is a standard inverting mode amplifier circuit. The preset Gain control VR3 must be adjusted so that the electronic switch is only just activated on the initial peak of each note. Diodes D7 and D8 rectify the output from IC8, and C9 is the smoothing capacitor.

This circuit has a suitably fast attack time, and it also has a fairly rapid decay so that the electronic switch is not held in the "on" state for an excessive time. Transistor TR1 is used as the electronic switch, and is a simple common emitter type which pulls the bias voltage in the oscillator circuit lower when activated.

Switch S3 enables transistor TR1 to be switched out of circuit so that the synchronisation can be disabled (which can be beneficial when using high modulation frequencies).

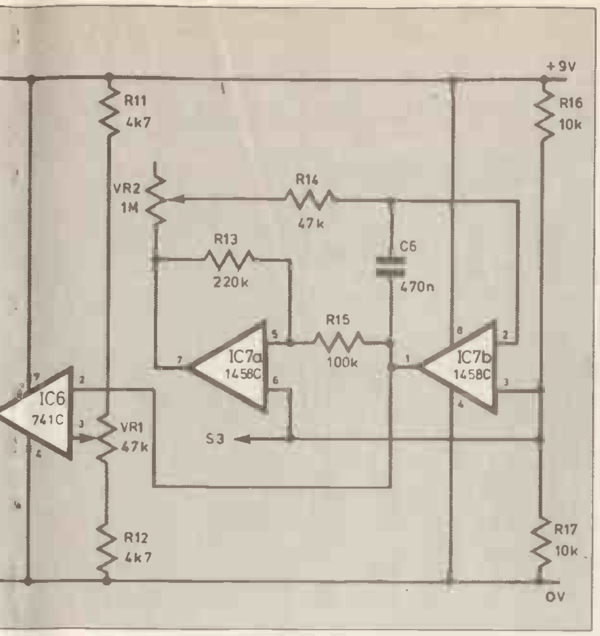
CONSTRUCTION

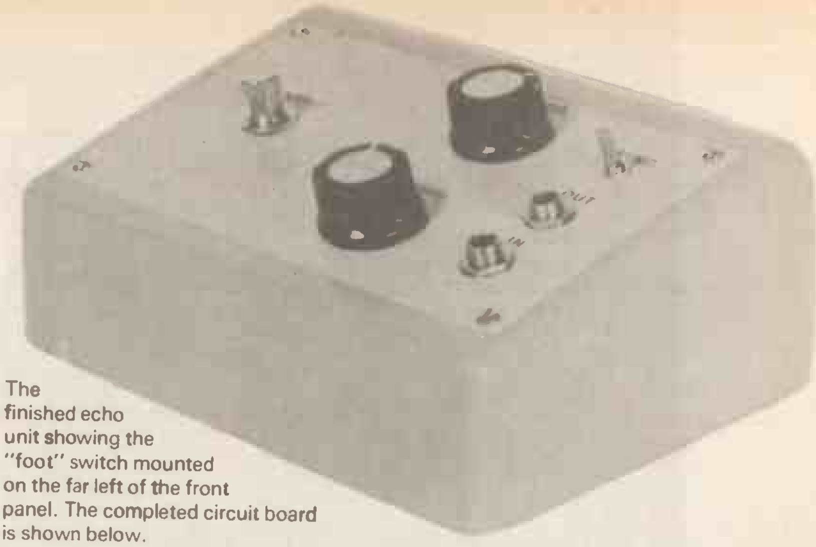
The component layout and full size printed circuit board foil master pattern for the Pseudo Echo Unit is shown in Fig. 6 and Fig. 7. The circuit board for this project is available from the *EE PCB Service*, code EE586.

Construction of the board is not difficult provided miniature printed circuit mounting capacitors are used (larger types could be very awkward to fit into place). Make sure that all the electrolytic capacitors and semiconductors are fitted the right way round and do not overlook any of the six link wires.

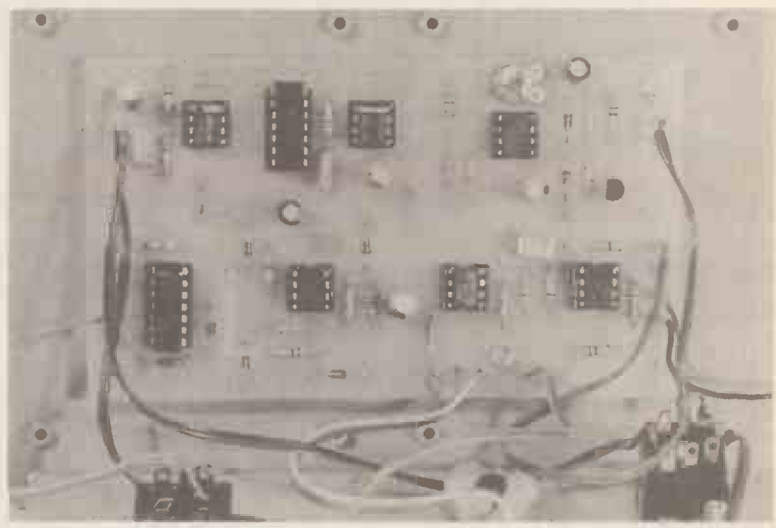
IC2, IC3, and IC4 are all MOS types, and consequently require the standard antistatic handling precautions to be taken. In particular, use integrated circuit holders for these devices, and do not fit them into the holders until construction of the unit is otherwise complete. At this stage only pins are fitted to the board at the points where connections to off-board components will eventually be made.

One of the smaller types of sloping-front case are ideal for this project, and the front panel should be arranged with switch S1 at one end of the panel, and the sockets and other controls towards the opposite end. Switch S1 should be a heavy duty push button switch of the push-to-make — push-to-break type, so that it can be operated by foot. It is for this reason that it should be mounted well clear of the other front panel mounted components (so





The finished echo unit showing the "foot" switch mounted on the far left of the front panel. The completed circuit board is shown below.



that they do not impede operation of this "foot switch").

The completed printed circuit board is mounted on the base panel of the case using the normal mounting pillars or screws plus spacers. It is then wired up to the front panel mounted components, see Fig. 6, and there is no need for any of this wiring to be screened, but it should be kept reasonably short and direct. In Fig. 6 it has been assumed that on/off switch S2 will be a set of make contacts on the input socket, SK1. A socket with a single set of make contacts is unlikely to be obtainable, and it is

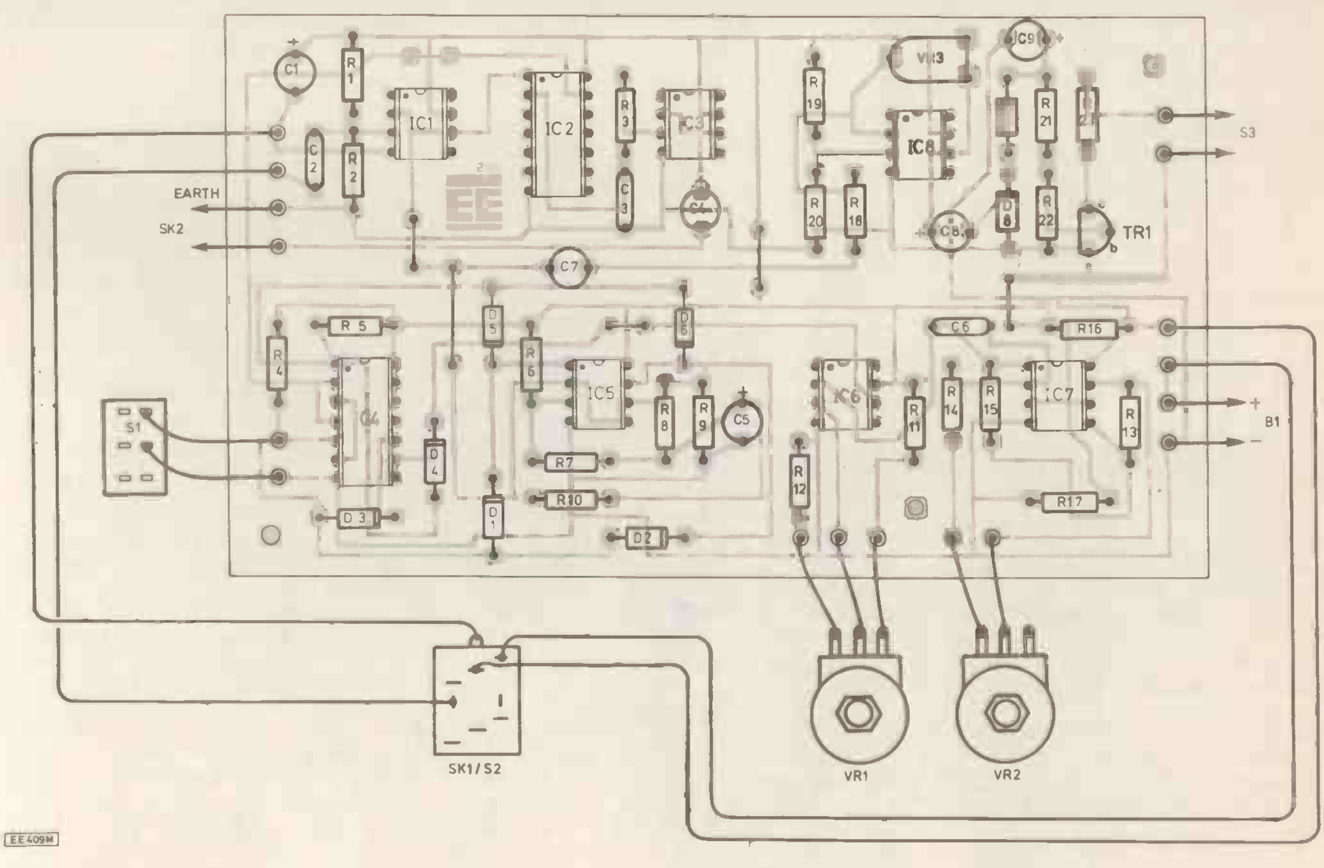


Fig. 6. Printed circuit board component layout and interwiring details for the case mounted components.

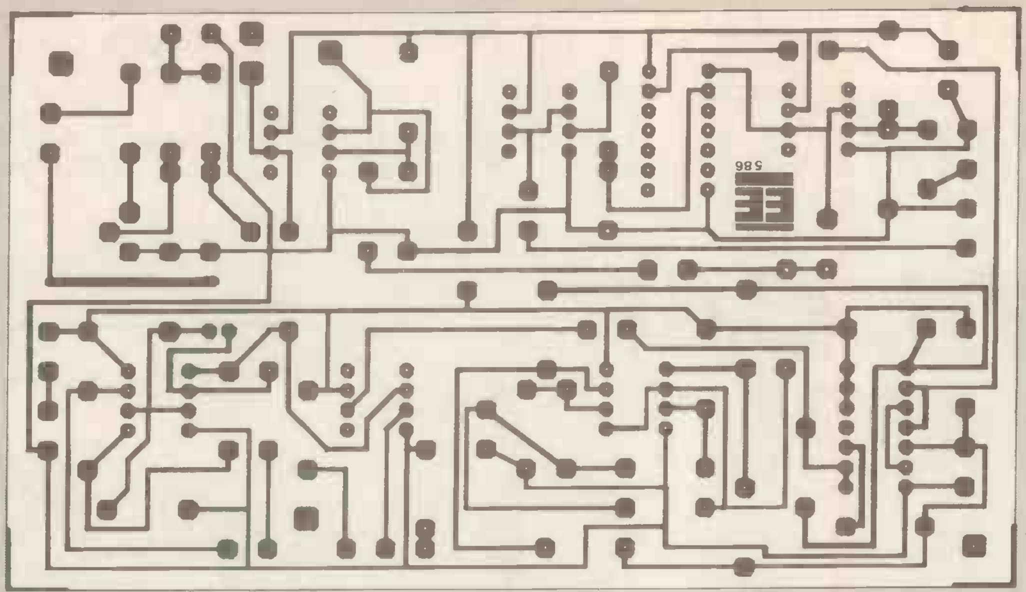


Fig. 7. Full size printed circuit board master foil pattern. This board is available from the *EE PCB Service*, code EE586.

therefore necessary to use two contacts of a socket having DPDT types.

With this method of switching the unit is automatically switched on when a plug is inserted into SK1, and switched off again when the plug is removed. This is common practice with musical effects units, but obviously an ordinary socket and a separate on/off switch can be fitted if preferred.

IN USE

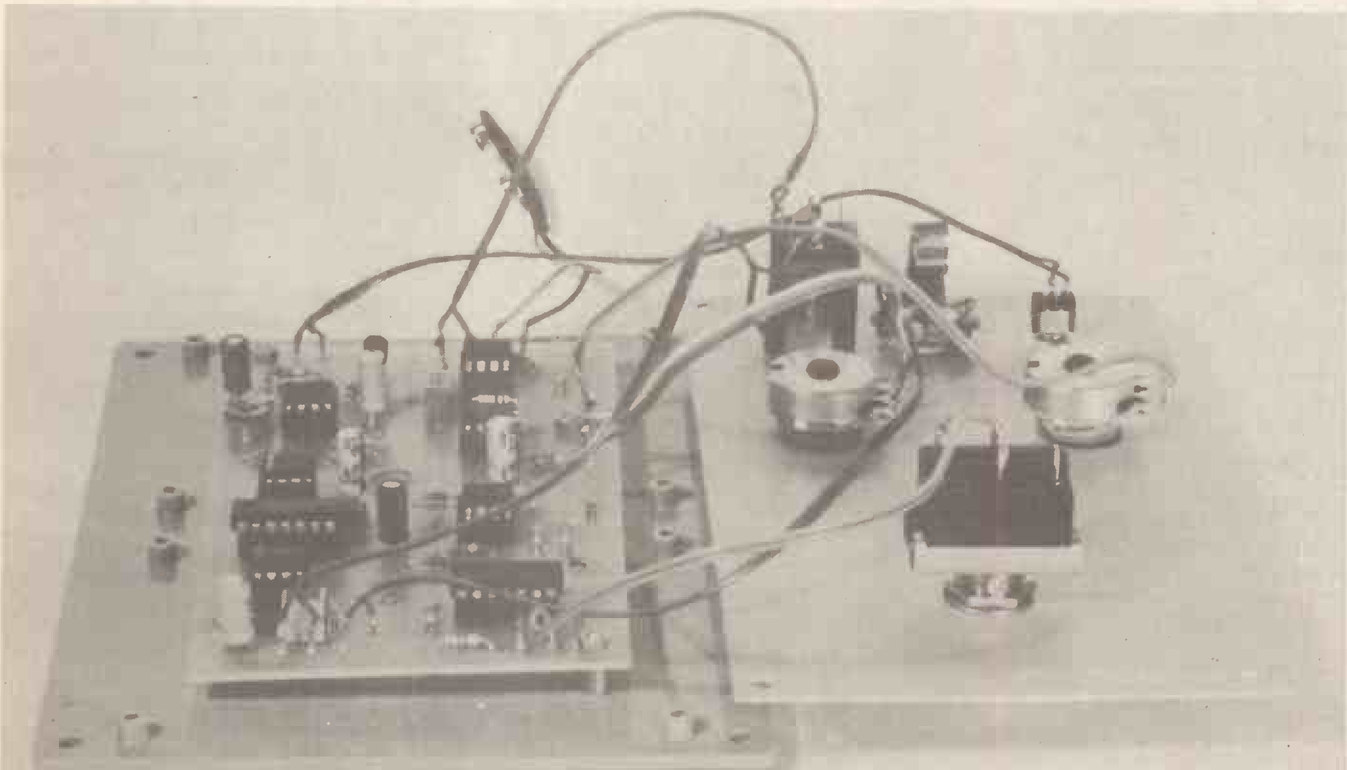
If the synchronisation feature is ignored initially, the unit can be tested without setting up VR3. The output from socket SK2 is coupled to the amplifier, mixer, or whatever via a standard screened jack lead. As explained previously, the unit is automatically switched on when a signal source is connected to Input-socket SK1, and switched off again when the plug is removed.

The effect is not one of the most subtle ones and it should be very apparent on any input signal. A little experimentation with the Frequency and Pulse Width controls will soon reveal the range of sounds that can be produced.

The unit will work satisfactorily with a wide range of input levels, but it is not suitable for use with very low level sources such as microphones and some guitar pick-ups unless a suitable preamplifier is added ahead of the unit. Inputs of up to about 6 volts peak to peak can be accommodated before clipping and serious distortion occurs.

It is really only worthwhile using the synchronisation facility when the Frequency control is set for quite low modulation frequencies. At high modulation frequencies is it likely to have no noticeable effect, and could be counterproductive by elongating the initial modulation cycle (although you may prefer things this way).

In order to give the preset gain control VR3 the correct setting, start with this component fully backed off (set fully anticlockwise) and then advance it very gradually while playing notes into the unit. Adjust it just far enough to produce the synchronisation effect. Remember, the synchronisation will only work on signals that have an envelope with an initial transient to switch on transistor TR1. □



JANUARY FEATURES...

FREE DATA CARD

G.T.i. CAR COMPUTER

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Since 1960 most satellite communications traffic has been carried by frequency modulation; little has changed in twenty years, but now digital techniques are resulting in a revolution. A change which is affecting the entire global telecommunications network. We investigate *'The Digital Revolution'*.

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A custom workbench amplifier designed specifically for listening to circuits under test.
This amplifier provides a high input impedance with immunity from overload damage and noise limiting.

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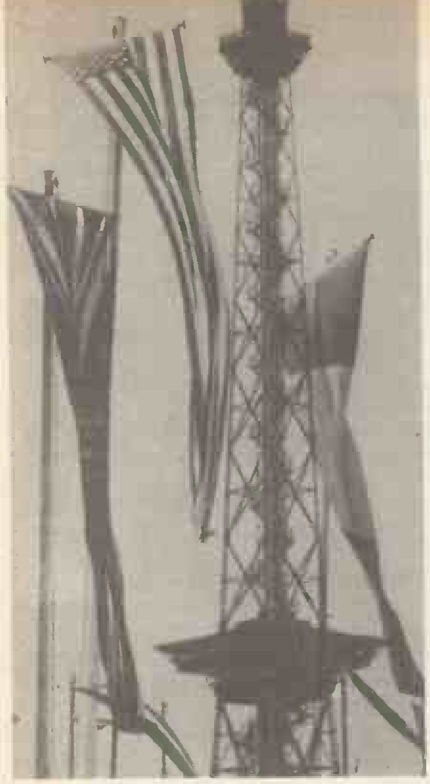
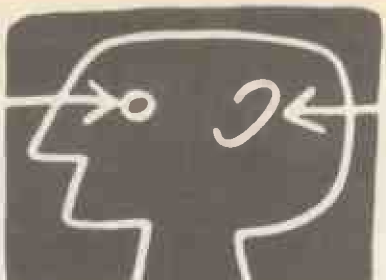
JANUARY 1988 ISSUE ON SALE FRIDAY, DECEMBER 11





INTERNATIONALE FUNKAUSSTELLUNG BERLIN

Our intrepid pilgrim Barry Fox made his biennial fact seeking pilgrimage to the European showcase of Radio and Audio developments in Berlin.

As he reports, looking for developments in the home entertainment market that will have an impact in 1988 was hard going.

THE West German Radio Show, or *Funkausstellung*, has been staged in Berlin for 63 years.

This year nearly half a million Berliners paid £4 each, and as much again for a catalogue, to ogle at the giant stands erected by 365 exhibitors from 26 countries, spread out through 25 enormous exhibition halls, a giant garden area and congress centre with 80 halls and rooms.

ELECTRONIC FOLK FESTIVAL

Because the event is heavily sponsored by the German radio and TV stations, there are continual live broadcasts from the stages erected in the gardens and halls. Berliners think of the *Funkausstellung* as a folk festival, not an electronics exhibition. They come with the family, sit in the sun, drink beer and watch big name artists perform live.

In an effort to attract attention, the electronics exhibitors must put on comparable shows, with performing bands, comedians, quiz shows and yes, most popular of all, Bingo. One visiting artist, ex-Who singer Roger Daltrey, summed up the situation succinctly, "There's nothing like this in Britain – and it makes me bloody angry."

The electronics industry is however angry for other reasons. The West German Government insists that the Berlin Funkausstellung be held in Berlin because it brings both prestige and currency into the city. But hotel space is so short that most are booked two years in advance.

"There's nothing like this in Britain – and it makes me bloody angry."

"The trade thinks two weeks or two days in advance, not two years," said a disgruntled exhibitor. "Those who book late have to stay in East Berlin, or in Hamburg flying in every day. We would do far more business if we could hold the show somewhere other than Berlin."

The exhibitors also resent the obvious fact that many visitors haven't the slightest interest in the electronics on show – they are just there for the fun of the fair. Because West Berlin is an isolated city in Eastern Germany, very few public visitors make the journey from other cities.

The press, too, seems increasingly disenchanted with the Berlin Show too. Although the *Funkausstellung* is proudly announced as "International" most of the press conferences are in German, without translation – and often staggeringly boring even with translation. There is very seldom any press information in English and it is often very hard work to find someone who knows the answers to technical questions.

This year, as every two years for the past decade or so, I made the reluctant pilgrimage and – as in previous years – found plenty of interest. But believe me it's hard going, and not something I would recommend to my worst enemy.

For most people in the electronics industry, the best thing about Berlin is staying at home and reading what others write about it. It is pointless even trying to give a run-down on what was on show. It is far more revealing to home in on the hot topics.

This year there were two big items of news on the agenda – the launch of CD Video and the launch of digital audio tape or DAT. Both were launched, but only "sort of". There was also an unveiling of Europe's high definition video system, intended to rival the Japanese proposals for a new standard.

As the demonstrations were for only 50 people at a time behind closed doors, only the pushiest with strings to pull, got in. But it was worth it.

CD VIDEO

CD Video is Philips' thinly disguised relaunch of the commercially unsuccessful, but technically superb, video disc. LaserVision failed in Europe because it came too late – after video tape which can record as well as play back.

Philips, and its software subsidiary Polygram, hopes that the time is now right to try again. This could prove a successful ploy because CD Video builds on the highly successful compact disc audio system. But there are dangerous signs that the launch is going wrong.

The name CD Video is intended to cover three sizes of disc, 12in. (as original LaserVision) with an hour on each side, 8in. for shorter programmes, and 5in. for 5 minute video clips plus an extra 20 minutes of sound only. A Combi player will handle all three sizes of disc, along with conventional sound only CD audio discs.

There are two good reasons for using the name CD Video instead of LaserVision. The old name has a smell of failure; also the new system has an improved method of recording the sound which creates compatibility problems with old equipment.

Whereas original LaserVision discs had an analogue stereo soundtrack, comparable to broadcast television or f.m. radio, the new CDV system has digital stereo sound, of exactly the same 16-bit quality as a sound-only compact disc. In America and Japan, where the NTSC TV system is used, Philips and Pioneer (the Japanese company which has pushed LaserVision very successfully in those countries) have been able to maintain complete compatibility with the old system by recording two soundtracks on each disc, one analogue and one digital.

But in Europe, where the PAL TV system is used, there is no room in the signal for two soundtracks so the obvious choice was digital. The new CDV discs have only digital soundtracks and old LaserVision discs have only analogue soundtracks.

The new PAL Combi CDV players will be able to play old PAL LaserVision discs but old PAL LaserVision players will not be able to play new PAL CD Videodiscs. This will inevitably cause consternation and confusion amongst the 10-15,000 people who have previously bought LaserVision players and will now want to buy discs from the new CDV catalogue. Philips and Pioneer have promised some kind of compensation when CDV hits the market, but plans are still in the air.

CDV was officially unveiled in America, in June at the *Chicago Consumer Electronics Show*, but plans for a full scale launch of an NTSC standard system has now been delayed until 1988. The reason given is that there is an inadequate supply of 5in. discs. The grand launch in Europe was scheduled for Berlin but it soon became clear that in Europe there is not only a shortage of 5in. discs, but there are obviously technical bugs in the PAL system left to be sorted out.

SMOKESCREEN

Although the main entrance hall to the Berlin exhibition was decked out as a CD Video launch room, with 24,000 discs hanging from the roof, a large screen audio-visual show and racks of 5in. discs round the walls, it was soon seen to be a smokescreen. Most of the discs on display were 5in. Audio Discs, not CDV discs. Out of a bank of six players, five were American/Japanese NTSC models made by Pioneer and the sixth – a PAL player made by Philips – was *not* working.

Several other firms at the show, for instance Grundig and Sony, were demonstrating NTSC players. Philips and Pioneer both demonstrated PAL players on their own stands but the performance of the Philips players was very poor indeed. Philips engineers at Berlin admitted that they were still identifying and evaluating the problems.

Although Philips and Polygram say they have been encouraged by the support for CDV won from the other software companies, there were signs in Berlin that this support has been slow coming. Undoubtedly there is a major commitment in the classical field from Unitel, and the promise of 5in. CD Video pop clips from literally dozens of famous artists – but the number of 5in. discs actually available for demonstration was pitifully small.

Almost all the 5in. discs so far demonstrated (NTSC and PAL) have been pressed by the Philips Du Pont optical joint venture factory in Blackburn. PAL discs were only trickling through to Berlin in small batches as the show opened.

Picture quality was usually very poor. Although there were a few carefully selected discs which gave acceptable pictures, most discs suffered from dropout, interference, shimmering colour noise and break-up. When the same discs were tried on Pioneer PAL players, the picture quality was much better, suggesting that Pioneer is further ahead in hardware development than Philips.

Dave Wilson, Customer Services Manager at Blackburn, says of current 5in. CDV product, "We have measured the quality parameters and are now very happy with signal-to-noise ratio. Drop-out levels are excellent – as good as for professional LaserVision. But some source material is still poor."

The clear inference from Blackburn's guarded statements is that Philips' prototype players cannot yet do justice to discs to meet the CDV spec.

PROBLEM

One problem is that the mechanism in the Philips PAL CDV player has been designed to sell at low cost and the servo control system is not yet sufficiently accurate. This means that the focused laser spot may not follow the track of information pits accurately.

This does not matter too much with sound-only digital code because the detection circuits have only to distinguish between one and zero pulses. For CD Video, however, the detector circuit is reading an analogue TV waveform and mistracking means loss of signal and distortion of the pictures on screen. Any blemish on the disc surface quite literally creates a hole in the picture and may upset the tracking control.

The picture line memory circuits designed to repair dropouts are clearly inadequate. Probably due to PAL delay line problems, the colours smudge so that the picture looks like a child's painting book.

The player must spin faster for CD Video than for ordinary CD audio and this draws more power from the d.c. supply. In turn this can create interference bars on the picture. By Berlin showtime Philips had made only around 20 PAL players, each carrying a large label on the rear warning that, "This apparatus has been assembled from piece parts from the trial run and is thus not intended for measurements as it does not meet the requirements of the specification."

Quite how Philips, with twenty years' experience of optical disc technology, can still be struggling to make a system work in time for a promised launch is unclear. What is clear, however, is that if Philips launches the system in its present form, with poor quality discs or players, there will be widespread criticism and CDV will be killed stone dead. However, if Philips waits too long after publicity created by a series of announcements throughout 1987, then the public will have lost interest in CDV by the time it is ready for sale.

This is what happened with the Philips V2000 video tape system and LaserVision. Both were announced before they were ready and the public lost interest. It is not an exaggeration to say that many of the pictures demonstrated at Berlin from CDV were more like the pictures offered by early VHS tape, or the awful RCA CED videodisc system, than optical disc LaserVision.

It is perhaps ironical that the audio-visual launch show used for the CD Video launch features a Humphrey Bogart look-alike – which is exactly what RCA and Hitachi did for the launch of the CED system a few years ago. This failed even more quickly than LaserVision. Either Philips has a short memory, or they assume that the trade and press have even shorter memories.

Although a subsidiary of Philips, Grundig's attitude typifies that of most electronics companies – other than system supporter Pioneer. "We have made no decision yet on coming to the market with CDV," says Grundig. "We will do so when it is clearly a success."

DAT HYPE

All the Japanese electronics companies, along with Grundig (which is buying DAT machines from JVC), had planned to launch at Berlin. But pressure from the record companies on the American Government and the Common Market in Brussels, made them think again. Grundig back pedalled, giving the same statement as parent company Philips – "No launch without support from the software industry."

Because DAT is such a political hot potato, each Japanese company at Berlin hoped another would make the first move. On opening day morning it was Sony who moved, with an October launch announcement.

Domestic DAT decks will cost £1300 and two hour tapes around £10. Sony also demonstrated two pre-production DAT decks, one a semi-pro portable and the other for upmarket in-car use.

Additionally, Sony announced two systems for mass producing pre-recorded software. One hooks up to 50 slave recorders to a master playback unit for video-style copying in real time. The other uses a magnetic transfer technique; the master DAT recording is spooled in a sandwich with blank tape and blitzed with a powerful magnetic field. The recording prints through from one tape to the other, and the copy tape is spooled off on the cassettes for sale.

Sony's DAT deck, the DTC-1000ES, does not have Copycode, the CBS encoding system which the record industry wants as a way of stopping home copying of discs. Sony vigorously opposes the system and says it would take between 12 and 18 months to modify the DAT electronics.

". . . Virtually all the big names in audio and video showed market-ready DAT, but with cop-out labels like Prototype Only . . ."

But the Sony deck does make two concessions to the record industry. It records only at 48kHz, making direct digital dubbing from a compact disc (recorded at 44.1kHz) impossible. Also the machine will refuse to make a digital recording from any other digital source if it is electronically marked with a copy-prohibit bit. Any company selling digital discs or tapes, or broadcasting digital radio sound, can add these bits to their software.

During the Berlin show the German tape group IM (Informationskreis Magnetband) reaffirmed opposition to Copycode, but pledged support for the Philips "no-clone" proposal. DAT recorders would incorporate circuitry which automatically puts a copy-prohibit flag on all recordings made on the recorder, thereby preventing people from digitally cloning digital dubs.

It was expected that once one Japanese company had announced the launch of DAT, the others would follow. But this did not happen.

When the show opened virtually all the big names in audio and video (including Grundig) showed market-ready DAT, but with cop-out labels like "Prototype Only" instead of the price and date for availability.

French company Thomson, which now owns Ferguson, also showed a "prototype" DAT deck, claiming that it was the only genuinely European deck on display. This was true, because although Philips has already developed DAT decks, none were shown even as prototypes.

So Sony has been left out front to take whatever flak is flying. But once Sony decks are in the shops, it is likely that the other Japanese companies will feel obliged to follow suit – because otherwise they stand to lose potentially valuable sales.

VIDEO NEWS

Grundig of West Germany unveiled a video recorder, due to go on sale in Britain shortly after Christmas, for between £600 and £700. It performs the apparently impossible trick of setting its own timer. This is done by using the digital codes for the BBC, ITV and Channel 4 teletext TV programme timetables.

The Grundig VS540 looks like an ordinary video recorder and connects with a TV set in the usual way. But it incorporates a teletext decoder. The VCR remote control lets the user decide which pages of Ceefax or Oracle teletext are fed from the recorder to the TV set for display on the screen. The displayed pages can be news, weather, information – or TV programme schedules.

To set the video recorder timer the user selects whichever teletext page shows the times of the day's TV programmes. An extra button on the remote control is then pressed, and a spot of light appears on screen. It looks like the cursor on a computer screen.

This "cursor" is moved up and down the screen by the remote control until it sits on the starting time displayed for whatever programme is to be recorded. When an "OK" button on the remote control is pressed, the video recorder automatically sets itself to start recording at the time chosen by the cursor.

The recorder is set to switch itself off again by positioning the cursor on the next time shown on the teletext page. If there is a risk of programmes running late, the user just plays safe by positioning the stop cursor on a later time. The system, called "Text Programming", works by recognising the digital codes used for teletext to display times on screen, and converting them into the digital signals needed to set the recorder timer.

There is a hidden bonus and a hidden snag. Anyone who owns a TV set without teletext, gets the service free when they buy the Grundig recorder, without the need to change their TV set.

The snag is that the recorder works on a twenty-four hour clock. Both the ITV and Channel 4 teletext services display their TV timetables in twenty-four hour time. But BBC1 and BBC2 work with a twelve hour clock, and AM and PM times. So until the BBC starts using a twenty-four hour clock, the Grundig recorder can only be set automatically to tape BBC TV programmes transmitted before noon.

New owner of Ferguson, Thomson of France, has a similar system which combines a modified video recorder with an existing teletext set. The TV set also has to be modified, by the incorporation of an infra-red transmitter as used by a remote control. When displaying timetable pages, the teletext set beams out infra-red signals which are picked up by the video recorder and used to set the timer in the same way as the Grundig system.

Thomson argues that it is clumsy to build a teletext decoder in a video recorder. But it will be even more clumsy for owners of teletext TV sets to have them modified to incorporate an infra-red transmitter, as well as buying a new video recorder with intelligent timer.

Although the Thomson system would work neatly where customers bought a new TV set and a new video recorder, both factory-designed for automatic timer setting, the Grundig system looks a far better bet for the high street market.

BBC LEADS THE WAY

It is always nice to see a British invention making good round Europe. Until recently it looked as if the BBC's Nicam digital system for broadcasting stereo sound with TV would clean up on the Continent,

ITT digital video recorder.

ousting the primitive and non-too-satisfactory German analogue system. But now the BBC has welshed on a previous commitment to the electronics industry that it would start broadcasting stereo sound with TV early in 1988. This has frozen the development of TV sets and video recorders with built-in digital stereo decoders and left the electronics companies wondering what on earth the BBC is playing at.

But another BBC development, RDS or radio data system, is going ahead. A 57kHz sub-carrier is added to the f.m. stereo multiplex system at the transmitter and the sub-carrier is modulated by data signals which convey information to any receiver equipped to receive it.

This can be programme identification codes, programme service names, alternative frequency lists, information about what other stations are transmitting and time codes. The European Broadcasting Union adopted the system as a standard and Germany starts using it next May.

RDS works with either home or car radio receivers. If the name of a programme is keyed in, the radio searches for the best reception frequency. RDS signals can turn off a national radio station or a cassette recorder, so that a driver can hear local traffic news when it is broadcast. The radio automatically switches to the nearest local radio station.

For years now, Germany has been running a traffic information system called ARI. This also uses a sub-carrier of 57kHz, with low frequency modulation (25Hz-53Hz, 60 per cent modulation) to identify the area of the transmitter and 30 per cent modulation at 125Hz to signal that a traffic announcement is coming up.

With ARI a car receiver can be set to switch on, or switch over, from another station when there is a traffic announcement from a local transmitter. But ARI cannot change channels to keep track of a programme, the user must pre-program an ARI receiver to hop frequencies and there is no time code facility.

The RDS system has been cleverly designed to be compatible with ARI so that the two can co-exist until RDS takes over and ARI is dropped. The RDS electronics will be integrated into a chip, which puts less than £10 on the price of a receiver. All the major European countries are now adopting RDS. Car owners will soon be able to drive round Europe setting their radios by station name and getting traffic information in each country – provided of course that they understand the language.

DIGITAL TV AND VIDEO

When ITT announced that it had developed chip sets for use in a TV set which would convert the incoming aerial signal into digital code and convert it back again into analogue form only for display on the picture tube, the system was heralded as the start of a new generation of TV set design. Digital TV has been slow to take off, because the general public is not the slightest bit interested in whether the signals inside a television set are in pulses or waves. All the public worries about is the cost of the set, the quality of the picture and the number of facilities on offer.

Digital circuitry is now being used in both TV sets and video recorders to provide extra facilities. Some, like "picture-in-picture", have limited appeal. Not many people want to watch a TV programme with a small picture of another programme inset at the corner of the screen.

The ITT chip set does however offer multi-standard operation and at Berlin more and more companies were offering TV sets which will work in virtually any country in the world. Loewe of Germany has now made multi-standard operation a standard feature for all top range TV sets.

Realistically this is of most benefit to the set-makers and retailers. They like single inventory manufacture and stocks, whereas few domestic users carry their TV sets round Europe with them. The big breakthrough will come – probably at the next Berlin show in two years time – when digital circuits are built into portables for multistandard operation.

The development of flicker-free TV sets is an interesting side benefit of digital design. The European TV systems are all based on a 50Hz standard, with 25 frames per second built up from 50 interlaced half frames or fields. Unfortunately, especially on large screen sets with bright pictures, this creates a nasty flicker. The human eye cannot discern 60 images a second, as used in America and Japan, but 50 per second is just on the border of perception.

The new flicker free sets use a digital CCD memory, of 4 megabit capacity, to store each incoming field, and display it twice instead of once. The result is a 100Hz field rate on screen, which is entirely free from flicker. The same memory can also be used to freeze a picture on screen, like a still frame. This is of little use when watching television live, but most major manufacturers are now offering at least one video recorder with a digital memory built in. This gives clear crisp still frame without the use of the extra playback heads normally necessary.

Digital memory in a VCR can also give a slow motion effect with sound. The tape runs at normal speed, with the soundtrack playing normally, but the digital memory grabs only a few frames each second from the tape and plays them on screen as a "strobe" succession of freeze frames which simulates slow motion.

PROJECT EUREKA

The MAC TV system, adopted as a future standard for European direct broadcasts by satellite, still uses the same 625-line picture format as PAL. Quality is improved by the different way of separating the colour and black and white signals.

In a rare example of cooperation between competitors, 30 electronics companies in Europe have been cooperating on the development of a high definition MAC system to rival technology which Sony of Japan is trying to sell into Europe with the backing of CBS of the US. The first working prototype was shown at Berlin.

Eureka project EU95 is led by Robert Bosch of West Germany, Philips of the Netherlands, Thomson of France and Thorn EMI of Britain, and backed by specialist electronics companies and broadcasters including the BBC and IBA, with aid from European governments. The Eureka members began work in June 1986. The aim is on a system which will give homes of the future much clearer and bigger TV pictures, while leaving owners of existing sets able to watch the same programmes, albeit with lower definition pictures.

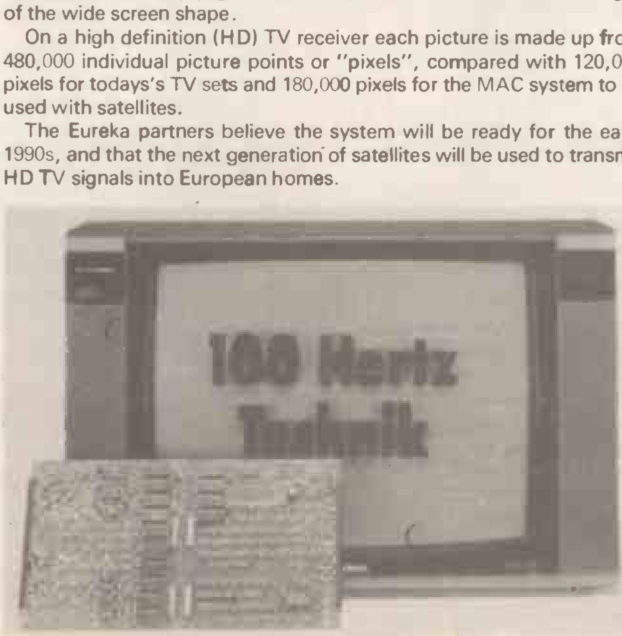
The Japanese high definition system uses 1125 lines for each picture, and displays 30 pictures a second (60 fields) on a widened TV screen. Europe does not like the Japanese system, because there is no easy compatibility between the different numbers of lines and pictures per second.

The Eureka project makes three radical changes. The number of picture lines is doubled to 1250 (from 625 for existing PAL or MAC); the aspect ratio is widened form the current 4:3 to 16:9; and, although only 25 pictures a second are transmitted, the receiver shows each picture twice to give the illusion of 50 pictures or 100 fields a second. The result is a wide screen picture, which is flickerless, and as clear as film.

The system is compatible with existing 625-line, 4:3 picture size receivers. They simply ignore half the picture lines and the outer edges of the wide screen shape.

On a high definition (HD) TV receiver each picture is made up from 480,000 individual picture points or "pixels", compared with 120,000 pixels for todays's TV sets and 180,000 pixels for the MAC system to be used with satellites.

The Eureka partners believe the system will be ready for the early 1990s, and that the next generation of satellites will be used to transmit HD TV signals into European homes.



Actually Doing it!!

CONTINUING from last month's article, we will now look at etching and drilling your own printed circuit boards. In the previous articles we considered methods of photographically reproducing the etch resist pattern onto the copper laminate board. It is worth pointing out here that the design can be traced onto the board, and then an etch resist pen or etch resist transfers can be used to produce the track pattern. The required materials are readily available from electronic component retailers.

With modern boards, which are often quite intricate, the transfers are probably worth the extra time and expense involved! Very professional boards can be produced using these. I will not go into detail here about methods of copying the design onto the board, but this is not too difficult. There is no single correct method, and most people seem to devise their own way of tackling the problem. The important things are to ensure that the track pattern is as accurate as possible, and that there are no breaks in any of the tracks. Be especially careful to ensure that the tracks all meet up with the pads correctly.

ETCHANT

There are various chemicals that can be used to etch away the exposed areas of copper to leave the copper track pattern, but ferric chloride is the only one used by home constructors. This is less dangerous than most of the alternatives, but it is still a substance that needs to be treated with respect. It attacks a number of metals apart from copper, it is poisonous, and it is an irritant. It also tends to put yellow stains on anything it comes into contact with, and these are often very difficult to wash out.

Avoid getting into contact with the etchant, and immediately wash off any that does get onto your skin using plenty of water. Always thoroughly wash anything that comes into contact with the etchant, including any utensils used when producing the board.

I expect that ferric chloride is the main "off-putter" for would-be printed circuit constructors. Although not the most pleasant of substances, provided it is used carefully and you are meticulous about cleaning up after each etching session, there is no reason for it to be troublesome. Many constructors find that this aspect of construction is not one that appeals to them and only use ready-made boards, but many others find that this is an interesting and worthwhile part of electronic project building.

You may well find that you wish to build circuits for which no ready made board is available, and the ability to build your own is then more than a little useful. I would certainly urge would-be board builders to take the plunge, and at least try making two or three boards to see how things go.

SOLUTION

If you do decide to give it a try, there is no difficulty in obtaining the ferric chloride these days. It is sold by several of the larger component retailers, and a few sell it in the form of a solution that is already made up and ready to use. It is more usually sold in the form of pellets, or sometimes it is available as crystals. The latter look more like chunks of yellow-brown rock than neatly shaped crystals. It no longer seems to be sold in powder form, which is probably just as well as it is very difficult to turn into a solution in this form.

The pellets and crystals dissolve in cold water reasonably easily. A plastic bottle is needed for mixing and storage purposes, and the type sold for storing photographic chemicals are probably the most suitable for this application. Metal containers are obviously unsuitable, and glass bottles (which could easily smash and make an unthinkable mess) are far less than ideal.

Gentle agitation or stirring will help to make the ferric chloride dissolve more rapidly. It can still take 20 minutes or more to fully dissolve though. The solution will probably become warm as the ferric chloride dissolves, and for this reason you should not start with hot water. It might get even hotter and melt the bottle! The exact strength of the solution is not too important, and anything (in weight) from one part ferric chloride to two parts water to about half this strength will do. If you buy a pack of about 250g or 280g of the chemical, mixing this with just under a litre of water will give a solution of good strength.

ETCHING

Etching the board is basically just a matter of immersing it in the etchant and waiting. However, a board etched under good conditions could take as little as five to ten minutes, while one processed under bad conditions could take days and give a markedly inferior result. For fast and efficient etching a reasonably fresh solution is required.

With use the copper from the board replaces the iron in the solution, and the etchant gradually turns to copper chloride (the iron is deposited as a sludge at the bottom of the storage bottle). This change in composition shows up as a change from a yellow brown colour to green, and eventually to a dark blue-green colour. When the solution reaches this dark colour it is certainly time to replace it.

Even with a fresh solution it can sometimes take an hour or more for a board to fully etch. If the board is simply placed copper side up in a dish of etchant, a thin layer of iron sludge tends to build up on the surface of the board. This hinders the etching, and drastically slows down the process. The board tends to etch much faster at the edges than towards the middle, which could lead to undercutting of the tracks and pads near the edges of the board.

One way of speeding things up and producing more even etching is to gently agitate the dish at fairly frequent intervals. Alternatively, lift the board out of the etchant (using plastic photographic tongs) from time to time, draining off the solution together with the sludge.

SUSPENDED

My preferred way of doing things is to have round bottomed dishes of various sizes, and to put the board copper side downwards in one of these. The dish needs to be one of a size that results in the board being held between about 10 and 100 millimetres above the very bottom of the dish, as in Fig.1. This enables the etchant to get at the copper properly, but there is a minimal build up of the iron sludge. The iron is heavier than the solution, so it falls away from the board and down to the bottom of the dish. This gives fast etching and requires a minimum of attention from the constructor. It is certainly the best method I have yet found.

An obvious drawback of this system is that you may not always be able to find a dish to match the size of board you wish to etch. Larger boards are especially awkward, since even the largest dish you can obtain may well prove to be too small. You may be able to devise other methods of obtaining a similar result, and I have found it possible to suspend boards on loops of single strand insulated wire as in Fig.2. This has the advantage of not requiring a round bottom dish of just the right size, but it can only be easily implemented using a fairly deep dish.

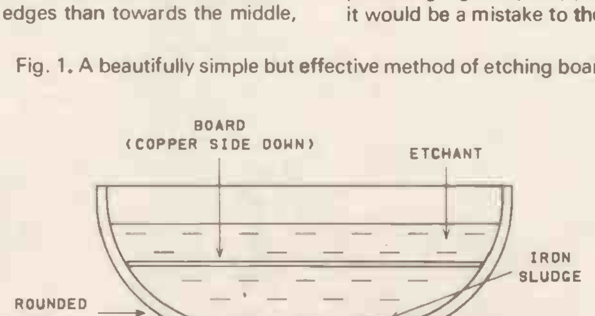
One point that has to be watched with this system of having the board copper side down is that air bubbles are not trapped under the board. This leaves areas of copper that are unetched, and it may be found that in immersing the board again to etch these away, the rest of the board becomes a little "overdone". Place the board in the etchant copper side uppermost initially, and make sure that the etchant flows over its entire surface. You should then find that air bubbles are easily avoided.

It is not a good idea to leave the board in the etchant any longer than is really necessary as this can lead to thinning of tracks and pads, or in an extreme case parts of the copper pattern might disappear altogether! Inspect the board every few minutes at least, and as soon as all the unwanted copper has been etched away, remove the board from the etchant and rinse it thoroughly under a tap.

DRILLING

To be honest, drilling printed circuit boards is not one of my favourite jobs. Modern projects are generally somewhat more complex than those in the past, and most boards require upwards of a hundred holes to be drilled. This can become a bit tedious, but it is a task that requires your full attention from beginning to end. Having spent a fair amount of effort producing a good quality product to this stage, it would be a mistake to then rush things and

Fig. 1. A beautifully simple but effective method of etching boards.



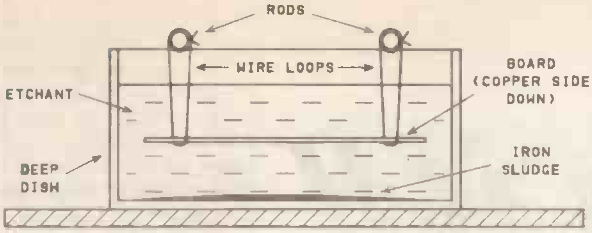


Fig. 2. An alternative etching method suitable for awkward boards.

ruin it. If necessary, drill the holes over several sessions rather than rushing in and doing the job in a single spell.

A one millimetre drill is suitable for most holes, but for semiconductors a slightly smaller drill of 0.8 millimetres in diameter is preferable. Preset resistors (and components such as relays which have similar pins rather than leadout wires) require mounting holes of about 1.5 millimetres in diameter. A few components (such as larger relays) require mounting holes of about two millimetres in diameter.

Four drill sizes are therefore ample to satisfy most requirements, but a larger size of about three to four millimetres will be needed to drill the mounting holes for the board itself. The size of these mounting holes will depend on the method of fixing you use, but about 3.3 millimetres is satisfactory for 6BA or M3 mounting holes.

DRILL

If you use a full size power drill it *must* be mounted in a stand. Otherwise it will be difficult to position the holes accurately, and the drills are likely to keep snapping. Really a full size power drill is not very good for this type of work, and a miniature type is the ideal tool for the job. The smaller types can be used quite effectively when hand-held, but there is less danger of snapping the drill bits if a drill-stand is used. Some of these do not permit holes to be drilled more than 40 millimetres or so from the edge of the board, which renders them unusable for the holes towards the middle of larger boards. One with a "reach" of about 100 millimetres or more is preferable. Small hand-drills are usable for drilling component mounting holes, but use drill bits of the "reduced shank" variety. Even with these great care needs to be taken in order to avoid snapping them, especially the very small diameter types.

There is not usually any great difficulty in getting the holes quite accurately placed, as the holes at the centres of the copper pads tend to guide the drill bit into position. Even with fibreglass boards power drills will drill through the board in only a couple of seconds, and the holes can be drilled at a fair rate.

Expect things to take quite a long time if you are using a hand drill – the use of s.r.b.p. board rather than fibreglass might help to speed things up. Various types of "long-life" drill are available, and their extra hardness is useful when dealing with fibreglass boards. Ordinary HSS drills tend to become blunted very quickly when working this material (due to the hardness of the glass filaments). Note that these extra hard drills are usually extra brittle as well! They need to be treated with even more care than normal, and are generally unsuitable for hand drills.

FINISH

The final stage is to remove the remaining etch resist and polish the copper to a good clean finish. Some photo-etch resists can be left on and will not hinder soldering. I still prefer to remove them as they seem to produce a marked increase in the fumes generated when soldering the components in place. The resist is easily removed using a scouring pad or one of the special printed circuit polishing blocks that are readily available from most component retailers. One final tip; if you are not going to solder the components in place within a few hours of completing the board, leave the resist in place until just before you are going to start work on the board. Otherwise the copper might start to oxidize, making it necessary to repolish the board.

Electronics is not exactly short of confusing jargon and abbreviations, and these will be the subject of next month's article.

Robert Penfold

TWINKLING STAR

G. CALLAND

Add a bit of sparkle to your Christmas festivities

DECORATIONS for the top of the Christmas tree can sometimes be dull and unexciting, either being a fairy or a tinsel star. This inexpensive and easy to build project will add a bit of sparkle to your tree.

The device screws into a lamp socket of any series wired fairy light set, and twinkles a single bulb. The effect is enhanced if the bulb is placed in the centre of a tinsel star.

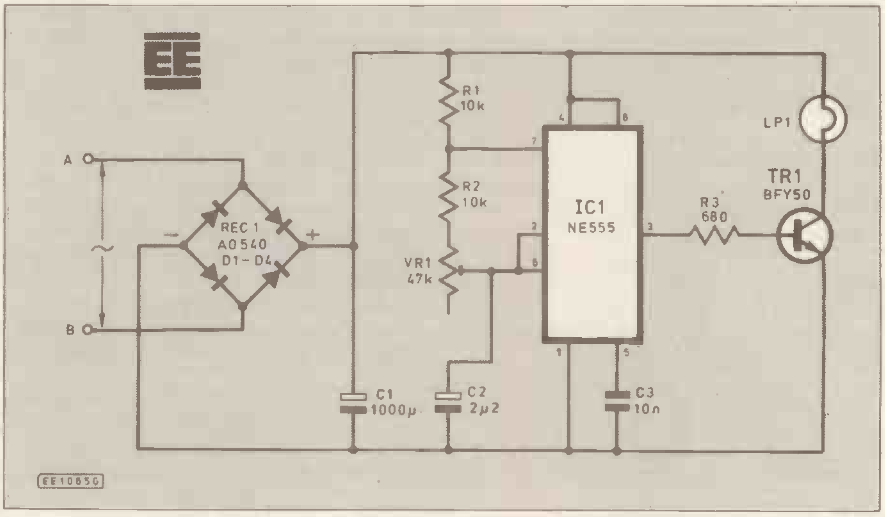


Fig. 1. Complete circuit diagram for the Twinkling Star.

HOW IT WORKS

The final circuit diagram for the Christmas Tree Twinkling Star is shown in Fig. 1. The a.c. from the fairy light set is rectified by the bridge rectifier REC1 (diodes D1 to D4) and smoothed by capacitor C1 to produce a steady d.c. voltage (6V for a 40 bulb set, 12V for a 20 bulb set). This then powers the 555 timer i.c. wired in the astable mode.

The frequency of oscillations is variable, by adjusting preset potentiometer VR1, from about 5Hz to 20Hz. The pulses from IC1 switch transistor TR1 on and off via resistor R3 and hence the bulb LP1 flashes.

CIRCUIT BOARD CONSTRUCTION

The full size printed circuit foil master pattern and component layout is shown in Fig. 2. The printed circuit board is small and ideal for the first time p.c.b. builder. However, for those who do not wish to build their own p.c.b., this board is available from the *EE PCB Service*, code 588.

Start construction by inserting the resistors, then the capacitors, taking care with the polarity. Then insert the transistor followed by the d.i.l. bridge rectifier, then the integrated circuit IC1. Pay particular attention to the orientation of the semiconductors, these should be inserted according to the component layout shown in Fig. 2.

CASE

The case is the smallest plastic case Vero make measuring 72mm × 47mm × 25mm, and is easily hidden by the tinsel star. Two holes should be marked and drilled in the case. One in the top for the bulb holder, and, one in one of the small sides for the supply leads, see Fig. 3.

A bulb will have to bite the dust so that the screw part of it can be used. The glass envelope should be carefully smashed, by wrapping in a cloth to prevent flying glass, and all pieces of glass removed. The filament should then be removed, and the filament leads carefully scraped to remove the enamel.

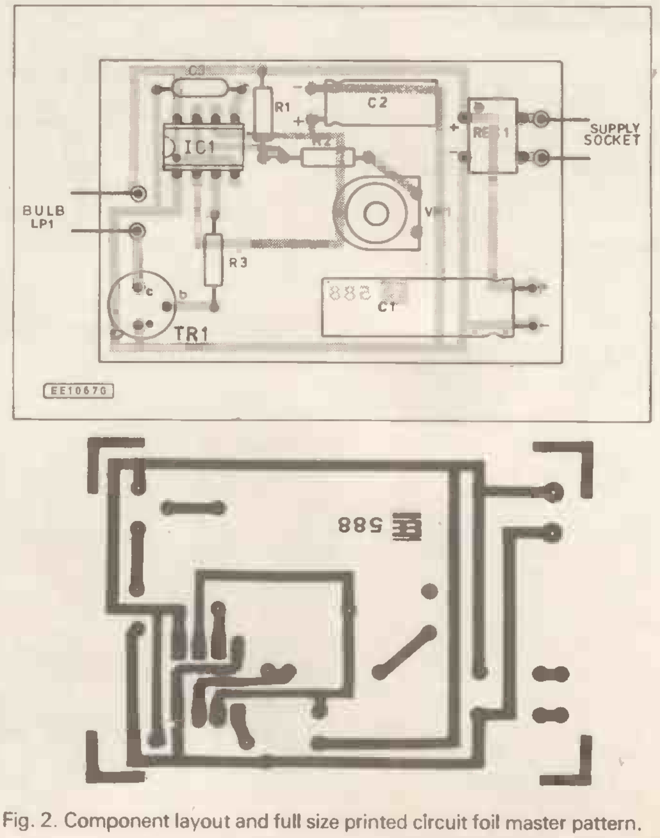


Fig. 2. Component layout and full size printed circuit foil master pattern.

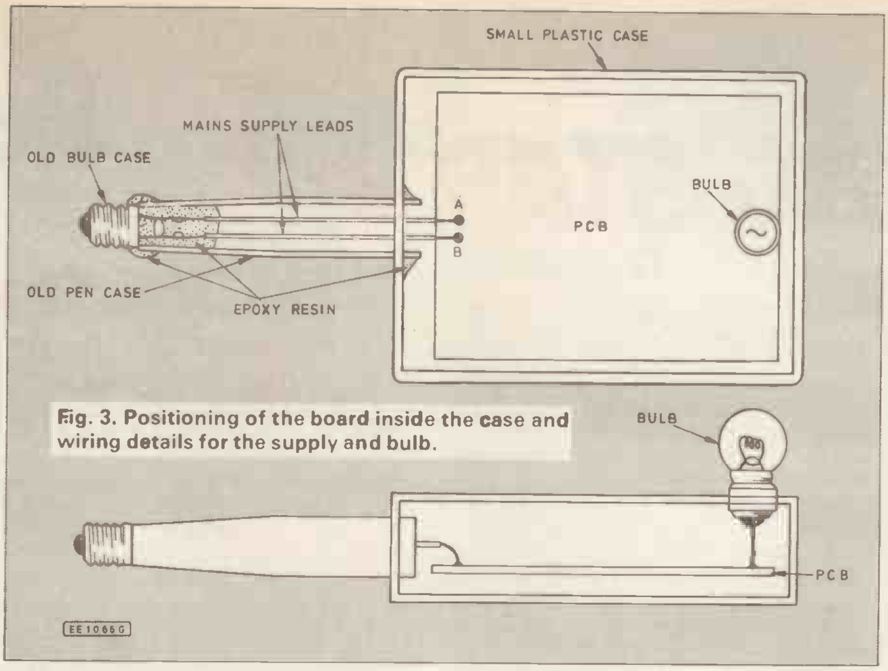


Fig. 3. Positioning of the board inside the case and wiring details for the supply and bulb.

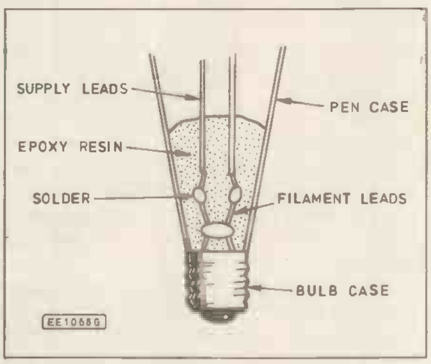


Fig. 4. The supply leads are soldered to the bulb filament leads and glued to the pen case.

The supply leads from the circuit board can now be easily soldered on to the filament leads and then the whole of the connection covered in an epoxy resin. This ensures that they are insulated and that the supply leads will not pull off, see Fig. 4.

The bulb case is then glued into the bottom half of an old pen case using epoxy resin, Fig 3. The other end of the pen case is glued into the main case. The circuit board is held in place by the supply leads and the bulb leads. The construction is then complete.

A suggested arrangement showing the unit mounted behind a decorative tinsel star is shown in Fig. 5. No doubt, many other ingenious ideas and applications will be tried and the final "display" should give many hours of pleasure to the young and not so young — Happy Christmas. □

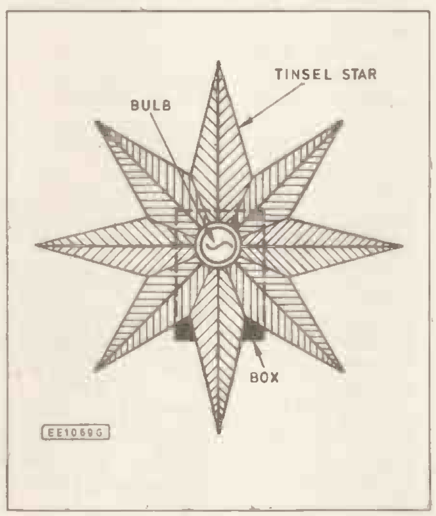


Fig. 5. The case is small enough to be mounted behind a decorative tinsel star.

COMPONENTS

Shop Talk

Resistors

R1	10k
R2	10k
R3	680

All 0.25W 5% carbon

Potentiometer

VR1	47k lin. skeleton preset, horizontal

Capacitors

C1	1000μ radial elec. 16V
C2	2μ2 radial elec. 16V
C3	10n polyester

Semiconductors

TR1	BFY50 *npn* transistor
REC1	A0540 250V 0.7A d.i.l. bridge rectifier
IC1	NE555 Timer

Miscellaneous

Plastic case, Vero 72mm × 47mm × 25mm; single-sided printed circuit board 60mm × 42mm, available from *EE PCB Service*, code EE588; bulb holder; old bulb; epoxy resin; pen case; wire, etc.

Approx. cost Guidance only £8.45

b...Beeb...Beeb...Beeb...Bee

. . . Logic Tester . . . Transistor Tester . . .

TESTING digital integrated circuits can be a difficult and time consuming job, but it is something that can often be accomplished quite quickly and easily with the aid of the BBC computer. One way of tackling the problem is to build up some hardware to connect the BBC ports to the device under test and to have a large program that will automatically test a wide range of logic devices. This is not something that we will pursue further here as this subject was covered in John Becker's excellent "Digital Chip Tester" article in the August 1987 issue of *Everyday Electronics*.

However, it is worth mentioning a more ad lib approach which has its attractions if only one or two chips will need to be tested every now and then, and the chips to be tested could be any in the vast CMOS and TTL ranges. Working out test set-ups and software to automatically test dozens of chips would take a massive amount of time, and ultimately most of the routines would probably never be used in earnest. Improvising test routines as and when necessary is perhaps a more practical approach, possibly backed up with prepared software and hardware set-ups for common logic chips.

Improvised Testing

A method of chip testing I have used successfully for some time is to have a solderless breadboard, and a lead to connect this to the user port of the BBC computer. The lead has a 20 way IDC connector to fit the user port, and a number of one millimetre plugs at the other end. It is not necessary to have all twenty leads terminated in plugs, as there are three +5 volt leads and seven earth leads. Only one of each needs to be fitted with a plug, and the other eight can simply be trimmed back so that they do not get in the way.

Connections

The general idea is to plug the chip to be tested into the breadboard, and to then wire it up to the user port in the appropriate manner. This means connecting the chip to the power supply rails of the computer, and then wiring its inputs and outputs to lines of the user port. It is then a matter of setting up the user port so that lines connected to inputs of the chip operate as outputs, and lines connected to outputs operate as inputs.

With software designed specifically to test the chip under investigation it is possible to have everything done automatically, with the program running tests and then reporting the nature of any errors that are discovered. With an improvised set-up it might be possible to devise a quick test routine that will provide largely or even totally automatic testing, but it is more likely that a largely manual approach will need to be adopted.

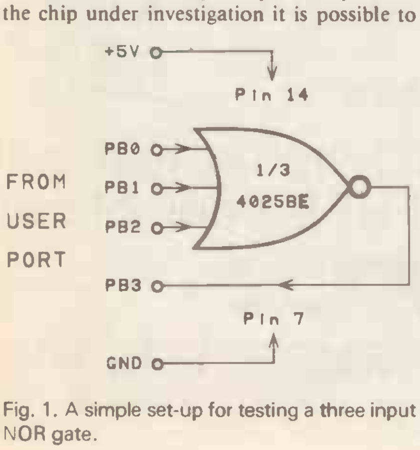


Fig. 1. A simple set-up for testing a three input NOR gate.

Gates are about the easiest devices to check, but with multi-gate types it is probably best to check them one at a time. It is just a matter of taking the inputs through every possible combination and noting the output states produced. As an example, assume that one of the three input NOR gates of a CMOS 4025BE is to be checked. This could be accomplished using the arrangement shown in Fig.1, which has PB0 to PB2 acting as outputs, and PB3 operating as an input to monitor the output level of the gate.

Results

A NOR gate provides a logic 1 output level if all its inputs are low, but a logic 0 output level if one or more of the inputs are taken high. This makes testing quite simple as the output of the gate should go high if a value of 0 is sent to the user port, but should go low if any other value is used.

One way of testing the gate would be to set up PB0 to PB2 as outputs, and then manually send values to user port and read the state of PB3. In this case it is probably quicker to type in a short test program though, especially if all three gates in the device are to be checked in turn. The simple program of Listing 1 is suitable. Note that it is just a matter of sending values from 0 to 7 to the user port in order to take PB0 to PB2 through their eight possible output combinations. The way in which the program functions should be fairly obvious to any experienced BBC user, and the detailed functioning of the program will not be described.

When run, the program simply prints a list of values sent to the user port, with the returned values printed beside these. When used with a three input nor gate this result should be obtained:

0	1	4	0
1	0	5	0
2	0	5	0
3	0	7	0

Something that should not fail to impress you is the speed at which this type of testing is completed. Even using BASIC rather than assembly language, a multi-input gate can be checked in just a fraction of a second!

Listing 1

```
10 CLS
20 ?&FE62 = 7
30 FOR OUTPUT = 0 TO 7
40 ?&FE60 = OUTPUT
50 PRINT OUTPUT,(?&FE60 AND 8)/8
60 NEXT
```

Complex Devices

Some other logic devices, such as inverters and buffers, are just as straightforward to test, or are even more simple. Obviously not all logic integrated circuits are quite as easy to test though, but it should be possible to devise simple test set-ups for all but the most awkward types. With something like a D type flip/flop, the easiest way of checking it would probably be to wire it to act as a divide by two circuit.CB1 could then be used as an output to provide pulses to the clock input, with PB0 being used to monitor the output state. This should, of course, change each time an output pulse is sent.

Although this type of testing is not 100 per cent reliable, in the vast majority of cases it will accurately indicate whether or not the test device is serviceable.

With something like a 3 to 8 line decoder or 4 to 16 line type there is a problem in that the user port has insufficient input/output lines to accommodate all the input and output terminals of the integrated circuit. It might be possible to overcome this by using the printer port and (or) the two digital inputs on the analogue port, or a VIA interfaced to the 1MHz bus could provide another twenty input/output lines. I would not recommend these methods for improvised testing though, as the likely result would be a "birds nest" and totally unreliable results. It is probably much better to keep the test set-ups as simple as possible.

Applying this philosophy to a 3 to 8 line or 4 to 16 line decoder, the inputs would be driven from output lines of the user port, and they would be cycled through the eight or sixteen possible combinations. One user port line would be set as an input and used as a logic state checker to quickly check the level at each output for each set of input levels. This may sound a rather cumbersome way of tackling the problem, but the chip could soon be tested, and thoroughly tested using this method.

Many logic devices have "inhibit" or "enable" inputs which can be used to deactivate the chip. Where necessary, these can be driven from output lines of the user port and tried at both states in order to ensure that they activate and deactivate the device properly.

With a little ingenuity it should be possible to test virtually any logic chip, with the "bit at a time" approach being adopted.

Linear Devices

Although computer testing lends itself more readily to operation with digital devices than other types, it is something that can easily be applied to linear semiconductors, passive components, or virtually any component in fact. The analogue port of the BBC micro is well suited to this application, but for much testing of this type an analogue output is needed in addition to an analogue input or inputs. There is no real difficulty here, since it is a very easy matter to add a digital to analogue converter to the user port.

Using the BBC computer for certain types of component testing is something that has been covered previously in this series of articles, and we will not go over the same ground again here. We will instead concentrate on types of testing that have not so far been considered, and this mostly means various types of semiconductor. This is an application where the graphics capability of the BBC micro can often be put to good use.

Something like transistor curve tracing is perfectly possible, and with the aid of a screen dump routine and a suitable printer hard copy of results can be obtained. A BBC computer plus some simple hardware and supporting software can provide test gear functions that would once have cost a minimum of several thousand pounds!

Transistor Checker

As a simple starting point, the circuit of Fig.2 shows a basic means of using the BBC computer as a transistor checker. R1 provides a nominal base current of 10 microamps to the test device, and S1a connects R1 to the appropriate supply rail for the type of transistor (*npn* or *pnp*) that is being checked. S1b provides similar switching for the emitter terminal of the test device.

In order to determine the current gain of the test transistor we must measure the collector current. The current gain is equal to the collector current divided by the base current, and having measured the collector current, there is obviously no difficulty in getting the computer to do the simple mathematics and print the current gain figure on the screen.

Although the analogue port responds to voltage rather than current flow, it is an easy matter to make the conversion from one to the other. It is actually just a matter of placing a resistor across one of the inputs, as the voltage developed across a resistor is proportional to the current flowing through it. For instance, with a 1k resistor a voltage of 1 volt per milliamp is produced.

The load resistor must be chosen to give convenient scaling, but there is no real problem here. Dividing readings from the analogue port by 64 gives a range of 0 to 1023, which in this case can conveniently be 0 to 10.23 milliamps. With a 10 microamp base current this represents a gain range of 0 to 1023, which covers all normal transistors. Apart from the division by 64, no further manipulation of the returned values is needed in order to give readings in current gain. Using Ohms Law to calculate the value of R2 gives an answer of just under 176 ohms, but the nearest preferred value of 180 ohms will give sufficient accuracy.

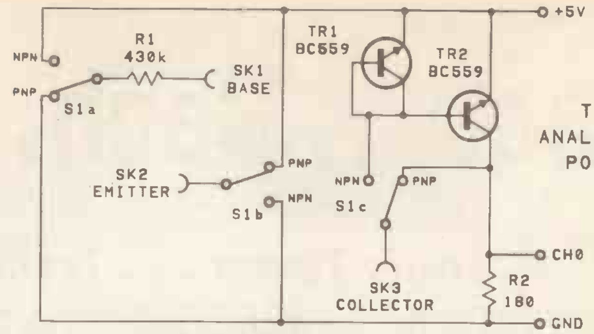


Fig. 2. The transistor tester interface.

There is a slight complication in the circuit when testing *npn* devices. This is due to the fact that the collector of an *npn* transistor connects to the positive supply rail, but the analogue inputs measure voltage relative to the negative supply rail. This requires some additional hardware to provide a suitable signal for the analogue port, and there are two possible approaches. One is to use a unity voltage gain inverting amplifier, or the alternative that is used here is to use a current mirror.

In this design the current mirror is formed by TR1 and TR2, and the action of this type of circuit is simply to provide a source current that is approximately equal to the current fed into its current sink circuit. There is no need to switch TR1 and TR2 out of circuit in the *pnp* mode, as they will not have any effect on readings.

Listing 2 is a simple program for use with the transistor tester circuit. This is another program which is very simple and straightforward, and which does not really merit a detailed description.

Listing 2

```
10 CLS
20 PRINTTAB(10,10)" CURRENT GAIN
="
30 GAIN = ADVAL(1) DIV 64
40 PRINTTAB(10,11)GAIN
50 FOR DELAY = 1 to 500:NEXT
60 PRINTTAB(10,11)"            "
70 GOTO 30
```

Next month we will continue on the same theme, but some more sophisticated circuits and software which make use of the BBC machine's graphics will be described.

...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

ANTENNAS

An antenna is the most important part of a radio station. The best equipment in the world hooked up to a poor antenna will perform badly, while modest rigs used with a good antenna can perform well and give great satisfaction.

The elementary form of antenna, from which more elaborate systems are developed, is the half-wave dipole, while two other basic types are also much used by amateurs – grounded antennas, which use the earth to represent one half of the required antenna length; and loops, which are helpful when there is insufficient space to erect a full-size dipole.

In choosing which antenna to use there are a number of considerations to take into account. This can often mean that the best antenna for the job is not the one chosen – and why amateurs experiment endlessly hoping to find the optimum radiator in the face of various restraints!

REQUIREMENTS

Firstly a decision has to be made as to which band or bands the antenna is to cover. They can be single or multi-band, but in the latter case obtaining equal performance on all bands can be a problem.

Having decided on the bands, what are the target areas! If medium/short distance working is required, e.g. UK and Europe, an antenna with a high angle of radiation is needed. If DX (long distance) working is hoped for then low angle radiation is needed.

An assessment can then be made of the different types of antenna which might meet one's particular needs, comparing the size of one's garden (if there is one!) against the physical dimensions of the proposed antenna, its cost if bought commercially, the need to keep on good terms with the neighbours, and the possibility of having to obtain planning permission to erect it.

A commercially made 60ft high tower/mast and antenna, with facilities for raising, lowering and rotating the antenna – the whole sitting in several tons of concrete in the ground – can well go into four figures. Faced with this possibility, it is not surprising that many amateurs opt for home-made systems, some comprising just a length of wire strung between two trees!

WIDE CHOICE

If they decide to make their own, there are many designs to choose from, mostly variations of the basic types already mentioned. There are books full of theory and practical designs, and frequent articles in the amateur radio magazines, such as *Practical Wireless*.

Some go straightaway for a wire dipole, accurately dimensioned for a particular band. This will present a matched load to a transmitter without the need for an antenna tuning unit (see last month's column) or other matching device. If it can be mounted at least half a wavelength above ground it is capable of DX communication, and can give a good performance.

The necessary dimensions may, however, cause a problem if space is not available. A dipole for the 80 metre band, for instance needs to be approximately 40 metres long and for DX working to be at least 40 metres above the ground. Such an antenna at about 8-10 metres above ground has a higher angle of radiation and can provide reasonable medium/short distance coverage.

Another popular type is known simply as a "long wire" antenna. There are preferred measurements to cover particular bands, but many amateurs with restricted sites simply work to the maxim, *"as long as possible and as high as possible"*. These antennas need a good earth connection and, with the help of an ATU, provide variable and sometimes surprising results over several, if not all, bands.

RADIATION PATTERNS

Such antennas have random radiation patterns, often resulting in only a small portion of the radiated energy going in the direction of the station being worked. Dipoles have a broad two-way directional pattern which is better, but for most of the energy to go in one direction only a specially designed antenna is required.

Probably the best known design is the YAGI beam which uses parasitic elements. These obtain their power by electro-magnetic coupling from a normally connected dipole and concentrate the radiation in one direction. Variations in the dimensions and spacings of the parasitic elements result in different characteristics in the antenna.

Adjustments can be made to obtain maximum forward gain, but this reduces the attenuation to the rear (the front-to-back ratio). In the interest of good selective reception it is normal practice to sacrifice some gain to obtain the best front-to-back ratio. Spacing also affects the band of frequencies (bandwidth) over which an antenna will give a satisfactory performance.

The more elements added to a beam the greater the gain achieved, but the signal beam becomes progressively narrower (beam width), so that accurate aiming of the beam becomes important to ensure that signals to and from the chosen area reach their destination.

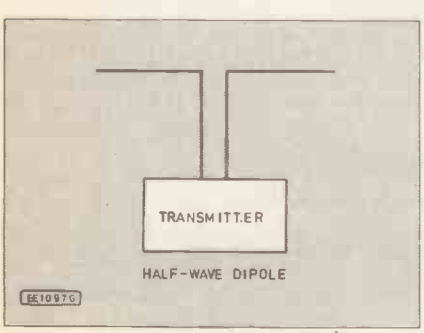
REDUCING THE SIZE

Because of space limitations some amateurs concentrate on reducing the size of antennas to fit into small gardens or even to use indoors. There is a limit to this because of falling efficiency below a certain size, but even so the results obtained can be very rewarding.

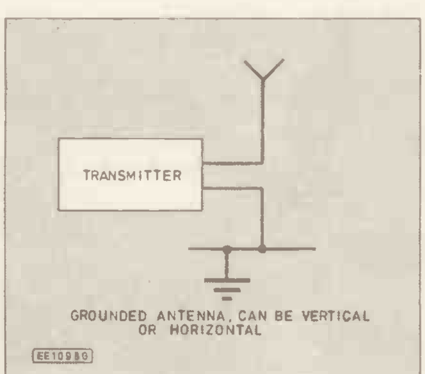
One antenna I made for the 10 metre band measured just 1.5 × 1.5 metres, comprising two driven elements, virtually dipoles folded round into rectangular shapes. I set this up one evening in my bedroom and pointed it towards America. I transmitted a power of just 2 watts and my first contact was with a station in Pennsylvania.

Shortly after I worked Wisconsin, followed by Minnesota, nearly halfway across the States. I was virtually striding across the country in giant steps thanks to my experimental miniature antenna. It was a wonderful feeling!

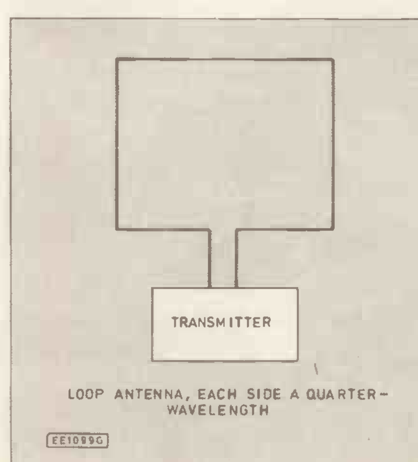
Another indoor antenna had helically wound elements in the shape of a broad letter V. It was essentially a dipole 2.5 metres wide against the normal 7 metres for the 15m band. I was using 5 watts, and the first station I contacted was in



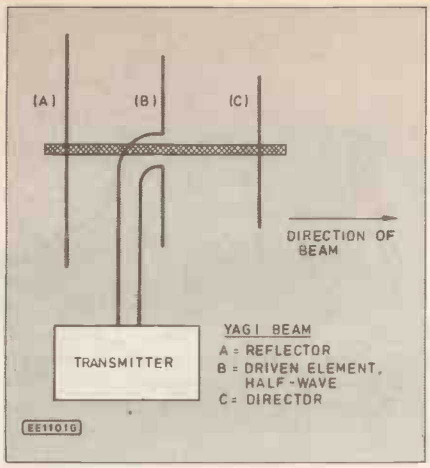
HALF-WAVE DIPOLE

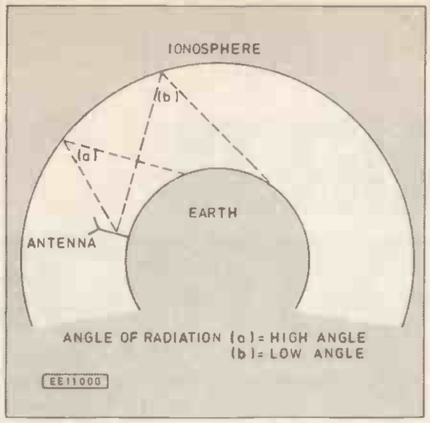


GROUNDED ANTENNA, CAN BE VERTICAL OR HORIZONTAL



LOOP ANTENNA, EACH SIDE A QUARTER-WAVELENGTH





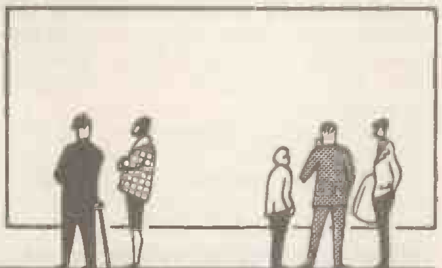
Brazil, a country I had never managed to work before.

GREATEST SUCCESS

In terms of size reduction my greatest success has been a 4.5 metres long antenna used for the 80m band, compared with the conventional length of about 40 metres. I even got a 2.25 metres version to work in a contact with Germany. The losses are so great on these however that my usual low-power operation is at a disadvantage and I have not continued with these particular trials.

It is easy to see why no single antenna is suitable for all purposes, and why antenna experiments are so interesting. They also happen to be great fun!

SHOP TALK



BY DAVID BARRINGTON

Good Connections

Two new products have come to our notice this month and would make welcome gifts at this time of year.

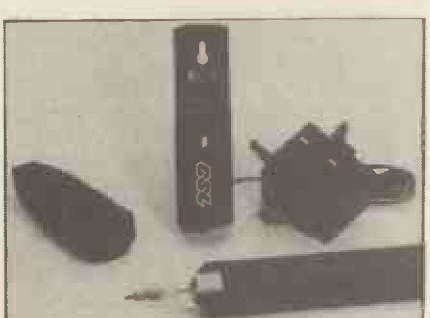
A new portable rechargeable soldering iron, which is claimed to be ideal for soldering CMOS and other static devices is being marketed by **Cirkit**. Featuring an illuminated tip, for which spares are readily available, the soldering iron has a safety hood for protection during operation.

Rated at 12W, with fast warm-up time, the iron comes with a 2mm diameter tip, a mains charger, wall or bench mounted charging stand and a 12V car charging lead which is connected via the vehicle's cigarette lighter.

The Turbo Solderor costs £15 and it is claimed that over 200 standard joints can be made from a full charge of 12 hours. The iron is available from: **Cirkit, Dept EE, Park Lane, Broxbourne, Herts EN10 7NQ. ☎ 0992 444 111.**

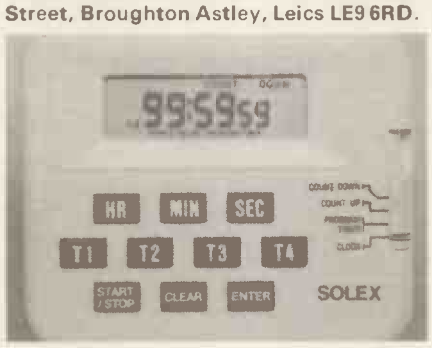
If you know someone who is 'forgetful' and suffers from problems of keeping important appointments and would like to give them a gift that may help, **Solex International** are offering two 'timekeepers' for the price of one.

For a limited period (until the end of '87), all mail order customers ordering their versatile Solex S540 timer will receive a *Free* five-function stopwatch.



The S540 is fully programmable with a liquid crystal display and an adjustable pocket grip. It also boasts a count-up, count-down function with electronic alarm and roll over facility.

The Solex S540 costs £14.95 each, including postage and packing, and is available from: **Solex International, Dept EE, 44 Main Street, Broughton Astley, Leics LE9 6RD.**



Greenweld Catalogue (EE Nov '87)

The volume of mail received by **Greenweld** in the first two weeks following publication of our November issue *'greatly exceeded expectations'*, said Peter Green of Greenweld. They have asked us to apologise to readers who sent in early orders for the delay in processing some of them.

Orders are now being despatched within a couple of days. (Tel: 0703 772501/783740.)

CONSTRUCTIONAL PROJECTS

Audio Signal Generator

There should be no difficulty in obtaining the low voltage audio amplifier i.c., type LM386N-1, used in the *Audio Signal Generator*. This is currently listed by Magenta, Omega, TK Electronics and Greenweld.

For those readers who may experience difficulties in obtaining parts, a complete kit (£12.99) may be purchased from **Magenta Electronics, Dept EE, 135 Hunter Street, Burton on Trent, Staffs, DE14 2ST.** Add £1 for p&p per order.

The printed circuit board is available from the *EE* PCB Service, code EE589.

Dual Mains Lights Flasher

The mains suppression type capacitor and the mains transient suppressor listed for the *Dual Mains Lights Flasher* should be available from most of our component advertisers. If readers do have difficulty, they may be purchased from Maplin, stock codes FF58N (IS Cap 0µ47) and HW13P (Mains Trans Supp).

When buying the BC184L transistor it is important to purchase one with the suffix L as pin connections for this device vary. The printed circuit board is available from the *EE* PCB Service, code EE587.

Pseudo Echo Unit

We cannot foresee any component buying problems for the *Pseudo Echo Unit* project. When ordering the In/Out switch S1 be sure to specify a robust 'foot-operated' type push-button switch. Also the jack socket SK1 should incorporate an on/off switch.

The printed circuit board is available separately through the *EE* PCB Service, code EE586 (see page 690)

Twinkling Star

We have only been able to find one source for the d.i.l. bridge rectifier called for in the *Twinkling Star* project. This is a Siemens A0540 device and is currently stocked by **Electrovalue, 28 St Judes Road, Englefield Green, Egham, Surrey.**

They inform us that they have very limited stocks and suggest that the A0553 device may be a suitable alternative. We have not had the opportunity to try this device and cannot vouch that it will work in this circuit.

One possible answer would be to use one of the more common TO case type rectifiers and bend the leads to suit the p.c.b. Provided the device is mains rated at 0.7A or more we can see no reason why other types cannot be used in this circuit.

The printed circuit board is available from the *EE* PCB Service, code EE588.

Windscreen Wiper Control

The only item that is likely to cause sourcing problems in the *Windscreen Wiper Control* is the 16A relay. This is stocked by Maplin Supplies, stock code YX99H (12V 16A relay).

Light-Operated Counter

Some readers may experience difficulty in obtaining the phototransistor TIL78 used in the *Light-Operated Counter* – this month's *Exploring Electronics* project.

This device is stocked by Magenta, Omni, TK Electronics, Omega and Xen Electronics.

WINDSCREEN WIPER CONTROL

P.J. DEEPROSE

Make a clean sweep with this low cost intermittent and dual car windscreen wiper controller

THIS project was designed to provide an intermittent wipe facility for those of us with "older" cars or cars lower down the range. While investigating possible designs the author saw an up-market car which sported a rather nice dual wipe facility. This circuit emulates this, and provides both an intermittent wipe and a dual wipe.

This latter feature is useful in the situation where a single wipe only results in a smeared windscreen. The delay between sweeps is variable, using a dash mounted control.

CIRCUIT DESCRIPTION

The NE555 timer, IC1, is set up as a pulse generator. Timing is determined by potentiometer VR2, capacitor C1, and VR1 or resistor R1.

The capacitor, C1, is charged via R1 (or VR1) and diode D1. This sets the pulse width, the duration of which is $C \times R$. For the intermittent wipe position this is $100\mu F \times 5k6 = 0.56$ seconds. The capacitor is discharged through VR2, the position of which determines the time between pulses, and hence the time between sweeps.

The output of IC1 drives a transistor TR1, via resistor R2; TR1 is being used as a switch. Relay, RLA, provides the control for the wipers.

Control of the wipers is achieved by the contacts of relay RLA in the following way. With the relay de-energised the car's wiper circuit is unaffected since the contacts are replacing the portion of wire that has been cut.

When the relay is energised there is 12V fed to the motor by the relay contacts RLA1. This causes the motor to run.

When the relay contacts are de-energised, if the wipers have not reached the parked position, current will flow via the park switch as normal. As the park switch takes care of the sweep once its contacts are in the run position, only a small pulse from the relay is needed for a complete sweep of the wipers to occur.

From the above description, all that is required for dual-wipe is a longer pulse; this is provided when VR1 is in circuit.

WIPER CIRCUIT OPERATION

The car wiper circuit in the off position, with the wipers in the parked position, is shown in Fig. 2. When the wipers are switched on current flows through the wiper switch to the motor, as the other side of the motor is earthed the motor will run.

When the wiper switch is turned off, if the wipers are not in the park position, the parking switch will be in the position shown in Fig. 3. Current will flow through the parking switch and wiper switch to the motor. This happens

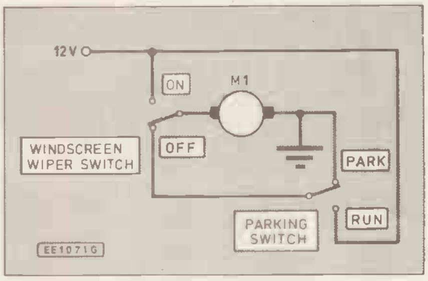
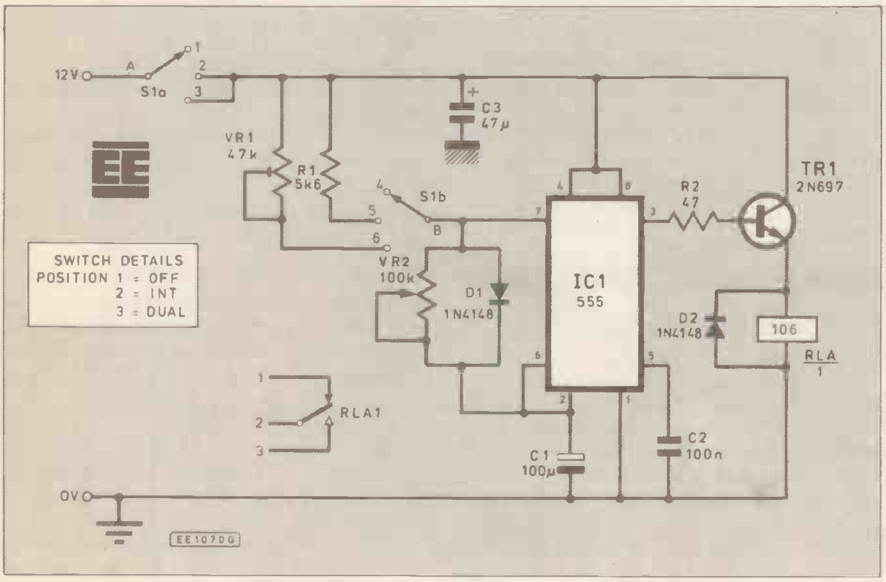


Fig. 2. Normal wiring of a car wiper circuit in the off position.

Fig. 1. Complete circuit diagram of the wiper controller.



COMPONENTS

Shop Talk
See page 679

Resistors
- R1 5k6
- R2 470

All 0.25W 5% carbon

Potentiometers
- VR1 100k lin. skeleton preset, horizontal
- VR2 470k lin. rotary

Capacitors
- C1 100µ elec. 25V
- C2 100n ceramic
- C3 47µ tantalum

Semiconductors
- D1,D2 1N4148 signal diode (2 off)
- TR1 2N697 *npn* switching
- IC1 NE555 timer

Miscellaneous

RLA 106 ohm coil, 12V relay, with 16A changeover contacts

S1 4-pole 3-way rotary switch

Suitable plastic case; stripboard, 0.1in matrix size 20 strips × 27 holes; in-line fuse holder and 10A fuse (FS1); interconnecting wire, 32/0.2mm wire for connecting relay contacts and circuit board to supply; plastic knobs (2 off); terminal pins; bullet/spade connectors, etc.

Approx. cost Guidance only **£10.50**

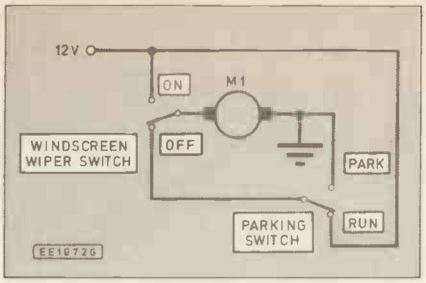


Fig. 3. Car wiper circuit switched off but with the wipers not yet parked.

until the wipers are in the correct position, and hence the parking switch is in the park position. The back e.m.f. generated by the motor results in dynamic braking of the motor since both sides are connected together.

CONSTRUCTION

The circuit panel is constructed on a piece of 0.1in matrix stripboard, size 20 strips × 27 holes. The component layout and underside view showing breaks in the copper strips is shown in Fig. 4.

There should be no problems in the construction of this project, providing normal care is exercised. Particular attention should be made when breaking the tracks on the stripboard, and soldering in the components and link w..res. Also, check that the components have been inserted with the correct polarity. Finally check all components and joints before testing.

Before mounting the circuit in the car a bench test should be carried out to ensure the circuit is working correctly. To test the circuit, first rotate the potentiometer VR2 to a position about midway between maximum and minimum.

Set the preset VR1 to about mid-range position. Connect a 12V supply to the positive and earth pins on the circuit board, with off/on switch in the off position. When the switch is turned to the ON position, check that the current does not exceed about 75mA. If the current is greater than 75mA turn off and check wiring.

Assuming all is well at this stage, connect a light bulb to the supply via the normally open contacts of the relay as shown in Fig. 5. Switch on the circuit again, the lamp should flash on and off, the frequency of which will be dependent on the position of the potentiometer VR2. Check that rotating the potentiometer alters the time between flashes from almost zero to about 50 seconds. Check that with the mode switch S1 in the INT. position the lamp is on for about half a second. With the mode switch in the DUAL position check that varying the position of the preset VR1 alters the length of time that the lamp is on.

INSTALLATION AND SETTING UP

Commence the installation of the unit by first disconnecting the car battery, this should be done whenever this type of work is to be carried out. A break should be made in the wire between motor and wiper switch on the car steering column, see workshop manual wiring diagram.

The contacts of the relay should be inserted as shown in Fig. 6, paying particular attention to the fact that the switching of wiper contact is connected to the motor side, and the normally closed (n.c.) contact is connected to the switch side. When making these connections use either the bullet type or spade type connectors available from motor factors.

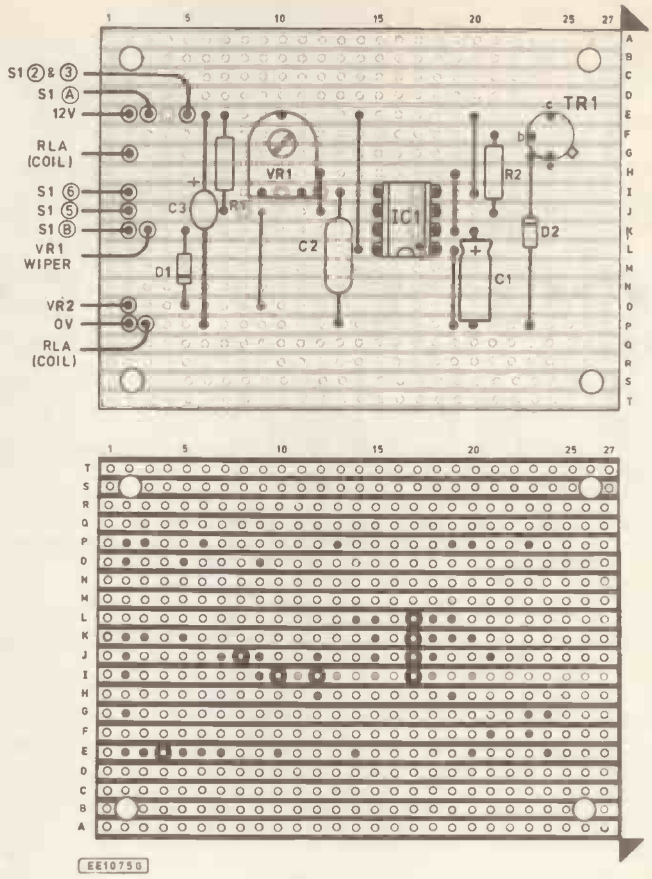


Fig. 4. Veroboard layout and wiring for the car wiper controller.

The normally open (n.o.) contact is connected, via a fuse FS1, to the supply using the 32/0.2mm wire. A suitable connection may be made at the fuse box, but see workshop manual.

The original wiper controller circuit was mounted, in its case, in the centre console of the car. However, the circuit can be mounted in any *dry* place, connect the wiper control circuit to a fused supply at the fuse box and the earth connection to a suitable earth point. Mount the potentiometer VR2 and mode switch S1 on the dashboard in a convenient position, bearing in mind that they should be easy to reach while driving.

Switch the circuit on with the switch in the INT. position and a single, delayed action, wipe should occur. Check that the time between sweeps can be altered by varying the position of VR2. With the switch in the DUAL position, alter the preset VR1 for two sweeps of the wipers. □

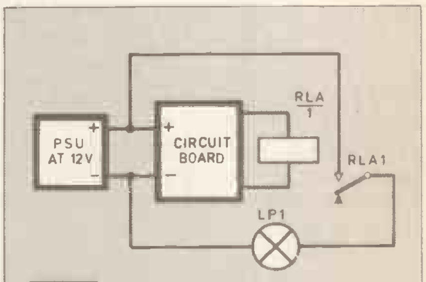
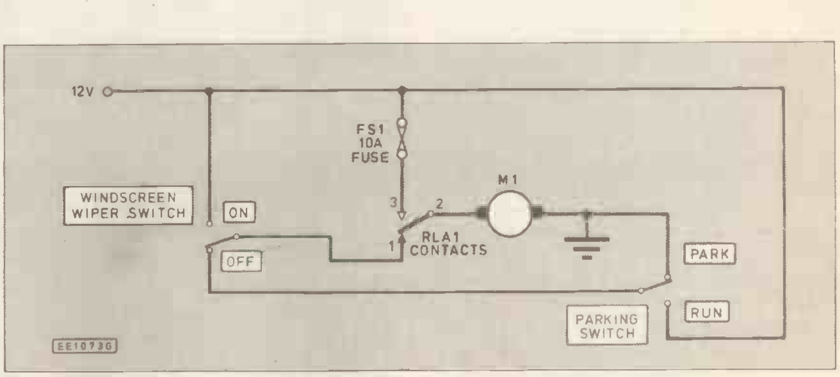
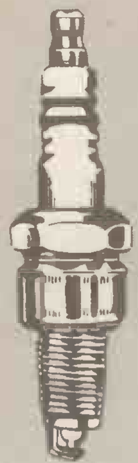


Fig. 5. Connecting the car wiper controller for test purposes, using a small 12V bulb.

Fig. 6. Wiring of RLA1 contacts to the car wiper circuit.





ELECTRONIZE IGNITION KIT

KIM HENSON

It is fair to say that I, as a car enthusiast, am more at home with a set of spanners than I am with a soldering iron . . . It was therefore with some trepidation that I surveyed the many and various components comprising the Electronize Design "Total Energy Discharge" electronic ignition kit, which I was about to assemble! To see how I would fare – just me (with my father for moral support) versus the kit – I ventured into my workshop, armed with an Antex soldering kit in one hand, and the Electronize ignition kit in the other . . .

THE SYSTEM

The "Total Energy Discharge" electronic ignition system is designed to give your car "easier starting, peak performance and improved economy". Based on proved capacitive discharge systems, the unit from Electronize is claimed to give 3½ times the energy of ordinary capacitive systems, and 3½ times the power of inductive systems. These benefits are combined with a spark three times the duration of ordinary capacitive systems, said to be essential for modern cars with weak fuel mixtures.

The resulting benefits are claimed to include higher output voltage under all conditions (and full ignition power even with a flat battery), improved economy through "no loss" of ignition performance between services, accurate timing and reduced contact wear/arcing, plus smoother performance, immune to contact bounce and similar effects.

The system has a built-in ignition timing light, and is suitable for all six and 12 volt negative earth vehicles, with engines of up to eight cylinders. Another useful feature is that, should the need arise, the system can be switched back to "conventional" ignition operation.

THE KIT

So much for the benefits, but first the kit must be assembled and fitted! Prior to assembling anything it pays to spend some time studying the instructions, and in the case of the Electronize kit, it has to be said that these are, in most respects, excellent. They include brief but useful hints on soldering and component identification, before describing in detail how the kit should be assembled. Clear diagrams are included at each stage, and a detailed and unmistakable "overall view" diagram shows the relative positions of each component on the printed circuit board.

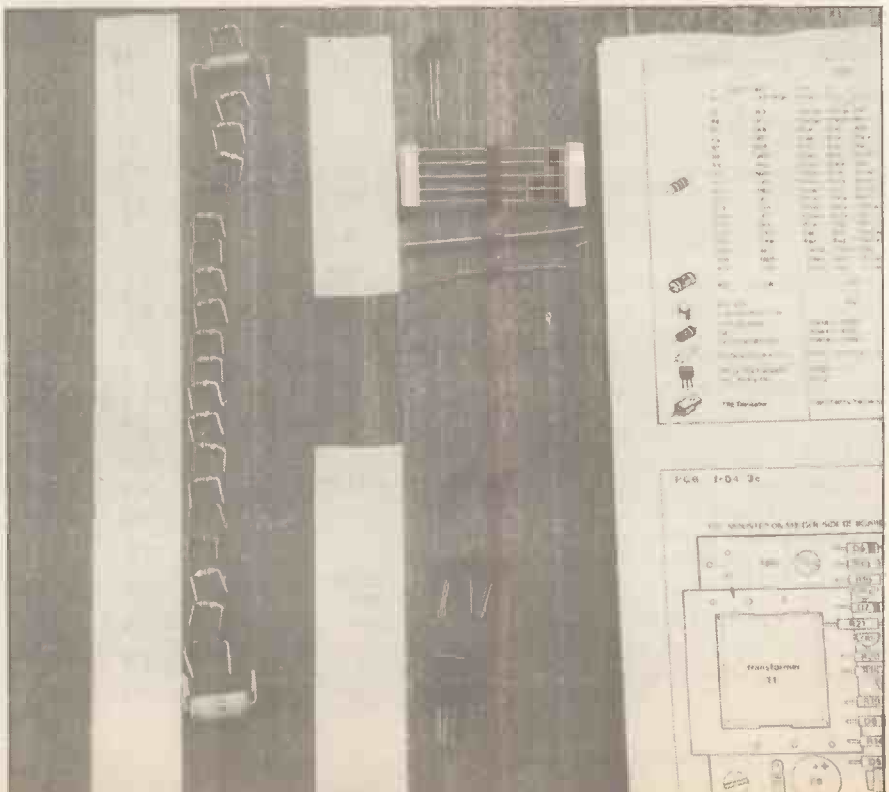
Having studied the instructions, I found it helpful to identify each of the resistors, diodes, transistors and other components by reference to the parts list provided, laying out all the parts, in order, on the bench. To make quite sure that I didn't confuse any of the components, I simply stuck lengths of masking tape to the bench, adjacent to the parts, and labelled them in sequence, on the tape – for example, resistors R1, R2, and so on. Of course it is a good idea to keep children and pets away from the working area, if possible, until the job is completed.

The kit contains *all* the necessary materials, including the electronic components, p.c.b., solder, heat sink compound, connecting leads, connectors and all the fixing screws required. This is most welcome, and a pleasant change from many car accessories I have fitted in the past, where items such as connectors and wiring are often omitted, or supplied in insufficient quantity.

ASSEMBLY

With all the parts checked and "labelled", assembly work could commence, using the solder supplied in the kit, and a soldering iron with a small 2mm bit. Electronize advise dealing with all the resistors first, and they describe in

The first step was to identify all the components, by reference to the detailed parts list supplied. I then laid out all the parts in order, on the bench, adjacent to lengths of masking tape, suitably labelled.



detail how the leads should be bent through 90 degrees and threaded through the p.c.b. in turn, prior to soldering.

Carefully heating the component lead and "floating" in the solder to each joint seemed strange at first (I am more used to welding motor car bodywork), but after a few joints, the job became easier. I took a great deal of care to get the soldering just right, and within a surprisingly short space of time, my stock of resistors had been reduced to zero, while my p.c.b. was beginning to look a little less bare. As each resistor was attached to the board, I snipped off the protruding wires, as described in the instructions, while double-checking that the soldered joints were smooth, and shiny in appearance.

During construction work, I found that it was often useful to rest the p.c.b. on two small wooden blocks, while soldering was being effected.

Having successfully attached all the resistors, I turned my attention to the diodes, once again following the Electronize instructions to the letter. The diodes too were far easier to deal with than I had imagined, and I was really beginning to enjoy the project!

Needless to say, pride comes before a fall and it was just when I was congratulating myself on my efforts thus far when I made a pretty fair attempt at setting fire to my thumb with the soldering iron. Duly warned, I redoubled my concentration, and turned my attention to the next stage – fixing the transistors and transformer in position, followed by the main switch (it can be soldered in place either way round, incidentally), the chokes and the capacitors.

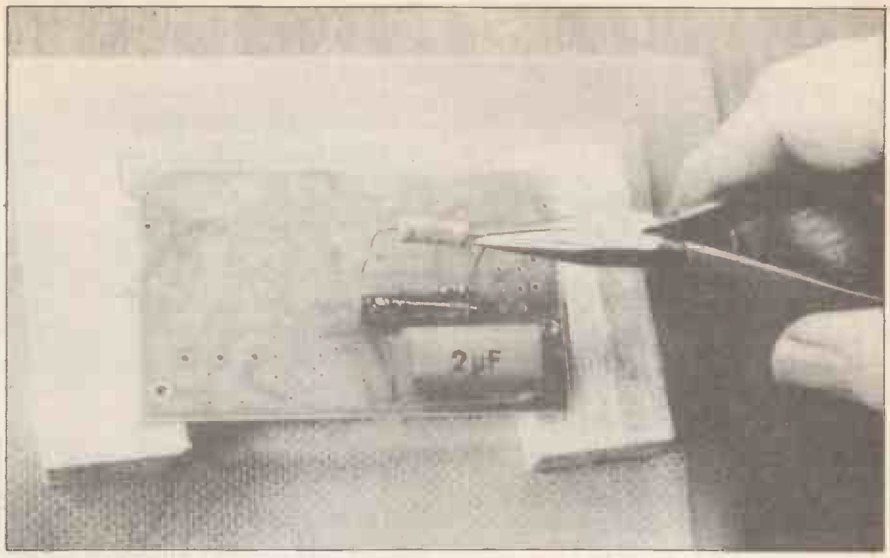
These duly fitted, I then attached the thyristor and the light emitting diode (which forms the timing light). It is of course important that the l.e.d. is fitted the correct way round, with its cutout facing the switch side of the board.

The output leads were then soldered to the unit, after stripping a short length of the insulation from each of the coloured leads in turn.

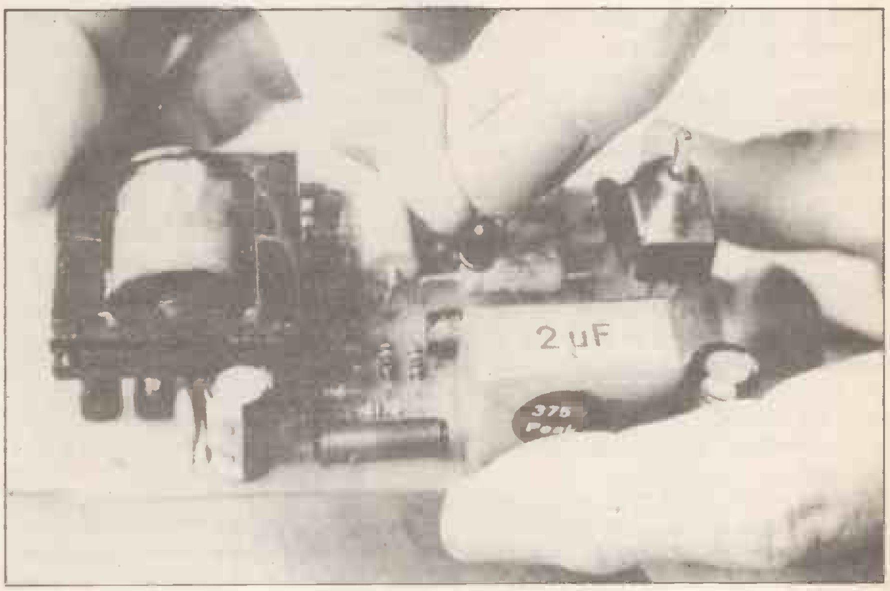
One of the trickiest parts of the whole operation is in attaching the power transistor to the board, due to the fact that its three connector leads have to be threaded very delicately through the p.c.b., while ensuring that it can be attached to the board with the screw, bush and spacer provided. The screw, once in position, must be tightened before the leads are soldered in place. Once again, though, this sounded more complicated than it actually was, and the job was soon accomplished.

CHECKS

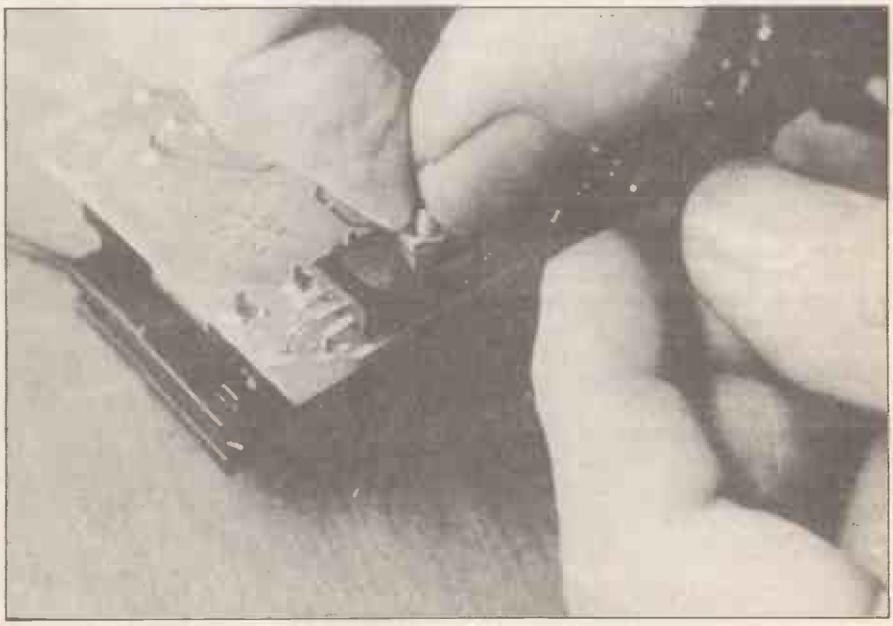
At this stage, Electronize advise you to inspect the board to ensure that all the components are correctly positioned, that all the leads have been correctly soldered, and that no fragments of solder are bridging adjacent tracks on the p.c.b. They also advise you to check that each of the leads have been trimmed so that they



Each of the components can then be carefully "fed" into position through the p.c.b., prior to soldering. I found it helpful to rest the p.c.b. on two small wooden blocks.



Before too long, the circuitry was almost complete; fitting the l.e.d. for the timing light required great care.



Probably the trickiest part of the whole operation was fitting the power transistor, since its three leads had to be bent very precisely before passing them through the p.c.b. The attachment screw and nut are tightened "finger-tight" prior to soldering the leads in position.

protrude by less than 3mm above the face of the p.c.b.

To check that the components had been soldered in their correct positions, I found it helpful for my father to call out the numbers of each component in turn, in "rows", from the main component diagram. Thankfully all seemed well, so the p.c.b. was wiped with a cloth dampened with methylated spirits (to remove solder flux) and I then painted the p.c.b. with polyurethane varnish, as advised by Electronize, to protect it from moisture when fitted to the car.

The next day, I applied heat sink compound (supplied with the kit) to the power transistor and its mica washer, and attached the p.c.b. to the baseplate (heatsink plate) of the unit. The case of the ignition unit can then be fitted and screwed home, making sure that the main switch and the l.e.d. (timing light) protrude through the case in the right places.

With the kit assembled, fitting is very straightforward, using the three self-tapping screws supplied. The unit is easily wired into the ignition circuit.

INSTALLATION

It remains to fit the assembled ignition system to the car. Once again, the installation instructions provided by Electronize are excellent. They are clear, unambiguous and well illustrated with diagrams. Installation is straightforward, since all the necessary connectors are provided.

The first step is to find a convenient site within the engine bay, in which to house the ignition unit. As far as possible, this should be away from exhaust pipe/-manifold heat, and also away from areas which are prone to vibration, or in the line of fire from road spray thrown up by the front wheels, for example.

Having chosen the site, three 3mm holes need to be drilled, for the unit to be attached with the self-tapping screws provided. I first marked the position of each hole in the unit's baseplate, against the engine bay "wall", using a long scriber, before centre-punching and drilling each hole. It is a good idea to grease the fixing screws; it helps when attaching the screws, and makes for easier removal, if ever required.

The four leads from the unit can then be shortened (if desired) before attaching the relevant crimp/solder type connectors (all supplied) and connecting them into the car's ignition circuits. I varied the Electronize instructions slightly at this point . . . Rather than attaching the red lead to the ignition coil's existing "positive" lead, using a "tap-in" ("Scotchlok" type) connector provided, I chose to use a "piggy back" crimp-on connector, so that the ignition unit can simply be "unplugged" when necessary – for future transfer to another vehicle, for example.

With the unit connected, the ignition was switched on and, hey presto, it worked perfectly!

CONCLUSIONS

Building the Electronze ignition system was the first such project I had ever undertaken, and I found it to be a straightforward and fascinating operation, courtesy of the delightfully clear instructions provided. I certainly intend to tackle similar projects in the future, now my appetite has been whetted.

The Electronize Total Energy Discharge ignition system costs £17.95 in kit form, or £23.90, ready to fit. p. and p. adds £1 to these prices, which include VAT. **Electronize Design are at Dept. EE, 2 Hillside Road, Four Oaks, Sutton Coldfield, West Midlands B74 4DQ,** ***(021) 308 5877***

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EE MARKET PLA
DEC '87

Robot Roundup

NIGEL CLARK

ROBOT CAVE

With Christmas fast approaching robot toys are again attracting a lot of interest as good presents. Toy robots in one form or another have always been popular ever since the idea of a mechanical servant was first conceived.

They used to be limited to metal models with clockwork providing the only form of mobility. These days with the use of the microchip their range of abilities has been greatly expanded to include a rudimentary form of programming, with a toy being able to remember complex routines of movements, and the enhancement of sensors and speech.

Some manufacturers and importers found the market a little disappointing last year but it has not stopped retailers from preparing to sell large numbers for Christmas stockings in 1987. Anyone who visits London for some crowded shopping will be able to drop into Harrods where the toy department has created a special robot cave with a large radio-controlled robot directing people towards it.

That robot, usually used for advertising and promotional work, is being sold at £12,000 but less expensive items can be bought in the cave with the maximum price about £180.

Many of the toys on offer are little more than dolls, most following the traditional mechanical-human image of the robot, with or without some form of simple movement and flashing eyes. They are relatively cheap but have little in common with what this column usually considers to be a robotic device.

However, there are still a number of items which while not satisfying everyone's idea of what a robot should be nevertheless can perform quite complex tasks and manoeuvres. A number of last year's favourites are still around, including *Omnibot 200*, *Omni Junior*, *Armstrong* and the *Petster* range. All come from the States and most are made by Tomy, which entered the toy end of the robot market earlier than most.

Top of the Tomy range is the *Omnibot* selling for about £180. It is radio-controlled and can be programmed to remember a routine which can also be stored on cassette. It has a small simple, spring-loaded gripper and can play all kinds of cassettes as well as speak.

As might be guessed, *Omni Junior* is a simpler version but can still appear complex with a given set of responses to a variety of situations. For example, when its right arm is pushed down to give the idea of a handshake it says, "I'm Omni Junior". It also has a bump sensor and when it hits something it will reverse and turn left, giving the impression that it can find its way around.

Armstrong is a mobile articulated arm which can be programmed through an infra-red link.

Petsters are the latest brainchild of Nola Bushnell, who tried to persuade the world that though robots did not have to do anything useful it would be a good idea to buy one even though they cost almost £1,000. Having failed with that he has had more success with the furry mechanical cats, hamsters and bears that make up the *Petsters*. On the same lines as the *Omni Junior*, they speak with a limited number of responses and have bump and object sensors.

Tomy Toys has increased its range this year with a variety of cheaper, less sophisticated devices on the lines of the earlier *Dingbot*, which responded to handclaps, rushing around in no particular direction.

WEIRD AND WONDERFUL

Another company which has been in the market for some time is **Milton Bradley**. It originally supplied the *Big Trak* but that was withdrawn some time ago and now the company concentrates on its series of *Robotix* kits. They are more toys than robots but I have mentioned these as, although they do not allow routines to be remembered, they do involve concepts of motorised movement and gearing.

They began in 1985 with a series of three kits which made various "hi-tech" figures with names like *Commander X* and *Dr Steel*. They were powered by simple motors and controlled by a battery-powered console of five switches. There were also extra pieces which allowed a limited amount of variation.

Last year, following the same formula, they added a set of weird and wonderful vehicles and a stronger motor. And this year there has been further expansion.

The range includes a simple winch called *Tork*, a bulldozer called *Trax* and other complicated mobiles. The prices are in the range up to about £80. There are other kits which, though intended for more serious use, with sophisticated models being possible, they are still not very expensive and could make a good present.

One of the first manufacturers on the scene with its robotics or computing sets was **Fischertechnik**. The original kit allowed ten different models to be built including a two axis arm with feedback provided by potentiometers and a simpler arm which played the Towers of Hanoi game.

A number of interfaces were developed for the sets to allow them to be controlled by the BBC B. This range was increased earlier this year with the introduction of a kit to make a more complex arm and an X - Y plotter, using more powerful motors.

Lego entered the market later, having researched the subject in detail before deciding to follow Fischer. Its first device was a simple buggy followed later by an arm and X - Y plotter. These can be controlled by battery-powered, hand-held controllers or by a computer with the help of an interface.

More recently **Meccano** launched its own sets for making robotic devices. However, unlike the others it only supplied the necessary parts leaving the design to individual tastes.

So you can see, it is possible to gain an insight into the world of robotics without having to spend a lot of money.

Part of the Petster Toy Range from Tomy.

a regular feature for the Spectrum Owner...

by Mike Tooley BA

LAST month we showed how the Z80-CTC Counter/Timer Interface described in October's *EE* can be used as a programmable timer. This month, as promised, we shall be looking at another application for the Z80-CTC in the form of a programmable event counter.

We shall also be dealing with a number of queries recently raised by readers. We begin, however, with a useful programming tool supplied by John Wall of Newcastle upon Tyne.

Keeping track of your Variables

John Wall's program (appropriately called VARS) is a routine for identifying and listing BASIC variables in RAM. The routine requires about 800 bytes of storage and is designed to be MERGEd with programs and used as a tool during software development.

The program lines have been numbered from 9900 to 9929 but readers can change these to conform with any valid line numbering convention. John has supplied lines 10 to 80 for demonstration purposes; they should *NOT* be included when the routine is MERGEd!

The main routine starts at line 9900. This effectively jumps from one variable to the next in the reserved area of RAM between VARS and E_LINE. The remaining lines are primarily concerned with PRINTing the variables on the screen.

```
10 LET sparrow = 25
20 DIM a$(10,20,2)
30 LET A = 42
40 DIM g(32)
50 LET x$ = "hello"
60 FOR i = 1 TO 20 NEXT i
70 GO SUB 9900
80 STOP
9900 CLS: LET ad = PEEK VAL "23627" + VAL "256"*PEEK VAL "23628"
9901 LET type = INT(PEEK ad/VAL "32"): IF PEEK ad = VAL "161" AND PEEK (ad + 1) = VAL "228" THEN PRINT ' "________variables used by routine________": PRINT
9902 LET y$ = CHR$(PEEK ad-VAL "32"*(type-VAL "3")): PRINT ad; " ";: GO SUB VAL "9898" + type*VAL "4"
9903 IF ad + VAL "1" = PEEK "23641" + VAL "256"*PEEK VAL "23642" THEN PRINT ' ' "list complete": RETURN
9904 GO TO VAL "9901"
9906 GO SUB VAL "9929"
9907 PRINT "string",y$;"$": RETURN
9910 LET ad = ad + VAL "6"
9911 PRINT "1 letter",y$: RETURN
9914 PRINT "num array",y$;"(";: GO SUB VAL "9928": RETURN
9918 LET ad = ad + VAL "1": IF PEEK ad> = VAL "128" THEN LET y$ = y$ + CHR$(PEEK ad-VAL "128"): GO TO VAL "9921"
9919 LET y$ = y$ + CHR$ PEEK ad: GO TO VAL "9918"
9921 PRINT "number",y$: LET ad = ad + VAL "6": RETURN
9922 PRINT "str array",y$;"$(";: GO SUB VAL "9928": RETURN
9926 LET ad = ad + VAL "19"
9927 PRINT "control",y$: RETURN
9928 LET y$ = "": FOR n = VAL "1" TO PEEK (ad + VAL "3"): LET y$ = y$ + STR$ PEEK(ad + VAL "2" + n*VAL "2") + ",": NEXT n: LET y$(LEN y$) = ")": PRINT y$
9929 LET ad = ad + PEEK (ad + VAL "1") + PEEK (ad + VAL "2")*VAL "256" + VAL "3": RETURN
```

Using the VARS routine

Having entered John's program it is worth experimenting with the variables used in lines 10 to 60 and, at each stage, running the program and noting the effects produced. The display will distinguish between the variables used in the main program and those contained within the VARS sub-routine.

Readers should find that the numeric variables (single letter, multi-letter and control) always remain in the same relative places and simple strings invariably go to the bottom of the list when they are redefined. Arrays should remain where they are when one or more elements are changed but move to the bottom of the list when redimensioned!

The nature of a variable may be changed by POKEing the appropriate information into the variable list. For example, x$ can be changed to w$ by:

POKE address, 87

where 'address' is the address at which x$ is stored and 87 is the decimal ASCII code for the letter 'w'.

This technique can be used to change several string variables to w$ and John suggests that you might like to do this and afterwards astound your friends by typing in a line of the form:

LET w$ = "abc": PRINT w$

The Spectrum will oblige by printing the wrong answer!

String arrays can be changed to a simple string by typing:

POKE address, PEEK address − 128

The information in the string will be nonsense but can be corrected by statements of the form:

LET w$ = ""

Changing fixed length variables to strings is a little more difficult as the string information has to be reconstructed. As an example, to change 'sparrow' it will be necessary to use a line of the form:

POKE address, 87 : POKE address + 1, 9 : POKE address + 2, 0

Again, the value 87 makes the variable into w$. The values 9 and 0 construct the two bytes which determine the length of the variable area.

In this case it is 7 for 'sparrow' plus 5 for the exponent and mantissa, minus 3 for the first three bytes of a simple string. This gives; 7 + 5 − 3 = 9. For a different variable the 9 would have to be replaced by (length of variable name) plus 2.

Deleting a Variable

It is also possible to get rid of a variable (though not one used by the VARS routine itself!). The method involves first changing the variable to w$ (as described earlier) then moving it to the bottom of the variable list (just above y$). This can be achieved by assigning a null string to w$ using a statement of the form:

LET w$ = ""

The null string w$ may now be combined with y$. This can be done by making w$ into y$ and adjusting its length to absorb the final y$ using a line of the form:

POKE address, 89 : POKE address + 1, 4 : POKE address + 2, 0

The value 89 represents 'y' and the 4 denotes the four bytes of the final y$. If the subroutine is executed (using GO SUB 9900), the reference to w$ will have disappeared!

How it Works

John has provided the following information for those who would like to know how the VARS routine works. To quote from his letter:

"The different types of variable are distinguished by the three most significant bits of the first byte. For instance, a number array has 100 binary (128 decimal) in these positions.

It is these bits which denote how far to jump to the next variable (line 9901). I have given a type number (below) to each variable based on these three bits. The first byte can be calculated by adding 1 to 26 (representing the letter) to the type number multiplied by 32.

(a) Simple string – type number 2.

The first byte will be between 65 and 90. The next two bytes give the number of characters in the string. This is the information given by LEN x$. The total length of the area is this number plus three.

(b) Single letter numeric variable – type number 3.

The first byte will be between 97 and 122. No information on the length of this area is needed as it is always six bytes long; one for the letter, one for the exponent and four for the mantissa of the number.

(c) Numeric array – type number 4.

These are the longest and most complicated of the variable areas. The second and third bytes give the total length of the variable area less three. The next few bytes give information about the number of dimensions and the value of each.

This information is used at line 9928 to print out details of the array variable. Notice that five bytes are needed for each element of the array. If memory is a problem (as it is with my program) and your needs are only for numbers up to 255, then it is better to use strings.

(d) Numeric variable with name comprising more than one letter – type number 5.

The area needed for these is the length of the name plus five bytes. The last byte of the name has 128 added to it so we know when the exponent and mantissa information is about to begin.

(e) Character array – type number 6.

These are very similar to numeric arrays except that only one byte is needed for each element of the array.

(f) Control variable – type number 7.

Control variables are used in FOR ... NEXT loops and the variable area contains corresponding information. Nineteen bytes are used for each control variable."

John concludes his letter with an interesting point:

"Two types numbers are not used; 0 and 1. Why didn't Uncle Clive use them to allow Spectrum users to have string names of more than one letter?"

Programmable Event Counter

In order to operate one of the Z80-CTC

channels as a counter, bit 6 in the appropriate channel control register must be set and a Time Constant Data Word must be loaded into the Time Constant Register. Thereafter, the CTC counts edges of the CLK/TRG input and, after each edge (and synchronous with the rising edge of the clock) the CTC's down counter is decremented. Bit 4 of the channel control register allows selection of either a rising or falling edge trigger.

In CTC Channels 0, 1, and 2, the zero count (ZC/TO) output is pulsed high when the down-counter reaches zero. Unfortunately Channel 3 does not have this facility and is thus not suitable for use in applications which require the generation of a zero count pulse.

If bit 7 of the Channel Control Register has been set, the zero count condition will also drive the interrupt (INT) pin low. The Z80-CTC is thus able to generate an interrupt request and gain the attention of the CPU at the end of a down counting sequence.

The down counter is automatically reloaded with the Time Constant Data Word when the zero count condition is reached. This time constant is held in the Time Constant Register.

It is important to note that there is no interruption in the sequence of down counting. If a new Time Constant Data Word is written to the Time Constant Register while the down counter is decrementing, the present count is completed before the new time constant is loaded into the down counter.

The basic arrangement used for event counting on Channel 0 is shown in Fig. 1. The input signal must have TTL compatible levels and, where conventional switches are employed they should be debounced to prevent counting spurious pulses. The output signal is a narrow positive-going pulse generated when the preset number of events has been reached.

In many applications (i.e. simple event counting) we may only require that the number of events detected be assigned to a variable and/or displayed on the screen. In other applications, we may wish to put the zero count pulse to some use.

If the pulse is too narrow for certain applications (e.g. driving an l.e.d. via a buffer) it will be necessary to incorporate a monostable pulse stretching circuit. Alternatively, the pulse may be used to trigger a 555 timer (operating from a +5V supply rail).

The following BASIC program can be used to test the arrangement shown in Fig. 1:

```
10 OUT 31, BIN 01011101
20 OUT 31, 99
30 PRINT AT 0,0; IN 31;"
40 GO TO 30
```

In line 10, the Channel 0 Control Register is loaded with the Channel Control Word,

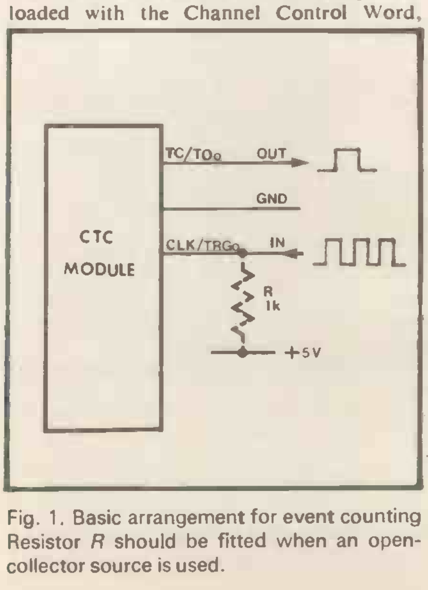

Fig. 1. Basic arrangement for event counting Resistor *R* should be fitted when an open-collector source is used.

01011101. It is briefly worth examining the function of each bit in this word:

Bit 7 – set to 0 in order to disable generation of interrupts (more on this topic next month)
Bit 6 – set to 1 to select Counter Mode
Bit 5 – set to 0 (but only valid for Timer Mode)
Bit 4 – set to 1 to select decrementing of the down counter on positive edges (a 0 in this bit position selects negative edge decrementation)
Bit 3 – set to 1 (but only valid for Timer Mode)
Bit 2 – set to 1 to indicate that the next word written to the channel will be a Time Constant Data Word
Bit 1 – set to 1 to reset the channel. Operation will resume when the Time Constant Data Word is loaded
Bit 0 – set to 1 to indicate a Control Word (a 0 in this bit position indicates an Interrupt Vector Word)

Line 20 sets the time constant data word to 99 (note that we have used decimal here rather than binary!). Hence we shall be counting a total of 100 events before the zero count pulse appears. Line 30 prints the current value held within the down counter at the top left-hand corner of the screen, whilst line 40 redirects control to line 30 in an infinite loop (press BREAK to escape).

In operation, the display on the screen counts down from 99 to 0 as each rising edge pulse is detected. In practice, we might wish to count up (rather than down) and allow the program to prompt us for the number of events to count before starting another cycle.

The following program shows how this can be achieved:

```
10 REM Prompt user for the number of events to count
20 INPUT "Number of events to count ";events
30 IF events<2 OR events>255 THEN BEEP 0.1, 0.1: GO TO 20
40 REM Initialise Channel 0 as an event counter
50 OUT 31, BIN 01011101
60 OUT 31, events
70 REM Loop forever getting and displaying events
80 PRINT AT 0,0;"Events ";events - IN 31 + 1;" "
90 GO TO 80
```

Purists will probably be somewhat dismayed by the lack of structure in the foregoing program. It does, however, serve to illustrate the ease with which programs can be produced to make use of the Z80-CTC as an event counter!

Points from the Post

Over the past few months my "*In-Tray*" has been overloaded with readers' queries. Most can be dealt with fairly easily but some readers raise specific problems (such as compatibility of add-on hardware) on which I find it impossible to supply any meaningful advice.

In the hope that someone out there can offer some suggestions, here is a selection of outstanding queries:

Greg Ziegler writes from New South Wales and mentions a problem getting Ocean's Laser Genius to provide hard copy in conjunction with an Interface One printer. Greg has also tried to make use of a Disciple Centronics port without success. Can anyone suggest a patch to cope with this!

R. Wilkes of Blackpool has found a source of inexpensive 3in. drives advertised by J. and N. Bull Electrical and wonders whether anyone has produced a "no frills" controller for such a device.

Since this would make a future *On Spec* project, I would be pleased to hear from anyone who can supply information along these lines.

D. O'Brien writes from Oldham to ask if anyone can supply information concerning use of the Amstrad DMP2000 in conjunction with the Opus Discovery drive. This topic will undoubtedly be of interest to a number of readers as the Amstrad series of printers is becoming increasingly popular.

F. Buddle from Sheerness, Kent, requires a means of producing User Defined Graphics for printed circuit board layouts. Since p.c.b. design usually requires a large number of pre-defined shapes, I suspect that the main problem here is the limited number of UDGs available.

If anyone can throw any light on this problem (or has developed a set of UDGs for p.c.b. design) I would be pleased to hear from them – this could be another useful topic for a future *On Spec*.

Last, but by no means least, *Leslie Hume* is searching for information relating to Spectrum Networking. If you can suggest books or articles on this esoteric subject please let me know!

Post Mortem?

Finally, I regularly receive requests from readers wishing to receive copies of our *Update*. Unfortunately, some of these requests fail to produce the desired result for a variety of reasons.

Most readers require the entire set of *Update* sheets (now totalling over 20) but include minimal postage and/or inadequate envelopes for their return. At first and second class UK postage rates respectively, the complete *Update* requires 40p and 34p stamps.

The cost within Europe is generally about 80p whilst to South Africa, New Zealand and Australia the Air Mail postage rises to a staggering £2.50. A single page sent to the same countries costs as little as 34p hence overseas readers may wish to be a little more selective over what they wish to receive. In the absence of any specific instructions, I usually try to cram in whatever I can (up to the limit of the postage supplied or the size of the envelope!).

If you would like a copy of our *On Spec Update*, please drop me a line enclosing a large (at least 250mm × 300mm!) stamped addressed envelope.

Mike Tooley, Department of Technology, Brooklands Technical College, Heath Road, Weybridge, Surrey, KT13 8TT.

Next month: We shall be reviewing Picturesque's Code Machine and attempting to dispell some of the mystery concerning interrupts.

NEWS

. . . from the world of electronics

SKYPHONE SET FOR TAKE OFF

Experimental 'in-flight' card phone

The final countdown has started for British Telecom's Skyphone with the award of a £2.6M contract for the equipment which will automatically connect airline passengers' telephone calls to friends, relations and business customers on the ground. The contract, with EB Communications, means that BT International has now completed the purchasing of all the major equipment and software required for the in-flight Skyphone system.

The contract represents a first for BTI, because the equipment will be the first designed to meet the full *INMARSAT* aeronautical standards for ground earth stations. It will be installed at BTI's satellite earth station at Goonhilly Downs in Cornwall.

Together with telecommunications authorities in Norway and Singapore, BTI are working towards providing global coverage for the "phones on planes" service. Apart from a dedicated earth station at Goonhilly Down, similar earth station facilities will be provided in Norway and Singapore.

The system is currently being developed and tested under a collaborative agreement between BTI, Racal and British Airways. It is hoped that trials of the new service, with calls connected by the operator, will begin next April on three British Airways 747 airliners, allowing passengers to make international telephone calls during flight.

The aircraft avionics equipment for Skyphone is already at an advanced stage of development by manufacturers under *INMARSAT* funding. A special antenna mounted on the aircraft transmits the signals to the *INMARSAT* satellite, where they are downlinked to the earth station, then automatically switched to the public telephone network.

The specially designed access control and signalling equipment will include 9.6Kbit/s voice coding devices and call control and itemisation software.

When fully operational, the service will allow passengers to make their own telephone calls from aircraft, paying by credit card only. It will also offer telephone and data message facilities for airline operations. The cost of calls is not yet finalised.

Passengers will be able to use push-button telephones mounted on the aircraft walls or on seat-backs. Initially, the system will not be able to handle incoming calls.

The operations room at Goonhilly Down responsible for the transmission of satellite signals will also be responsible for the in-flight telephone service, via Aerial 7 (inset), during Skyphone trials.

East-West Summit

An historic meeting of leading figures from the record industries of Eastern and Western Europe took place recently.

Executives from 20 member countries of the EEC, EFTA and Comecon meet to discuss key topics of mutual concern. These included the problems of widespread private copying or home taping of recorded music and the possibility of its escalation through the use of Digital Audio Tape (DAT) machines.

At the meeting it was announced that recording companies from the USSR, Bulgaria and Poland would be applying for membership of the International Federation of Phonogram and Videogram Producers.

PCB SERVICE

Printed circuit boards for certain constructional projects (up to two years old) 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* Editorial Offices, 6 Church Street, Wimborne, Dorset BH21 1JH. Cheques should be crossed and made payable to *Everyday Electronics. (Payment in £ sterling only.)*

Please note that when ordering it is important to give project title as well as order code. Please print name and address in Block Caps. **Do not send any other correspondence with your order.**

Readers are advised to check with prices appearing in the current issue before ordering.

NOTE: Please allow 28 days for delivery. We can only supply boards listed in the latest issue. Boards can only be supplied by mail order and on a payment with order basis.

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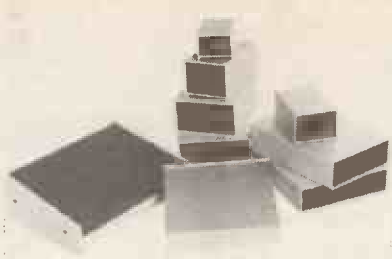

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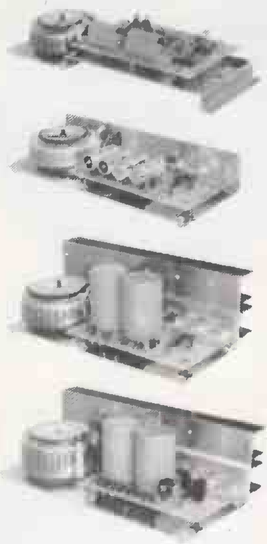

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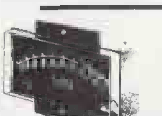

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1" voice coil. Res. Freq. 56Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £10.99 + £1.50 P&P ea.

8" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1¼" voice coil. Res. Freq. 38Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £12.99 + £1.50 P&P ea.

10" 60 WATT R.M.S. Hi-Fi/Disco etc.
1¼" voice coil. Res. Freq. 35Hz. Freq. Resp. to 15KHz. Sens. 89dB. PRICE £16.49 + £2.00 P&P

PANTEC HOBBY KITS.

Proven designs including glass fibre printed circuit board and high quality components complete with instructions.

FM MICROTRANSMITTER (BUG) 90/105MHz with very sensitive microphone. Range 100/300 metres. 57 × 46 × 14mm (9 volt) **Price: £8.62 + 75p P&P.**

3 WATT FM TRANSMITTER 3 WATT 85/115MHz varicap controlled professional performance. Range up to 3 miles 35 × 84 × 12mm (12 volt) **Price: £14.49 + 75p P&P.**

SINGLE CHANNEL RADIO CONTROLLED TRANSMITTER/RECEIVER 27MHz. Range up to 500 metres. Double coded modulation. Receiver output operates relay with 2amp/240 volt contacts. Ideal for many applications. Receiver 90 × 70 × 22mm (9/12 volt). **Price: £17.82** Transmitter 80 × 50 × 15mm (9/12 volt). **Price: £11.29** P&P + 75p each. S.A.E. for complete list.

3 watt FM Transmitter

VISA

POSTAL CHARGES PER ORDER £1.00 minimum. OFFICIAL ORDERS WELCOME, SCHOOLS, COLLEGES, GOVERNMENT BODIES, ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER VISA/ACCESS/C.O.D. ACCEPTED

Access

BURGLAR ALARM

Better to be 'Alarmed' then terrified.
Thandar's famous 'Minder' Burglar Alarm System. Superior microwave principle. Supplied as three units, complete with interconnection cable. **FULLY GUARANTEED.**

IDEAL for Workshops, Factories, Offices, Home, etc. Supplied ready built.

Control Unit — Houses microwave radar unit, range up to 15 metres adjustable by sensitivity control. Three position, key operated facia switch — off — test — armed. 30 second exit and entry delay.
Indoor alarm — Electronic swept freq. siren. 104dB output.
Outdoor Alarm — Electronic swept freq. siren. 98dB output. Housed in a tamper-proof heavy duty metal case.
Both the control unit and outdoor alarm contain rechargeable batteries which provide full protection during mains failure. Power requirement 200/260 Volt AC 50/60Hz. Expandable with door sensors, panic buttons etc. Complete with instructions.

SAVE £138.00 Usual Price £228.85

BKE's PRICE £89.99 + £4.00 P&P

? Why buy a collection of self-assembly boards!

OMP LINNET LOUDSPEAKERS

The very best in quality and value. Made specially to suit todays need for compactness with high sound output levels. Finished in hard wearing black vynide with protective corners, grille and carry handle. All models 8 ohms. Full range 45Hz - 20KHz. Size 20" × 15" × 12". Watts R.M.S. per cabinet. Sensitivity 1W. 1mtr. dB.

OMP 12-100 Watts 100dB. Price £149.99 per pair.
OMP 12-200 Watts 102dB. Price £199.99 per pair. Delivery: Securicor £8.00 per pair

OMP 19" STEREO RACK AMPS

Professional 19" cased Mos-Fet stereo amps. Used the World over in clubs, pubs, discos etc. With twin Vu meters, twin toroidal power supplies, XLR connections. MF600 Fan cooled. **Three models** (Ratings R.M.S. into 4ohms). Input Sensitivity 775mV

MF200 (100 + 100)W.	£171.35	Securicor
MF400 (200 + 200)W.	£228.85	Delivery
MF600 (300 + 300)W.	£322.00	£10.00

1 K-WATT SLIDE DIMMER

- * Control loads up to 1Kw
- * Compact Size 4⅗" × 1" × 2½"
- * Easy snap in fixing through panel/cabinet cut out
- * Insulated plastic case
- * Full wave control using 8 amp triac
- * Conforms to BS800
- * Suitable for both resistance and inductive loads. Innumerable applications in industry, the home, and disco's, theatres etc.

PRICE £13.99 + 75p P&P

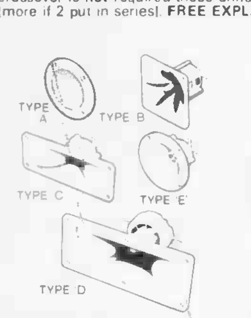
BSR P295 ELECTRONIC TURNTABLE

* Electronic speed control 45 & 33⅓ r.p.m. * Plus Minus variable pitch control * Belt driven * Aluminium platter with strobed rim * Cue lever * Anti-skate (bias device) * Adjustable counter balance * Manual arm * Standard ½" cartrige fixings * Supplied complete with cut out template * D.C. Operation 9-14v D.C. 65mA
Price £36.99 — £3.00 P&P.

ADC Q4 mag. cartridge for above. **Price £4.99 ea.** P&P 50p

PIEZO ELECTRIC TWEETERS MOTOROLA

Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.90 each** + 40p P&P.

TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £5.99 each** + 40p P&P.

TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £6.99 each** + 40p P&P.

TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £9.99 each** + 40p P&P.

TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £5.99 each** + 40p P&P.

LEVEL CONTROL Combines on a recessed mounting plate, level control and cabinet input jack socket. 85 × 85 mm. **Price £3.99** + 40p P&P.

STEREO DISCO MIXER

STEREO DISCO MIXER with 2 × 5 band L. & R. graphic equalisers and twin 10 segment L.E.D. Vu Meters. Many outstanding features 5 Inputs with individual faders providing a useful combination of the following:—
3 Turntables (Mag), 3 Mics, 4 Line plus Mic with talk over switch. Headphone Monitor. Pan Pot. L. & R. Master Output controls. Output 775mV. Size 360 × 280 × 90mm.
Price £134.99 — £3.00 P&P

B. K. ELECTRONICS

UNIT 5, COMET WAY, SOUTHEND-ON-SEA, ESSEX. SS2 6TR TEL: 0702-527572

EVERYDAY ELECTRONICS DECEMBER 1987

1988

RTVC

TWEETERS – 40W

AUDAX **TW10A**

Chassis dimensions	Fixing centres
A 64×90mm	74×48mm
B 80×80mm	4–76mm PCD
C 74mm diameter	3–60mm PCD
D 50×50mm	42×42mm

Impedance	8 ohms
Power maximum	40W @ 5kHz
Frequency response	2.5kHz–25kHz
Resonant frequency	2.9kHz
Output SPL	91db
Coil diameter	10.5mm
Overall weight	55g

FERROFLUID DOME TWEETERS

State of the art advanced technology miniature hi-fi horn loaded tweeter has excellent dispersion and response. Supplied with a first order crossover 2.2uF–4.7uF non-polarised capacitor.

Order Code 001A, B, C or D **£4.85+50p p&p**

CONE TWEETERS

Nom. 5W
Max. 40W
(System)
Imp. 4 ohms

PHILIPS

Chassis size	66×66×23mm
Fixing centres	54×54mm
Weight	100g

Order Code 002A **£3.59+50p p&p**

Nom. 18W
Max. 54W
(System)
Imp. 4 ohms

SANYO

Chassis size	62×62×25mm
Fixing centres	50×50mm
Weight	80g

Order Code 002B **£2.99+50p p&p**

Nom: 6W
Max. 40W
(System)
Imp. 8 ohms

RIGHT

Chassis size	78×30mm
Fixing centres	4 holes on 72mm PCD
Weight	180g

Order Code 002C **£2.59+50p p&p**

3½″×2½″ – 30W

EAGLE

Impedance	8 ohms
Power maximum	30W @ 5kHz
Frequency response	2.5kHz–18kHz
Coil diameter	25mm
Chassis dimensions	90×65mm
Fixing centres	75×50mm
Overall weight	350g

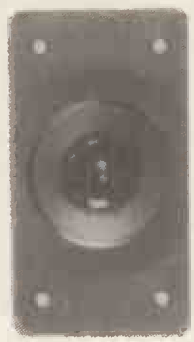
DOME TWEETER

All plastic black front plate, with silver hard dome centre.

Order Code 003 **£3.19+50p p&p**

2⅜″×4⅜″ – 60W

AUDAX **DW6×11**



Impedance	8 ohms
Power maximum	60W @ 5kHz
Frequency response	1.8kHz–19kHz
Resonant frequency	2.05kHz
Output SPL	95db
Coil diameter	14mm
Chassis dimensions	60×110mm
Fixing centres	40×80mm
Overall weight	85g

DOME TWEETER

A very high efficiency tweeter with ferrofluid cooled voice coil mated to a polymer cone.

Order Code 004 **£6.55+50p p&p**

4¾″×3½″ and 4″ – 60W

AUDAX **HD 100 D25**

Impedance	8 ohms
Power nominal	50W @ 5kHz
Power maximum	60W @ 5kHz
Frequency response	5kHz–22kHz
Resonant frequency	800Hz
Output SPL	89db
Coil diameter	25mm
Chassis dimensions – SQ	120×90mm
Fixing centres – SQ	100×60mm
Chassis dimensions – R	100mm dia.
Fixing centres – R	4 holes on 86mm PCD
Overall weight	530g

DOME TWEETERS

Soft polymer dome tweeter with high efficiency and high dispersion for hi-fi use.

Order Code 005SQ or 005R **SQ £9.90, R £7.90+£1.00 p&p**

3¾″ – 35V

MOTOROLA **KSN1038A**

Impedance	1,000 ohms @ 1kHz
Power nominal	16V (with res.)
Power maximum	35V (50W)
Frequency response	2kHz–30kHz
Output SPL	100db
Chassis dimensions	95 (dia.)×60mm
Fixing centres	4 holes on 85mm PCD
Overall weight	64g

PIEZO SUPER HORN TWEETER

No power or matching problems. Connect multiples in series for your power requirements.

Order Code 006 **£5.55+50p p&p**

RTVC

2″×6″ – 35V — MOTOROLA KSN 1025A

Impedance	450 ohms @ 1kHz
Power nominal	20V (with res.)
Power maximum	35V (100W)
Frequency response	2kHz – 30kHz
Output SPL	95db
Chassis dimensions	187×95×115mm
Fixing centres	6 holes 86 – 86×64mm
Overall weight	132g

PIEZO SUPER HORN TWEETER

No power or matching problems. Connect multiples in series for your power requirements.

Order Code 007 — **£9.25** + 65p p&p

3½×3½″ – 35V — MOTOROLA KSN1005A

Impedance	1,000 ohms @ 1kHz
Power nominal	16V (with res.)
Power maximum	35V (50W)
Frequency response	3kHz – 25kHz
Output SPL	100db
Chassis dimensions	85×85×74mm
Fixing centres	70×70mm
Overall weight	62g

PIEZO SUPER HORN TWEETER

No power or matching problems. Connect multiples in series for your power requirements.

Order Code 008 — **£5.35** + 50p p&p

10″×4″ – 45W — SOUNDLAB MHT392

Impedance	8 ohms
Power nominal	30W
Power maximum	45W
Frequency response	2kHz – 10kHz
Output SPL	110db
Chassis dimensions	267×107×159mm
Fixing centres	10 holes @ 60mm
Overall weight	440g

HIGH FREQUENCY HORN

Die cast metal wide dispersion horn. Black crackle finish.

Order Code 009 — **£15.95** + £2.50 p&p

5½″ – 150W — AUDAX/SIARE TWVZ

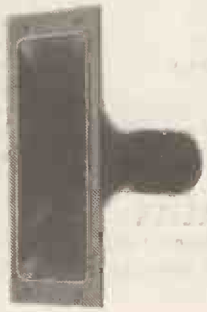
Impedance	8 ohms
Power maximum	150W @ 5kHz
Frequency response	1kHz – 22kHz
Resonant frequency	360Hz
Output SPL	94db
Coil diameter	25mm
Chassis dimensions	140×80mm
Fixing centres	104×50mm
Overall weight	2.2Kg

BULLET TWEETER

High efficiency, low resonance yellow fibreglass tweeter.

Order Code 010 — **£37.95** + £3.00 p&p

4″×9¼″ – 100W — SOUNDLAB 957100M



Impedance	8 ohms
Power nominal	50W
Power maximum	100W
Frequency response	800 – 10,000Hz
Resonant frequency	650Hz
Output SPL	98db
Chassis dimensions	236×102×174mm
Fixing centres	212×60mm
Overall weight	421g

MID-RANGE HORN

All moulded plastic mid-range horn. All black finish. Supplied complete with R/C type crossover.

Order Code 011 — **£10.95** + £1.50 p&p

5″ – 35W — SOUNDLAB PF5253

Impedance	8 ohms
Power nominal	25W
Power maximum	35W
Frequency response	600 – 8,000Hz
Resonant frequency	550Hz
Output SPL	98db
Coil diameter	25mm
Chassis dimensions	130 dia×51mm
Fixing centres	85×85mm
Overall weight	500g

MID-RANGE

Foam edged, paper cone mid-range speaker.

Order Code 012 — **£3.90** + £1.00 p&p

4″×4″ – 70W — AUDAX HDM8ND

Impedance	8 ohms
Power maximum	70W @ 1kHz
Frequency response	900Hz – 12kHz
Resonant frequency	850Hz
Output SPL	91db
Coil diameter	16.5mm
Chassis dimensions	100×100×42mm
Fixing centres	70×70mm
Overall weight	210g

MID-RANGE SPEAKER

A compact hi-fi mid-range speaker with ferrofluid cooled voice coil for resonance damping and high power handling. For use in a 3-way system.

Order Code 013 — **£6.90** + 95p p&p

5″ – 50W — AUDAX HD13D34H

Impedance	8 ohms
Power nominal	50W @ 3kHz
Frequency response	3kHz – 18kHz
Resonant frequency	900Hz
Output SPL	92.5db
Coil diameter	34.6mm
Chassis dimensions	132 dia×38mm
Fixing centres	4 holes on 120mm PCD
Overall weight	1.4kg

DOME MID-RANGE TWEETER

A quality mid-range tweeter for hi-fi use with a big 96mm magnet for high efficiency.

Order Code 014 — **£19.95** + £1.50 p&p

VISA *TEL: 01-992 8430*

6" – 150W | **AUDAX/SIARE** | **16VR**

Impedance	8 ohms
Power maximum	150 @ 1kHz
Frequency response	400 – 15,000Hz
Resonant frequency	250Hz
Output SPL	95db
Coil diameter	25mm
Chassis dimensions	155 × 87mm
Fixing centres	4 holes on 144mm PCD
Overall weight	2.3kg

BULLET MID-RANGE

High efficiency mid-range fitted with yellow fibreglass cone and foam surround.

Professional

Order Code 015 **£39.95 + £2.95 p&p**

4" × 4" – 60W | **AUDAX** | **SATWE6**

Impedance	8 ohms
Power nominal	30W
Power maximum (after network)	60W
Frequency response	5kHz – 18kHz
Resonant frequency	3kHz
Output SPL	105db
Coil diameter	38.8mm
Chassis dimensions	100 × 100 × 72mm
Fixing centres	4 holes on 107mm PCD
Overall weight	1.4kg

BULLET SUPER TWEETER

Aluminium coned super tweeter for sound reinforcement of musical instruments.

Professional

Order Code 016 **£24.95 + £1.95 p&p**

6" × 4" | **AUDAX** | **AM10**

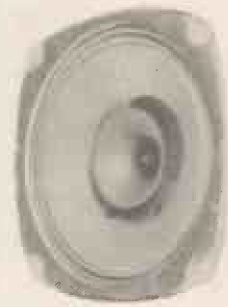
Impedance	8 ohms
Power nominal	4W
Power maximum	10W
Frequency response	130 – 12,000Hz
Resonant frequency	140Hz
Output SPL	89db
Chassis dimensions	152 × 103 × 50mm
Fixing centres	125 × 68mm (main slots)
Overall weight	275g

FULL RANGE

Ideal for in-car, music centre and TV use. Paper cone with pleated edge.

Order Code 017 **£3.99 + 65p p&p**

5" – 12W | **WEMAN** | **FCP2**



Impedance	4 ohms
Power nominal	6W
Power maximum	12W
Frequency response	80 – 12,000Hz
Resonant frequency	110Hz
Output SPL	89db
Chassis dimensions	130 dia × 50mm
Fixing centres	97 × 97mm
Overall weight	400g

FULL RANGE

Dual cone speaker for small PA or in-car use. Matching black grills to suit available.

Order Code 018 **£2.99 + 65p p&p** **GRILLS £1.50 per pair**

5" – 100W | **AUDAX** | **HD13B25H**

Impedance	8 ohms
Power nominal	(as bass/mid) 30W
Power maximum	(as mid) 100W @ 900Hz
Frequency response	65 – 5,000Hz
Resonant frequency	36Hz
Output SPL	84db
Coil diameter	25mm
Chassis dimensions	131 × 131 × 76mm
Fixing centres	4 holes on 134mm PCD
Overall weight	1.36kg

BASS/MID RANGE

Vinyl coned rubber surround hi-fi bookshelf speaker. Ideal mid-range for a 3-way system.

Order Code 019 **£19.25 + £2.00 p&p**

5¼" – 60W | **SOUNDLAB** | **525LUX**

Impedance	8 ohms
Power nominal	45W
Power maximum	60W
Frequency response	63 – 20,000Hz
Resonant frequency	63Hz
Output SPL	92db
Coil diameter	25mm
Chassis dimensions	131 dia × 73mm
Fixing centres	4 holes on 110mm PCD
Overall weight	1172g

FULL RANGE

Small high powered dual paper cone speaker. With rubber surround.

Order Code 020 **£8.90 + £1.90 p&p**

6½" – 20W | **AUDAX** | **HIP166**

Impedance	4 or 16 ohms
Power maximum	20W
Frequency response	45 – 9,000Hz
Resonant frequency	55Hz
Output SPL	89db
Coil diameter	20mm
Chassis dimensions	165 dia × 62mm
Fixing centres	4 holes on 156mm PCD
Overall weight	400g

BASS/MID-RANGE

A general purpose speaker for in-car/home use. Paper cone with rolled surround.

Order Code 0214 (4 ohms) or 02116 (16 ohms) **£4.95 + 75p p&p**

6½" – 60W | **SOUNDLAB** | **65LUX**

Impedance	8 ohms
Power nominal	45W
Power maximum	60W
Frequency response	56 – 20,000Hz
Resonant frequency	38Hz
Output SPL	94db
Coil diameter	25mm
Chassis dimensions	165 (dia) × 76.5mm
Fixing centres	4 holes on 157mm PCD
Overall weight	1.25kg

FULL RANGE

Compact full range driver. Foam rubber edged paper cone.

Order Code 022 **£9.90 + £2.00 p&p**

6¾" – 60W **AUDAX** **HDP15F**

Impedance	8 ohms
Power maximum	60W
Frequency response	65–5,000Hz
Resonant frequency	52Hz
Output SPL	87db
Coil diameter	25mm
Chassis dimensions	170×170×65mm
Fixing centres	134×134mm
Overall weight	800g

BASS/MID-RANGE

A composit material, flat diaphragm speaker, with microcomb damped polymer foam between aluminium sheets.

Order Code 023 **£12.95** + £1.50 p&p

6¾" – 80W **AUDAX/SIARE** **18VR**

Impedance	4 or 6 ohms
Power maximum	80W
Frequency response	35–5,000Hz
Resonant frequency	37Hz
Output SPL	91db
Coil diameter	25mm
Chassis dimensions	175×175×77mm
Fixing centres	4 holes on 175mm PCD
Overall weight	1.4kg

BASS/MID-RANGE

High quality driver with yellow fibreglass cone. Rubber rolled surround for hi-fi/in-car use.

Order Code 0244 (4 ohms) or 0246 (6 ohms) **£17.90** + £1.90 p&p

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8" – 50W **AUDAX** **HIF20FSP**

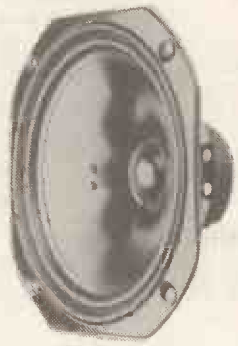
Impedance	8 ohms
Power maximum	50W
Frequency response	45–6,000Hz
Resonant frequency	45Hz
Output SPL	90db
Coil diameter	25mm
Chassis dimensions	210×210×85mm
Fixing centres	4 holes on 219mm PCD
Overall weight	800g

BASS/MID-RANGE

Hi-fi speaker with black plastic coated cone, rolled vinyl surround.

Order Code 025 **£10.90** + £1.50 p&p

8" – 70W **AUDAX/SIARE** **22PPGH**



Impedance	8 ohms
Power maximum	70W
Frequency response	40–5,000Hz
Resonant frequency	45Hz
Output SPL	90db
Coil diameter	32mm
Chassis dimensions	210×210×92mm
Fixing centres	155×155mm
Overall weight	1.25kg

BASS/MID-RANGE

A high compliant speaker with black vinyl cone and rolled rubber surround.

Order Code 026 **£16.90** + £2.00 p&p

8" – 40W **AUDAX** **HIF21F**

Impedance	8 ohms
Power maximum	40W
Frequency response	55–9,000Hz
Resonant frequency	43Hz
Output SPL	92db
Coil diameter	25mm
Chassis dimensions	212 dia × 75mm
Fixing centres	4 holes on 201mm PCD
Overall weight	720g

BASS/MID-RANGE

Quality all purpose speaker with paper cone and pleated doped surround.

Order Code 027 **£9.50** + £1.50 p&p

8" – 54W **SANYO** **S20F78**

Impedance	4 ohms
Power nominal	18W
Power maximum	54W
Frequency response	55–5,000Hz
Resonant frequency	45Hz
Output SPL	93db
Coil diameter	25mm
Chassis dimensions	210 dia×85mm
Fixing centres	4 holes on 198mm PCD
Overall weight	800g

BASS/MID-RANGE

A quality speaker for in-car/hi-fi use. With paper cone and rolled surround.

Order Code 028 **£6.59** + £1.00 p&p

8" – 60W **SOUNDLAB** **8LUX**

Impedance	8 ohms
Power nominal	40W
Power maximum	60W
Frequency response	38–18,000Hz
Resonant frequency	40Hz
Output SPL	89db
Coil diameter	25mm
Chassis dimensions	210 (dia)×94mm
Fixing centres	4 holes on 198mm PCD
Overall weight	1.3kg

FULL RANGE

A dual paper coned high compliant rolled edge foam surround speaker.

Order Code 029 **£12.95** + £1.50 p&p

10" – 60W **SOUNDLAB** **10LUX**

Impedance	8 ohms
Power nominal	40W
Power maximum	60W
Frequency response	35–12,000Hz
Resonant frequency	35Hz
Output SPL	86db
Chassis dimensions	255 (dia)×105mm
Fixing centres	4 holes on 248mm PCD
Overall weight	1.75kg

FULL RANGE

A dual coned high compliant rolled edge foam surround speaker. With paper cone.

Order Code 030 **£15.90** + £2.00 p&p

VISA *TEL: 01-992 8430*

10" – 200W **SOUNDLAB** **10200M**

Impedance	8 ohms
Power nominal	100W
Power maximum	200W
Frequency response	30 – 3,000Hz
Resonant frequency	35Hz
Output SPL	96db
Chassis dimensions	254 (dia) x 108mm
Fixing centres	4 holes on 244mm PCD
Overall weight	3.4kg

WOOFER

High power woofer. Foam edged paper cone. Black steel basket.

Order Code 031 **£29.90** + £3.75 p&p

12" – 70W **CELESTION** **G12M-70PE**

Impedance	8 ohms
Power maximum	70W
Frequency response	80 – 6,000Hz
Resonant frequency	75Hz
Output SPL	117db
Coil diameter	38mm
Chassis dimensions	310 dia x 130mm
Fixing centres	4 holes on 297mm PCD
Overall weight	3.5kg

BASS/MID-RANGE

An extremely flexible speaker with tight, brilliant tonal characteristics. Paper cone with pleated edge.

Order Code 032 **£32.25** + £3.75 p&p

12" – 100W **CELESTION** **G12H-100 PE**

Impedance	8 ohms
Power maximum	100W
Frequency response	80 – 6,000Hz
Resonant frequency	75Hz
Output SPL	120db
Coil diameter	44mm
Chassis dimensions	310 dia x 135mm
Fixing centres	4 holes on 297mm PCD
Overall weight	4.5kg

BASS/MID-RANGE

The ultimate in presence and projection for guitarists in all styles of music. Paper cone with pleated edge.

Order Code 033 **£39.95** + £3.95 p&p

12" – 150W **CELESTION** **S12-150 PE**

Impedance	8 ohms
Power maximum	150W
Frequency response	80 – 6,000Hz
Resonant frequency	80Hz
Output SPL	125db
Coil diameter	51mm
Chassis dimensions	310 dia x 135mm
Fixing centres	4 holes on 297mm PCD
Overall weight	5.25kg

BASS/MID-RANGE

An extremely loud, robust high performance professional bass/mid-range speaker for guitarist. Paper cone with pleated edge.

Sidewinder

Order Code 034 **£59.95** + £3.95 p&p

12" – 150W **AUDAX** **HD33S 66**

Impedance	8 ohms
Power nominal	150W
Frequency response	39 – 2,000Hz
Resonant frequency	24Hz
Output SPL	96db
Coil diameter	66.8mm
Chassis dimensions	334 dia x 125mm
Fixing centres	6 holes on 311mm PCD
Overall weight	7.5kg

WOOFER

Bass speaker with paper cone and foam edge surround for extended bass response.

Professional

Order Code 035 **£79.95** + £7.00 p&p

12" – 150W **AUDAX** **PR33S66**

Impedance	8 ohms
Power nominal	150W
Frequency response	45 – 2,500Hz
Resonant frequency	30Hz
Output SPL	98db
Coil diameter	66.8mm
Chassis dimensions	334 dia x 125mm
Fixing centres	6 holes on 311mm PCD
Overall weight	7.5kg

WOOFER

Bass speaker with paper cone and double rolled cambric edge surround.

Professional

Order Code 036 **£74.95** + £7.00 p&p

12" – 200W **SOUNDLAB** **12200M**

Impedance	8 ohms
Power nominal	50W
Power maximum	200W
Frequency response	26 – 3,000Hz
Resonant frequency	26Hz
Output SPL	93db
Coil diameter	50mm
Chassis dimensions	305 (dia) x 125mm
Fixing centres	6 holes on 295mm PCD
Overall weight	3.5kg

WOOFER

Superior quality bass speaker. Foam rubber edge paper cone.

Order Code 037 **£34.95** + £3.75 p&p

12" – 200W **AUDAX** **PR33S 100**

Impedance	8 ohms
Power nominal	200W
Frequency response	50 – 2,500Hz
Resonant frequency	34Hz
Output SPL	103db
Coil diameter	100mm
Chassis dimensions	334mm dia x 125mm
Fixing centres	6 holes on 311mm PCD
Overall weight	10kg

BASS/MID-RANGE

Bass reflex speaker with paper cone and double rolled cambric edge surround.

Professional

Order Code 038 **£85.99** + £7.00 p&p

15" – 200W **AUDAX** **PR38S 100**

Impedance.................... 8 ohms
Power nominal.................... 200W
Frequency response......... 45 – 3,000Hz
Resonant frequency................ 33Hz
Output SPL...................... 103db
Coil diameter.................... 100mm
Chassis dimensions........ 386.5 × 125mm
Fixing centres 8 holes on 372.5 mm PCD
Overall weight..................... 10kg

WOOFER

A no-compromise deep bass driver for the connoisseur. Paper cone with double pleated edge.

Professional
Order Code 039 **£89.95 + £7.00 p&p**

15" – 250W **CELESTION** **S15-250 CE**

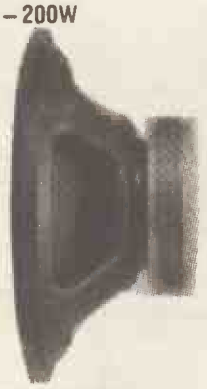
Impedance.................... 8 ohms
Power maximum.................. 250W
Frequency response......... 40 – 5,000Hz
Resonant frequency................ 40Hz
Output SPL...................... 125db
Coil diameter..................... 64mm
Chassis dimensions....... 395 dia × 155mm
Fixing centres....... 8 holes on 370mm PCD
Overall weight................... 6.9kg

WOOFER

A robust extremely loud high performance professional bass driver. Paper cone with cambric edge.

Order Code 040 **£128.95 + £7.00 p&p**

18" – 200W **CELESTION** **G18Z200 CE**



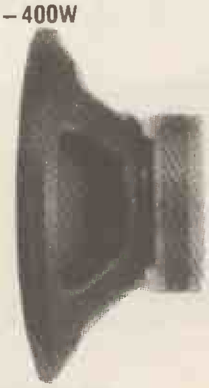
Impedance.................... 8 ohms
Power nominal.................... 200W
Power maximum.................. 250W
Frequency response......... 35 – 4,000Hz
Resonant frequency................ 20Hz
Output SPL...................... 117db
Coil diameter..................... 76mm
Chassis dimensions......... 460 × 190mm
Fixing centres....... 8 holes on 438mm PCD
Overall weight................... 8.6kg

WOOFER

Ultra reliable guitar/PA speaker. Paper cone with cambric edge.

Order Code 041 **£114.95 + £7.00 p&p**

18" – 400W **CELESTION** **G18Q-400CE**



Impedance.................... 8 ohms
Power maximum.................. 400W
Frequency response......... 35 – 4,000Hz
Resonant frequency................ 20Hz
Output SPL...................... 122db
Coil diameter..................... 76mm
Chassis dimensions......... 460 × 210mm
Fixing centres....... 8 holes on 438mm PCD
Overall weight.................. 13.8kg

WOOFER

Ultra reliable high power bass guitar/PA speaker. Paper cone with cambric edge.

Order Code 042 **£149.95 + £7.00 p&p**

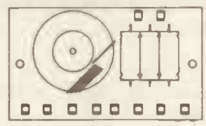
Remember: *A crossover must be used with all tweeters and mid-range units (except Piezos)*

'LOUDSPEAKER ENCLOSURE DESIGN AND CONSTRUCTION'

53 page illustrated book **£3.95 + 50p p&p**

CROSSOVERS

2-WAY 100W **HYN2**

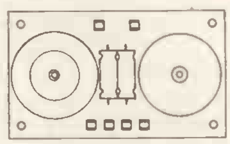


2-way high power crossover with 3 selectable crossover frequencies.

Type.................... 2-way
Impedance............... 8 ohms
Input power.............. 100W
Attenuation........... 6db/oct
Crossover........ 2k, 2.5k or 4kHz

Order Code 043 **£4.95 + 65p p&p**

2-WAY 200W **2W225K**

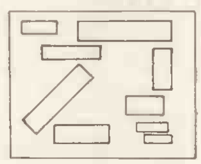


2-way high powered crossover. 2.5kHz crossover frequency.

Type.................... 2-way
Impedance............... 8 ohms
Input power.............. 200W
Attenuation.......... 12db/oct
Crossover............... 2.5kHz

Order Code 044 **£9.25 + 95p p&p**

3-WAY 60W **L3**

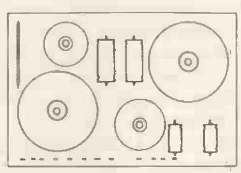


3-way crossover network. 700Hz and 3,500Hz crossover frequencies.

Type.................... 3-way
Impedance............... 8 ohms
Input power............... 60W
Attenuation........... 6db/oct
Crossover......... 700Hz, 3,500Hz

Order Code 04460 **£4.95 + 65p p&p**

3-WAY 100W **SN7000**

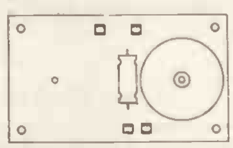


3-way crossover network. 700Hz and 5kHz crossover frequencies.

Type.................... 3-way
Impedance............... 8 ohms
Input power.............. 100W
Attenuation.......... 12db/oct
Crossover.......... 700Hz, 5kHz

Order Code 045 **£9.95 + 95p p&p**

LOW PASS FILTER **LP38**

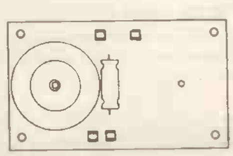


800Hz, 300W low pass filter network.

Impedance............... 8 ohms
Input power.............. 300W
Attenuation.......... 16db/oct
Cut-off................. 800Hz

Order Code 046 **£8.95 + 95p p&p**

HIGH PASS FILTER **HP35K**

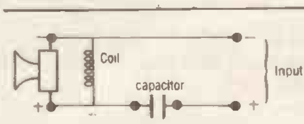


5kHz, 300W high pass filter network.

Impedance............... 8 ohms
Input power.............. 300W
Attenuation.......... 16db/oct
Cut-off.................. 5kHz

Order Code 047 **£6.25 + 95p p&p**

2-WAY 70W



Coil and capacitor.
Crossover............... 2.5kHz

Order Code 049 **£1.50 + 20p p&p**

VISA ***TEL: 01-992 8430***

2k OHMS/V — ETU102

- Miniature multitester
- 15 ranges
- Diode protection
- Ohms zero
- Mirrored scale
- Leads with 2mm plugs

Battery and instruction manual included.

AC volts	0–10–50–250–1000V ± 4%
DC volts	0–2.5–10–50–250–1000V ± 3%
DC current	0–500u–5m–250mA ± 3%
Resistance	0–5k–5000k ohms ± 3%
Decibels	–10 to + 22dB
Protection	diodes
Dims	100 × 65 × 30mm

Order Code 050 £6.90 + £95p p&p

1.0M OHMS — KD508

- 15 ranges
- 0.5" 3½ digit LCD display
- Compact size
- Automatic zero and polarity
- Full overload protection
- Over-range and low battery indication
- Leads with 4mm shrouded plugs

Battery and instruction manual included.

AC volts	0-2-20-200-500V ± 4%
DC volts	0-2-20-200-1000V ± 1%
DC current	0-2m-20m-200mA ± 2%
Resistance	0-2k-20k-200k-2M ohms ± 2%
Protection	Fuse
Dims	113 × 67 × 22mm

Order Code 054 £21.90 + £1.50 p&p

20k OHMS/V — ETU2070

- 19 ranges (including 10Adc)
- Battery test
- Continuity buzzer
- Fuse and diode protection
- 3-colour mirrored scale
- Two tone beige plastic case
- Leads with 4mm plugs

Batteries and instructions included.

AC volts	10-50-250-1000V ± 4%
DC volts	0.25-2.5-10-50-250-1000V ± 3%
DC current	50u-5m-50m-500mA-10A ± 3%
Resistance	10k-100k-10M ohms ± 3%
Battery test	1.5V/10 ohms 9V/900 ohms
Decibels	-8 to + 62db
Protection	Fuse and diodes
Dims	150 × 100 × 40mm

Order Code 051 £15.50 + £1.50 p&p

10M OHMS — KD578

- 20 ranges (including 10A ac/dc)
- 0.4" 3½ digit LCD display
- Display hold and memory features
- Autoranging resistance and voltage
- Automatic polarity
- Continuity buzzer
- Leads with shrouded 4mm plugs

Battery and instruction manual included.

AC volts	0-2-20-200-750V ± 1.2%
DC volts	0-200m-2-20-200-1000V ± 0.8%
AC current	0-20m-200mA ± 1.2%
	0-10A ± 2%
DC current	0-20m-200mA ± 1.2%
	0-10A ± 1.5%
Resistance	0-200-2k-20k-200k-2M ohms ± 1%
Continuity	Buzzer sounds at 20 ohms or less
Protection	Fuse
Dims	127 × 69 × 25mm

Order Code 055 £42.90 + £2.00 p&p

20M OHMS — HC5050E

- 41 ranges including 12A ac/dc and 1200V ac/dc
- AC peak-peak measurement
- Polarity reverse switch
- Power indicator
- ±DC voltage and current measurement (centre zero)
- Mirrored scale
- Fuse and FET protection
- Leads with 4mm shrouded plugs

DC volts	0-0.3-1.2-12-30-120-300-1200
	centre zero 0-±1.5-0.6-6-15-60-150-600 ± 2.5%
AC volts	RMS 0-3-12-30-120-300-1200
	P-P 0-8.4-33-84-330-840-3300 ± 3%
DC current	0-1u-0.3m-3m-300m-12A
	centre zero 0±0.5u-0.15m-1.5m-15m-150m-6A ± 2.5%
AC current	0-12A ± 3.5%
Resistance	0-1k-10k-100k-1M-10M-1000M ohms ± 2.5%
Decibels	–10 to + 63
Protection	Fuse and FET
Dims	170 × 125 × 50mm

Order Code 052 £32.90 + £1.50 p&p

LOGIC PROBE — HYT07

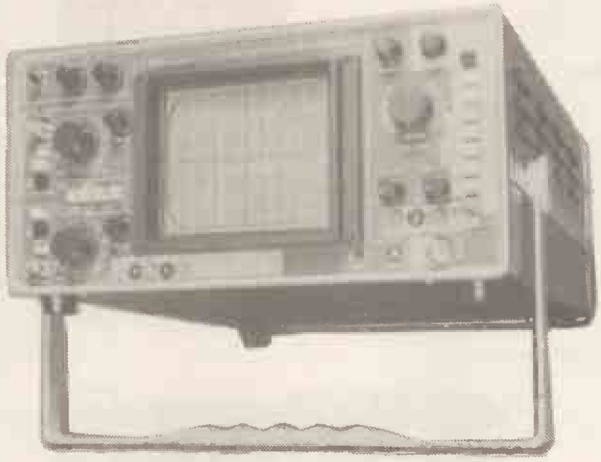
Logic probe suitable for displaying the logic state of each gate of TTL, CMOS, etc. devices. Logic state displayed in light and sound. Pulse enlargement capability allows pulse detection down to 25nsec. Supplied with comprehensive instruction manual.

Working voltage	4-16Vdc
Thresholds: HI	70% Vcc
Lo	30% Vcc
Input impedance	1M ohms
Max. input frequency	20MHz

Order Code 053 £9.50 + £95p p&p

RTVC

CROTECH **DUAL TRACE DC-25MHz OSCILLOSCOPE** **3133**



- DC-25MHz Bandwidth
- 2mV/div Sensitivity
- Add and Subtract mode
- X-Y Operation
- 40ns/div – 0.2s/div Timebase
- Triggering to 40MHz
- Active TV Trigger
- Variable Hold Off
- 5" CRT
- 10 × 8 Div Display
- Z Modulation
- Component Comparator
- Triple Output DC Source

Order Code 056 **£365.00** + p&p poa

ALTAI **SINGLE BEAM OSCILLOSCOPE** **OST5M**

A high quality portable single beam oscilloscope with 3" CRT screen, high vertical sensitivity of 10mV/division, direct cascade amplifiers and a frequency range from DC to 5MHz. Ideal for lab, school and service use.

Vertical axis:
Frequency range.......... AC: 2Hz – 5MHz
DC: DC – 5MHz
Deflection sensitivity.......... 10mV/div
Input impedance.......... 1M ohms
Max. input voltage.......... 500V p-p and DC

Horizontal axis:
Frequency range.......... DC – 5MHz
Deflection sensitivity.......... 250mV/div
Input impedance.......... 1M ohms
Max. input voltage.......... 100V p-p and DC
Sweep range.......... 10Hz – 100kHz in 4 steps and H.EXT
Synchronizing.......... Internal/External
Power.......... 240 Vac 50Hz
Dims.......... 160 × 202 × 305mm

Order Code 058 **£165.90** + p&p poa

ALTAI **RPS1203**

Regulated power supply for use with CB rigs, auto equipment. High stability circuitry with high surge current capability. Overload protection. Manufactured according to the requirements of the Electrical Safety Regulations for domestic use.

Input voltage.......... 240Vac 50Hz
Output voltage.......... 13.8Vdc
Output current.......... 3A continuous, 5A max.
Stability.......... 1%
Ripple.......... 25mV
Connections... 4mm banana socket/screw terminals
Dims.......... 170 × 130 × 83mm

Order Code 057 **£13.95** + £3.75 p&p

ALTAI **PP243**

Variable regulated power supply with overload protection. Meter reads voltage or current (switched). Two voltage ranges; 0 – 12V and 12 – 24Vdc. Ideal for laboratory use.

Input voltage.......... 240Vac 50Hz
Output voltage.......... 0 – 24Vdc (2 ranges)
Output current.......... 3A continuous
Stability.......... 0.2%
Ripple.......... 2.5mV
Dims.......... 180 × 110 × 180mm

Order Code 059 **£52.95** + £3.75 p&p

ALTAI **AL12**

Regulated power supply with voltage selector switch designed for use in fixed installations or fitted on flying leads. Input and output via screw terminals. Internal thermal fuse for overload protection.

Input voltage.......... 240Vac 50Hz
Output voltage.......... 6/9/12Vdc (selectable)
Output current.......... 1A continuous
Stability.......... 2%
Ripple.......... 25mV
Dims.......... 142 × 65 × 60mm

Order Code 060 **£9.95** + 95p p&p

VISA ***TEL: 01-992 8430***

PHONIC **STEREO MIXER** **MX7700**

4-channel stereo disco mixer with built-in 5-band graphic equalizer. LED display, monitored output, fader mix, cue control and equalizer defeat button. 4 inputs.

Input sensitivity	Mic. 1.5mV, Phono 1.5mV, Line 75mV
Input impedance	Mic. 10k ohms, Phono 50k ohms, Line 50k ohms
Max. input level	Mic. 100mV, Phono 140mV, Line 5V
Output impedance	600 ohms
Rated output	Amp 1V, Rec. 1V
Hum and noise	Mic. –52db, Phono –62db, Line –65db
Frequency response	Mic. 30–16000Hz
	Phono 30–20000Hz
	Line 20–30000Hz
Equalizer section:	
Control frequencies	60Hz, 250Hz, 1kHz. 3.5kHz, 12kHz
Control range	±12db, boost or cut
Power	240Vac
Dims	400×80×280mm

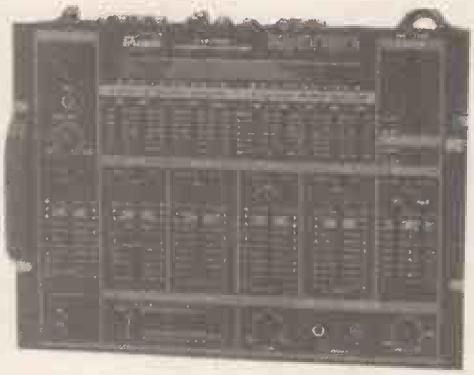
Order Code 061 **£109.95** + £3.00 p&p

PHONIC **STEREO MIXER** **MRT60**

5-channel stereo disco mixer in rack-mounting case capable of mixing a total of 10 phono, line and mic inputs, switchable on the front panel. Twin 5-band graphic equalizer with insert/bypass switch. DJ mic channel with low cut filter, pan pot and auto fade. Cross fader between channels 1 and 2. Separate L and R output levels and stereo/mono switch. Outputs to amp, tape and headphone.

Inputs: Mic	0.3mV 600 ohms
Phono	2.5mV 47k ohms
Line/CD	150mV 47K ohms
Outputs: Amp & tape	2V nom
Headphone	150mV @ 8 ohms
Frequency response	20–20000Hz
Hum and noise	6mV
Equalizer control frequencies	60, 250, 1k, 3.5k, 16kHz
Equalizer control range	±12db boost or cut
Talkover	Decrease 14db program level
Power	240Vac 50Hz
Dims	360×265×88mm

Order Code 062 **£134.95** + £3.00 p&p



ALTAI **STEREO MIXER** **VMM500**

5-channel stereo sound mixer with mag/crystal pick-up select switches on phono channels. Talkover facility on mic channel. Selectable headphone monitoring. Outputs to amp and tape. Twin VU meters.

Inputs: Mic	0.3mV 600 ohms
Phono	3mV 50k ohms (mag) 150mV 100k (cry)
Tape/tuner	150mV 100k ohms
Outputs: Amp	1V
Tape	0.8V
Headphone	80mV @ 75 ohms
Frequency response	20–20000Hz
S/N ratio	48db
Power	240Vac 50Hz
Dims	334×100×192mm

Order Code 063 **£59.95** + £3.00 p&p

PHONIC **STEREO MIXER** **MR50A**

5-channel stereo sound mixer in 19" rack mounting case which can handle a total of 8 inputs, selectable on the front panel. Special facility between channels A and B allows recording on channel A from channel B. Stereo mic inputs have level, bass and treble controls and talkover facility. Output section has stereo/mono switch and separate level, bass and treble controls for L and R. Twin switchable VU meters. Outputs to amp, tapes, headphones and slave.

Inputs: Mic	0.3mV 600 ohms
Phono	3mV 47K ohms
Tape/video/CD	140mV 22k ohms
Aux	140mV 39k ohms
Outputs: Amp and tape	1.5V nom 5V max
Headphones and slave	400mV @ 8 ohms
Frequency response	20–20000Hz
S/N ratio	64db
Hum and noise	3mV
Crosstalk	–56db
Talkover	Decrease 14db program level
Power	240Vac 50Hz
Dims	482×132×60mm

Order Code 064 **£114.95** + £3.00 p&p

SHURE **10-L-LC Dynamic**

The Prologue Series 10 embodies performance features, ruggedness, and sound quality never before available at this price. Highly unidirectional (Cardioid) and uniform pickup pattern is combined with response (80 to 10kHz) tailored for voice intelligibility and satisfactory musical instrument reproduction. Slim, low-profile probe shape for hand or stand (includes slip-in swivel adapter). On/Off switch, 3-pin professional audio connector.

80 to 10,000Hz
Cardioid (Unidirectional)
0.15mV (−76.5db)

Order Code 065 **£22.90** +£1.50 p&p

SHURE **12-L-LC Dynamic**

The popular ball shape of the Prologue Series 12 increases ruggedness while providing added protection against wind noise and vocal 'popping' sounds. Better suited for hand-held use than probe-shaped microphones. Cardioid pickup pattern helps control feedback and background noise. For voices or instruments. On/Off switch. Professional 3-pin connector. Surprisingly low in cost, surprisingly high in performance, ruggedness and versatility.

80 to 10,000Hz
Cardioid (Unidirectional)
0.15mV (−76.5db)

Order Code 066 **£31.90** +£1.50 p&p

SHURE **SM58-LC Dynamic Vocal**

THE world-standard professional vocal microphone, with the distinctive Shure upper mid-range presence peak for an intelligible, lively sound. It is without question the unsurpassed first choice among rock, pop, R&B and country music vocalists. A tough, handsome microphone that weighs less than 11oz . . . the SM58 is often imitated in appearance but never duplicated in performance, ruggedness and reliability.

50 to 15,000Hz
Cardioid (Unidirectional)
150 ohms
0.18mV (−75.0 db)

Order Code 067 **£149.90** +£1.50 p&p

SHURE **588SD Dynamic Vocal**

The Unisphere B 588SD features all the most desirable features in a unidirectional dynamic microphone at an attractive price. A built-in windscreen minimizes breath popping when used close-up and subdues wind noise when used outdoors. A locking on/off switch permits controlling the microphone at the performer's position. The 588SD microphone has a uniform cardioid polar pattern that reduces feedback. Dual impedance design.

80 to 13,000Hz
Cardioid (Unidirectional)
Dual: 150 ohms/High
0.08mV (−82.0db) 150 ohms
1.16mV (−59.5db) high

Order Code 068 **£55.90** +£1.50 p&p

SHURE **515SD Dynamic Instrument Vocal**

The most economical of the Shure Unidyne microphones, the 515SD features the uniform, symmetrical cardioid pickup pattern, feedback suppression, and high-quality performance characteristics that have made the Unidyne models world famous. The 515SD has a wide frequency response, shaped with a low-frequency rolloff and high-frequency presence boost. Dual impedance, selectable at on-off switch.

80 to 13,000Hz
Cardioid (Unidirectional)
Dual: 150 ohms/High
0.074mV (−82.5db) 150 ohms
1.1mV (−59.0 db) High

Order Code 069 **£40.90** +£1.50 p&p

ALTAI **DM5000**

A heavy metal mic, dark grey colour with silver trim. On/Off switch. 6m noiseless lead with XLR connector. In carrying case. Built-in windshield. Holder included. With case.

Type....... Uni-directional. Dynamic
Impedance............. 500 ohms
Response........... 30 − 18000Hz
Sensitivity.......... −76db @ 1kHz
Head dia.................. 54mm
Length. 178mm (excluding connector)

Order Code 070 **£19.90** +£1.50 p&p

ALTAI **500 ohms & 50k ohms DM450**

Quality microphone made from heavy zinc diecast metal, silver finish. On/off switch. 5m noiseless lead fitted with 4-pin dual impedance plug. Holder included.

Type....... Unidirectional. Dynamic
Impedance.. 500 ohms and 50k ohms (dual)
Response........... 60 − 12000Hz
Sensitivity...... −75db (500 ohms) @ 1kHz
−60db (50k ohms) @ 1kHz
Head dia.................. 42mm
Length. 175mm (excluding connector)

Order Code 071 **£13.90** +£1.50 p&p

ALTAI **EM250 Stereo Eletret Condemn**

All silver plastic body with black metal mesh head. Built-in windshield. Integral 3m lead to 2×6.35mm jack plugs. Takes 1.5V 'AA' type battery (supplied). Holder included.

Type................ Bi-directional
Impedance............ 1000 ohms
Response........... 50 − 18000Hz
Sensitivity......... −70db @ 1kHz
Dia: Head................. 37mm
Body................. 22mm
Length.................. 170mm

Order Code 072 **£11.90** +£1.50 p&p

MICROPHONE CABLE **BMC6P**

6.35mm mono metal jack plug to XLR female plug. Black straight noiseless cable.
Length.. 6m

Order Code 073 **£6.90** + 20p p&p

VISA **TEL: 01-992 8430**

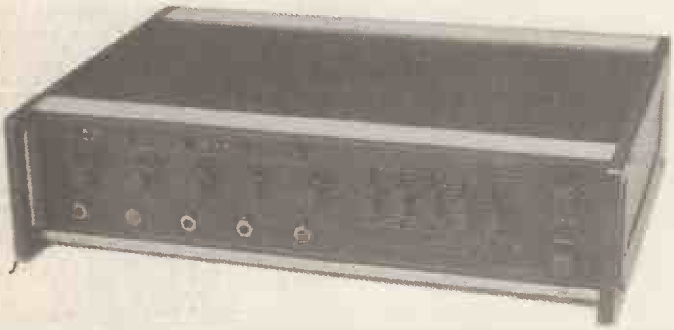
AMPHONIC — 125+125 POWER AMPLIFIER — PA250

Output power........125W RMS max. per channel
Output impedance.................4 to 16 ohms
(max. power into 4 ohms)
Sensitivity..................450mV @ 22K ohms
Protection........Electronic short-circuit and fuses
Power.......................220–240Vac 50Hz
Chassis dim..................435×125×280mm
Weight............................10kg approx.

125 watt per channel stereo power amplifier with independent volume controls, professional 19" rack mount and silent running cooling fan for extra reliability.

Order Code 074 **£124.99**+£7.00 p&p

SOUNOLAB — 100W AMPLIFIER WITH GRAPHIC — AX100



Output power........115W (4 ohms) 80W (8 ohms)
Output impedance...........4–8 ohms/100V line
Frequency response...............30–20000Hz
Inputs: Mic 1, 2, 3 & 4...........2mV 200 ohms/
18mV 50k ohms
Aux.....3mV 47k ohms/200mV 100k ohms
Controls: Volume........4x mic, 1x aux, 1x master
Graphic Equalizer.............5 channel
Power... Mains on/off switch with indicator
Power..........................240Vac 50Hz
Dims.......................410×305×100mm

Powerful 100W amplifier with full mixing facilities for four low or high impedance microphones plus music. A five band graphic equalizer replaces the usual bass and treble controls. Slave output socket for connection to additional amplifier plus effects in/out facility. 4–8 ohms or 100V line outputs.

Order Code 075 **£209.95**+£7.00 p&p

SOUNOLAB — BULLHORN — SK66

Output power. 10W (nom), 16W (max)
Audible range...........0.5–1km
Power12Vdc (8×'C' batteries not inc)
Dims.........230 (dia)×340(L)mm
Weight.................. 1.65kg

Hand held or shoulder hanging model with detachable noise cancelling microphone (on curly lead). Anti-howl amplification. Mic has press-to-talk switch and volume control. Horn has rubber bumper rim and pistol grip. Made of ABS plastic and metal (blue and grey).

Order Code 076 **£56.90**+£4.70 p&p

SOUNOLAB — HORN — KP86

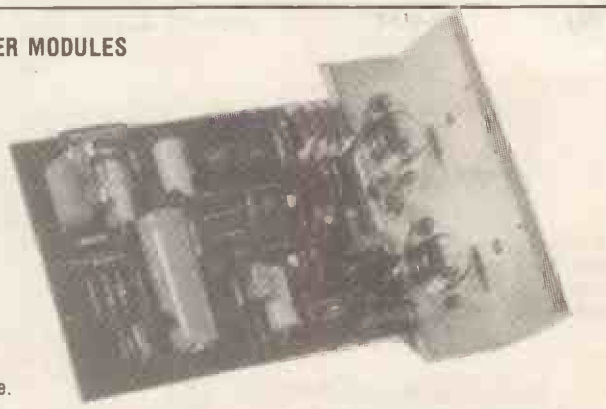
Horn size..............8"×4½"
Output.....................30W
Frequency response. . 450–10000Hz
Impedance...............8 ohms

Completely weatherproof horn. White ABS plastic. Adjustable fixing bracket.

Order Code 077 **£13.90**+£3.00 p&p

125W HIGH POWER MODULES

High quality power amplifier module for PA and domestic systems. Its ingenious design and clever use of generously rated components, with short-circuit protection simplifies installation.



Output power...............15W to 125W (RMS)
Output impedance..................4 to 16 ohms
(max power into 4 ohms)
Operating voltage.................50–80V max
Sensitivity............................400mV
Frequency response...............25Hz–25kHz
Dimensions .... 90×165cm

Power supply parts comprising mains transformer, rectifier and capacitor are available.

Order Codes and Prices: **Module 078 £19.90**+£1.10 p&p **PSU mono 079 £9.70**+£2.50 p&p **PSU stereo 080 £15.50**+£2.50 p&p

AUDIOLINE — REMOTE CONTROL TELEPHONE ANSWERING MACHINE — MODEL 800

- Dual microprocessor control
- Twin cassette full logic tape deck
- Call screening
- Message received indicator/counter
- Rewind
- Playback
- Save
- Marker memo
- Cancel

Functions can also be operated by using the remote control from an outside phone. BT approved.

Order Code 081 — **£97.90** + £5.00 p&p

BETACOM — TELEPHONE ANSWERING MACHINE — LR3

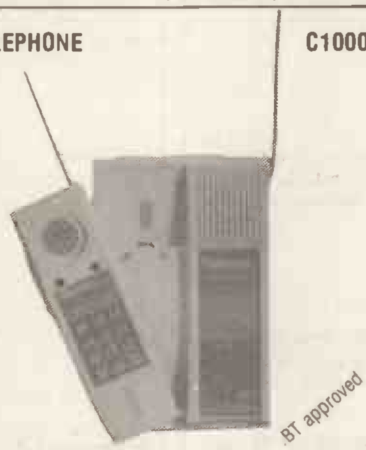
- BT approved with modular plug for use with standard BT socket
- Double tape: one to record your outgoing announcement, the other to record incoming messages
- You need only to record your outgoing message once
- Fast erase: to clear tape of old messages
- Monitor
- Fast forward scan
- Rewind and review
- Message indicator

Order Code 082 — **£78.90** + £5.00 p&p

BETACOM — CORDLESS TELEPHONE — C1000

- Last number redial
- 200 metre distance from base
- Ringer on/off switch
- Pager
- Selectable codes
- Mute button
- BT plug for use with standard BT socket

Colour: white



BT approved

Order Code 083 — **£76.90** + £4.00 p&p

AUDIOLINE — TELEPHONE — TEL30

Electronic 10-memory telephone with last number redial, adjustable ringer, memo pad and recall facility. Can be laid flat or mounted upright (using optional bracket – Part No. 221). BT approved. Colours: Beige, White and Black.

Order Code 084 — **£28.90** + £2.50 p&p

TAI — 2-WAY — IT20

Two-station intercom/baby alarm. Master to sub-station. White plastic case with on/off switch and volume control. Built-in call signal. 15m lead (3.5mm plugs) supplied.

Power........................ 9V battery (PP3)
Dims........................ 105×78×45mm

Order Code 085 — **£9.90** + £1.75 p&p

ALTAI — FM INTERCOM 2 to 6-WAY — ETL8083A

FM frequencies.. 230, 260 & 290kHz
Power.............. 240Vac 50Hz
Dims............ 182×122×45mm

FM 3-channel wireless intercom. Automatic voice activation facility for hands free conversation. Keyboard controls. Volume control. Mains powered and connected. Matt black plastic case. Automatic squelch control for noise free operation. 2 to 6 stations may be used.

Order Code 086 — **£36.90** + £2.50 p&p

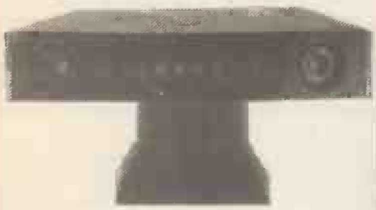
VISA *TEL: 01-992 8430*

MOSS SECURITY

REMOTE CONTROL VEHICLE PROTECTION SYSTEMS

MS716/718

MS702



MS715 (illustrated) or the MS705 (smaller unit with one remote control)

MS703

The MS705 or MS715 are two very efficient vehicle security systems. Their unique 'current' and 'adjustable shock' sensing circuitry offers round the clock protection for your vehicle. With the addition of an ultrasonic interior sensor (MS702 or MS703) they will detect any movements inside the vehicle. MS716 or MS718 are central door locking interface modules (for the MS715 only). The MS718 is designed for vacuum operated central door locking systems eg Mercedes and Audi.

- Individual coded remote controls
- Remote instant arm/disarm (and Immobilisation on MS715)
- Ultra high power reflex horn siren (MS715 = 120db, MS705 = 110db)
- Easy to fit – hard to beat
- Extendable system
- Security circuit
- Current/shock sensing, etc

MODEL	ORDER CODE	PRICE £	P&P £	PACKAGE DEALS
MS705	087	43.90	2.50	MS705 & MS703 TOTAL £62.90 + £2.50 p&p
MS715	088	68.90	2.75	
MS702	089	27.50	0.95	MS715 & MS703 TOTAL £84.90 + £2.75 p&p
MS703	090	21.90	0.95	
MS716 or MS718	091	12.90	0.75	MS702 instead of MS703: extra £5.00

PHILIPS

HOME SECURITY

BURGLAR ALARM

IDEAL FOR FLATS, MAISONETTES AND SMALLER OFFICES OR HOUSES. With pressure mat, magnetic reed switches, cable, internal alarm unit and control unit. Built-in timed entrance and exit delay. Liquidated stock. Fully guaranteed.

Order Code 092 **£29.99** + £2.75 p&p

ALTAI DOORPHONE

Two station, mains powered, handset type door phone, allowing conversation with visitors without opening door. Electric door lock release push button. Volume hi-lo switch. Battery connections for stand-by power. Ivory and fawn plastic body. Free standing or wall mounted (bracket supplied).

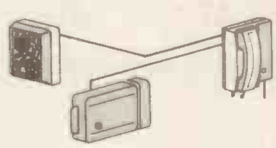
Power . . . . . 240Vac or 9Vdc (stand-by)
Dims . . . . 210 × 100 × 70mm

Order Code 093 **£29.90** + £2.50 p&p

ALTAI ELECTRIC DOOR LOCK DL3

Solenoid operated door lock complete with 5-lever cylinder lock, manual release and mounting hardware.

Power 12Vdc 0.5A
Dims . . . . 130 × 105 × 38mm



Order Code 094 **£26.90** + £2.50 p&p

RTVC

UNIVERSAL NI-CAD BATTERY CHARGER

Universal Ni-Cad battery charger. All plastic case with hinged lid. Charge/test switch with filament lamp showing degree of charge. Separate LED indicators at each of the five charging points.

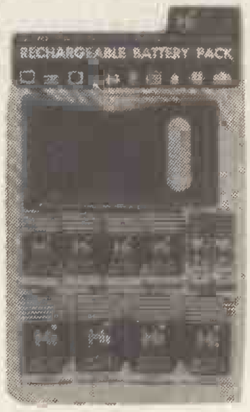
Charges........... PP3 (9V), AA (1.5V penlite), C (1.5V HP11), D (1.5V HP2)
Power.. 240Vac 50Hz
Dims.. 210×100×50mm

Order Code 095 **£5.95 + £1.40 p&p**

RECHARGEABLE BATTERIES

Size	AA	C	D
Rate	1.25V 500mAh	1.25V 1200mAh	
Charge rate	50mA	250mA	
Order Code	096	097	098
Cost £	3.90/4	1.90 each	2.10 each
P&P £	0.50/4	0.50/2	1.50/2

HI-TECH RECHARGEABLE BATTERY PACK



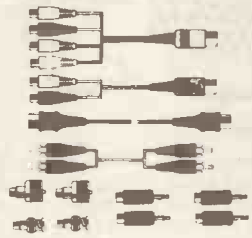
A complete rechargeable battery pack. Simply plug charger into standard 13 amp socket. Each charge costs less than 1p. Ideal for: stereo radio/cassette, toys, camera, photo flash, shavers, torches, calculators etc, etc. Pack contains: charger, 4×'AA' size Ni-Cad batteries, 4×'C' and 4×'D' size sleeve adaptors.

Order Code 099 **£11.50 + £1.40 p&p**

VIDEO CABLE SET

for recording from any video to any video

12 PIECE

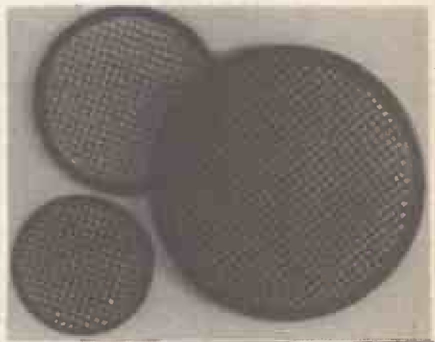


- 1 screened lead – 5-pin DIN plug to 5-pin DIN plug. Mirror image. 1.5m
- 1 twin, screened lead – 2 phono plugs to 2 phono plugs. 1.5m
- 1 twin, screened lead – 2 phono sockets to 5-pin DIN. 180mm
- 2 twin, screened leads – 4 phono sockets to 5-pin DIN. 180mm
- 2 adaptors – phono socket to PL259 (UHF plug)
- 2 adaptors – phono socket to BNC plug
- 4 adaptors – phono socket to 3.5mm jack plug

Order Code 100 **£5.95 + 75p p&p**

ALTAI CABINET GRILL

Black finish metal mesh speaker grill with black rubber surround. Robust construction made from 1.1mm thick steel. Grill pitch 11mm×11mm.



Size	5"	8"	10"	12"	15"
Cost £	1.95	2.50	2.95	3.95	4.95
P&P £	.50		1.05		1.75

Order Code 101 **Please state size**

CONDITIONS

HOW TO ORDER

Personal shoppers may visit either of our branches (map overleaf). All mail/phone orders to our Acton address please.

METHOD OF PAYMENT

Cash, cheque, Giro, postal order, Access or Visa card. Cheques and postal orders should be crossed and made payable to RTVC Ltd. If you intend to pay by Access or Visa card, you may telephone your order to us.

ALL PRICES INCLUDE VAT AT 15% RATE.

POST & PACKING/CARRIAGE CHARGES ARE FOR UK ONLY

Overseas customers kindly arrange transportation.

Specifications in this catalogue are given in good faith, but they should be regarded as for guidance only, and are subject to change without prior notice. Goods are sold subject to availability. Prices are correct at 1st November 1987.

RETURNS

Except for faulty goods or goods sent in error, no goods may be returned without our prior consent.

Allow 28 days for delivery.

50p

VISA **TEL: 01-992 8430**

TV SOUND TUNER

In the cut-throat world of consumer electronics, one of the questions designers apparently ponder over is "Will anyone notice if we save money by chopping this out?" In the domestic TV set, one of the first casualties seems to be the sound quality. Small speakers and no tone controls are quite common and that really is quite sad, as the TV companies do their best to transmit the highest quality sound. Given this background a compact independent TV tuner that connects direct to your Hi-Fi is a must for quality reproduction. The unit is mains operated. This TV SOUND TUNER offers full UHF coverage with 5 pre-selected tuning controls. It can also be used in conjunction with your video recorder.

Order Code: 102 £29.50 +£2.50 p&p

As above but with built-in stereo headphone amplifier for the hard of hearing

You can tune into theTV channel you want while still receiving the picture on your TV set. In fact it is rather like a second television, but without the screen. So that the ordinary TV can be placed for everyone to see, and the volume on it can be comfortable for others, while the sound tuner can be placed where you can control it. You will need to plug in one of your own listening aids such as headphones or an induction loop to hear the sound. The tuner is mains operated, has 5 pre-selected tuning controls and can be used in conjunction with a video recorder.

Size: 10¾" × 7½" × 2½" (270mm × 192mm × 65mm)

Order Code: 103

£35.90 +£2.50 p&p

MAIL ORDER & ALL TRADE ENQUIRIES TO ACTON BRANCH.

Callers Welcome at either branch.

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21 High Street, Acton, London W3 6NG.
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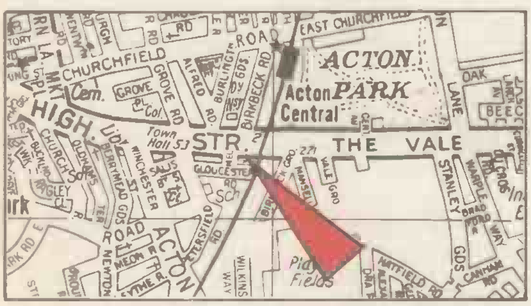
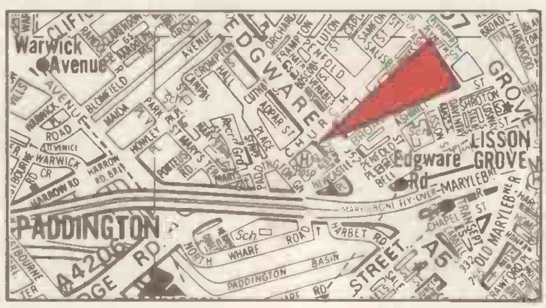
Monday to Saturday 9.00 – 5.30.
(5 minutes walk from Edgware Rd Tube Station).





N.B. At both shops you will also find a wide range of Hi-fi, in-car entertainment, telephones & answering machines, electronics accessories, etc. . .

TEL: 01-992 8430

Radio & T. V. Components (Acton) Ltd.

RTVC

ORDER WITH CONFIDENCE – ESTABLISHED OVER 25 YEARS