EVERYDAY ELECTRONICS

OCTOBER 1989

INCORPORATING ELECTRONICS MONTHLY

£1.40

FREE INSIDE!

MARCO 32 PAGE CATALOGUE

SEISMOGRAPH

New Series LOGO LEGO & THE SPECTRUM

CAR IGNITION SYSTEMS

The Magazine for Electronic & Computer Projects

No. 3 LIST BAKERS DOZEN PACKS

All packs are £1 each, if you order 12 then you are entitled to another free. Please state which one you want. Note the figure on the extreme left is the pack ref number and the next figures are the quantity of items in the pack, finally a short description.

BD152	1	Gas or liquid shut off valve, clockwork dial, setting can be on for up to 12 hours.
BD153	1	Same as BD152 but thermostatically operated.
BD154	1	12v operated drip proof relay, ideal for outdoor or in-car operation.
BD158	4	12 way 5 amp screw down polythene bodied connector strips. Used to be called choc blocks when made of Bakelite.
BD159	2	12 way 25 amp connector blocks
BD160	1pr	Plug together 12 way connector blocks, ideal for quick joins in leads.
BD168	2	Component mounting tag strips each with 50 stand up tags.
BD169	4	Short wave air spaced trimmers 3-30pf. Screw driver operated.
BD170	4	Assorted neon type numicator tubes made by HIVAC.
BD175	1	2 watt mains motor driving gearbox, final speed 200rpm.
BD177	5	12v Lilliput bulbs.
BD178	3	Panel mounting slim line indicator lights with amber lens. These take Lilliput bulbs.
BD179	3	Oblong mains neon indicator lights, approx 1in x ½in.
BD181	100	PVC grommets for insulation through ⅜th hole.
BD182	1	25pf air spaced tuning capacitor, small hole fixing with ¼in spindle.
BD189	1	20 amp double pole switch on flush plate which fits standard 3x3 electrical box, illuminated when on.
BD190	1	20 amp dp switch but surface mounting, oblong shape.
BD191	6	Lamp holder adpators which take two pin plug, also supplied.
BD200	1	10 digit switch pad, telephone type.
BD205	1	Very small 12v operated relay with one pair change-over contacts.
BD212	1	Mains transformer 230v primary and two 8v ½ amp secondaries.
BD213	2	5 core curly leads, tinsel wire for phones, etc.
BD214	2	Sub-min toggle switches double pole double throw.
BD215	4	Mini dpdt slide switches with chrome dolly instead of the usual plastic toggle.
BD217	100	Standard wire ending push-ons for standard ¼in tags.
BD218	100	Ditto, but right angled.
BD219	100	Soldercon tags. With these you can make your own sockets for ICs etc.
BD223	4	1200 watt fire spirals, bright nickel chrome wire.
BD224	1	Battery operated motor made for 9v cassette players but speed controllable by lowering voltage.
BD227	4	50k quad pots. Standard ¼in spindle single hole fixing.
BD228	1	Ice stat thermostat. Ideal for controlling water pipe antifreeze coils.
BD229	1	Instrument buzzer, variable low, medium or soft.
BD233	2	Eagle educational kits. One makes chemical balance with weights and the other has electricals for experiments.
BD234	4	500µf + 500µf 50v electrolytics.
BD236	1	Mains transformer with 9v 750mA secondary.
BD237	1	Computer grade electrolytic 3150µf at 40v.
BD243	2	8x4 16 ohm loudspeakers permanent magnet, 5 watts.
BD246	4	Standard size ½meg with ¼in spindle and dp switch
BD247	1	The medium wave permeability tuner, couple this to a ZN414 and you have a radio.
BD248	1	A noise suppressor/mains filter
BD249	1	13A socket on plate with spur, fits normal electrical box.
BD253	1	Oven thermometer — bimetal type, reads 200-500°F.

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

CAMERAS. Three cameras, all by famous makers, Kodak etc. One disk, one 35mm and one instamatic. All in first class condition, believed to be in perfect working order, but sold as untested. You can have the three for £10 including VAT, which must be a bargain — if only for the lenses, flash gear etc. Our ref 10P5B.

EQUIPMENT WALL MOUNT It is a multi-adjustable metal bracket that could be used for mounting flood light, loudspeaker, TV camera, even a fan and on almost any sort of wall or ceiling even between wall and ceiling. The main fixing brackets rotate such that an inward or an outward corner can be accommodated. Front panel also tilts upward or downwards to a reasonable angle and can be easily removed separately for wiring. A very useful bracket. Regular price would be around £6 each. Our price only £3. Our ref 3P72. Or 2 for £5. Our ref 5P152.

MICROPHONE LEADS 6m twin screened wire terminating one end with a standard ¼in mono jack plug and the other end with the usual screwed on microphone connector. With coiled spring for lead protection. Price £1. Our ref BD174.

EXTRA SPECIAL CROC CLIPS Medium size, just right for most hook-ups. Normally sell for around 10p to 15p each. These are insulated and have a length of wire connected to them but this is very easy to snip off if you do not need it. 20 for £1. Our ref BD117A.

DON'T MISS THAT IMPORTANT CALL Fit an extension lead and take your phone in the other room with you. 5m long, one end has the standard flat BT socket and the other the standard flat BT phone plug so you don't have to interfere with the house wiring, you simply plug it in. Price £3. Our ref 3P70.

COPPER CLAD PANEL For making PCB. Size approx 12in long x 8½in wide. Double-sided on fibreglass middle which is quite thick (about ¹⁄₁₆ in) so this would support quite heavy components and could even form a chassis to hold a mains transformer, etc. Price £1 each. Our ref BD633.

3 VOLT MOTOR Very low current so should be very suitable for working with solar cells. £1 each. Our ref BD681.

STEREO HEADPHONE AMPLIFIER Very sensitive. A magnetic cartidge or tape head will drive it. Has volume control and socket for stereo headphones. 3v battery operated. £1 each. Our ref BD680.

FET CAPACITOR MICROPHONE EAGLE CI.200 Output equivalent to a high class dynamic microphone while retaining the characteristics of a capacitor microphone. Price £1. Our ref BD646.

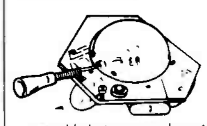
SUB-MAN TOGGLE SWITCH Body size 8mm x 4mm x 7mm SBDT with chrome dolly fixing nuts. 3 for 1.00. Order ref BD649.

POWERFUL IONISER

Generates approx. 10 times more IONS than the ETI and similar circuits. Will refresh your home, office, workroom etc. Makes you feel better and work harder – a complete mains operated kit, case included. £12.50+£2 P&P. Our ref 12P5/1.

LINEAR RECORD PLAYER Made by BSR, their ref VL315. Hailed as the most sophisticated of record players, is completely electronically controlled. Due to cancelled export order we are now able to offer these brand new, complete with cartridge and diamond stylus at only £15 plus £2 post. This is a 12v DC operated unit. Our ref 15P25. Two or more post free.

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

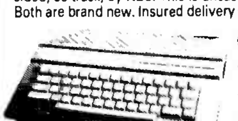


ELECTRONIC SPACESHIP. Sound and impact controlled, responds to claps and shouts and reverses when it hits anything. Kit with really detailed instructions. Ideal present for budding young electrician. A youngster should be able to assemble but you may have to help with the soldering of the components on the pcb. Complete kit £8. Our ref 8P30.

THERE IS GOING TO BE A BURIAL! For several years now we have been offering mains operated clocks at only £1 each. These are cooker clocks which in addition to telling you the time would also switch things on and off at pre-set times. However, despite this silly price these have been very slow sellers and as we have still almost 10,000 of them in store which we have to clear we are making one even sillier final offer before burying them. You can have 16 brand new clocks still in original packing for only £5. Our ref 5P151. Add £3 post if not collecting.

BUSH RADIO MIDI SPEAKERS Stereo pair. BASS reflex system, using a full range 4in driver of 4ohms impedance. Mounted in very nicely made black fronted walnut finish cabinets. Cabinet size approx 8½in wide, 14in high and 3½in deep. Fitted with a good length of speaker flex and terminating with a normal audio plug. Price £5 the pair plus £1 post. Our ref 5P141.

3½in FLOPPY DRIVES We still have two models in stock: Single sided, 80 track, by Chinon. This is in the manufacturers metal case with leads and IDC connectors. Price £40, reference 40P1. Also a double sided, 80 track, by NEC. This is uncased. Price £59.50, reference 60P2. Both are brand new. Insured delivery £3 on each or both.



ATARI 65XE COMPUTER At 64K this is most powerful and suitable for home and business. Complete with PSU, TV lead, owner's manual and six games. Can be yours for only £45 plus £3 insured delivery.

REMOTE CONTROL FOR YOUR 65XE COMPUTER With this outfit you can be as much as 20 feet away as you wil have a joystick that can transmit and a receiver to plug into and operate your computer and TV. This is also just right if you want to use it with a big screen TV. The joystick has two fire buttons and is of a really superior quality, with four suction cups for additional control and one handed play. Price £15 for the radio controlled pair. Our ref 15P27.

AGAIN AVAILABLE: ASTEC PSU. Mains operated switch mode, so very compact. Outputs +12v 2.5A, +5v 6A, ±5v .5A, ±12v 5A. Size: 7½in long x 4¾ in wide x 2¼in high. Cased ready for use. Brand new. Normal price £30+, our price only £10. Our ref 10P34 plus £1 postage.

VERY POWERFUL 12 VOLT MOTORS. ⅓rd Horsepower. Made to drive the Sinclair C5 electric car but adaptable to power a go-kart, a mower, a rail car, model railway, etc. Brand new. Price £20 plus £2 postage. Our ref. 20P22.

PHILIPS LASER

This is helium-neon and has a power rating of 2mW. Completely safe as long as you do not look directly into the beam when eye damage could result. Brand new, full spec. £30 plus £3 insured delivery. Mains operated power supply for this tube gives 8kv striking and 1.25kv at 5mA running. Complete kit with case £15. As above for 12V battery. Also £15. Our ref 15P22.

ORGAN MASTER Is a three octave musical keyboard. It is beautifully made, has full size (piano size) keys, has gold plated contacts and is complete with ribbon cable and edge connector. Can be used with many computers, request information sheet. Brand new, only £15 plus £3 postage. Our ref 15P15.

FULL RANGE OF COMPONENTS at very keen prices are available from our associate company SCS COMPONENTS. You may already have their catalogue, if not request one and we will send it FOC with your goods.

A REAL AIR MOVER Circular axial fan. It moves 205cu ft per minute which is about twice as much as our standard 4½in. square fans. Low noise, mains operated, 6½ in diameter. Ex computers. Regular price over £30 but yours for £10 if you order quickly. Our ref 10P71A.

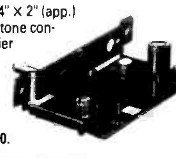
HIGH RESOLUTION MONITOR. 9in black and white, used Philips tube M24/306W. Made up in a lacquered frame and has open sides. Made for use with OPD computer but suitable for most others. Brand new. £16 plus £5 post. Our ref 16P1.

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

FDD BARGAIN

3½in made by Chinon of Japan. Single sided, 80 track, Shugart compatible interface, interchangeable with most other 3½in and 5¼in drives. Completely cased with 4 pin power lead and 34 pin computer lead £40 plus £3 insured delivery. Our ref 40P1.

MINI MONO AMP on p.c.b. size 4" x 2" (app.) Fitted Volume control and a hole for a tone control should yopu require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amp. Brand new, perfect condition, offered at the very low price of £1.15 each, or 13 for £12.00.



J & N BULL ELECTRICAL

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

MAIL ORDER TERMS: Cash, PO or cheque with order. Orders under £20 add £1.50 service charge. Monthly account orders accepted from schools and public companies. Access and B/card orders accepted. –minimum £5. Phone (0273) 734648 or 203500.

POPULAR ITEMS — MANY NEW THIS MONTH

Some of the many items described in our current list which you will receive if you request it

POPULAR ITEM AGAIN AVAILABLE Twin 0005 tuning capacitor with normal ¼in spindle now listed by many firms at over £10 each. We have htme brand new and in perfect condition at £2 each. our ref 2P40.

SUB-MIN PUSH SWITCHES Not much bigger than a plastic transistor but double pole. PCB mounting. Three for £1. Our ref BD688.

CARTRIDGES for the Double Microdrive. Price 4 for £5. Our ref 5P146.

NICAD CHARGER UNIT Metal pronged, plastic case contains mains transformer and rectifiers with output lead and plug — made to charge two cells but no doube adaptable or wonderful spares value. Only 50p each, two for £1. Our ref BD385.

EDGEWISE PANEL METER If you are short of panel space then this may be the answer. It has a FSD of 100µA and a nice full vision scale. It fits through a hole approx 1¼in x ½in. Another feature is that it has an indicator lamp behind the scale which you could light up, it would then serve as an on/off indicator. Price £1. Our ref BD700.

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

COMPUTER SPECIAL The Perex 16meg Byte tape streamer. These are brand new and really an exceptional bargain. A few only so hurry. Only £15. Our ref 15P29.

20 WATT 4OHM SPEAKER With built in tweeter. Really well made unit which has the power and the quality for hi-fi reproduction. 6½in diameter. Price £5. Our ref 5P155. It is heavy so please add £1 to cover postage if not collecting.

MINI RADIO MODULE Only about 2in square with ferrite aerial and solid dia tuner with its own knob. It is a superhet and it operates from PP3 battery and would drive a crystal headphone direct but be better with our mini mono amp. Price £1. Our ref BD716.

BULGIN MAINS PLUG AND SOCKET The old faithful 3 pin with screw terminals. The socket mounts through a 1½in hole and the mains is brought in by the insulated plug. Used to be quite expensive but you can have 2 pairs for £1 or 4 of either plug or socket for £1. You could make yourself a neat and compact bench panel with these. Our ref BD715, BD715S or BD715P.

MICROPHONE If you want a low cost microphone then just arrived we have a very small hand-held dynamic mic with on/off switch in the handle, its lead terminates with one 3.5 plug and the other a 2.5 plug for remote control. Price only £1. Our ref BD711

EXTENSION CABLE WITH A DIFFERENCE It is flat on one side making it easy to fix and to look tidy. It is 4 core so suitable for telephone, bell, burgular alarms, etc. 50 yard coil for £5. Our ref 5P153.

MOSFETS FOR POWER AMPLIFIERS AND HIGH CURRENT DEVICES 140v 100w pair made by the famous Hitachi Company. Reference 2SK413 and its component 2SJ118. Only £4 the pair. Our ref 4P42.

BATTERY OPERATED TRAVEL MECHANISM On a plastic panel measuring approx. 9in x 3½in. Is driven by a reversible 12v battery motor, fitted with a pulley and belt which rotates through a threaded rod and causes a platform to travel backwards and forwards through a distance of approx. 5in. Price £5. Our ref 5P140.

MAINS OPERATED WATER VALVE with hose connection for inlet and outlet suitable for low pressure. Auto plant watering, etc. Only £1 each. Our ref BD370.

20 VOLT 4 AMP MAINS TRANSFORMER Upright mounting with fixing feet. Price £3. 3P59.

16 OHM PM SPEAKERS Approx. 7in x 4in. 5watts. Offered at a very low price so you can use two in parallel to give you 10 watts at 8 ohms. £1 for the two. Our ref BD684.

EHT TRANSFORMER 4kv 2mA Ex-unused equipment. £5. Our ref 5P139

4 CORE TINSEL COPPER LEAD As fittd to telephones, terminating with flat BT plug. 2 for £1. Our ref BD639.

EHT TRANSFORMER 8kv 3mA. £10. Our ref IOP56

VERY USEFUL MAGNETS Flat, about 1in long, ½in wide and ¼in thick. Very powerful. 6 for £1. Our ref BD274(a).

ACORN COMPUTER DATA RECORDER Ref ALF03. Made for the Electron or BBC computers but suitable for most others. Complete with mains adaptor, leads and handbook. £10.00. Ref 10P44. Add £2 special packing.

SOLAR CELLS Will give good current (depending on size) from sunlight or bright daylight. Module A gives 100mA. Price £1. Our ref BD631. Model C gives 400mA. Price £2. Our ref 2P199. Model D gives 700mA. Price £3. Our ref 3P42.

SOLAR POWERED NI-CAD CHARGER 4 Ni-CAD batteries AA (HP7) charged in eight hours or two in only 4 hours. It is complete, boxed ready to use unit. Price £6. Our ref 6P3.

METAL PROJECT BOX Ideal for battery charger, power supply etc., sprayed grey, size 8"x4¼"x4" high, ends are louvred for ventilation other sides are flat and undrilled. Price £3. Order ref 3P75.

13A PLUGS Good British make complete with fuse, parcel of 5 for £2. Order ref 2P186.

13A ADAPTERS Takes 2 13A plugs, packet of 3 for £2. Order ref 2P187. 20v-0-20v. Mains transformers 2½ amp (100 watt) loading, tapped primary, 200-245 upright mountings £4. Order ref 4P24.

CAPACITOR BARGAIN Axial ended — 4700µf at 25v. Jap made. Normally 50p each, but you will get 4 for £1. Ref 613.

SINGLE SCREENED FLEX 7.02 copper conductors, pvc insulated then with copper screen, finally outer insulation. In fact quite normal screened flex. 10m for £1. Our ref BD668.

3 CORE FLEX BARGAIN No. 1 Core size 5mm so ideal for long extension leads carrying up to 5 amps or short leads up to 10 amps. 15m £2. ref 2P189

3 CORE FLEX BARGAIN No. 2 Core size 1.25mm so ideal for long extension leads carrying up to 13 amps or short leads up to 25A. 10m for £2. Order ref 2P190

ALPHA-NUMERIC KEYBOARD This keyboard has 73 keys with contactless capacitance switches giving long trouble free life and no contact bounce. The keys are arranged in two groups, the main area field is a QWERTY array and on the right is a 15 key number pad, board size is approx. 13"X4" — brand new but offered at only a fraction of its cost namely £3 plus £1 post. Ref 3P27.

⅛ HORSEPOWER 12 VOLT MOTOR Made by Smiths, the body length of this is approximately 3in., the diameter 3in. and the spindle ³⁄₁₆th of an inch diameter. It has a centre flange for fixing or can be fixed from the end by means of 2 nuts. A very powerful little motor which revs at 3,000rpm. We have a large quantity of them so if you have any projects in mind then you could rely on supplies for at least two years. Price £6. Our ref 6P1, discount for quantities of 10 or more.

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ABC

The Magazine for Electronic & Computer Projects

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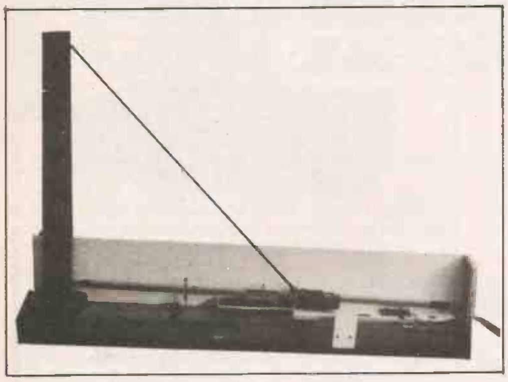
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .



Our November '89 Issue will be published on Friday, 6 October 1989. See page 619 for details.

Projects

Series

Features

THE RTC MONITOR II

100 WATT SPEAKER KIT £60.00 +£3.50 P&P (pair)

RESPONSE: 55Hz–20kHz
BASS POLYMER CONE D: 22cm
DOME TWEETER: 14mm
OVERALL SIZE
(HWD): 382,252,204mm
RECOMMENDED AMP POWER:
10-100 watts per channel

The performance standard achieved in this compact design is distinctively superior to anything else available at the price. The drive units used are of sophisticated design and have been carefully integrated with a Complex Crossover. Stereo performance is exceptionally good with a well focussed sound stage and sharp resolution of detail. Distortion throughout the frequency range is low even at quite high power input and this gives a great sense of dynamic range and openness especially when used in bi-wired mode.

Supplied with:— 2 READY CUT BAFFLES, ALL CROSSOVER COMPONENTS, 2 BASS MID-RANGE, 2 DOME TWEETERS, HOOK UP WIRE, GRILLE CLOTH, SCREW TERMINALS AND SCREWS.

CROSSOVER KIT. To build 2 sets of crossovers **£11+£1.75** post. (Featured in *Everyday Electronics*–May 1989 issue). Reprint Free with Kits

AMPHONIC 125+125 POWER AMPLIFIER

125 watt per channel stereo power amplifier with independent volume controls, professional 19" rack mount and silent running cooling fan for extra reliability.

Output power .... 125W RMS max. per channel
Output impedance .... 4 to 16 ohms (max. power into 4 ohms)
Sensitivity .... 450V at 22K ohms
Protection .... Electronic short-circuit and fuses
Power .... 220-240V a.c. 50Hz
Chassis dim .... 435×125×280mm
Weight .... 10kg approx

£124.99+£7.00 p&p

J.B.L. BOLIVAR COMPONENT SPEAKERS

10" HI-FI BASS UNIT WITH 1½" VOICE COIL, HIGH COMPLIANT, RE-INFORCED MOULDED PAPER CONE, ROLLED FOAM EDGE WITH A BIG 4½" MAGNET 6Ω IMPEDANCE **£18.73**

4½" 100W HI-FI MID RANGE 1" VOICE COIL, PAPER CONED AND DOPED CAMBRIC EDGE FITTED WITH A 3½" MAGNET. 6Ω IMPEDANCE **£5.33**

4½" HI-FI TWEETER ¾" VOICE COIL, 1¾" CONE WITH FOAM EDGE, 2¾" MAGNET, 6Ω IMPEDENCE **£6.33**

POSTAGE £4.70 PER ORDER

52W 2-WAY COMPONENT SPEAKER SYSTEM £3.95

Comprises 8in rolled surround bass unit and 2¼in tweeter for In-Car or Hi-Fi use. 4 ohm. *Made by Sanyo.*

8 OHM HI-FI COMPONENT SPEAKER £4.95
6½in. Audax 60w. Res freq. 45Hz bass-mid
8in SOUND LAB 60W £12.95
Res freq. 38Hz full range
12in DANTEX 100W £21.75
Res freq. 23Hz bass unit
Postage **£3.20** each order

★ SPECIAL PURCHASE
Batteries C size NiCad 2.2 Ah EVERY-READY AN220
£1.98 each

£1 BARGAIN PACKS BUY 10 GET 1 FREE

Please state pack(s) required
No=Order No. Qty=Quantity per pack

No	Qty	
BP010	2	6½" Speaker 8Ω 10 watt
BP012	2	6½" Speaker 4Ω 10 watt
BP013	3	8"×5" Speaker 4Ω 6 watt *made by E.M.I.*
BP015A	1	5½" full range 12 watt 4Ω speaker with matching grill. For small p.a. or in car use.
BP015B	1	30 watt, dome tweeter. Size 90×66mil *JAPAN made*
BP016	6	2200µf can type Electrolytic 25V d.c computer grade *made in UK by PHILIPS*
BP017	3	33000µf 16V d.c. electrolytic high quality computer grade *UK made*
BP018	3	2000µf 50V d.c. electrolytic high quality computer grade *made in USA*
BP019	20	20 ceramic trimmers
BP020	4	Tuning capacitors, 2 gang dielectric a.m. type
BP021	10	3 position, 8 tag slide switch 3 amp rated 125V a.c. *made in USA*
BP022	5	Push-button switches, push on push off, 2 pole change over. PC mount *JAPAN made*
BP023	6	2 pole 2 way rotary switch
BP024	2	Right angle, PCB mounting rotary switch, 4 pole, 3 way rotary switch *UK made by LORLIN*
BP025	4	3 pole, 3 way miniature rotary switch with one extra position off (open frame YAXLEY type)
BP026	4	4 pole, 2 way rotary switch *UK made by LORLIN*
BP027	30	Mixed control knobs
BP028	10	Slide potentiometers (popular values)
BP029	6	Stereo rotary potentiometers
BP030	2	100k wire wound double precision potentiometers *UK made*
BP031	6	Single 100k multitune pots, ideal for varicap tuners *UK made by PHILIPS*
BP032	4	UHF varicap tuner heads, unboxed and untested *UK made by PHILIPS*
BP033	2	FM stereo decoder modules with diagram *UK made by PHILIPS*
BP034	3	AM IF modules with diagram UK made by PHILIPS
BP034A	2	AM-FM tuner head modules. *UK made by MULLARD*
BP034B	1	Hi-Fi stereo pre-amp module inputs for CD, tuner tape, magnetic cartridge with diagram. *UK made by MULLARD*
BP035	6	All metal co-axial aerial plugs
BP036	6	Fuse holders, panel mounting 20mm type *JAPAN made*
BP037	6	In line fuse holders 20mm type *UK made by BULGIN*
BP038	20	5 pin din, 180° chassis socket
BP039	6	Double phono sockets, Paxolin mounted
BP041	3	2.8m lengths of 3 core 5 amp mains flex
BP042	2	Large VU meters *JAPAN made*
BP043	30	4V miniature bulbs, wire ended, new untested
BP044	2	Sonotone stereo crystal cartridge with 78 and LP styli *JAPAN made*
BP045	2	Stereo cassette record and play heads *JAPAN made*
BP046	4	6-0-6 4VA mains transformers, P.C. mount *UK made*
BP047	1	24V 750mA mains power supply. Brand new boxed *UK made by MULLARD*
BP049	10	OC44 transistors. Remove paint from top and it becomes a photo-electric cell (or P12) *UK made by MULLARD*
BP050	30	Low signal transistors n.p.n., p.n.p. types
BP051	6	14 watt output transistors. 3 complimentary pairs in T066 case *(Ideal replacement for AD161 and 162s)*
BP052A	1	Tape deck pre-amp IC with record/replay switching No LM1818 with diagram
BP053	5	5 watt audio ICs. No TBA800 *(ATEZ)*
BP054	10	Motor speed control ICs, as used with most cassette and record player motors
BP055	1	Digital DVM meter I.C. *made by PLESSEY* as used by *THANDAR* with diagram
BP056	4	7 segment 0.3 LED display (R.E.D.)
BP057	8	Bridge rectifiers, 1 amp, 24V
BP058	200	Assorted carbon resistors
BP059	1	Power supply PCB with 30V 4V/A transformer. MC7818CT IC & bridge rectifier: Size 4"×2¾"
BP060	1	Transcription record player motor 1500rpm 240V a.c.
BP061	5	6.35mm Mono jack plugs
BP063	5	6.35mm stereo switched jack sockets
BP064	12	Coax chassis mount sockets
BP065	1	3mtr Euro-mains lead with a matching chassis socket

MULTIBAND RADIO

VHF 54-176 MHz + AM CB BANDS 1-80
Listen to: AIR TRAFFIC CONTROL, AIRCRAFT, RADAR PUBLIC UTILITIES RADIO AMATEURS AND MANY MANY MORE

£15.95
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SQUELCH CONTROL
"RUBBER DUCK AERIAL"

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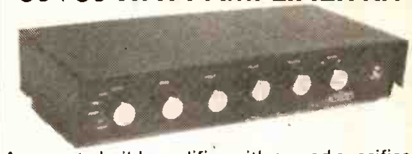
MAIL ORDER TERMS. POSTAL ORDERS and or CHEQUES with orders. Orders under £20 add £3.00 service charge. Nett monthly accounts to Schools, Colleges and P.L.C. only. ACCESS / VISA. *Phone orders between 9.30 & 12pm please Phone: 01-723 8432 or 01-992 8430*
Callers 323 Edgware Road, London W2

30+30 WATT AMPLIFIER KIT



An easy to build amplifier with a good specification. All the components are mounted on the single P.C.B. which is already punched and backprinted.

- 30W×2 (DIN 4 ohm)
- CD/Aux, tape I, tape II, tuner and phono inputs.
- Separate treble and bass
- Headphone jack

Size (H.W.D.) 75×400×195mm
Kit enclosed: case, P.C.B., all components, scale and knobs **£36.80.** post £3.50
(Featured project in *Everyday Electronics* April 1989 issue). Reprint Free with kit.

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 preselected tuning controls. It can also be used in conjunction with your video recorder.

£29.50 +£2,50 p&p

As above but with built-in stereo headphone amplifier for the hard of hearing
You can tune into the TV 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: 270×192×65mm. **£35.90** +£2.50 p&p

A.M. F.M. STEREO TUNER KIT

SPECIAL OFFER!*
£8.95 *Plus £2.50 p&p*
This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics
For ease of construction and alignment it incorporates three Mullard modules and an I.C. I.F. System.
FEATURES: *VHF, MW, LW Bands, interstation muting and AFC on VHF. Tuning meter. Two back printed PCB's. Ready made chassis and scale. Aerial: AM-Ferrite rod, FM-75 or 300 ohms. Stabilised power supply with 'C' core mains transformer. All components supplied are to strict P.E. specification. Front scale size: 10½"×2½" approx. Complete with diagram and instructions.*

Hi-Fi stereo cassette deck transport mechanism, complete with 3 digit rev counter and tape heads, 12V d.c. operation. Unused manufacturers surplus *JAPAN made*
£6.20 +£1.50 P&P 2 for £10 +£2.50 P&P

EXTRACTABLE HOUSING FOR YOUR CAR STEREO ★ SIZE DIN E ★ HANDLE INCLUDED ★ SPACE FOR MEMORY BATTERY ★ 4 OR 2 SPEAKER SYSTEM.
ENABLES YOU TO REMOVE YOUR VALUED STEREO FROM YOUR CAR (WITHOUT THE AID OF A HAMMER AND CHISEL, CHAINSAW ETC). **£9.95 postage £2.50**

NEXT MONTH

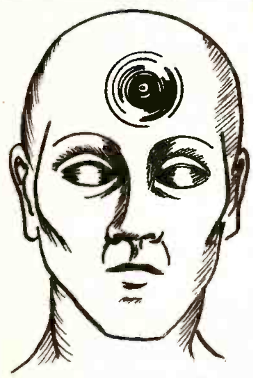
FREE

WITH THIS ISSUE OF EE
GREENWELD
ELECTRONICS COMPONENTS CATALOGUE

132 PAGES OF BARGAINS

WORTH £1.50

Once again EE is proud to be able to give away the full Greenweld catalogue. It comes FREE, banded with every copy next month.



EEG BIOFEEDBACK MONITOR

Would you like to listen to the rhythms of your mind?
You don't have to be a master of Zen and Yoga to learn how to relax after a stressful day!
The brain produces various frequencies of electrical or "brain-wave" activity, the best known being Alpha, Beta and Theta. Scientists believe the control of these "waves" is one of the secrets of ralaxing.

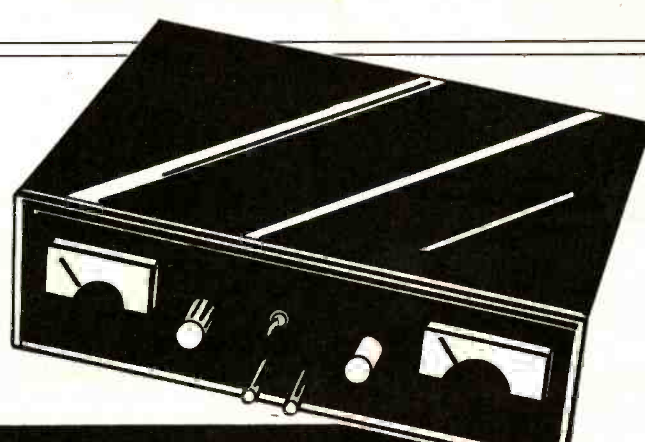
Build the EEG Biofeedback Monitor and all will be revealed.

IRON-ON REMINDER

Forgetting about a switched-on soldering iron can have results varying from pitted bit to a fire hazard, especially if left overnight. So, for constructors who habitually nod off, or wander away to watch their favourite TV programme, this circuit is a must.

VARIABLE POWER SUPPLY

A powerful, fully variable 0-30V 2A output power supply that will prove invaluable in the workshop.



EVERYDAY ELECTRONICS

NOVEMBER ISSUE ON SALE OCTOBER 6 1989

NEW COMPONENT PACKS

New components, lots of new packs, and a better selection than ever in the old favourites. If you haven't yet sampled these delicious component assortments, you just don't know what you're missing! All the packs are **£1** (+VAT) each, but if you order five packs you can select an extra one **FREE**. Order ten packs and you can have three extra packs **FREE**. Go for it!

PASSIVE COMPONENTS

PACK 1 – 200 RESISTORS. Finest carbon film, with lots of E12 values and a few precision.
PACK 2 –100 CAPACITORS. Polystyrene, ceramics, metallised film. A fine selection!
PACK 3 –30 ELECTROLYTICS. Values to 470µF.
PACK 4 –15 LARGE ELECTROLYTICS. Values to 4,700µF.
PACK 5 – 10 TANTALUM CAPACITORS. Values from 0.1µF to 68µF!
PACK 6 – 20 HIGH VALUE POLYESTER CAPACITORS. Values to at least 3µ3.
PACK 7 – 15 DIL RESISTOR NETWORKS. Lots of values.
PACK 8 – 50 POWER RESISTORS. 1W and above.
PACK 9 – 30 SUB-MINIATURE CAPACITORS. Look like diodes!

OPTO ELECTRONICS & DISPLAYS

PACK 11 – 10 5mm LEDS: 4 red, 2 yellow, 2 orange, 2 green.
PACK 12 – 10 3mm LEDs: 4 red, 2 yellow, 2 orange, 2 green.
PACK 13 – 10 Rectangular LEDs. Mixed red and green.
PACK 14 – 10 Mixed LEDs. All shapes, sizes, colours.
PACK 15 – 2 DUAL 0.3" CA 7-seg displays (panel type).
PACK 16 – 1 DUAL 0.5" CC 7-seg display (panel type).
PACK 17 – 1 QUAD 0.3" CA 7-seg display (panel type).
PACK 18 – 2 INFRA-RED COMPONENTS. Emitter and receiver.
PACK 20 – 1 CALCULATOR DISPLAY, eight digits.
PACK 23 – 2 PHOTOTRANSISTORS. Respond to visible and IR light.

SEMICONDUCTORS

PACK 26 – 3 TAG136D MAINS TRIACS (400V, 4A).
PACK 27 – 30 IN4000-SERIES RECTIFIERS.
PACK 28 – 30 MIXED SEMICONDUCTORS. Diodes, transistors, ICs, triacs, all sorts.
PACK 29 – 20 ASSORTED ICs. CMOS, TTL, linear, memory, as available. Changes daily!
PACK 30 – 20 TRANSISTORS. High grade general purpose NPN.
PACK 31 – 12 BC212 TRANSISTORS. High grade general purpose PNP.
PACK 32 – 12 BC213 TRANSISTORS. High grade general purpose PNP.
PACK 33 – 3 DUAL OP-AMPS MC1458. With data.
PACK 35 – 20 RECTIFIERS. Studs, high current, glass bead, top hat, IN4000, etc.
PACK 36 – 50 DIODES 1N4148. The most popular type for projects!
PACK 39 – 10 SURFACE MOUNT AND LCC ICs. Special hi-tech pack!

MISCELLANEOUS

PACK 41 – 4 POWER MICROSWITCHES. Push to break.
PACK 42 – 8 SPST STANDARD MICROSWITCHES (V3).
PACK 43 – 5 SPST ROLLER-OPERATED MICROSWITCHES (V3).
PACK 44 – 1 MINI BIO-FEEDBACK KIT. With PCB, components and instructions.
PACK 45 – 1 MINI DREAM-MACHINE KIT. With PCB, components and instructions.
PACK 46 – 1 MINI BURGLAR ALARM KIT. With PCB, components and instructions.
PACK 47 – 6 AUDIO TRANSFORMERS.
PACK 48 – 200 CABLE CLIPS to attach alarm or doorbell wires to wall.
PACK 51 – 1 CRYSTAL OSCILLATOR MODULE, 19.6608MHz.
PACK 52 – 12 PP3 BATTERY CLIPS.
PACK 53 – 2 PIEZO TRANSDUCERS. Use as microphone or speaker.
PACK 60 – 100 MYSTERY PACK of at least 100 components. The most popular pack of all!

AUTUMN COLLECTION

Buzz like a butterfly, hoot like a bee; the computer you pay for, but the switches are free! Match this famous quotation with our equally famous sound effects computer, and you could be on your way to a fortnight's holiday in the Canary Islands. On the other hand, you're much more likely to be sitting in your front room. But you never can tell where people read their electronics mags, can you?

SOUND EFFECTS COMPUTER

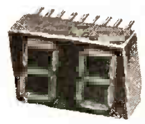
Take a powerful PIC655A single chip computer, mask program it to produce the most outrageously realistic sound effects, add an audio amplifier to bring them up to loudspeaker level, and you have the Highgrade Sound Effects Computer. How about a motor rally, complete with gear changes? Or a ship hooting its mournful way through the fog? Or a fly so realistic it'll have you running for the swat! Sirens, helicopters, steam trains, aliens – you name it, it's in there. The computer is easily programmed with the thirteen switches supplied. In one mode you can even play it like a synthesizer! I have to admit, it's my favourite project of the moment.
With your computer we also give you: a battery connector, a loudspeaker, thirteen switches, and a wiring diagram and programming instructions. You add a PP3 battery, a length of connecting wire and ten minutes of your time to connect it all together.
SOUND EFFECTS COMPUTER KIT **£12.80!** (+VAT)

LCD DISPLAY MODULES

On one side of the PCB is an LCD which displays two lines of text and symbols. On the back there's a powerful surface-mount drive IC to take in data, store it, and drive the display. Interface is through an eight-way connector for the power supply and data signals. We supply full data on the IC, which should be enough for you to get it up and running!
LCD DISPLAY MODULE **£6.60** (+VAT) 10 DISPLAYS **£54!** (+VAT)

LED DISPLAYS

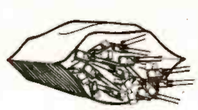
TYPE 1: DUAL 0.56" COMMON ANODE
Large, high brightness digits for displays that have to be visible at some distance. Each display has two digits, but the connections to each are entirely separate. They can be butted up to each other to make a display as long as you choose! And just look at the price:
10 0.56" DUAL CA DISPLAYS **£4.80!** (+VAT) 50 DISPLAYS FOR **£22!** (+VAT)



TYPE 2: 1½ DIGIT 0.5" COMMON CATHODE
Another two digit display, with the left-hand one lighting up as ±1. Once again, connections to the two digits are entirely separate.
PACK OF 10 1½ DIGIT 0.5" CC DISPLAYS **£3.80!** (+VAT) 50 DISPLAYS FOR **£17!** (+VAT)

BAR-GRAPH LED MODULE

Eleven rectangular green LEDs assembled as a bar graph display. The central LED is turned edge-on to indicate the 'normal' position, or for centre-zero or tuning indicator displays. All LED leads are individually available at the rear of the assembly.
BAR GRAPH MODULE **£1.40** (+VAT) 10 MODULES **£11.80!** (+VAT)



LEDs

Rectangular LEDs in a tasteful shade of green, or a violent primary red. Bring some colour into your life! The prices ARE genuine.
PACK OF 100 RED, GREEN OR MIXED (you choose) RECTANGULAR LEDs **£3!** (+VAT)
PACK OF 500 RED, GREEN OR MIXED LED's **£14!** (+VAT)

BUFFER AMP

Elantec EL2033 damn fast (100MHz) buffer amplifiers. Equivalent to National LH0033C. Current list price is **£28.50** each, I kid you not. With data.
EL2033 100MHz BUFFER AMP **£2.80!** (+VAT)

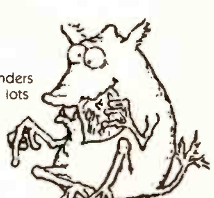
KEYBOARDS

Full size QWERTY keyboard units with separate numeric pad and function keys. Exactly 100 keys in all. Must be good value just for the switches!
COMPUTER KEYBOARD **£4.80!** (+VAT)

POWER METERS

Meter movement scaled 0-10 with red pointer against a green scale which can be back lit for glowing effect. Full scale approx. 1mA.
POWER METER **£1.80!** (+VAT) 5 METERS **£7.80** (+VAT)

MONSTER PARCELS



PARCEL 3 Lots and lots of ICs. Who knows what might turn up? Into the parcel go all the remainders from past lists, ICs we haven't got enough of to advertise separately, all the CMOS and TTL, and lots more. Some IC's will be common and familiar, some won't. Some have data and some don't. Some you'll recognise at once, others you'll have to do some detective work on. A fascinating mixture with lots of nice surprises for you if you know your ICs.
PARCEL 3A: 100 ICs for **£12!** (+VAT) PARCEL 3B: 500 ICs for **£49!** (+VAT)

PARCEL 4 Tants. So much nicer than common old electrolytics, I always think. An excellent range of values, now reaching as high as 68µF (all parcels) and up to 100µF if you're lucky!
PARCEL 4A: 100 TANTS FOR **£6.80!** (+VAT) PARCEL 4B: 500 TANTS FOR **£29!** (+VAT)

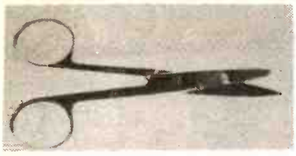
PARCEL 6 Transistors. A useful selection of general purpose types, with a few exotics to keep you on your toes. Lots of BC212s, BC54Bs, and other common types.
PARCEL 6A: 200 TRANSISTORS for **£7.80!** (+VAT)

PARCEL 7 LEDs! All kinds of shapes, sizes, styles and colours. How about making an LED garden? During the day, flowers. At night, a spectacular display of coloured LEDs!
PARCEL 7A: 100 LEDs for **£5.90!** (+VAT)
PARCEL 7B: 500 LEDs for **£24.90!** (+VAT)

UK Orders: Please add £1 postage and packing and 15% VAT to the total (including postage).
Europe and Eire: Please add £2.50 carriage and insurance. No VAT.
Outside Europe: Please add £4.80 carriage and insurance. No VAT.
Access Orders Please phone 0600 3715 for immediate attention to your order.

HIGHGRADE COMPONENTS LTD UNIT 111, 8 Woburn Road, Eastville, Bristol BS5 6TT.

SURGICAL TOOLS



Another parcel of precision made stainless steel high grade surgical tools, made by Rocket of London.
All these tools have minor surface faults (very difficult to find on many!!)

TWEEZERS
A wide variety of sizes and styles, from a small 86mm tweezer to a robust 205mm pair for heavy duty work. Sold in sets as described below at a substantial saving over the individual price; typically £6 per pair!
Z4191 Pack of 11 all different, featuring both straight and curved ends, serrated and plain varying in length from 86mm to 205mm. List price is around £100. **£12.95.**
Z4192 Pack of 6 pairs (over 130mm) **£7.95.**
Z4193 Pack of 6 small pairs (up to 150mm) **£6.95.**
Z4194 Pack of 6 selected pairs across the range. **£7.50.**

SCISSORS
Superb quality instruments with pointed, rounded and flat ends. Again these are sold in sets to give excellent value.
Z4195 Pack of 10 assorted pairs from 100 to 140mm long, with both pointed and rounded ends, straight and curved cutting blades. Everything from extremely fine points to general purpose. All 10 pairs for just **£13.95.**
Z4196 Pack of 5 asst. pairs across the range **£7.95.**

BREADBOARDS

PROTOBLOC 1
G708 Protobloc 1 has a total of 400 tie points consisting of two sets of 30 rows of 5 interconnected sockets plus 4 rows of interconnectd sockets running alongside, suitable for use as power supply rails. All contact positions are clearly defined on an alphanumeric grid. ABS polymer board mounted on an adhesive foam base. Will accommodate up to three 16 pin devices. An ideal introduction to solderless circuit development systems. Size 80×60mm **£2.50**

PHOTOBLOC 2
G711 Photobloc 2 has a total of 840 tie points consisting of two sets of 64 rows of 5 interconnected contact sockets plus 4 rows of 50 interconnected socklets running alongside, suitable for use as power supply rails. All contact positions are clearly defined on an alphanumeric grid. ABS polymer board mounted on an adhesive foam base. Will accommodate up to seven 16 pin devices.
Size 172×64mm **£3.95**

PHOTOBLOC 2A
G712 As above, but the ABS polymer board is mounted onto a rigid base plate complete with three 4mm terminals in red, black and green for power connections. A mounting bracket which clips into the base is also provided to accept a variety of components including switches and potentiometers, etc.
Price **£6.95**

PROJECT BOARD GL24
G724 2 of type G711 mounted onto a rigid baseplate with 3 coloured terminals, for power connections. Over-all size 225×150mm **£13.95**

PROJECT BOARD GL36
G736 3 of type G711 and an additional strip of 100 tie points mounted onto a rigid base plate with 4 coloured terminals. Overall size 242×195mm
Price **£19.95**

POWER SUPPLIES

0-24V DC 3A
A112 Variable stabilized power supply with overload protection. Meter reads voltage or current (switched). Two voltage ranges; 0-12V and 12-24Vd.c. Ideal for laboratory use.
Input voltage:- 240Va.c. 50Hz
Output voltage:- .... 0-24Vd.c. (2 ranges)
Stability:- 0.2%
Ripple:- 2.5mV
Dims:- .... 180 × 110 × 180mm
Price £64.50

0-24V DC 5A
A113 Variable stabilized power supply with overload protection. Meter reads voltage or current (switched). Two voltage ranges; 0-12V and 12-24Vd.c. Ideal for laboratory use.
Input voltage:- 240Va.c. 50Hz
Output voltage:- .... 0-24Vd.c. (2 ranges)
Stability:- 0.2%
Ripple:- 4mV
Dims:- .... 180 × 180 × 110mm
Price £85.00

1990 CATALOGUE

128 PAGES OF ELECTRONIC COMPONENTS AND EQUIPMENT. HUGE RANGE! AMAZING VALUE! DON'T MISS OUT — RESERVE YOUR COPY NOW — ONLY £1.50 POST FREE!! PUBLISHED ON 1st OCTOBER 1989

HITACHI OSCILLOSCOPES
FOR QUALITY AND VALUE

V223 DC-20MHz, dual Channel, single time base delayed sweep, DC offset, alternate magnifier, 6in screen, 5mV/div vest. sensitivity 0.2µs/div-0.2s/div sweep time. Complete with 2 probes, manual, mains lead. **£475**

Other models from **£339** — full details in catalogue.

SWITCH MODE POWER SUPPLIES

ASTEC Model AA12531
I/P: 115/230V ac 50/60Hz
O/P: V1 + 5v 5A
V2 + 12v 0.15A
Size: 160 × 104 × 45mm
Partially enclosed panel with fixing holes in steel case on 120 × 125mm centres.
Inputs and Outputs are on colour coded leads; there is also an EEC socket on a flying lead .... **£6.95.**

ASTEC Model AC9231
I/P: 115/230V ac 50/60Hz
O/P: 50Watt max:
V1 + 12v 2.5A
V2 + 5v 6.0A
V3 12v 0.5A (+ or −)
V4 5v 0.5A (+ or −)
Size: 203 × 112 × 60mm
Fully enclosed case with built in tapped mounting holes.
Inputs and Output pins on edge of panel .... **£12.95.**

CAR SPEAKERS

New range of high power, high quality 'Soundlab' speakers.
Specially designed for in-car use at powers up to 240W!! All are 4Ω impedance.
Chassis mounting models, complete with leads, grilles and all necessary fixings:
RTS410 2×50W, 4in, 100-18,000Hz **£12.95**
RTS520 2×50W, 5in+1¾in, 80-18,000Hz **£15.95**
RTS630 2×100W, 6½in+2in+1in, 60-20,000Hz **£29.95**
PODS — Sophisticated 3-speaker systems:
RTS300 2×75W, 3in, 2in & 1in units, 80-18,000Hz ... **£27.95**
RTS400 2×120W, 4in, 2in & 1in units, 60-20,000Hz . **£39.95**

METEX METERS
8 different models in our catalogue!!

- ★ 4½ digit 12mm LCD display
- ★ 30 ranges including **20A ac/dc**
- ★ **Frequency counter**
- ★ Capacitance test with zero adjust
- ★ **Data hold switch**
- ★ Transistor test
- ★ Diode test
- ★ Continuity test
- ★ Test leads with 4mm plugs
- ★ Rugged yellow case
- ★ Carrying case

Battery and instruction manual included.
AC volts 0-200m-2-20-200-750Vac ±0.5%
DC volts 0-200m-2-20-200-1000Vdc ±0.5%
AC current 0-2m-200m-20Aac ±1.0%
DC current 0-200µ-2m-200m-20Adc ±0.5%
Resistance 0-200-2k-20k-200k-2M-20MΩ ±0.15%
Capacitance 0-20p-200n-20µF ±2.0%
Frequency 0-20k-200kHz ±2.0%
Transistor hFE 0-1000 NPN/PNP
Dims 176 × 90 × 36mm

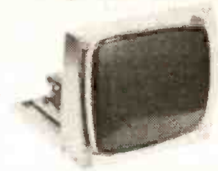
M4650 £94.00

GREENWELD ELECTRONIC COMPONENTS

All prices include VAT; P&P **£2.00** per order. Min Credit Card £5. No CWO min. Official Orders from Education welcome — min invoice charge £10.00
Our shop has enormous stocks of components and is open from 9-5.30 from Mon-Sat. Come and see us!
HOW TO CONTACT GREENWELD: By Post: Use the address below: **By Phone:** (0703) 772501/783740 (ansaphone out of business hours): **By Fax:** (0703) 787555: **By EMail:** 72:MAG36026: **By Telex:** 9312131093 (GW G).
Payment is accepted by cheque/postal order/cash inc foreign currency bank notes/book tokens.

443D MILLBROOK ROAD, SOUTHAMPTON, SO1 0HX.

GREEN SCREEN HI-RES 12in MONITOR CHASSIS



Brand new and complete except for case, the super high definition (1000 lines at centre) makes this monitor ideal for computer applications. Operates from 12V d.c. at 1.1A. Supplied complete with circuit diagram and 2 pots for brilliance/contrast, plus connecting instructions. Standard input from IBM machines, slight mod (details included) for other computers .... **Only £24.95**

DISK DRIVE PSU KIT
Ideal for powering single 3½in or 5¼in drive. Mains input, stabilized smoothed outputs, 5V at 1A + 12V at 1A. Simple, easy to assemble kit with all parts and full instructions. **£4.95**

FREE SOFTWARE!!
To introduce our NEW software service, featuring all the best public domain and shareware, we're giving away, absolutely free, a 5¼in disk containing a complete catalogue of over 500 programs together with 2 FREE games.
To obtain your free copy, simply add to your order "FREE DISK". Don't forget to add £2.00 post, even if you order nothing else! Please note all available software, plus this free disk is only for IBM PC compatible machines using MS.DOS.
The catalogue on disk contains brief information on all software available.

BIB ACCESSORIES
BCC11 Liquid Static Eliminator. A spray can of special formula liquid giving long term neutralisation of all harmful static charges from all glass and plastic surfaces. Comes complete with cloth. **£1.**
BCC8 Computer terminal maintenance kit for screen, keyboard and printer. Contents: Soft brush for keyboard and stiff brush for printer and print cleaning fluid. Aerosol can of air-blast. Kleen-Screen, an antistatic liquid; cleaning cloths. All this is contained in a presentation pack for just **£2.95.**
VE13 Lens Care Kit — High quality brush with dust protector, a bottle of antistatic lens cleaning fluid and a super soft lint free cleaning cloth, all contained in a handy storage wallet. Ideal for all still and movie/video camras — plus of course, spectacles. Offered at the exceptionally low price of just **£1.50.**

ANTEX SOLDERING EQUIPMENT
We stock the full range of Antex Soldering Irons, all at discounted prices.
Model C Popular basic 15 watt model.
Price .... **£7.95.**
Model CS 17 watt model with leakage less than 2µA .... **£7.95.**
Model XS 25 watt general purpose iron, with a wide range of bits available.
Price .... **£7.95.**
Model MLXS For car/boat/caravan, this 12V model with large clips to connect on battery is rated 25 watts .... **£10.95.**

STEREO VIDEO SOUND MIXER

MX300 This versatile mixer is an essential part of editing videotapes. It allows audio inputs from camcorder or second video recorder (phono), cassette recorder or other music source (phono), and 2 microphones (3.5mm). The original soundtrack can be monitored and there is a master output (phono) to the VCR. Power can be a PP3 battery of an external 9V source. Smartly styled in a sloping front case with a matt black finish the overall dimensions are
175 × 110 × 55mm .... **£19.95.**

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

KIT REF 444

£20.85

PET SCARER
EE MAY 89
Produces high power ultrasound pulses. L.E.D. flashes to indicate power out-put and level. Battery powered (9V–12V or via Mains Adaptor).

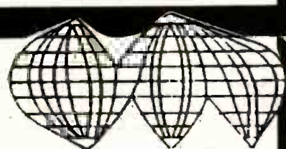
KIT REF 812
Mains Adaptor £1.98

£13.80

DIGITAL CAPACITANCE METER
EE DEC 85
Simple and accurate (1%) measurement of capacitors from a few pF up to 1,000 μF. Clear 5-digit LED display indicates exact value. Three ranges – pF, nF, and μF. Just connect the capacitor, press the button and read the value.

KIT REF 493

£44.25



3 BAND SHORT WAVE RADIO
EE AUG 87
Covers 1.6–30 MHz in 3 bands using modern miniature coils. Audio output is via a built-in loudspeaker. Advanced design gives excellent stability, sensitivity and selectivity. Simple to build.

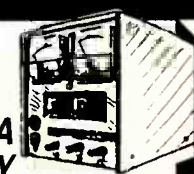
KIT REF 718

£28.25

DIGITAL FREQUENCY 200 MHz METER
EE NOV 86
An 8 digit meter reading from AF up to 200 MHz in two ranges. Large 0.5" Red LED display. Ideal for AF and RF measurements. Amateur and C.B. frequencies.

KIT REF 563

£62.98



MOSFET VARIABLE BENCH 25V 2.5A POWER SUPPLY
EE FEB 88
A superb design giving 0.25V and 0-2.5A. Twin panel meters indicate Voltage and Current. Voltage is variable from zero to 25V. A Toroidal transformer MOSFET power output device, and Quad op-amp IC design give excellent performance.

KIT REF 769

£52.96

MINI STROBE
EE MAY '86
A hand held stroboscope which uses 6 "ultra bright" LEDs as the light source. Designed to demonstrate the principles of stroboscope examination, the unit is also suitable for measuring the speed of moving shafts etc. The flash rate control covers 170–20,000 RPM in two ranges.

KIT REF 529

£14.76

ACOUSTIC PROBE
EE NOV '87
A very popular project which picks up vibrations by means of a contact probe and passes them on to a pair of headphones or an amplifier. Sounds from engines, watches and speech travelling through walls can be amplified and heard clearly. Useful for mechanics, instrument engineers and nosey parkers!

KIT REF 740

£18.65

MAINS TESTER & FUSE FINDER
EE MARCH '86
A handy unit which sounds an audible warning when the mains supply is disconnected and gives visual indication on three neon lamps of the connections to mains sockets. Designed for checking correct connections of mains wiring and for tracing which socket connects to which fuse in fusebox. Can detect no live, no neutral, no earth, L/N reversal, L/E reversal.

KIT REF 512

£9.39

EE EQUALISER
EE MAY '87
A mains powered Ioniser with an output of negative ions that give a refreshing feeling to the surrounding atmosphere. Negligible current consumption and all-insulated construction ensure that the unit is safe and economical in use. Easy to build on a simple PCB.

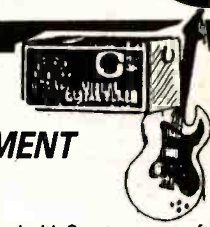
KIT REF 707

£16.54

MUSICAL DOORBELL
EE JAN '86
This project uses a special I.C. pre-programmed with 25 tunes and 3 chimes. A Magenta design, the circuit is battery powered and only draws current whilst producing sounds. Two rotary switches select the tune required. Provision is made for three bell pushes, each of which sounds a different tune, so that three points of entry can be identified.

KIT REF 497

£19.95



VISUAL GUITAR INSTRUMENT TUNER
EE JUNE '87
Magenta designed with Quartz accuracy from a built in crystal. The guitar string frequency is compared with the reference to produce an ouptput in the form of "rotating" circle of LEDs. Speed and direction of rotation indicates how far out of tune. Possible to tune other instruments by simple circuit modification.

KIT REF 711

£24.48

LIGHT RIDERS
EE OCT '86
Thre projects under one title – all simulations of the Knight Rider lights from the TV series. The three are a lapel badge using six LEDs, a larger LED unit with 16 LEDs and a mains version capable of driving six main lamps totalling over 500 watts.

KIT REF 559 CHASER LIGHT	**£14.52**
KIT REF 560 DISCO LIGHTS	**£20.89**
KIT REF 561 LAPEL BADGE	**£10.86**

EE TREASURE HUNTER
EE AUG '89
A sensitive pulse induction Metal Detector. Picks up coins and rings etc., up to 20cms deep. Low "ground effect". Can be used with search-head underwater. Easy to use and build, kit includes search-head, handle, case, PCB and all parts as shown.

KIT REF 815 — **£39.95**
Headphones — **£1.99**

STEPPING MOTOR INTERFACE
EE JULY '85
This interface enables 4 phase unpolar stepping motors to be driven from four output lines of any computer user port. The circuit is especially suitable for the ID35 motor and our MD200 which are commonly used in buggies and robot arms. Supplied complete with ribbon cable and connector for the BBC user port.

KIT REF 464

£8.95

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

The Magazine for Electronic & Computer Projects

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THE SEASON

This issue marks the start of another "season" of electronics. The schools and colleges are back, hobbyists are getting down to earnest construction work after the summer "sunshine" lay-off and many training schools and companies are launching a new set of recruits on their future careers.

It is always a busy time for us and a time when issues are bursting with extras. This year is no exception with the *Marco* catalogue free inside this issue and *Greenweld's* free with next month's issue. December will carry a free circuit board, together with a couple of projects you can build on it, and all these issues will have a bumper crop of projects, etc.

SNAPPED UP

I am sure all readers will find the catalogue particularly useful so please make sure your copy is ordered from your newsagent. It is inevitable that issues with catalogues and other extras are snapped up quickly and while we do print extras to meet the demand there can still be shortages in some areas.

If you do have difficulty in getting a copy please let us know, we can usually get our distributors to investigate. Our circulation is steadily rising and that can sometimes go unnoticed by newsagents who find themselves with a shortfall.

TEACH-IN

Another *Teach-In* book – No. 3 – is about to be published. This one is the complete *Exploring Electronics* series that appeared in *Everyday Electronics* some time ago. The 28 parts have been collected together into a single publication costing just £2.45. For anyone interested in "learning by doing" this publication is a must – watch out for it on the bookstalls on 22nd September.

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Annual subscriptions for delivery direct to any address in the UK: £15.70. Overseas: £19.00 (£36 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

Certain back issues of EVERYDAY ELECTRONICS are available price £1.50 (£2.00 overseas surface mail—**£ sterling only please**) inclusive of postage and packing per copy. Enquiries with remittance, made payable to Everyday Electronics, should be sent to Post Sales Department, Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH. In the event of non-availability remittance will be returned. *Please allow 28 days for delivery.* **We have sold out of Sept. Oct. & Dec. 85, April, May, Oct. & Dec. 86, April, May & Nov. 87, Jan., March, April, June & Oct. 88.**

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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.

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

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

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

EE SEISMOGRAPH

TONY HOPWOOD and ANDY FLIND — Part One

Is this the first homebrew Seismograph? Watch for earthquakes and nuclear tests around the world.

QUITE A FEW months ago it was decided to build a seismograph and the following is the fruit of this dedicated labour.

There are few books on the subject, so building one turned out to be a voyage of discovery in a little travelled scientific backwater.

The theory is simple enough. A freely suspended mass will tend to remain still as the earth trembles under it, and the relative motion between the support frame and mass can be detected and recorded by mechanical or electronic means to give the profile of a seismic event.

There are two basic types of seismometer. Portable "velocity type" instruments designed to respond to vertical or transverse waves shorter than two seconds period, and longer period fixed instruments. The most spectacular traces are recorded by long period instruments which can detect the surface waves arriving from earthquakes anywhere on the planet, so that's what I built.

A seismometer tuned to over six seconds period has the big advantage of discriminating against short wave local disturbances like traffic, while still able to detect the short sharp transients that signify the onset of a distant earthquake.

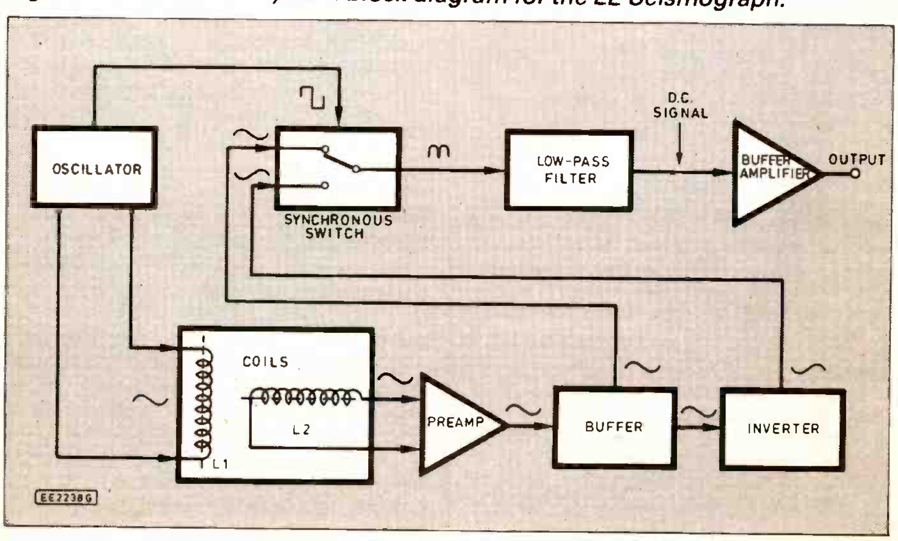
It was decided to build a "garden gate" type — a horizontal pendulum tuned to an eight second period, with the beam set North/South to be most sensitive to East/West transverse waves.

Short period instruments are usually electrodynamic with a moving magnetic mass exciting a fixed coil to convert seismic motion into voltage. As the period increases, this gets more difficult, and involves coils with thousands of turns of fine wire to give adequate signal as well as precision temperature compensated spring suspensions.

A simpler way is to use electronics to sense the deviation of a long period seismic beam from its mechanical null— so with the help of Andy Flind, an electronic pickoff system was developed which gave high sensitivity and stability without needing any precision mechanical fitting.

Construction is split between electronics and mechanics (to be described next month) and can be tackled in any order, although some thought should be given to the siting of what is rather a large instrument before final construction is started!

Fig. 2. The electronics system block diagram for the EE Seismograph.



ELECTRONICS

The electronics of this project are designed to sense tiny movements of the Seismograph's main beam whilst imposing practically no friction. As well as being sensitive, the circuit needs good long-term stability, a feature not often required of d.i.y. circuits.

There are various transducers capable of detecting movement. The best known, the variable resistor, is unsuitable because of its high level of friction. Various optical and capacitive sensors, often used in industry, were rejected because they involve electro-mechanical "follower" mechanisms that would be difficult to make. Linear Hall-effect devices were considered, but they are expensive, their long-term drift characteristics were unclear, and they draw a fairly high operating current. The possibility of battery operation was considered desirable for this project.

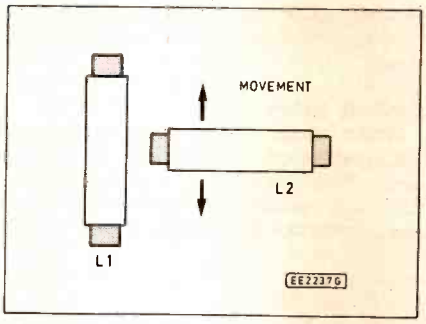


Fig. 1. Coil position and movement.

The system chosen uses two coils wound on short lengths of ferrite rod. One of these is energised with a sinewave current. The other is placed at right-angles about five to ten millimetres away from it, as shown in Fig. 1. If the coil positions are carefully adjusted, it is possible to find a "null" point where induced voltages in the second coil cancel to zero. Small displacements then result in output voltages, which are amplified and detected to indicate the movement.

As a bonus, the phase of the induced output depends on the direction of movement away from null. In one direction it is in phase with the energising signal, in the other, opposite to it. If a synchronous detector is used, driven by the oscillator, the direction of movement will be indicated by positive or negative output.

BLOCK DIAGRAM

A block diagram of the system is shown in Fig. 2. An oscillator drives one coil and a

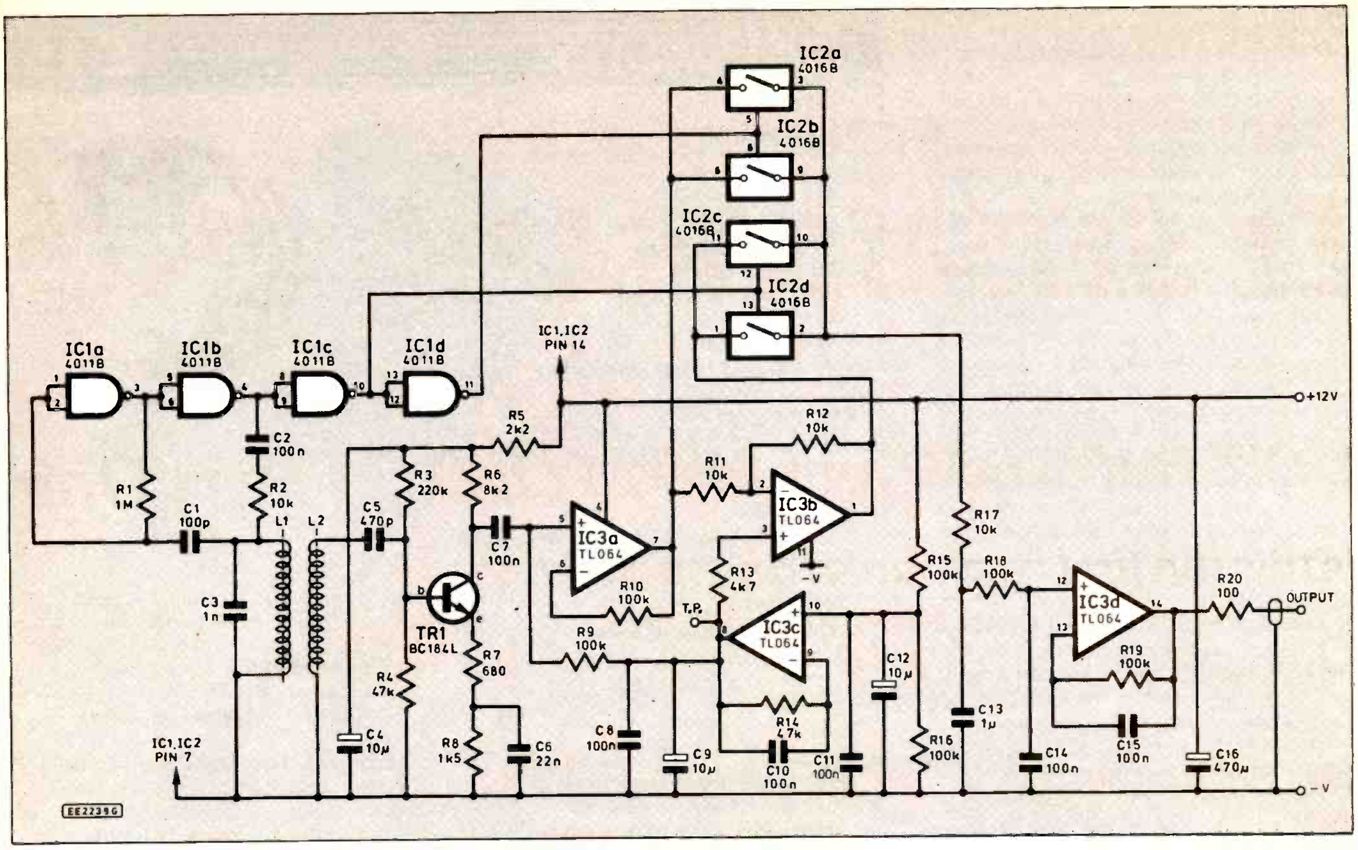


Fig. 3. Circuit diagram for the detector stage of the Seismograph. The coils L1, L2 are wound on ferrite rod and are interchangeable.

synchronous electronic switch. The output from the second coil is amplified, buffered and inverted before going to the switch.

The various signal waveforms in the circuit are shown, and it will be seen that the switch output is similar to that from a full-wave rectifier. The remaining a.c. component in this is removed by passive low-pass filtering, and a d.c. amplifier and buffer complete the circuit.

Whilst the effect is not completely linear it is good enough over the range of movement needed for the EE Siesmograph. It takes only a small energising current from a simple oscillator, is extremely sensitive, yet is easy to mount and set up. Careful design of the electronics provides good long-term stability. Additionally, it's cheap and easy to make.

Disadvantages? Well, the coil on the beam needs two wires to energise it, but these, if thin and placed close to the fulcrum, do not impair peformance.

PRACTICALITIES

An instrument of this type is often sited some distance from occupied buildings to minimise disturbance and vibration from human activities. However, it would be useful to have the output available in the workshop or laboratory. With this in mind, the circuit is split into two sections, a "Detector" board for the Seismometer itself, and a "Control" unit, containing the power supply and output processing circuitry.

Connections between the two units consist of a single-ended low voltage supply, and one low-impedance signal lead that uses the negative supply as "common". This arrangement means that connections between the two can normally be made using the cheapest three-core cable available; screening and similar precautions are unlikely to be necessary.

CIRCUIT

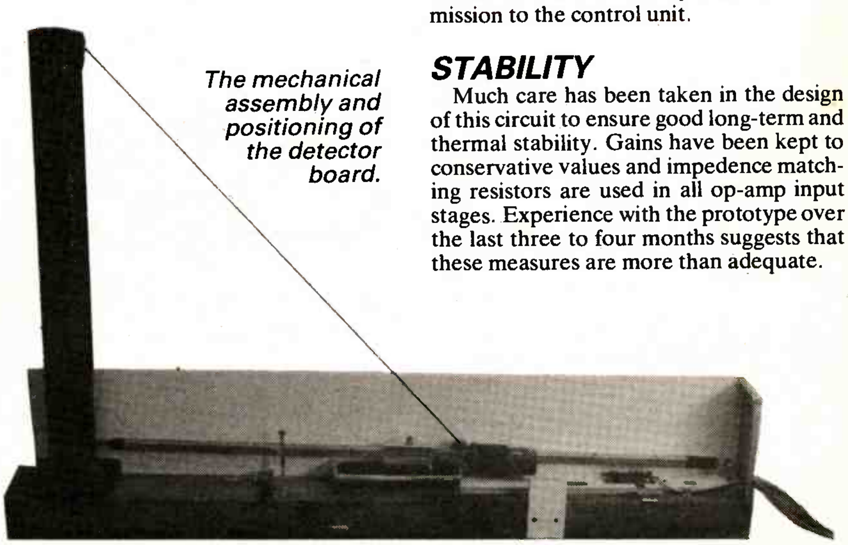
In the detector circuit diagram, Fig. 3, the coil L1 is driven by a simple oscillator formed by two NAND gates IC1a and IC1b. The coils each have an inductance of about 2.5mH, so with C3, 1nF, the frequency is about 100kHz. This is low enough for simple processing but high enough for the characteristics of the ferrite. With L2 positioned as described, an output only appears when it moves away from the "null".

As the small movements to be detected produce small signals, TR1 provides voltage amplification of about ten. Its collector output is buffered and inverted by IC3a and IC3b. The two anti-phase signals from these go to an electronic two-way switch formed from IC2, a CMOS 4016B quad analogue switch, and the remaining two gates of IC1. The switch output is similar to that of a full-wave rectifier, but is positive or negative depending upon the phase of the input relative to that of the driving oscillator.

A d.c. reference of half the supply voltage is required for the op-amp stages of the circuit, this is supplied by IC3c and appears superimposed on the switch output. Simple low-pass filtering, R17, R18 and C13, C14, removes the high frequency component of the signal, leaving a d.c. output that is nominally half the supply but swings positive or negative with coil movements. This is buffered by IC3d for transmission to the control unit.

STABILITY

Much care has been taken in the design of this circuit to ensure good long-term and thermal stability. Gains have been kept to conservative values and impedence matching resistors are used in all op-amp input stages. Experience with the prototype over the last three to four months suggests that these measures are more than adequate.



The mechanical assembly and positioning of the detector board.

SUPPLY

The "Control" part of the circuit, Fig. 4, provides a regulated supply for the detector and processes its output. A 12-0-12 volt 100mA transformer and bridge rectifier produces two supplies, positive and negative. These are regulated with three-terminal 100mA regulators IC1 and IC2 to give +12 volts and −5 volts relative to the "common rail". This rail is also the negative supply and common for the detector, and is intended to be earthed.

The purpose of the negative supply is to enable the output to swing below as well as above the earthed "common", since many chart recorders require such a signal. The signal processing part of the circuit begins with low-pass filter R9 and C11, which removes any noise induced in the connecting lead between the units, although the low output impedance of the detector unit should minimise such interference. The signal is then amplified by IC3b, a non-inverting amplifier with a voltage gain set at about two.

The other half of IC3 (IC3a) provides a reference voltage controlled by VR1 and VR2, "coarse" and "fine" zero adjusters. It will be recalled that the input is a voltage that varies about a nominal value of six volts; the effect of R7 is to shift the output downwards by six volts to swing about the "common" rail.

CONSTRUCTION

Construction can start with the Control unit, since the 12V supply will be needed for testing the detector. After ensuring that the board fits the slots of the moulded case, the transformer should be mounted on it. The holes for this are not provided as their spacing will vary with different makes of transformer. Its position can be seen from the layout Fig. 5, and the mounting screws should connect its metalwork to the large earthed area of copper on the p.c.b.

The bridge rectifier and 470μF capacitors C1 and C5 should be fitted, taking care with polarity, and the unit powered up. Since this implies connection to live mains, the usual precautions should be taken to avoid inadvertant personal contact!

A check should now reveal about 17 volts across each capacitor. If this seems OK, C2, C3, C4 and C6, C7, C8 should be added (with the power disconnected of course), with the regulators IC1 and IC2. Check the polarity of the two 100μF capacitors. If the unit is energised again, the 12 volt positive supply should now appear across C4 and the 5 volt negative across C8.

With the power supplies operating correctly, the remaining components can be fitted. A socket is recommended for IC3; these cost only pence and make trouble-shooting far simpler.

Resistors R1 and R2 are not mounted on the p.c.b. R6 sets the circuit gain. If it is desired to experiment with this, R6 may be mounted on Veropins for easy access, or even replaced by a variable component. The stage gain is given by R8/R6. With the value given, the sensitivity of the prototype was about 50mV per thou. (of an inch!) of movement when the coils were 5mm apart, half this at 10mm apart.

COMPONENTS

Approx. cost Guidance only **£15**

Shop Talk

See page 636

Control Unit

Resistors

R1	18k
R2,	180k
R3, R4	10k (2 off)
R5	4.k7
R6, R9	100k (2 off)
R7, R8	220k (2 off)
R10	100

All 0.6W ±1% metal film type.

Potentiometers

VR1,	10k lin. carbon
VR2	10k lin. carbon

Capacitors

C1, C5	470μ radial elect. 35V (2 off)
C2, C3, C6, C7, C10, C11	100n polyester (6 off)
C4, C8	100μ radial elect 25V (2 off)
C9	1μ polyester
C12	47n polyester

Polyesters are miniature layer type.

Semiconductors

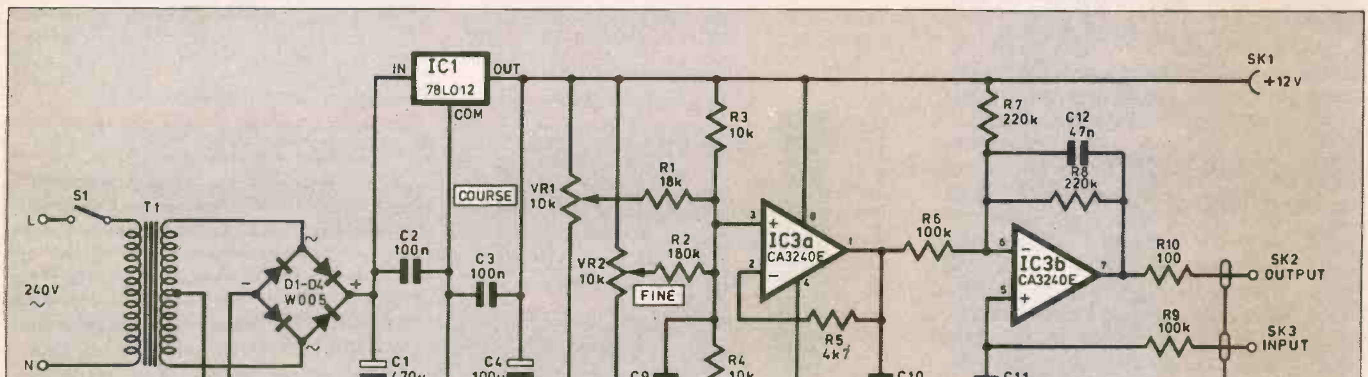
D1 to D4	W005 bridge rectifier, 50V 1.5A
IC1	78L012 12 volt 100mA positive regulator
IC2	79L05 5 volt 100mA negative regulator
IC3	CA3240E, dual op-amp, MOSFET inputs

Miscellaneous

SK1	4mm socket red.
SK2	4mm socket black.
SK3, SK4	phono sockets (2 off)
T1	Mains transformer 12-0-12V 100mA sec.
S1	SPST 240V toggle switch

Printed circuit board, available from the *EE PCB Service*, order code EE658; 8-pin d.i.l. socket; case, ABS plastic, 150 × 80 × 50mm; control knobs (2 off)

Fig. 4. Circuit diagram for the control stage of the Seismograph.



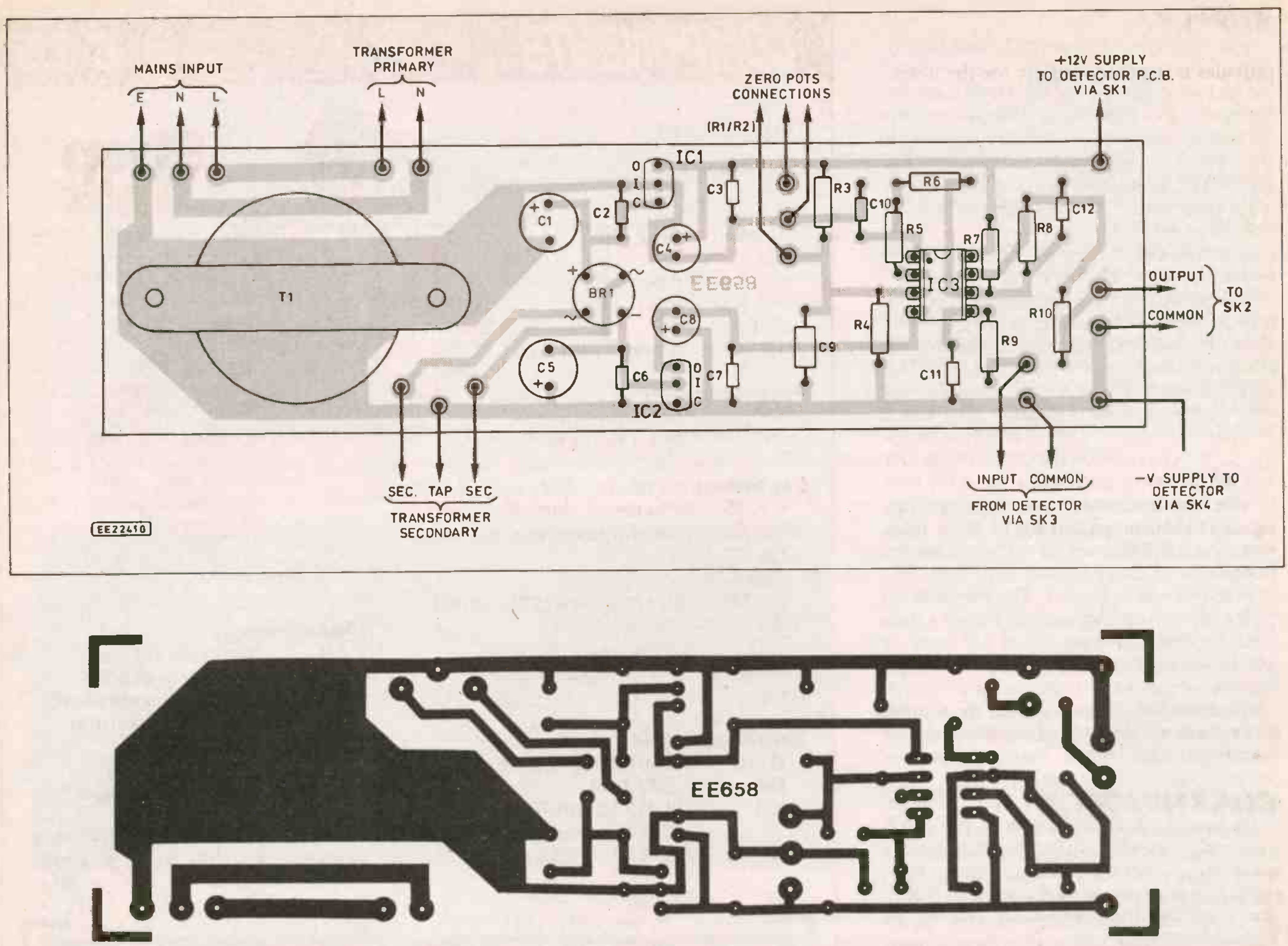
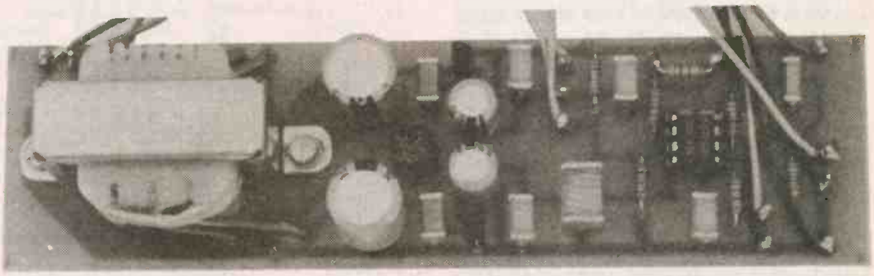
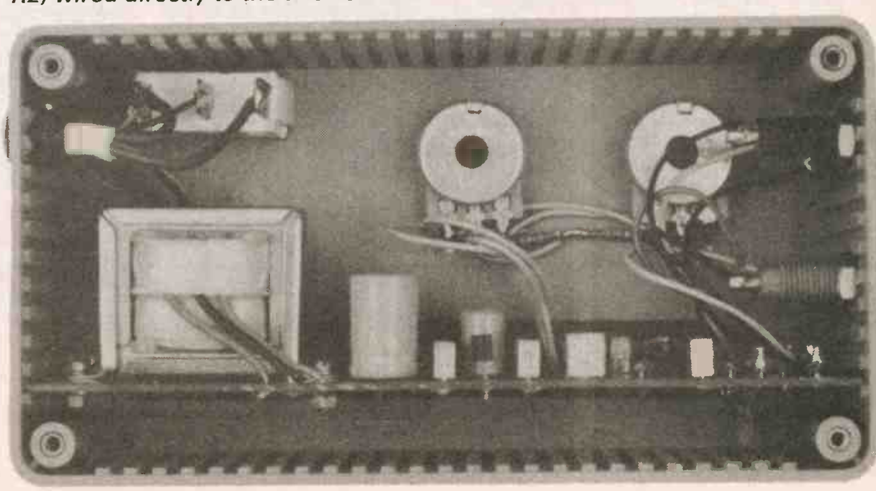


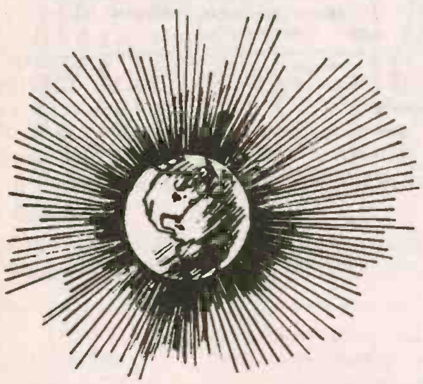
Fig. 5. Control unit printed circuit board component layout and full size copper foil master pattern. This board is available through the EE PCB Service, code EE658.



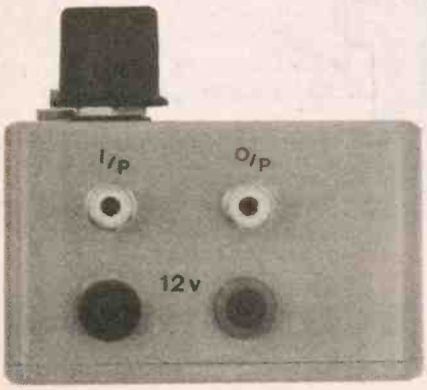
Completed circuit board for the control unit.



The completed board slotted into the plastic case. Note the two resistors (R1, R2) wired directly to the two controls.



The four input/output sockets on the side of the case.



TESTING

The board is now ready for final testing. Two 10k resistors should be connected from the supply rails to the input as shown in Fig. 6., and one pot and the 18k resistor to the zero-setting connections. IC3 should be inserted. If the unit is energised and the output monitored, the pot should provide output adjustment of plus and minus 2.5 to 3.0 volts (2.8 on prototype).

A "wet finger" across one of the 10k resistors should produce movement in the appropriate direction and the 180k resistor across either should cause a shift of about 0.7 volt. A quick retest of the supply volts, +12V and −5V, and a check that nothing is overheating completes the job. The transformer and IC2 run slightly warm; this is normal.

COILS

The coils are needed to test the detector p.c.b., so these can be wound next. Each consists of 250 turns of 32 s.w.g. enamelled copper wire, layer-wound over 4cm of a 5cm length of ferrite rod. The ferrite is cut to length by notching around it with a fine-toothed file and snapping it. A layer of insulation tape keeps the wire from touching the ferrite.

Once wound, the wire must be secured to prevent movement, which would affect stability in this project. There are various ways to do this; for the prototype heat-shrink sleeving over each coil provided both security and protection to the windings, but a dip in potting resin might be even better. None of the coil dimensions is critical in any way, as only one coil is resonant and the frequency only has to be approximately correct.

DETECTOR BOARD

Construction of the detector board begins with the fitting of all components as shown in Fig. 7, save the three i.c.'s. Sockets should be used for these; they should not be inserted yet.

Following a careful physical check, including correct electrolytic polarity, the board can be powered with a 12 volt supply, still without i.c.'s. Following the usual electrolytic charging surge the supply current should settle to 0.6 to 0.7mA. Any significant variation from this value should be investigated before proceeding. Assuming it is correct, the voltage at TR1 collector should be about 6 volts above the negative

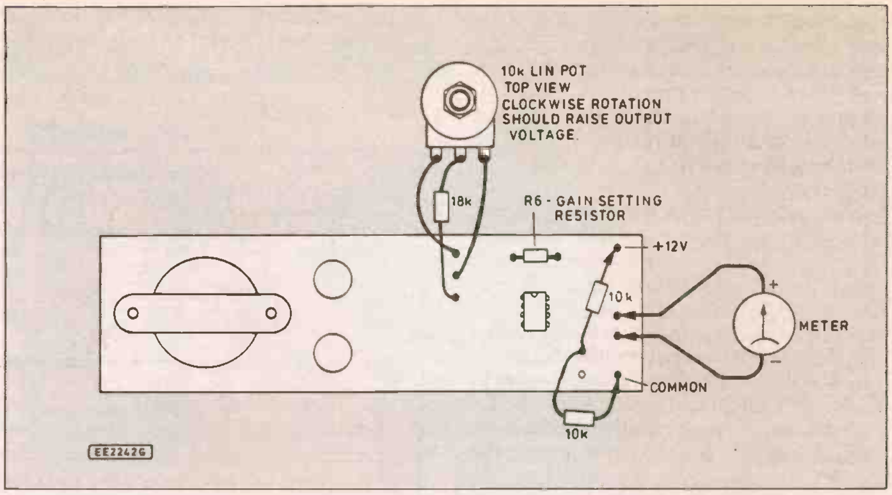
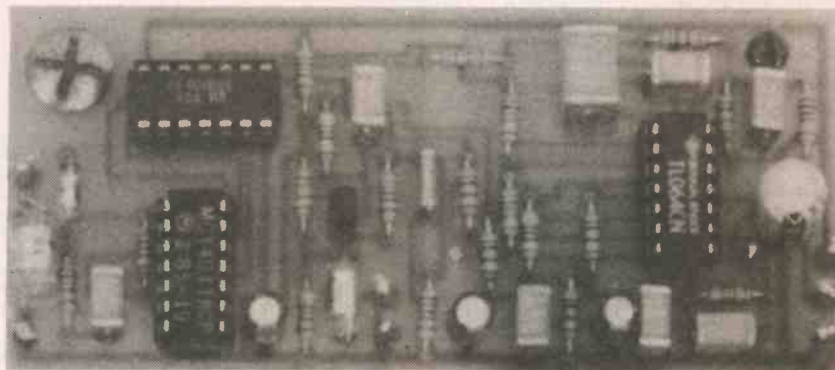


Fig. 6. Set-up for testing the control board.



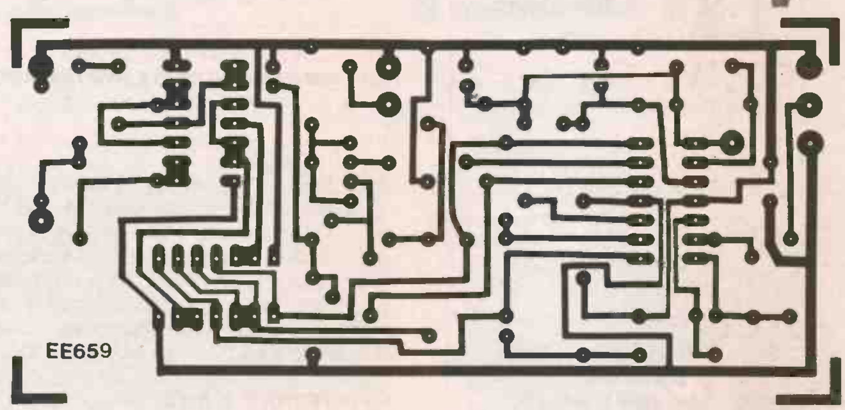
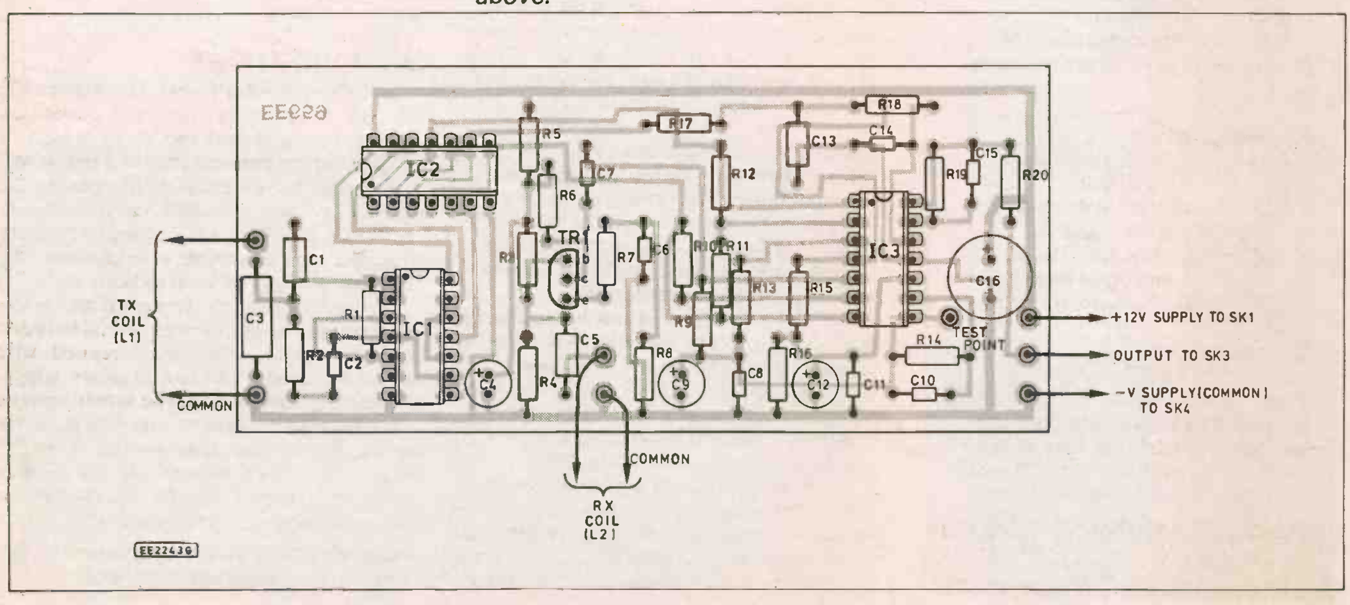


Fig. 7. Printed circuit board component layout and full size copper foil master pattern for the detector board. The completed board is shown in the photograph above.



(common) supply. If so, IC1 should be inserted and the TX coil connected. This will push the supply current to around 1mA and the four output pins of IC1, pins 3, 4, 10 and 11, should appear to be at about 6 volts d.c. although in reality they will be switching from rail to rail at the operating frequency.

Next insert IC3. This will raise the supply current to about 1.8mA. The first three outputs, pins 1, 7 and 8, and the "test point" (driven from pin 8), should all be at 6 volts, set by divider R15 and R16. If so, IC2 can be inserted and the receiver coil L2 connected. The output should be monitored and the coils placed at right angles to each other, 5mm to 10mm apart. Careful adjustment of their relative positioning should locate a 6 volt output point, the "null".

Alternatively, the meter can be connected between the test point and output, where the null will give an output of zero volts with movement to either polarity. If the coils are around 5mm apart, a sideways movement of 2mm to 3mm should cause an output change of one volt, with polarity depending upon direction. The final current drain will vary slightly but should be about 1.8 to 1.9mA. This low supply current will allow long-term use from batteries if neccessary, especially if the p.s.u. board is replaced with a circuit incorporating one of the new C-MOS micropower regulators such as the RS LP2951 or MAX666CPA.

COMPONENTS

Detector Board

Resistors

- R1 1M
- R2, R11, R12, R17, 10k (4 off)
- R3 200k
- R4, R14 47k (2 off)
- R5 2k2
- R6 8k2
- R7 680
- R8 1k5
- R9, R10, R15, R16, R18, R19 100k (6 off)
- R13 4k7
- R20 100

All 0.6W ±1% metal film

Shop Talk
See page 636

Capacitors

- C1 100p polystyrene
- C2, C7, C8, C10, C11, C14, C15 100n polyester (7 off)
- C3 1n polystyrene
- C4, C9, C12 10μ radial elect. 50V (3 off)
- C5 470p polystyrene
- C6 22n polyester
- C13 1μ polyester
- C16 470μ radial elect. 16V

Polyesters are miniature layer type.

Semiconductors

- TR1 BC184L npn silicon transistor
- IC1 4011B CMOS quad NAND gate
- IC2 4016B CMOS quad analogue switch
- IC3 TL064 quad op-amp.

Miscellaneous

14-pin d.i.l. sockets (3 off); Veropins; 8mm ferrite rod, 10cm length; 32 s.w.g. enamelled copper wire; heatshrink sleeve (see text); p.c.b. available from the *EE PCB Service*, order code EE659.

Approx. cost guidance only **£12**

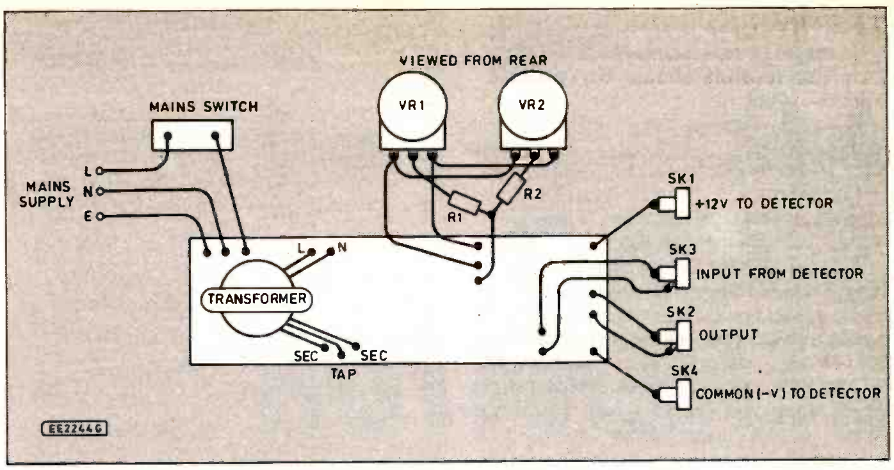


Fig. 8. Interwiring from the board to case mounted components.

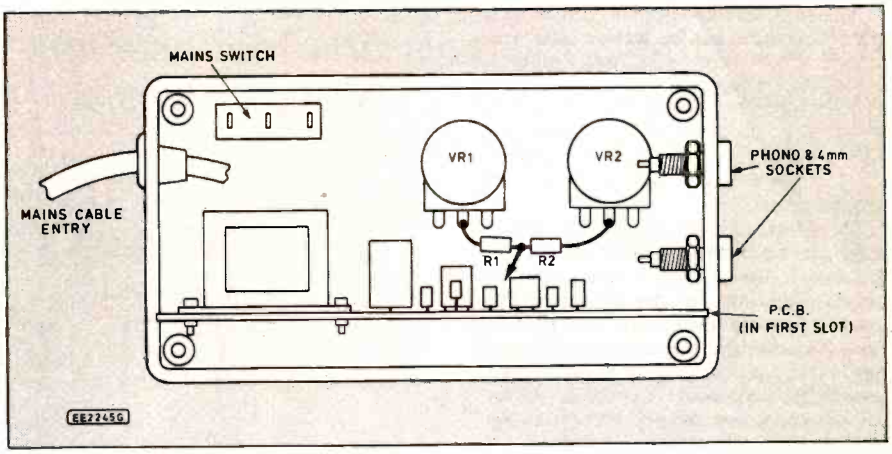


Fig. 9. Layout of components inside the control unit plastic case. Note the lead from the junction of the two resistors to the board.

HOUSING AND MOUNTING

The control and output board is housed in a 150×80×50 mm ABS plastic box with internal slots for the p.c.b. Input and output connections are made through phono sockets, whilst the 12 volt supply is available from red and black 4mm sockets. The "coarse" and "fine" zero adjusters and the mains switch are situated on top of the box. Wiring between these components is shown in Fig. 8. The prototype was not fitted with a mains fuse, it being felt that a 2amp plug fuse was sufficient. However a 100mA cartridge fuse could be incorporated into the case if preferred.

The detector board is not housed as in most cases it will be incorporated into the equipment with which it is to be used.

Setting up and use of the detector is straightforward as it is very tolerant of misalignment, much of which can be compensated for with the "zero" adjustment. The coils are not too sensitive to nearby metal, though obviously they should not be mounted hard against large structural metal components. In particular, any form of mounting that involves a complete metal loop around either of the coils must be avoided as this would act as a "shorted turn" drawing much energy from the system. If twists of wire are used, they must be of insulated wires. Nylon cable ties would be fine, or perhaps glue.

For the Seismograph installation, it is best to install the transmitter coil L1 on the moving beam, with a twisted pair of thin wires connecting it to the p.c.b., with the flexing portion of these wires as close to the beam's fulcrum as possible. At this point it will have the least influence on the beam action. The receiver coil is best connected to the board with screened lead, kept as short as possible.

ADJUSTMENT

For correct adjustment a meter should be used to set up the detector, connected between output and the "test point". It should have a range of plus and minus one volt, and the coils should be adjusted for an output as close to zero as possible. If desired a 100-0-100μA meter can be fitted together with as suitable series resistor, say 10k, for continuous local indication.

In areas of high interference it may prove necessary to screen the signal lead between the two units. Two-core screened wire could be used, with the negative supply (common) connected to the screen and the 12 volt positive supply and signal to the cores. In most installations this shouldn't prove necessary though, simple 3-core cable or telephone wire, etc. should be adequate even over long distances.

Next Month: Mechanical assembly, setting-up and seismic recording.

Pocket Money Project

I.C. SOUND GENERATOR

CHRIS BOWES

A very simple, low cost unit that uses the popular 555 timer i.c. and a single transistor for audio sound generation

THIS MONTH we introduce a simple I.C. Sound Generator circuit, which can be used either on its own or incorporated with other circuits in this series to provide an audible addition to a control or alarm circuit. Like all of the circuits in this series it can be operated from a single nine volt battery and may be mounted inside a case if this is desired.

The generator circuit uses a 555 timer in the standard astable mode. The basic circuit for this is shown in Fig. 1a. In this arrangement the i.c. produces an output at pin 3 (the i.c.s output connection) which repeatedly switches on and off in a timed sequence as shown in Fig. 1b. The duration of the on and off periods is governed by the values of R_A, R_B and C in the manner shown in Fig. 1b.

The output current from the 555 timer is not sufficiently high to enable the circuit to directly drive a loudspeaker so a single transistor is used as an emitter follower to provide the necessary current handling capacity.

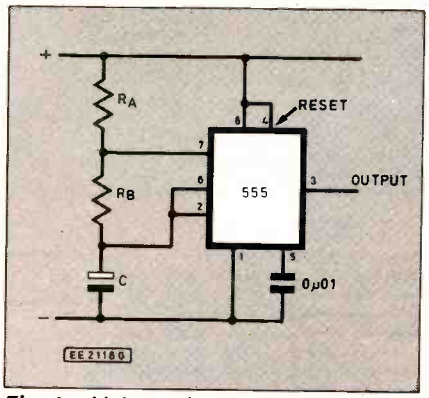


Fig. 1a. Using the 55 timer in the astable mode.

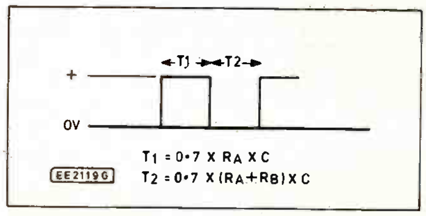


Fig. 1b. 555 timer astable timing diagram.

CIRCUIT DESCRIPTION

The full circuit diagram for the I.C. Sound Generator is shown in Fig. 2. Basically the circuit consists of the 555 timer astable circuit shown in Fig. 1, with preset VR1 and resistor R1 taking the place of R_A and resistor R2 taking the place of R_B. Preset VR1 is included to enable the frequency of the output oscillation of IC1 to be adjusted so as to give the desired output tone and resistor R1 is included to provide a minimum resistance in the circuit and to prevent damage to the i.c. which would otherwise occur should VR1 be accidentally set to its zero value.

The frequency of the circuit's operation is determined by the values of VR1, R1, R2 and capacitor C1. With the components specified the operating frequency will be at approximately 1kHz. Capacitor C2 is required by the bipolar timer i.c. to set the control voltage level at pin 5 of IC1. If you use the CMOS version of the 555 timer then C2 may be omitted.

A simple emitter follower amplifier, formed by transistor TR1 and resistors R3, R4, is used to provide the current gain needed to drive the loudspeaker LS1. When a current flows through the base-emitter circuit of the transistor this allows a much higher current to flow through the collector-emitter circuit.

The emitter follower circuit makes use of the fact that the transistor's construction is such that the voltage between the base and emitter is maintained at 0.7V. When the voltage at the output (pin 3) of IC1 is at the 0V level then no current flows through TR1. When the voltage at pin 3 rises to the battery voltage then a current flows through the base-emitter circuit.

In order to maintain the base-emitter voltage at 0.7V the voltage across the loudspeaker consequently rises to approximately 0.7V less than the battery voltage. As the output from IC1 is constantly being switched on and off this causes the voltage across the loudspeaker to be switched on and off at the same frequency.

Resistor R3 is included in the base circuit of TR1 to ensure that the current flowing through the base-emitter of the transistor is kept to a safe level. Similarly, resistor R4 is included in the collector of TR1 to restrict the maximum current flowing through the loudspeaker to a level which will prevent damage occurring.

CONSTRUCTION

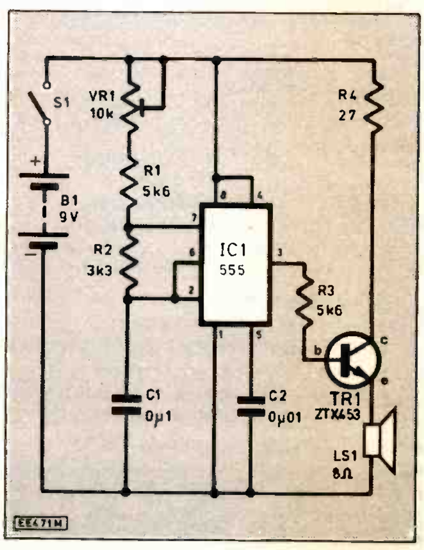
The first task when commencing the construction of the I.C. Sound Generator is to cut a piece of stripboard 13 strips deep and 20 holes wide. If you are going to mount the project into a box by using p.c.b. stand-offs you will need to allow an extra six holes width (three each side) on the board for case mounting holes using a 4mm drill, make these mounting holes at the four corners of the board before starting to construct the circuit.

The component layout and details of breaks required on the underside copper tracks is shown in Fig. 3. It is important that these track breaks are made completely so that not even the merest sliver of copper remains to bridge across the track break.

Once the board has been prepared you can start the electronic construction. To help with this the strips and holes have been numbered and lettered, see Fig. 3.

Although it does not make any difference to the operation of the circuit which order you insert the components into the

Fig. 2. Complete circuit diagram for the I.C. Sound Generator.



stripboard you will find it easier to construct the circuit if the components are inserted in ascending order of size. Commence by inserting and soldering the five link wires into place, as shown in Fig. 3. The wire links are made with insulated single-core wire and after soldering in place cut off any excess wire protruding on the underside of the board with your cutters.

The next task is to put the resistors in their correct places by first bending the wires of the resistor at right angles to the body of the component so that they will fit through the holes, as shown in Fig. 3. Counting across and down the board, using the numbers and letters as a guide, put all of the remaining resistors into their correct position and solder them into place. Also fit and solder preset VR1 into place.

The next item to be inserted into position is the i.c. holder. Although it is possible to solder the i.c. directly into place, using a socket will both make the construction simpler and make for easier replacement if a fault should occur. It is important that you take care to make sure that the notch on the i.c. holder is facing towards the bottom of the stripboard as this will help you when inserting the 555 timer into place.

Next come the capacitors which are both non polarised types so it does not matter which way round they are inserted. Finally insert transistor TR1 into the correct holes, making sure that it is orientated as shown in Fig. 3, and soldered into place.

The final step, prior to connecting the battery, is to insert IC1 into its holder making sure that the notch on the i.c. corresponds with the notch on the i.c. holder. Some versions of the 555 timer do not have a notch in one end but have a slight, circular dent near pin one. In this case the end with the indentation goes nearest to the edge of the i.c. holder which has the notch.

CASE

Although the project can be easily used as it stands or be incorporated into another project, you may wish to mount it into its own case. The easiest way to do this is to use self adhesive p.c.b. mounting strips as shown in the photographs.

Alternatively, you may use stand-offs in the position of the mounting holes previously drilled in the stripboard before making the circuit up. The requisite holes should be carefully marked on the body of the case and the appropriate stand-offs mounted in suitable positions to support the stripboard. Similarly suitable mounting holes must be drilled to accommodate the switch S1 and loudspeaker LS1.

In the version of this project shown in the photographs the loudspeaker is not provided with mounting holes so it was necessary to hold the loudspeaker against the case lid by means of a strip of material which spans the width of the loudspeaker and is held in place with two bolts which are accommodated in suitable holes drilled in

INTERWIRING

The connecting wires to the battery can now be soldered into place on the board. The black wire from the battery connector goes to the point on the stripboard shown as B1 −V and the red wire of the battery connector goes to one tag of the on/off switch S1. Another red wire is then connected between the other switch terminal and the B1+V connection on the stripboard.

Two wires should also be soldered to the loudspeaker and connected to the LS1+ and LS1− connection points on the stripboard.

COMPONENTS

Resistors

R1	5k.6
R2	3k.3
R3	1k
R4	27

All 0.25W 5% carbon

Shop Talk

See page 636

Potentiometer

VR1	250k min. skeleton preset, horiz.

Capacitors

C1	0μ1 Mylar 16V
C2	0μ01 Mylar 16V

Semiconductors

TR1	ZTX453 *npn* silicon
IC1	NE555 bipolar timer

Miscellaneous

LS1	8 ohm loudspeaker
S1	Min. toggle switch (optional)
SK1	3.5mm switched jack socket (optional)
B1	9V (PP3 or equivalent) battery

Stripboard, 0.1in matrix 13 strips×20 holes (see text); plastic case to suit (optional); 8-pin i.c. socket; battery connector; connecting wire; solder etc.

Approx. cost Guidance only **£7**

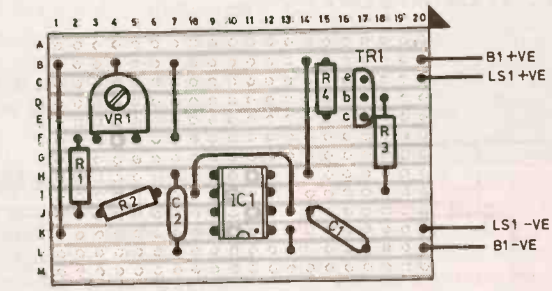
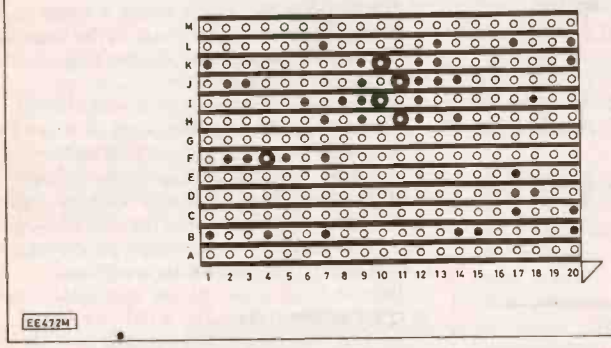
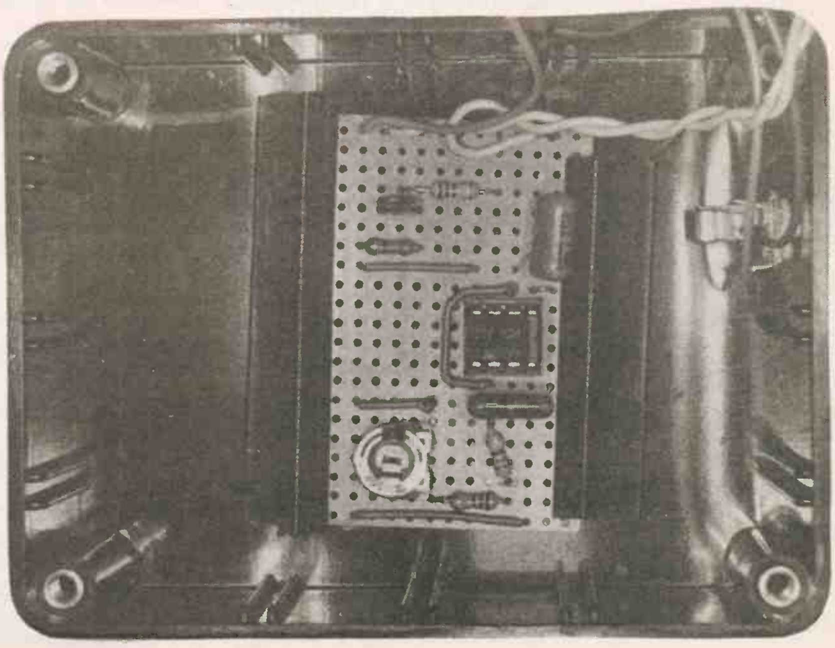


Fig. 3. Stripboard component layout and details of breaks required in the underside copper strips.



The completed board mounted in its case.



the case. It will also be necessary to drill a matrix of holes in the lid to allow the sound from the loudspeaker to be transmitted.

In order to provide remote switching the case can be fitted with a small switched jack socket, which is mounted in the side of the case and wired in series with the battery and switch S1. If desired the switched socket can be wired in such a way that when the jack plug is removed the socket is shorted out — thus allowing the circuit to be controlled solely by S1 until the jack plug is inserted, when the circuit can then be controlled from the end of the cable connected to the jack plug.

When preparing the case all of the holes required should be drilled before installing the circuitry. Similarly if the case is to be painted or lettered this should be completed before the circuitry is installed.

TESTING

Before connecting the battery and testing the circuit you should carefully examine the stripboard to make sure that all of the components are inserted into their correct places, are the correct way round and that there are no blobs of solder shorting out the tracks.

If the circuit does not operate correctly it will be necessary to check for faults. In this project the only components which will cause problems if they are connected the wrong way round are IC1 and TR1.

If no mechanical problems are found then it will be necessary to check the circuit through to see whether there is a faulty component or not. You will probably find that you will need to use a test meter to perform this stage of the process.

Because of the high frequency of operation of this circuit fault finding with a test meter can be somewhat difficult. However, the process can be made easier by temporarily connecting a capacitor of between 22μF and 100μF in parallel with capacitor C1. This will cause the output frequency of the circuit to be slowed down to a level where the operation of the circuit can be easily measured. Fault finding then becomes much easier.

You should be able to measure the battery voltage between any 0 volt connection and both pins 8 and 4 of IC1 as well as between the Battery+ connection to the board and pin 1 of IC1. If these voltages are not present this will indicate faulty wiring up of the stripboard.

The next step is to check the voltage at the output (pin 3) of IC1. If the circuit is working correctly this voltage should be regularly switching between 0 volts and the battery voltage.

If this does not occur and the output is locked permanently at a fixed voltage then you should remove the i.c. from its socket and check the voltage at the pin 3 connection again. If the voltage persists with IC1 removed then the fault does not lie with IC1 but most possibly with the wiring associated with the i.c. and the output or its associated wiring.

Replace the i.c. and check the voltages at pins 2, 6 and 7. The voltage at pin 7 should be fluctuating around a value which is roughly ⅔rds of the battery voltage. The voltages at pins 2 and 6 should be identical (because these two pins are connected together by a wire link) and these should also be fluctuating in a similar manner, but at a voltage slightly less than that found at pin 7.

If neither or only one of these voltages are present then the most likely cause is that the circuit from the positive voltage rail, through preset VR1, resistors R1 and R2 is not correctly made. This is best checked by measuring the voltage present between 0V and each junction in the component chain through VR1, R1, R2 and capacitor C1 and investigating at the point where no voltage is measured.

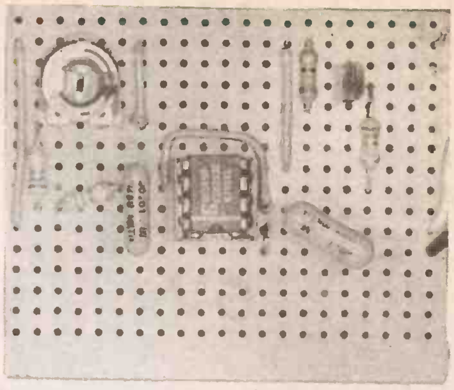
If a voltage is present between 0V and pin 7 but no voltage, or only a very small voltage, is measured between the 0V rail and pins 2 or 6 of IC1 then you should check that the resistance between pins 7 and 6 of IC1 is roughly equal that of resistor R2. If this is correct then check the resistance of capacitor C1 with the resistance range of your meter.

If the resistance is very low (less than about 500 ohms) then you should replace capacitor C1. If there is no voltage measurable between pins 6 and 2 of IC1 then this could be caused by a short circuit between the connections of C1 or by a short circuit within C1.

OUTPUT STAGE

If the voltage switching described above is taking place then the i.c. and its associated components are working correctly and the fault will most probably lie in the area of transistor TR1 and its associated components. The first point to check is the junction of resistor R3 and the base of TR1.

The voltage at this point should fluctuate between 0 volts and almost full battery voltage, in time with the fluctuations in the output of IC1. If this is happening then you should be able to measure a similar voltage change at the junction of the emitter of TR1 and the loudspeaker LS1.



The completed circuit board showing the five link wires.

The voltages between 0V and the emitter and collector of TR1 should both be measured. The voltage at the emitter should rise and fall, following the fluctuations of the output from IC1. If the voltage at the emitter does not rise and fall but stays at 0V then the connections to the loudspeaker should be checked out.

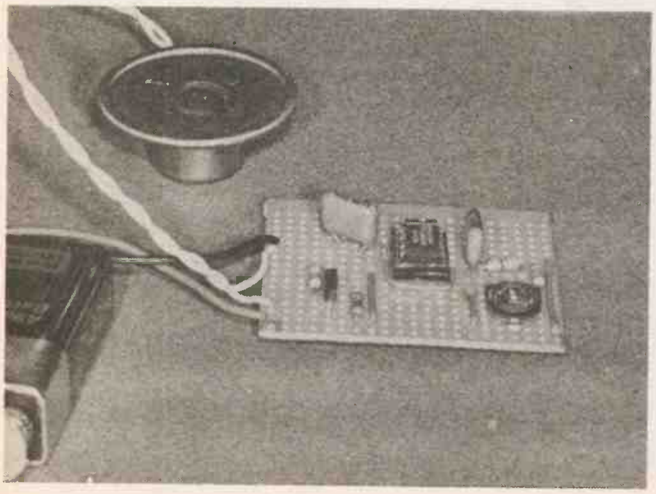
If the voltage remains locked at a level approaching the battery voltage, then the transistor should be checked for correct function by removing it from the circuit and measuring the resistance between the base and emitter and the base and collector. It is important to measure these resistances with ***both*** polarities of the meter current.

Because of the construction of the transistor a high resistance should be measurable between the base and the other connections, with the base connected to one of the meter leads, and a low resistance should be measurable between the base and the emitter or collector, with the base of the transistor connected to the other lead of the meter. If the resistances measured do not match the expected results then the transistor should be substituted for a new one.

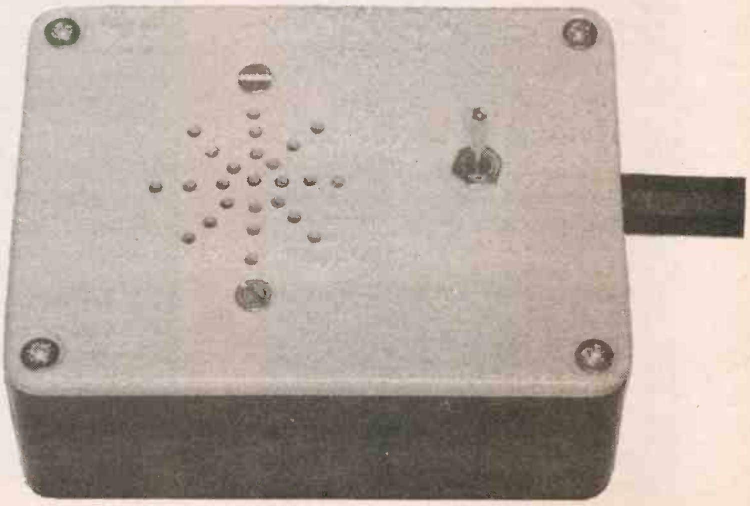
SETTING UP

Once construction and testing are complete the circuit can be very easily set up by installing the battery, switching the circuit on and adjusting preset VR1 until a sound at the desired pitch is heard. □

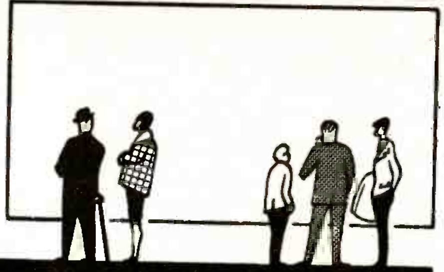
The completed board wired to the loudspeaker and battery prior to mounting in the case.



The completed unit showing the matrix of holes above the speaker, the optional switch and jack plug.



SHOP TALK



BY DAVID BARRINGTON

Newcomer

With the new season now in full swing, it is time to take stock and replenish the "component store". One item that often gets overlooked, but should be considered a top priority is updating the collection of components catalogues.

One catalogue that should be added to the list is the latest from **Jidenco**. Calling upon their vast experience in selling to the trade, their first venture into Mail Order for the constructor contains over 100-pages, is printed on top quality paper and is lavishly illustrated with photographs of stock items.

The stock of opto-devices, including l.e.d.s and seven-segment displays is quite extensive. The relay section is also fairly far ranging. Amongst other items that caught the eye, is a range of surface mount devices (SMD's).

Copies of the catalogue cost £1.50 and is available direct from Jidenco. The catalogue contains discount vouchers redeemable as follows: 50p off £5 plus orders; £1 off £10 plus orders; £5 off £50 plus orders. **Jidenco CD, Jidenco House, Dept EE, Vale Road, Windsor, Berks, SL4 5JW.**

EE Seismograph

Readers should not experience too many difficulties when purchasing components for the "electronics" section of the *EE Seismograph*. The "hardware" or mechanical requirements for the project will be highlighted next month.

The ferrite rod required for the "detector" coils seems to come in various diameters and lengths and may prove a little difficult to source locally. The range varies from about 8mm to 12mm diameter and 100mm to 200mm length.

It is quite feasible that the "null point" can be pinpointed on all the various combinations of ferrite rod and the most popular size stocked appears to be the 10mm diameter by approximately 140mm length. Ferrite rods are currently listed by **Magenta, Maplin, Cirkit, Omni, TK Electronics** and **Greenweld.**

If you have to cut down the length of a rod, be extremely careful as ferrite is very brittle. It is suggested that readers follow the details for cutting the rod, contained in the article, to the letter.

Logo Lego and Spectrum

The 74LS series of i.c.s called for in the *Logo Lego and Spectrum* project are very common devices and should not present any purchasing problems. Most of the other components for this project are also standard off-the-shelf items.

However, the 6V miniature relays may prove a little difficult to locate locally. The ones in the prototype model were ordered through Maplin and are listed under their "Ultra Miniature" range, code FM91Y (Ult-Mn Rlay 6V SPDT).

Other relays can be used provided they have contacts rated at 2A and a coil resistance of about 100 ohms. The contact ratings will, of course, depend upon the type of load and application required.

The Spectrum edge connector and the Darlington driver, type ULN2803A, are now quite common devices and stocked by most component advertisers. The printed circuit board for this project is available from the *EE PCB Service*, code EE660.

Readers experiencing any difficulty in obtaining Lego kits can contact them direct at **Lego UK Ltd., Dept EE, Wrexham, Clwyd, LL13 7TQ.** We also understand that **Magenta Electronics** ***(☎0283 65435)*** are a recognised stockist of Lego kits and should be able to obtain most parts.

Stabilized Power Supplies

Of the components required for the 700mA version of the *Variable Stabilized Power Supply*, the mains transformer selected by the designer was specially wound by the **Trent Coil Winding Co.** Quote order code 00493 (£10.25 plus £2.55 post and packing).

Many of our advertisers now supply special transformer kits for making up your own mains transformers. With these kits you just select the secondary requirements and, referring to a table, wind on the necessary number of turns. Alternatively, specialist transformer suppliers such as **Jaytee Electronic Services** should be able to come up with a suitable unit.

The printed circuit board for the 700mA version is available from the *EE PCB Service*, code EE656 (see page 684).

Turning our attention to the 1A *30V Variable Stabilized Power Supply*, the author has again selected from the Trent mains transformers. The one specified is the 00494 (£10.25 plus £2.55 p&p) used in a previous project and can be obtained from Trent Coil Winding Co., Dept EE, 26 Derby Road, Long Eaton, Notts.

The only source to date that we have been able to locate for the large, moving coil, panel meter (110mm × 83mm) used in the prototype models is from **Maplin**. This is listed under their "Large Meters" section, code RX54J (50µA Lrge Pan Meter). The Q-type quoted by the designer was the listing title adopted by Electrovalue, however we have been informed that all their stocks of the Q45 are exhausted and not likely to be replaced (i.e. discontinued).

The smaller T-type alternative meter suggested is also an Electrovalue designation. But, in this case, the 60mm × 46mm is stocked by most of our component supplier advertisers. The meter resistance does differ and you will have to recalculate the meter resistors accordingly.

As there are numerous equipment cases on the market, the final choice is left to the individual constructor. It should be an all *metal* type and be able to take the weight of the mains transformer and have plenty of room for the heatsink/circuit board.

The printed circuit board for the 30V Variable Stabilized Power Supply is obtainable through the *EE PCB Service*, code EE657 (see page 684).

Music on Hold

The melodies generator chip UM34811A appears to be the only item that could possibly cause sourcing problems to constructors of the *Music on Hold* project. This is a 16-pin multi-instrument melody i.c. which has a 512-note memory and is capable of generating up to 16 tunes.

Looking through our library of components catalogues, this device appears to be only listed by Maplin. This should be ordered as code, UJ44X (UM34811A).

Be sure to specify the lever type when ordering the microswitch. The small printed circuit board is available from the *EE PCB Service*, code EE646 (see page 684).

Simple L.E.D. Timer

We do not expect any component buying problems for readers undertaking the *Simple L.E.D. Timer*, one of this month's pocket money projects.

There are two popular CMOS versions of the standard 555 timer i.c. stocked by practically all our component advertisers and either of these should work in this circuit. The two devices in question are designated ICM7555 and TLC555C and are completely pin for pin compatible with the bipolar 555 timer.

The bargraph type l.e.d. display is now quite a common unit and should be stocked by most good component suppliers, although it may prove a bit cheaper to purchase individual standard l.e.d.s. The 6V-12V solid state buzzer is another item that is stocked, in many versions, by most advertisers.

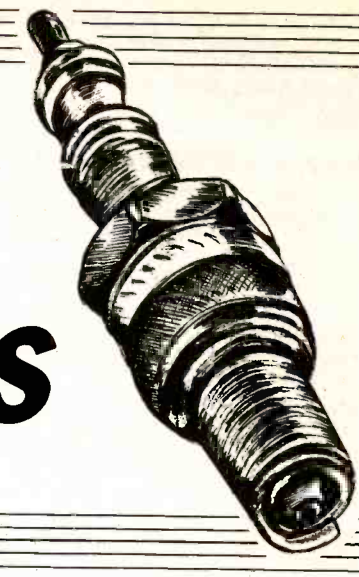
I.C. Sound Generator

We cannot forsee any component sourcing problems for readers constructing the *I.C. Sound Generator*, this month's "pocket money" project.

The self-adhesive stand-off insulator strips or "feet" for mounting the circuit board in the case should be generally available. No doubt readers will have their own ideas about mounting the board in the case.

Special Feature

CAR ELECTRONIC IGNITION SYSTEMS



STEWART ROBERTSON

"You know about electronics what's up with my car?" You reply, "Well, er, you see" pregnant pause, "I don't know–gulp–in fact I don't know anything about electronic ignitions." How embarrassing. Well it was when it happened to the author. Having read Everyday Electronics religiously every month, he still didn't know the answers.

THE FOLLOWING article sets out to redress the balance in the reader's favour. You'll need something in your favour because there are very few cars made these days with standard ignition systems. So let's start at the beginning.

INDUCTANCE

If you apply a voltge to an inductor the current doesn't instantaneously rise to a maximum but grows relatively slowly. The actual rate of growth is dependant on the applied voltage and the resistance and inductance of the circuit.

What happens is the growth of current is resisted by a voltage (called back e.m.f.) which is induced in the inductor. Similarly when a steady current is switched off the inductor opposes that change by producing an e.m.f. which tries to maintain the flow of current.

Now e.m.f.s are voltages, so by getting current to flow through a coil and then switching the current off we can generate a voltage. Which if the inductance is large the resistance low and the rate of switch-off quick can be quite a high voltage.

TRANSFORMERS

This high voltage can be stepped up to say 40kV if we use the transformer action by winding another coil of many turns around the inductor. This is essentially the action of a *coil* in a conventional ignition system.

The current is switched on and off by the contact breaker points in the distributor. The rotor arm and distributor cap are used to direct the high voltage to the correct spark plug. See Fig. 1.

HOW IT WORKS

Let's just go over the circuit in case we have to find any faults in it. The source of supply is the car battery which, by a heavy duty cable, normally connects to the starter solenoid. The solenoid terminal is used to feed current to the ignition switch, which in turn feeds the coil positive (+) terminal.

Current flows to Earth (car chassis) through the coil if the contact breaker points are closed. When the points open a high voltage is induced and there is a capacitor connected across the points to reduce arcing and enhance the effect.

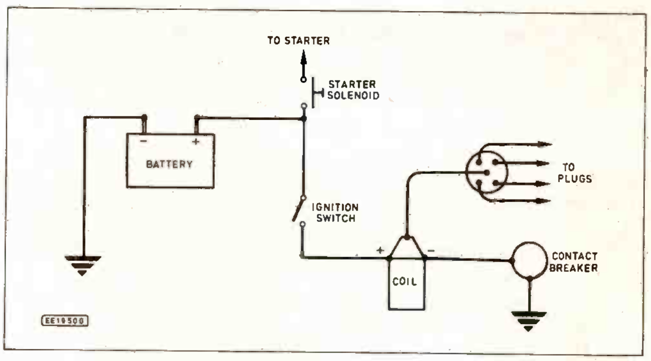


Fig. 1a. Conventional c.b. ignition system.

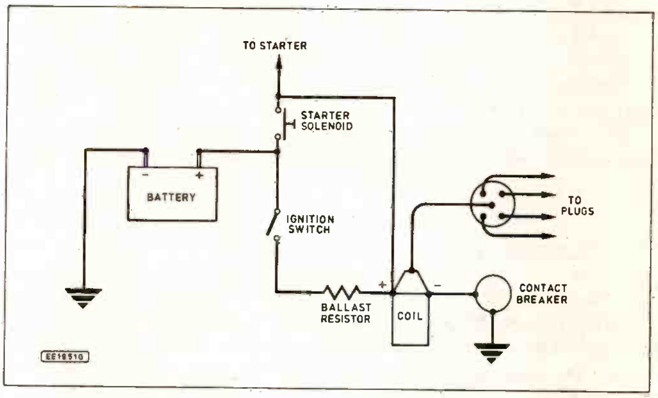


Fig. 1b. Conventional ignition system with an in-circuit current limiting "ballast" resistor.

High voltages leave the coil by the thick lead (lots of insulation) which goes to the distributor. Typical coil primary resistance is three ohms and maximum current in the region of four amps.

This system is called the "*Kettering*" system after Charles Kettering who invented it. It works O.K. provided the spark is made to occur when the respective cylinder is just before-top-dead-centre (BTDC). This can usually be adjusted by rotating the distributor in its mounting and is called "*timing*" the ignition.

SPARK ADVANCE SYSTEMS

Unfortunately there are some mechanical add-ons to enhance performance (anything mechanical is unfortunate). One of these add-ons is to advance the spark so that it occurs earlier at high engine revolutions.

This is known as the "centrifugal advance system" and is a quaint collection of bob weights and springs buried in the bottom of the distributor. As the revs increase it rotates the cam of the contact breaker points a few deegrees in the direction of rotation, thus the spark occurs earlier.

Similarly the base plate is rotated by another system which advances the spark only on light throttle openings. This is an economy device which is activated by a vacuum capsule on the side of the distributor.

C.B. IGNITION ENHANCEMENTS

Ballast Resistor

The current carried by the coil is forced through by the voltage applied by the battery. Unfortunately, when cranking from cold the battery does not provide as high a voltage. A solution is to provide a coil which has a resistance of only 1.5 ohm so that at the reduced voltage it will still draw about 4A of current.

However, when the engine is running, 12V to 14V will be available and so an extra resistance ("ballast resistor") is connected into the circuit to limit the current to the 4A required. See Fig. 1b. This system aids starting.

Sliding Points

When the points arc, they are eroded; if the arcing can be spread over a larger area it will take longer to erode the points and service intervals can be extended. The more recent Minis have an example of how to achieve this.

As the points open the base plate and cam follower are arranged so that the points surfaces slide across each other and spread the

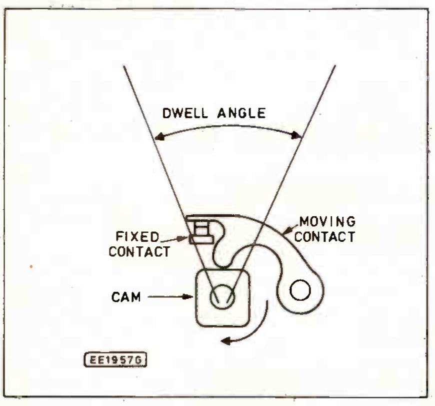


Fig. 2. Dwell angle or "dwell time" is the period the contacts are closed.

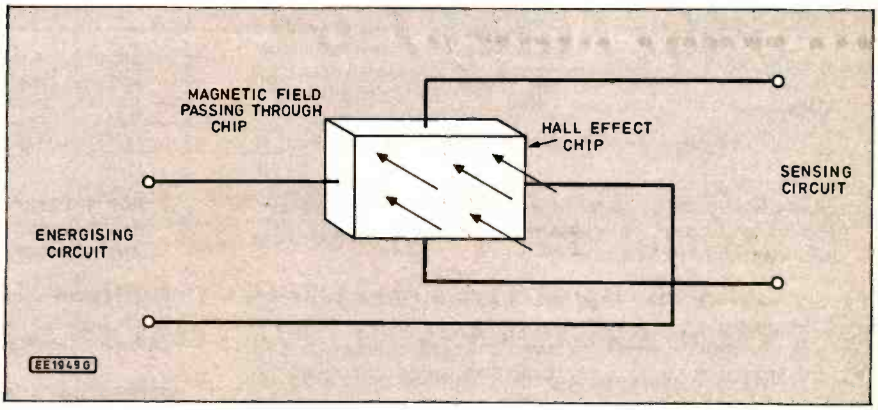


Fig. 3. Basic action of the Hall effect device. A magnetic field from a magnet is broken by a rotating disc and induces an energising pulse in the device.

LIMITATIONS

The Contact Breaker system was invented by Charles Kettering in 1908. Although he was undoubtedly a far-seeing man (he later became head of General Motors) it is not surprising that we are now able to improve on his invention.

The areas most in need of improvement are to be found in the low voltage section of the distributor.

Points

The points are a switch which when closed allows current to flow in the coil. The size of the voltage that is generated by the coil is directly proportional to the SPEED that the points open and the AMOUNT of current that the coil carries.

Both speed and amount of current are limited by the size of the points set. A large set could carry more current but would not open so quickly or alternatively a small set would open quickly but not be able to carry the current. A modern points set is a compromise.

Dwell

The time that the coil has to store energy is determined by the time the points are closed and is known as the "dwell time". At high engine speeds the dwell time is very short and can become inadequate leading to misfiring and certainly to inadequate combustion and loss of power and economy. This occurs because the dwell time is controlled by a fixed dwell angle of cam rotation. See Fig. 2.

Maintenance

Arcing at the points surface erodes the metal and adjustment is lost. The cam follower also wears and contributes to loss of gap.

Adequate gap to prevent arcing and maintain dwell angle is gradually lost and needs to be restored every 5000 miles or so. If emissions and economy are to be maintained even more frequent adjustment is called for.

Timing

All timing operations are controlled mechanically. They are therefore subject to friction, wear and general lack of accuracy. Low emission, high performance and good economy all rely upon accurate timing.

erosion over a greater area. This is claimed to increase service intervals to 12,000 miles.

TRANSISTOR ASSISTED IGNITION

So far in our view of ignition systems it's implied that the improvements have been to increase the maintenance period and improve economy. But there is now an even greater pressure on the manufacturers to reduce emissions. Rich mixtures of fuel and air produce a lot of nasty by-products but they do ignite easily. Modern engines run on lean mixtures—some very lean indeed.

To make sure the air/fuel mixture ignites properly it requires a high energy spark and a high voltage. The ordinary C.B. ignition systems are not always able to manage this, particularly at high engine speeds, so transistor assisted systems were introduced.

The energy stored in a coil is equal to $\frac{1}{2}LI^2$ where L=the inductance and I=the current. It is clear that if the current is doubled the energy available is four fold. Unfortunately the points are already over burdened—if they were made larger to carry more current they would have too much inertia to handle the revs.

But by the use of transistors (usually a Darlington Pair) large currents can be controlled quite easily and additionally the current can be switched very fast and with no arcing. Triggering of the transistors can be by contact breaker points or by some device which requires less maintenance.

ADVANTAGES

Large currents mean high energy, similarly fast switching speeds mean high voltage generation—this gives reliable firing when cranking and at high engine speeds. Dwell angle is less critical. Points sets, if used, carry only small currents and therefore last longer without adjustment.

Switching is clean, no arcing, so timing is more accurate. Also the effects of points bounce can be eliminated which ensures more accurate timing.

Overall the result is a car which starts more reliably, produces more power and is more drivable when cold and needs less choke. This is bound to improve emissions and fuel economy.

HOW TO RECOGNISE

This type of system has now been superseded but was normally housed in a module attached to the side of the distributor or

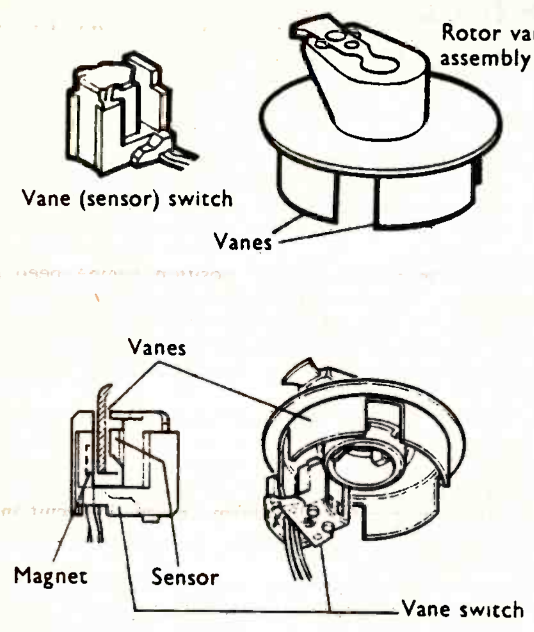


Fig. 4. Hall effect arrangement. (a) Vane switch (or sensor) and rotor vane assembly. (b) Interaction of rotor vane and vane sensor.

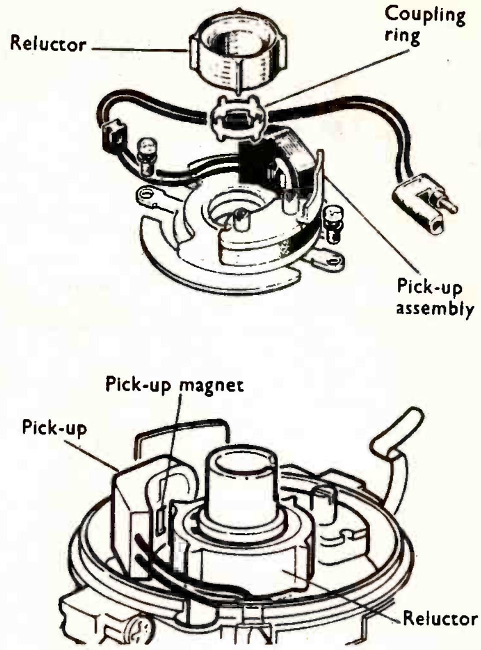


Fig. 5. Early distributor reluctor system arrangement. (a) Reluctor and pick-up assembly. (b) Reluctor tooth and pick-up alignment.

attached to the coil. The coils have a low primary resistance of about three-quarters of a ohm.

Any system which is electronic but still uses the points is likely to be of this type. The modules are commonly called "amplifiers" or "igniters".

IGNITION TRIGGERING SYSTEMS

Contact points are mechanical switches; because they are mechanical they wear and need regular adjustment. They also bounce when they open and close at high speed, this can affect the accuracy of their timing.

ALTERNATIVES

With transistor ignition systems it is no longer necessary to rely on the points to perform the triggering function. With only a little more circuitry it is possible to trigger them with sensors which have no moving parts.

Early systems sometimes used photo-electric light sensors which produced a pulse when masked from a light source by a revolving disc. These were perfectly satisfactory but modern practice is to use a magnetic sensor and two systems now predominate.

Hall Effect

Modern semi-conductor technology has produced a device which when placed in a magnetic field deflects an electric current and is called a "Hall Effect" device. See Fig. 3.

The actual arrangement is to fix a Hall Effect chip in a distributor so that a flanged disc rotating on the distributor shaft masks it from a magnet. Slots in the flange allow the magnetism to reach the Hall Effect device when the trigger pulse is required.

The Hall Effect chip is supplied with current and at the correct moment a trigger pulse appears on the output connection which is fed to the control module. No adjustment should ever be required. See Fig. 4.

Reluctor Systems

When a magnetic circuit is broken any coil in that circuit will experience an induced voltage. This voltage can be used to trigger a transistor ignition system. If a toothed wheel is part of the magnetic circuit then the circuit will be interrupted when a tooth is not in alignment with a pole piece.

An early method was to put the toothed wheel into a distributor and this has the advantage of being able to utilise the centrifugal advance and the vacuum advance systems. The disadvantages are that distributor bearings wear, gear backlash and the mechanical advance systems still produce some inaccuracy. See Fig. 5.

A more recent method is to put the toothed wheel on the flywheel where there is no backlash or possibility of drive gear wear. Additionally extra teeth can be provided so that engine speed can be sensed by the same sensor. However, alternative systems are then required to replace the vacuum and centrifugal advance. See Fig. 2.

ADVANTAGES

Accurate ignition timing from a no-maintenance system which once set should not need adjustment.

CONSTANT ENERGY IGNITION

It takes time between each spark for the current and hence the magnetic field in the coil to grow to its maximum. If the coil does not reach full capacity it will not generate its full output and will be unable to ignite weak mixtures and misfiring can occur.

Certainly incomplete combustion leading to poor power and high emissions do occur. This is particularly the case with high revving engines and 6, 8 and 12 cylinder units.

There are numerous solutions to this problem but because electronics are relatively cheap it is common to find combined systems. The commonest are described below:

Electronic Dwell Control

Dwell period is related to the angle that the cam in the distributor rotates through while the points are closed. This is called "dwell angle" and is usually about 50 degrees on a contact breaker system (see Fig. 2).

If dwell angle is increased at high revs, there will be an increase in dwell *period* compared with a fixed dwell angle system. This is easy to arrange if electronic triggering is in use. The increased period allows the coil time to reach its maximum current flow and hence maximum energy storage.

The reduced dwell at low revs, reduces current consumption and heating of the coil.

Constant Current Operation

With constant current operation the coil resistance is made so low (0.80 ohm) that the coil current rises to its maximum even in the short time available at high revs. The constant current circuitry prevents it from rising too high in the longer periods available at low revs.

STATIONARY ENGINE CUT-OFF

Both the above systems employ a circuit which cuts off current to the coil when the engine is stationary. This is essential as otherwise the coil would overheat with the high current (as high as about 18A) which could flow if the ignition were left on.

These systems optimise the ignition system so that regardless of engine speed, battery voltage, starting or high revs, the engine is provided with a powerful and consistently timed spark. And yet at low revs, or when stationary, components are protected from excessive heat and power is not wasted.

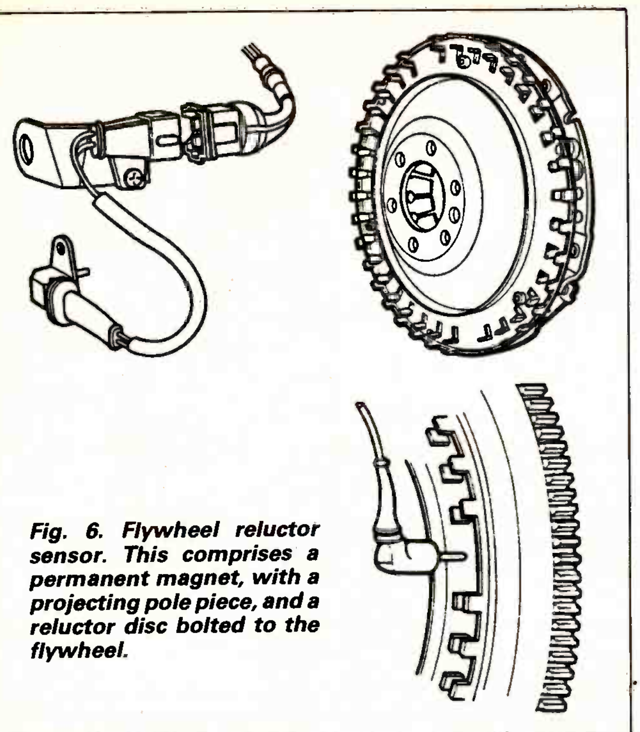


Fig. 6. Flywheel reluctor sensor. This comprises a permanent magnet, with a projecting pole piece, and a reluctor disc bolted to the flywheel.

HOW TO RECOGNISE

Most modular electronic ignition systems now incorporate all or some of the previously mentioned techniques. These systems are usually housed in packs which are attached to the side of distributors or on the bulkhead with the coil.

However, note they still use the mechanical vacuum and centrifugal advance mechanisms so there is still a distributor-like casing driven by the cam-belt or camshaft. Only in the programmed ignition systems is the distributor eliminated (except for cap and rotor arm).

PROGRAMMED IGNITION

Transistor ignition systems with a conventional distributor using centrifugal advance and vacuum advance do not completely meet the requirements of modern engines in modern operating environments.

Distributor systems sense engine load by the use of manifold depression. This is arranged to mechanically vary the rotation of the distributor. Apart from the usual difficulties associated with mechanical control systems such as friction, wear and backlash; there is a limitation in the range of different amounts of advance which can be accommodated. See Fig. 7.

Similarly centrifugal (bob weight) advance systems mentioned previously have all the mechanical disadvantages mentioned and can provide only two stages of advance. Finally mechanical systems have no facility for the input of additional information such as engine temperature.

MICROPROCESSOR IGNITION CONTROL

Programmed Ignition comes in the ubiquitous "black box" called an ECU (Electronic Control Unit). It makes use of a ROM i.c. to store information about a particular engine's advance requirement under all load and speed conditions. In operation this is then read by a *microprocessor* and further modified by additional inputs such as coolant temperature and engine knocking ("pinking") to provide the optimum ignition advance.

The stored information called an engine "map", is worked out by the engine manufacturer on an engine test bed (see Fig. 8). Even the most rudimentary programmed ignition system will require the following inputs: engine position; engine speed; manifold depression; battery voltage and coolant temperature.

Engine position and speed are often taken from a flywheel reluctor sensor, (see Fig. 6) which comprises a permament magnet with a projecting pole piece and a reluctor disc which is bolted to the flywheel.

The disc has pairs of lugs projecting at 10 degree intervals around the circumference. The sensor is mounted in such a way on the engine that as the flywheel rotates the pairs of lugs pass each side of the projecting pole piece. Thus for an instant at 10 degree intervals the sensor and the lugs form a magnetic circuit and also pulses are generated, their frequency indicating the speed of rotation of the engine.

However, at Top-Dead-Centre (TDC) for cylinders 1 and 4 and at 180 degrees further round thus TDC for cylinders 2 and 3 there are pairs of lugs missing. There will therefore be pulses missing at these points and the ECU can thus detect TDC for the appropriate cylinders (see Fig. 9). In this way engine speed and position is passed to the ECU.

ENGINE LOAD

Engine load is the other important parameter and this is related to manifold depression. In other words if the throttle is wide open (full load) manifold depression will hardly exist as the manifold will be at virtually atmospheric pressure. If on the other hand the car is decending a hill on a trailing throttle (no load) there will be a large vacuum or high manifold depression.

On light loads the engine runs much more economically if the ignition is advanced. You may recall that a vacuum capsule is fitted to distributor type ignition systems to achieve this. With programmed ignition the manifold pressure passes up a pipe to the ECU where it is measured with a pressure transducer.

ADDITIONAL INPUTS

Engine temperature is a useful input to include in an ignition system in that retarding of the timing can lead to better drivability from cold and speedier warm-up. A coolant sensor is already available on most cars anyway (for the temperature gauge) and so this is relatively cheap to implement.

Temperature sensors are made from a negative temperature coefficient semiconductor, encapsulated in a brass housing and screwed into the engine block or thermostat housing. Their resistance varies from about 10 kilohms at −10°C to about 300 ohms at engine running temperature.

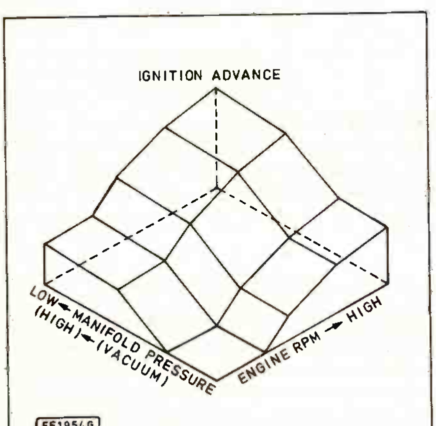


Fig. 7. Ignition or "engine" map using the distributor system.

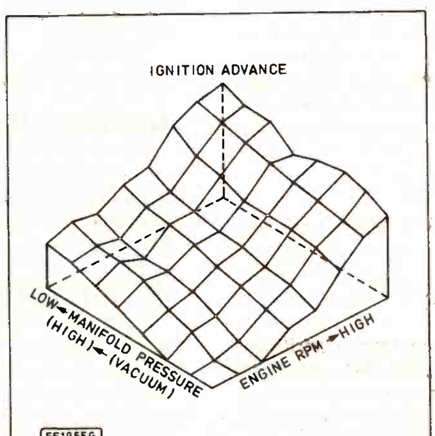


Fig. 8. Engine map using the programmed ignition system.

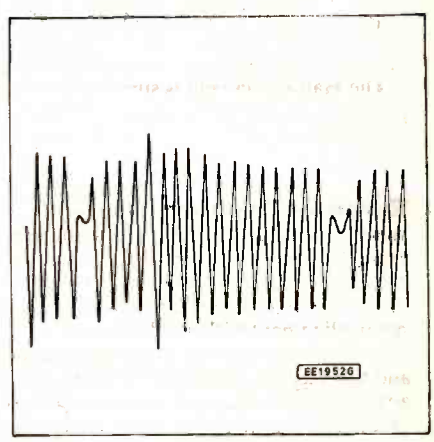


Fig. 9. Typical waveform to be expected from a reluctor sensor output.

KNOCK SENSOR

A significant addition with programmed ignition is the "knock sensor"! Engines are more economical, more powerful and produce less harmful emissions if run at maximum advance.

In the past the standard setting always had to allow a margin for error because the consequences of an *over-advanced* engine are dire; broken pistons and burnt valves to name a couple. But with a microprocessor looking after the ignition it could run the engine at maximum safe advance and it could sense the onset of "knocking", "pinking" (or whatever you call it) it could then retard the ignition until the unwanted condition ceased.

This "feedback" scheme of things is exactly what is implemented and what is more the relatively high speed of a microprocessor allows it to differentiate between different cylinders and only retard the ignition on the cylinder required. Being a feedback system there is also the possibility that this can compensate for the age of the vehicle or the wrong fuel.

The knock sensor is a piezo electric accelerometer and is screwed into the block. The name belies a simple construction of a piezo crystal which is clamped between the block and a weight (i,e, a thick washer). See Fig. 10.

Vibration of the engine thus squeezes the crystal and produces a signal. The tricky bit is then to sort out which signal is the one which indicates knocking. Inside the ECU you can imagine there are bandpass filters and other bits of jiggery pokery (sorry signal processing).

A typical algorithm for the microprocessor is: At the fourth ignition pulse after the knock has occurred the timing is retarded in steps of 1.25 degrees until the knock disappears. The ignition is then advanced by 0.625 degrees every 32 engine revs until the advance agrees with the figure in the ROM (Read Only Memory) or the knock occurs again.

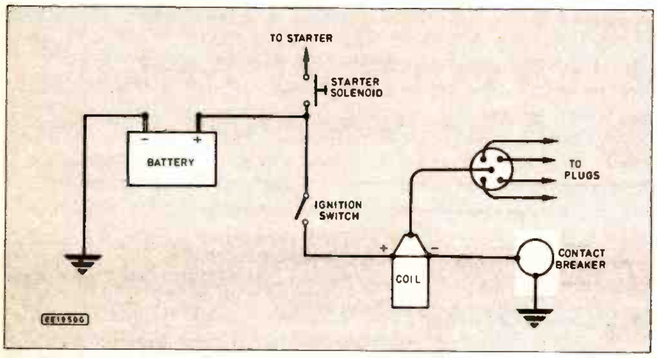


Fig. 10. Mechanical arrangement for the piezoelectric transducer "knock sensor" and examples of output waveforms. The sensor is screwed into the engine block.

PROGRAMMED IGNITION ADVANTAGES

The advantages of the programmed ignition are: Better drivability; easier starting; smoother running; improved economy and power and automatic adjustment for the age of vehicle. Additional inputs can be added to give traction control, smooth idle, smoothed auto gear change, turbo boost control and exhaust gas recirculation. Inter-connection with a fuel management system is also possible which enhances the effect of both systems.

HOW TO RECOGNISE

Apart from the rotor arm and distributor cap all the other functions of a distributor have been replaced by an Electronic Control Unit (ECU). The ECU is a box, often black, it has a finned section and apart from a multiplug has a vacuum pipe from the inlet manifold leading into it, It is often mounted on the bulkhead or suspension turret.

FAULT-FINDING

Both programmed ignition and the simpler module type ignition system are easy to fault find as long as you remember that their function is to replace the contact breaker. Have a look at the diagram of the basic system (Fig. 1 and Fig. 11) and visualise the ECU in place of the contact breaker and ignore all the sensors.

Clearly a bulb connected across the two coil terminals should flash when the engine is cranked, if not then check for battery voltage from the coil all the way back to the battery. You should also find battery voltage on the coil negative with the engine stationary–due to "stationary engine cut-off" referred to earlier.

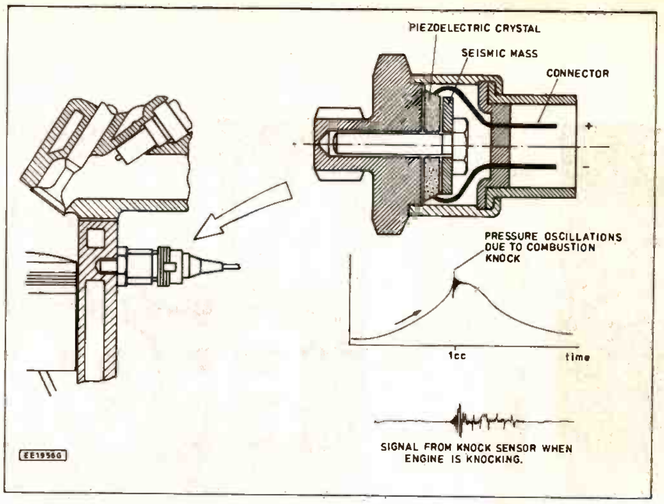


Fig. 11. Block diagram showing the Electronic Control Unit (ECU) superimposed on the conventional c.b. system. (See also Fig. 1.).

If the test bulb still does not flash then it has to be the feed to the module or ECU which is often taken from the coil positive terminal or direct from the ignition switch.

If the car still does not start, *and assuming it is the ignition,* then it must be the high tension circuit. ***A word of caution is due here: electronic ignition circuits produce quite a kick, so be careful!***

High tension circuits must be tested in such a way that you always provide an "Earth" path. If you don't it'll find one of its own and do some damage on the way. The best check is to dive in the middle. Remove the lead to the centre of the distributor cap and rest it on the engine in such a way that a spark can jump to the block. When cranking if you don't get a healthy spark which will jump across ¼in. then you've got problems with the coil. If you have a spark then the fault must be in the distributor cap or rotor arm.

With a Programmed Ignition the sensors can cause a problem. Obviously if the TDC sensor has failed the system will not function. Check out with a multimeter, reluctor coils have a resistance in the couple of hundred to three or four kilohms bracket. Failed ones are open circuit or short circuit.

Similarly with coolant temperature sensors, open or short. Good ones range from 10 kilohms when cold down to 300 ohms at 100°C. Hall Effect sensors are difficult but try your multimeter switched to a.c. volts on the output lead. With the engine cranking any reading probably means O.K.

POOR PERFORMANCE

Apart from tired components like plugs and leads poor performance can only be caused by bad timing, so with the module type of ignition check it and also check the operation of the vacuum and centrifugal advance systems.

Programmed ignition cannot get its ignition timing wrong except if it thinks the engine is cold so check out the coolant temperature sensor. The only other problem could be "pinking" and this points the finger at the knock sensor.

Incidentally, correct function of this component can be verified by tapping the engine block close to the sensor quite hard and repeatedly with a spanner. If the engine is ticking over at hot idle speed you will detect a drop in speed which indicates the timing has been retarded. However, some cars have a stepper motor controlling the idle speed so this will have to be disconnected first.

IN CONCLUSION

We have purposely not attempted to explain the workings of the inside of "black boxes" found in the ignition systems on cars. Nobody in their right mind is going to attempt to fix one of them at the side of the road.

The guts of the ECU's however are very interesting and will perhaps be considered at a later date. What we have attempted to do is show that although sophisticated, these systems are quite easy to understand at the block diagram level and give enough, we hope, information to quickly resolve any problem associated with them.

Do please look before you leap — like any electrical device in the hostile environment of a car engine compartment — most faults are caused by poor connections. □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...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

MORE PRIMARY BANDS

Although there is apprehension about pressures on amateur radio frequency allocations at the next World Administrative Radio Conference it is heartening to be able to report some gains at the present time.

The WARC held in 1979 agreed that the 18.068 to 18.168 and 24.890 to 24.990MHz bands should be transferred to the amateur service on a primary basis. In order to protect existing users, while replacement frequencies were being found for them, the bands were made available to Class A amateurs initially on a restricted basis only.

These restrictions involved limitations on type of transmission, maximum power and antenna characteristics, and a requirement that no interference be caused to other services. Only Morse transmissions were allowed with a maximum power of about 10 watts, and antennas were limited to horizontal polarisation with no greater gain than that of a half-wave dipole.

The original services have since been moved to other frequencies and, as from 1st July 1989, the two bands are now available to amateurs on a primary basis, using all permitted modes of transmission at the normal power levels applying to the amateur h.f. bands.

Apart from Morse, stations can also operate with telephony, radio teletype (RTTY), data, facsimile, and slow-scan TV, with power limits of 100W carrier or 400W PEP (peak envelope power) for emissions with suppressed or reduced carrier, e.g. single-sideband (SSB). There is no restriction on the performance of antennas so beams can be erected to provide better long distance (DX) performance.

Despite the restrictions a good number of amateurs have been using these bands for the last few years. New h.f. transceivers nowadays include facilities for the "new WARC bands", and the dropping of the Morse only rule will undoubtedly make the bands interesting for many more operators.

POWER LEVELS

I have quoted "maximum power" in watts, which is how the amateur licence used to specify power. The present licence however sets out power limits in dBW, which is a way of expressing power levels relative to a fixed amount of power, in this case one watt.

Using this system, 1W is written as 0dBW. Doubling the figure in watts adds 3 to the dBW figure so, for example, 2W equals 3dBW and 4W equals 6dBW.

In the amateur licence, therefore, the 100 watts and 400 watts I mentioned above are defined as 20 and 26dBW respectively. The definition was changed in 1982, but most amateurs I know find it confusing and still talk about "watts" when referring to the power of their transmitters. No doubt that is why advertisements for the latest "state-of-the-art" rigs also still describe power levels in the old-fashioned way.

EARLY COMMUNICATIONS

Edinburgh's Museum of Communication will be displaying some interesting items from its collection in the Upper Library, Bo'ness over the weekend 16th to 18th September. On show will be examples of early spark transmission, telegraph and telephone mechanisms, early single and multi-valve receivers, services communication receivers and transmitters, clandestine radios, early domestic wireless sets, gramophones, horn speakers, and more.

These are just a few of the things collected over the years by the museum's curator, Harry Matthews. He is continually adding to the collection and is always pleased to hear from anyone having interesting items which need a "good home" where they can be preserved for posterity.

Harry is always involved in interesting activities. In *Morsum Magnificat*, Summer 1987, there was a description of one of his projects—"tidying-up", photographing, and drawing the circuits of a historic WW2 spy-set for Leith Police who were setting up their own museum.

The set had an interesting story. It was in the luggage of Werner Walthi, arrested at Waverley Station, Edinburgh, in September 1940, and subsequently hanged as a spy. A code used by the Germans was found in Walthi's luggage and decoy messages were transmitted with the radio giving false information on the movement of British shipping, resulting in a number of U-boats being destroyed.

Further particulars about the museum, and the special exhibition at Bo'ness, can be obtained from Harry Matthews, 22 Kinglass Avenue, Bo'ness, West Lothian, EH51 9QA.

Incidentally, Bo'ness is the home of the Kinneil and Bo'ness Steam Railway. Over the weekend of the museum's exhibition trains will be operating on the 7 mile return journey to the Birkhill Clay Mine, newly opened to the public this year by the Bo'ness Heritage Trust.

SKELETON IN THE CUPBOARD

Most of the time in this column I extol the attractions of amateur radio as an enjoyable and satisfying scientific hobby covering many fields often on an international scale. It has social, adventurous and experimental aspects, plus worthwhile opportunities for public service, all at the choice of the individual. My message, as ever, is "come and join us".

But nothing is perfect and there is one area of activity within amateur radio where problems have existed for years, and no-one seems to know how to deal with it. This is the disruptive behaviour of a small section of operators using v.h.f. repeaters.

Talk-through repeater stations are installed by clubs or groups at favourable high sites to enable amateurs operating mobile stations, usually from their cars, etc., to contact other stations over greater distances than is normally possible by direct transmission. The repeaters receive signals on one frequency and re-transmit them on another, and because they are used by many different stations there is need for good operating discipline.

Unfortunately, some operators pay no regard to these needs, hogging the repeaters for normal base-station, rather than mobile, operation; making new users of repeaters unwelcome; interrupting on-going QSO's (contacts) with foul language, abuse, or illegal transmissions of music and generally blocking access for other users.

It all started in the early '70s when repeaters were first introduced and I remember it being said then that nothing could be done by the authorities unless the culprits were actually heard by them and could be identified. There were apocryphal tales of the "boys" going out at night in their cars with direction-finding equipment to find the culprits, but what happened when they did I cannot say!

Nowadays there are some 250 repeaters throughout the country and while some areas seem to have less trouble than others, the problem still exists. The licensee for all UK repeaters is the Radio Society of Great Britain while the various groups are franchised to run the repeaters on the Society's behalf.

Following complaints by over 70 amateurs about the misuse of one repeater last year the repeater group concerned declared that although it was responsible for the technical side of the installation it could not censor the users. In response to this the RSGB's Repeater Management Group emphasised that the group as franchise holder was responsible for the way the repeater was used, adding that in a similar case the DTI had requested a shut down.

Occasionally one hears that an amateur has been prosecuted for repeat er offences, both in the UK and in other countries. It seems a pity though that the only other solution is the shut down of a repeater since that surely represents a victory for the few saboteurs over the majority of decent users.

Many people listening to amateur radio for the first time, perhaps in a friend's shack, hear repeaters in action and judge the hobby from what they hear. I can assure them that if they listen on other frequencies they will get a completely different impression.

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Special Series

STABILIZED POWER SUPPLIES

STEVE KNIGHT — Part Four

Apart from delving into the basic theory of p.s.u. design and potential problems, this short five part series will introduce three practical projects which are fairly simple to build and have reasonably good specifications.

The three stabilized units are: Variable 0V to 12V 1.5A; Variable 0V to 25V 1A; Variable 1.5V to 25V, with switched current limits of 0.5A, 1A, 1.5A and 2A.

TWO REGULATED power supplies with current limiting, one providing 0 to 25V at 700mA and the other 0 to 30V at 1.0A, are our subjects this month. Before getting on with the constructional details, however, a few words about the meters used on these projects won't be out of place.

The addition of a voltmeter/ammeter indicator to any power unit, although not strictly necessary, really completes the job and gives it a more professional finish. Of course, it is always possible to calibrate the voltage control knob on the panel with voltage markers, and since for a stabilized supply there is negligible variation in the output voltage within the specified current range, this is an inexpensive alternative. If cost is also in mind, a single voltmeter can be fitted; this will indicate gross current overloads by either falling to zero on short-circuited loads or failing to increase when the normal current has been exceeded.

The thing to try and avoid is rescaling a meter which has a scale marked in a completely different fashion from what is actually wanted. This *can* be done and the author has rescaled many, but it is a job that requires some skill and a whole lot of patience in removing an existing scale without damaging the instrument itself and some reasonable artistry in marking the new scale to its proper divisions.

METER

In both this month's designs, a 50μA meter, type Q45, has been used. This is a large meter measuring 110mm × 83mm and the scale, as provided, is marked (naturally!) 0-50μA.

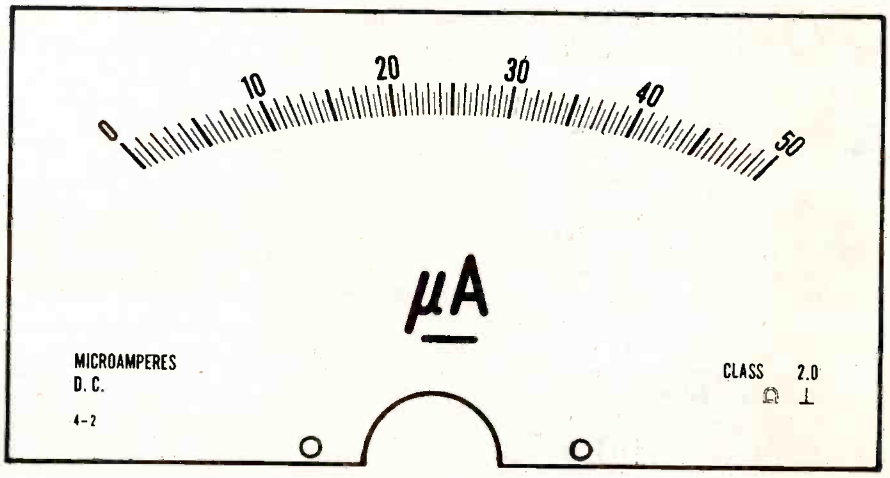
The scale changes needed are fairly simple to carry out, but *do NOT* under any circumstances do this on a dirty bench top or anywhere else where there are iron filings or other pieces of eager minutiæ waiting to get into the moving-coil mechanism and jam everything solid. Find yourself a dust free corner away from the wife, kids and the dog; then carefully remove the plastic covering and put it to one side.

Equally carefully remove the two scale fixing screws and *slide* the scale from beneath the pointer. Now put the meter and the two screws inside the plastic cover and put the lot in a safe place.

METER SCALE

The first of this month's projects needs a scale reading 0-25V and 0-1A, and Fig. 4.1a and Fig. 4.1b shows the scale before modification and afterwards. You need a packet of rub-of lettering with figures which reasonably match those already in the scale.

The existing μA marking and scale figures have now to be removed; this is best done by *gently* scraping them with a used razor blade, keeping the blade at right angles to the surface and avoiding "digging in" the corner of the blade. This sounds as though we are going to end up with a patchy surface but with the necessary pati-



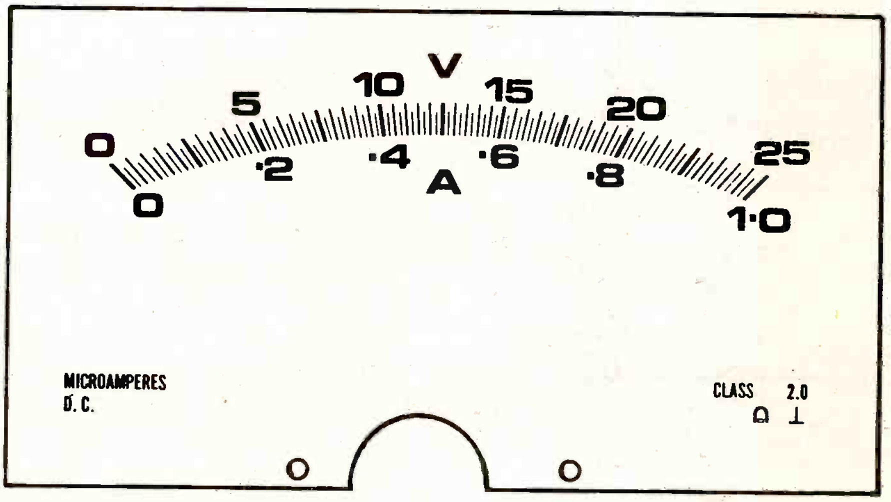


Fig. 4.1. Meter scaling before (a) and after (b) modification. The top figures are removed as well as the μA marking.

ence the scale print will come off and leave the underlying white surface undisturbed.

Practice on the small unimportant printing at the foot of the scale first. Then get rid of all the dust and add the V and A lettering and the additional numbering as shown in Fig. 4.1b. You then have a scale reading 0-25V and 0-1A.

For the second project we need a scale reading 0-30V and 0-1A. Here the voltage scale doesn't fit readily into the existing divisions, so we leave the 0-50 markings as they are and add only the current figures 0-1A in exactly the same way as before. True, we shall only be using three-fifths of the scale length for our 30V output, but these scales are quite large and easily read so this is no great hardship.

Reassemble the scale on to the meter, taking care that the scales don't fall into the works, and snap the cover back into place. Do this at the bottom first so that the zeroing button engages properly. It should do this without adjustment if you haven't disturbed it.

You can if you wish use a smaller 50μA version of this meter, the type T21 (see Shoptalk), and modify the scale in the same way. If you don't fancy rescaling meters in this way, use separate meters for voltage and current. The 1A type T30 and the 30V type T43 are suitable.

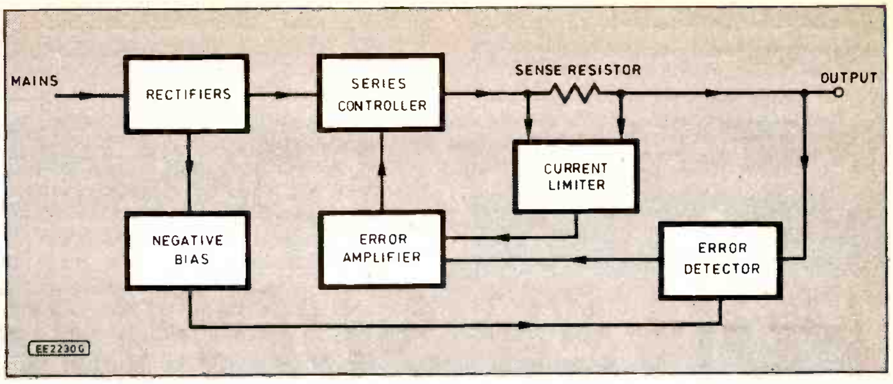


Fig. 4.2. The general block diagram for the two stabilized supplies described.

REGULATED SUPPLIES

Both projects to be described are very similar in construction and apart from a few minor details, the assembly instructions which follow can apply equally to both designs. Both circuits use discrete transistors, four in the case of the 25V unit and six in the case of the 30V unit.

Some might think that the circuits are retrograde in that they are not using integrated packages, but apart from fairly expensive regulator i.c's, the performance figures for these designs are better than those obtainable from integrated systems. Also, few external components are saved by their use and additional circuitry is nearly always required to get the output voltage range from i.c. regulators down to zero. We will be coming to an example of integrated design with these additions in next month's project.

Both circuits operate on the principles shown in the block diagram of Fig. 4.2 where the various parts covered in Part 1 of this series are now brought together in practical form.

Constructional Project

VARIABLE STABILIZED POWER SUPPLY

0-25V at 700mA maximum, ripple less than 3mV r.m.s.

THE COMPLETE circuit diagram for the 0-25V Stabilized Power Supply is shown in Fig. 4.3. This design will provide a highly stabilized output adjustable from 0 to 25V at a maximum current of 700mA and with a ripple of less than 3mV r.m.s at full load. The output impedance is one ohm, D.C. to 80kHz.

The power input is derived from transformer T1 which has two secondary windings, one of 28V at a current rating of 1.5A and the other of 12V at a rating of 100mA. Both of these supplies are rectified by bridge rectifiers REC1 and REC2 respectively. After smoothing by capacitor C1, the positive supply line from REC1 goes on through the series regulator transistor TR1, a 2N3055 (or a 2N3771 may be used), and the current sense resistor R9 to the positive supply output terminal.

The output from bridge rectifier REC2 provides, after smoothing by capacitor C2, a negative line which supplies the zener reference diode D3 and also biasses the emitter of the error detector TR3 in conjunction with the diodes D1, D2, to approximately −0.7V. This arrangement allows the output voltage to be taken down to zero.

The series regulator transistor TR1 carries the whole of the output current and acts as an automatic resistance. Its base current is controlled by the error amplifier

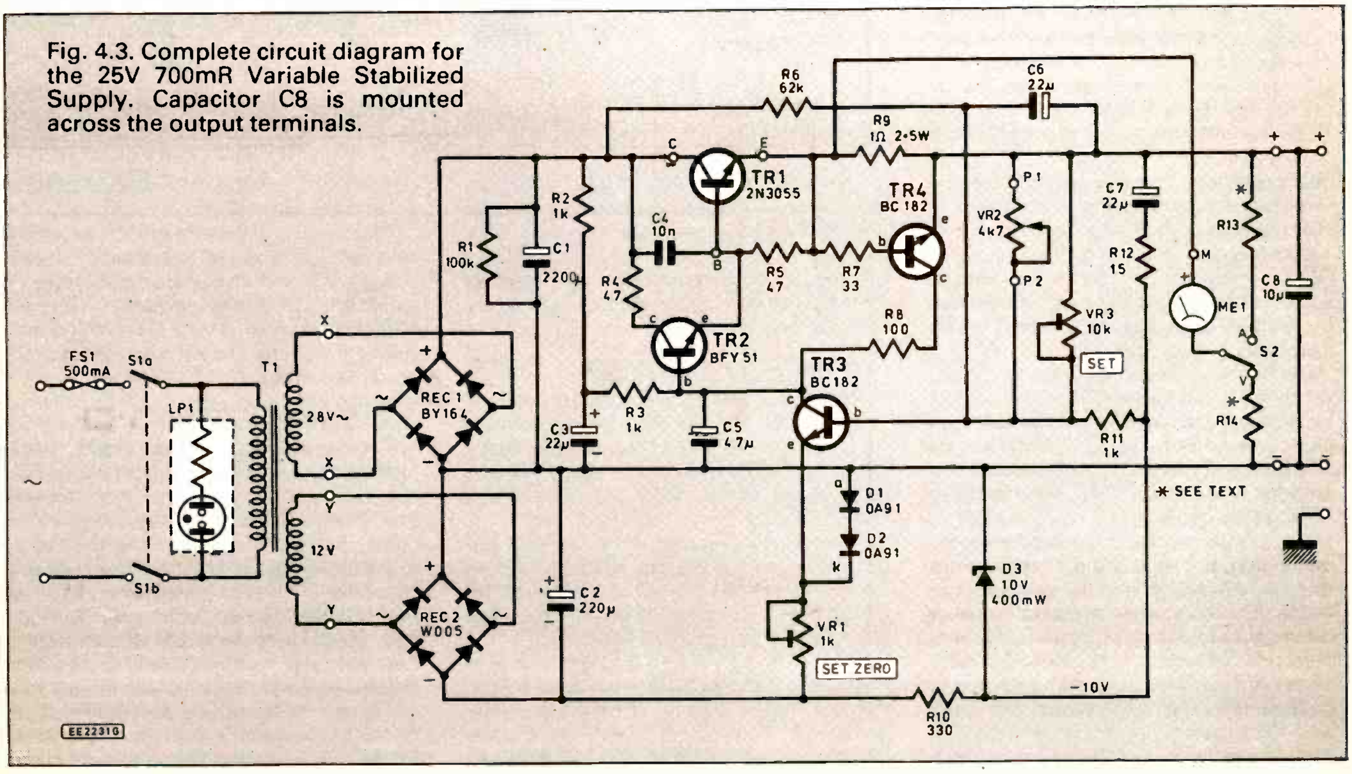


Fig. 4.3. Complete circuit diagram for the 25V 700mR Variable Stabilized Supply. Capacitor C8 is mounted across the output terminals.

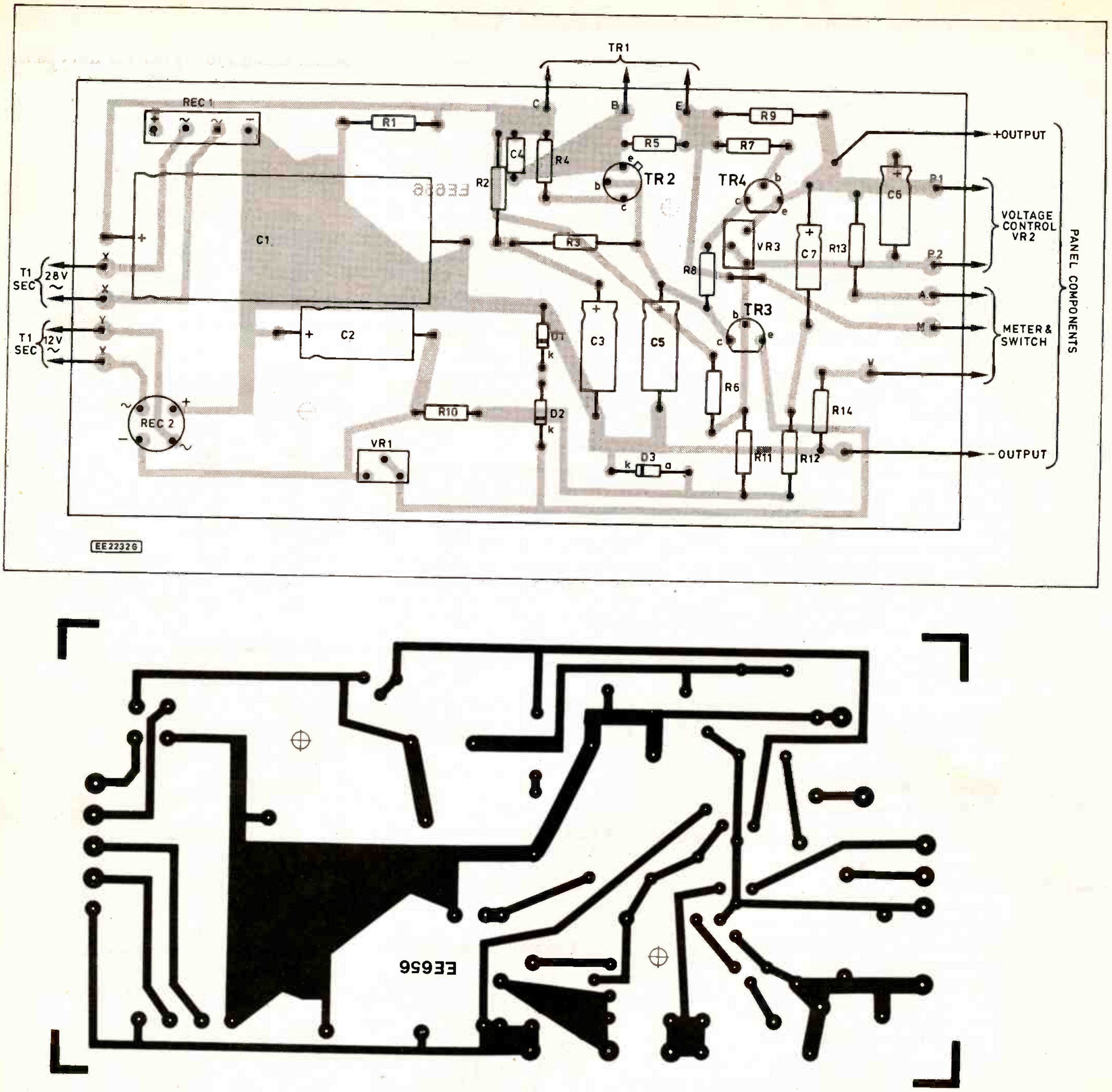


Fig. 4.4. Printed circuit board component layout and full size copper foil master pattern. Drill fixing centres marked "F" to suit mounting spacers.

TR2 which amplifies the output from the error detector TR3 to a level sufficient to drive the base of TR1.

Base bias for TR1 and collector bias for TR2 are provided by resistor R4. Hence, whatever happens at the base of TR3 has the effect of adjusting the effective series resistance of TR1.

The base of TR3 connects to the voltage adjusting potentiometer VR2. This control sets the required output voltage to anything between 0V and 25V. Once this is set, any unwanted variation in the output level is passed to the base of TR3 and initiates the feedback to TR1.

Suppose the output tends to fall slightly. The voltage at the base of TR3 falls and its collector current (derived through resistors R2-R3) also falls. This increases the base voltage of TR2 which, being in emitter-follower configuration, increases the base current of TR1. This reduces the resistance of TR1 and the output fall is compensated.

This regulation also acts to reduce the output ripple voltage; any ripple on the rectifier side of transistor TR1 is passed by way of resistor R6 to the base of the error detector (TR3), and this, together with capacitor C6 effectively bypassing VR2 to a.c. ripple components in the output, enables the feedback to treat the ripple as an unwanted variation.

CURRENT LIMITER

Transistor TR4 serves as the current limiter. Its base-emitter bias is derived from the voltage developed across the series resistor R9. Providing that this voltage is less than about 0.7V, TR4 remains switched off.

The value of resistor R9 is one ohm and when the output current reaches 700mA, the voltage drop is 0.7V. This then switches transistor TR4 on and takes control away from the error detector TR3.

The base of TR2 consequently moves negative and TR1 is biased back to the point where a 700mA current cannot be exceeded, In actual practice, the current limit may lie betweeen 650 and 750mA, depending upon the tolerances of resistor R9 and transistor TR3.

The output is monitored by the switch selected Voltmeter/Ammeter already described and finally smoothed by capacitor C8. Preset controls VR1 and VR3 are used to set up the voltage limit readings on the meter when the unit is ready for testing.

CONSTRUCTION

Everything except the mains transformer, the meter and its switching, and the voltrage adjust control, goes on to a printed circuit board (p.c.b.). In turn, this p.c.b. screws on to a simple aluminium heatsink which carries the series regulator transistor TR1. The same heatsink is used in the second project to be described, and what is said here about the various mountings will apply equally well to the later design.

The circuit board component layout and full-size copper foil master pattern is shown in Fig. 4.4. A ready-drilled printed circuit board is available from the *EE PCB Service*, code EE000.

When assembling this board the only precautions to be taken are, the usual ones of getting the rectifiers, electrolytics and diodes the right way round. More care is needed for bridge rectifier REC2 than for REC1. Bridge REC1 can only go in one of two ways but REC2 can go in any one of four!

Check very carefully, and take care with the soldering, in particular around the transistor connections. Transistor TR2 must have a corrugated type heatsink pushed on to it, and wirewound resistor R9 should be spaced away from the surface of the board by at least 3mm. There is a short link needed immediately below the position of VR3, don't overlook this or the meter won't work, although everything else will.

AMMETER/VOLTMETER

Resistors R13 and R14 need a few words. These convert the basic 50μA meter movement into an ammeter (A) and a voltmeter (V) respectively. Resistor R14 is switched in series with the meter on the *voltage range*; since the meter has to read 25V full scale deflection (f.s.d) and its own internal resistance is stated to be 1700ohms, we have to restrict the current through it to 50μA when 25V is applied to it and R14 in series. By Ohm's law we get: $R14 = 25/(50 \times 10^{-6}) = 500k\Omega$, less $1700\Omega = 498{,}300\Omega$.

Well, we aren't going to pick that off the shelf, and the and the best we can do is to use a 510kΩ, 1 per cent resistor. This will tend to make the reading slightly on the low side but this is compensated for by the fact that the voltage is actually being measured on the higher potential side of resistor R9 and what appears at the terminals is always slightly less than this.

For the *current reading*, the f.s.d.is 1A. What we are now effectively reading is the voltage drop across R9 interpreted in terms of current.

If 1A flowed through R9 it would drop 1V, hence we want the meter to provide f.s.d. when 1V is applied to it and the series resistor R13. Hence $R13 = 1/(50 \times 10^{-6}) = 20k\Omega$, less $1700\Omega = 18.3k\Omega$. An 18kΩ, 1 per cent resistor will do here.

If, of course, you use any alternative meter, you will need to recalculate these values.

HEATSINK

We now have to fit the circuit board to the heatsink which carries the 2N3055 series controller transistor (TR1), and we do this in the same way as we did for last month's project. Bend a piece of 16s.w.g. aluminium (you can use 14s.w.g. if you wish) to the dimensions shown in Fig. 4.5.

Place the board on the heatsink, away from the "bend" side, and mark through the two fixing holes indicated by "F" on the board. The board will be screwed to the aluminium sink at these points using ½in. spacers.

Let the bottom edge of the board be a quarter inch or so above the foot of the aluminium. There is nothing critical about the actual positioning.

Spray the heatsink black if possible and mount TR1 at its centre, insulating the transistor TO3 case from direct contact with the aluminium with the usual insulating kit. A silicone rubber washer is preferable to mica here, but if you use the latter, give both sides of it a thin smear of heat transfer compound before mounting.

Solder three *differently* coloured flexible leads to the emitter, base and collector (case) of transistor TR1 long enough to reach to the E, B and C solder pads at the top edge of the board after it has been screwed to the heatsink. It is easier if you have soldered Vero pins to these points, and the same, if you wish, to the other output pads.

When the board has been screwed to the heatsink, it should look something like Fig. 4.6; TR1 leads looping neatly over the top edge of the board and soldered to the appropriate pins. The spacers may be either metal or plastic types, 6BA or 4BA threaded. If you use metal types, ensure that they are not fouling the board wiring tracks. Their length is not critical, but ½in should be considered a minimum.

This completes the board and heatsink assembly.

BOXING UP

We have not specified any particular case for this project (or for the next one come to that) because there is a vast range of suitable cases available at a vast range of prices. Enough to say that the front panel shouldn't measure less than about 229mm (9in) wide by 127mm (5in) high, and you will need a depth of 102mm (4in) minimum.

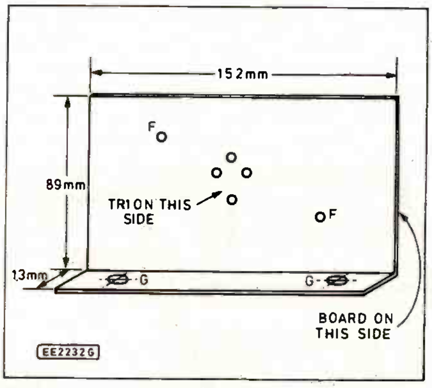
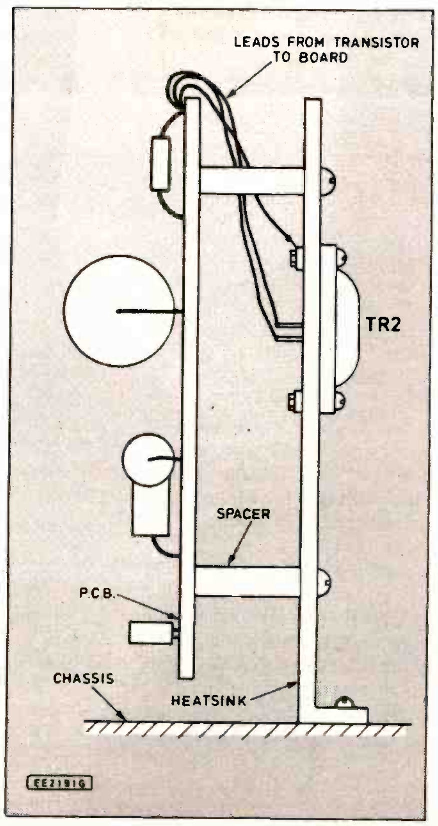


Fig. 4.5. Heatsink (16 or 14s.w.g.) drilling details. Holes at "F" to match board and two holes "G" 4BA clear. Centre group to suit TO3 transistor outline.

Fig. 4.6. Circuit board mounted on heatsink.



COMPONENTS

25V UNIT

Shop Talk

See page 636

Resistors

R1	100k
R2, R3	1k 0.5W (2 off)
R4, R5	47 (2 off)
R6	62k
R7	33
R8	100
R9	1 2.5W wirewound
R10	330
R11	1K
R12	15
R13	18K 1% see
R14	510k 1% text

Potentiometers

VR1	1k min. skeleton preset, vert.
VR2	4k7 rotary carbon, lin.
VR3	10k min. skeleton preset, vert.

Capacitors

C1	2200μ axial elec. 63V
C2	220μ axial elec. 25V
C3, C6, C7	22μ axial elec. 25V
C4	10n metal film
C5	47μ axial elec. 25V
C8	10μ tantalum 35V

Semiconductors

REC1	BY164 1.4A bridge rectifier
REC2	W005 1.5A bridge rectifier
D1, D2	OA91 (2 off)
D3	10V. 400mW Zener
TR1	2N3055 *npn* silicon power
TR2	BFY51
TR3, TR4	BC182 (2 off)

Miscellaneous

S1	2-pole 250V. 1A toggle (or slide)
S2	s.p.c.o. miniature toggle
LP1	220-250V neon indicator
T1	Mains transformer, 28V and 12V secs. (Trent type 00493)
ME1	50μA moving coil meter

Printed circuit board, available from *EE PCB Service*, code EE656; case to choice, front panel minimum of 229×127mm; 16s.w.g. aluminium heatsinks corrugated TO heatsink; terminals, 4mm type 1 black, 1 red; 500mA fuse; connecting wire, solder etc.

Approx. cost Guidance only **£30**

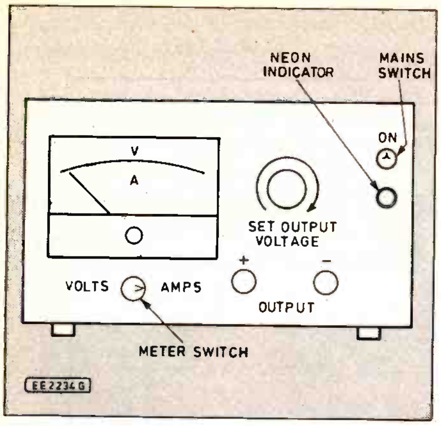


Fig. 4.7. Suggested front panel layout.

This panel size will allow room for the specified meter, the meter switch, the voltage adjust potentiometer, the mains switch and indicator neon and the output terminals. The mains lead can come in at the rear where the fuse can also be mounted. A suggested layout is shown in Fig. 4.7, with the lettering carried out in rub-down letters before the components are fitted.

Inside the box, mount the mains transformer and the heatsink and board panel. The wiring from the board to the external parts is fairly self-explanatory from the circuit diagram: there are two pairs of leads from the *XX*, *YY* points to the mains transformer T1 secondary windings (make sure you put them to the right windings) and three leads to the meter switch from points *A*, *M* and *V*.

There are two leads, positive and negative respectively, to the output terminals (note that capacitor C8 is soldered directly across these), and two leads from points P1, P2 to the voltage adjust potentiometer VR2.

Just one point about this last component; the *maximum* output voltage corresponds to the control resistance being all in, i.e. connect P1 to the slider or wiper (w) terminal and P2 to the terminal representing the fully *anticlockwise* position of the slider as viewed from the front. If you do get it wrong, no harm will be done, the output will just decrease instead of increasing as you advance the control clockwise.

TESTING

Before switching on and testing the unit, carry out the following adjustments: set preset control VR3 fully anticlockwise i.e. all in circuit. Also preset VR1 to mid-position and the voltage adjust control VR2 fully anticlockwise (minimum output).

Put the meter switch S2 into the VOLTAGE (V) position. Switch on and carefully advance the voltage control on the front panel; if all is well, the voltmeter should read an increasing output.

If this does not happen, it may be that the meter switch has been wired the wrong way round, so switch over to the "amps" side as a quick check. If the meter now reads, reverse the switch wiring.

As the maximum of 25V is approached, adjust the voltage control VR2 *in conjunction* with preset VR3 so that, by the time the voltage control has reached its maximum position, the voltmeter just reads 25V f.s.d. (full scale deflection). Preset VR3 is simply in parallel with VR2 and adjusts the total resistance to give the output level we want.

Now reduce the voltage control to its minimum setting and adjust preset VR1 so that the meter reads exactly zero. Return to maximum voltage and readjust VR3 if necessary to restore the output to 25V. This completes the voltage setting up.

To check on the current side of things and to ensure that the current limiter is working, switch over to CURRENT (A) on the meter switch S2 and short circuit the output. The ammeter should read somewhere about 700mA (0.7A).

This checks the limiting and also the current metering. Remove the short circuit and if by now nothing has started to complain, the power unit is ready for use.

Keep in mind when using this power unit, that once the current limit is reached, the voltage output will stay put and cannot be further increased. For example, suppose you have a load rsistance of 30Ω, then the greatest voltage you can get before 0.7A is reached is 21V. The voltmeter will not, therefore, go past the 21V position.

Constructional Project

VARIABLE STABILIZED POWER SUPPLY

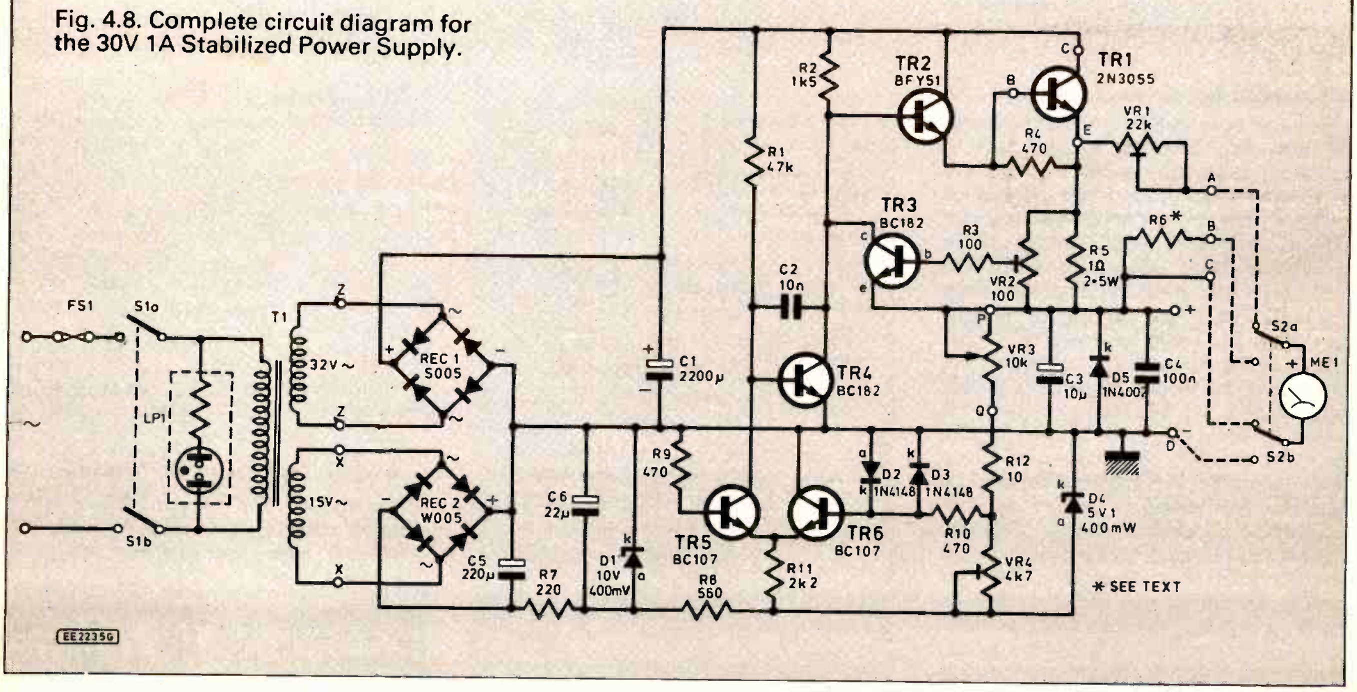
WE NOW turn to the second of this month's offerings, a 0-30V regulated supply which will provide us with a maximum current of 1A. The complete circuit diagram for the 0-30V Stabilized Power Supply is shown in Fig. 4.8.

In most respects this circuit is similar to the one we have already discussed, as a glance at Fig. 4.8 will show. A mains transformer T1 with twin secondary windings provides a positive and a negative supply by way of the two bridge rectifiers and appropriate smoothing and there is the familiar series controller transistor TR1 with its driver TR2.

The error detector this time consists of a "long tailed pair", transistors TR5 and TR6 in a differential circuit. This gives an advantage over the previous supply in that stabilization against temperature changes is provided by this form of circuit. Only the difference between the two bases is amplified and temperature variations will tend to move both bases in the same direction.

The output from the collector of TR5 goes to the error amplifier TR4 which in

Fig. 4.8. Complete circuit diagram for the 30V 1A Stabilized Power Supply.



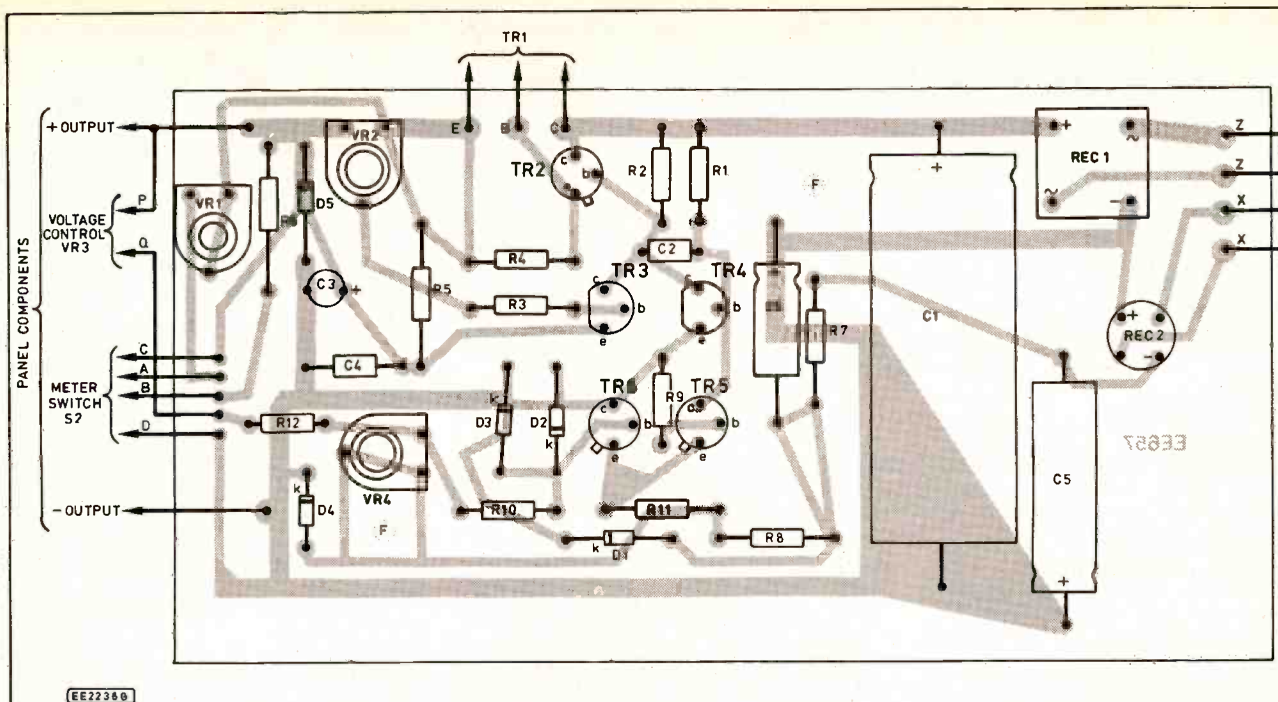
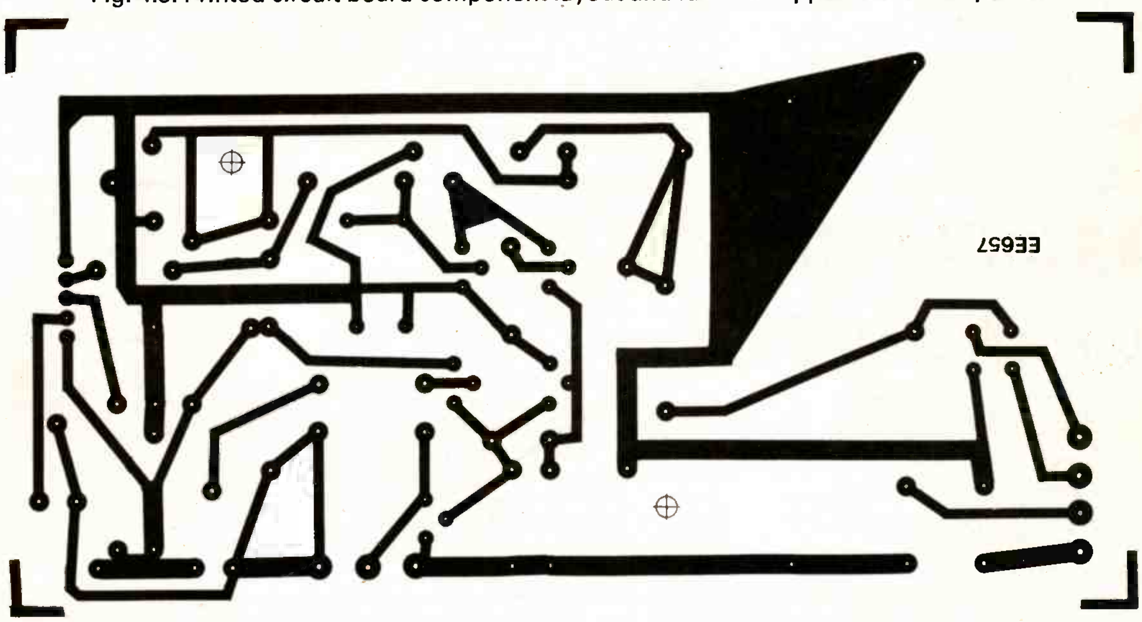


Fig. 4.9. Printed circuit board component layout and full size copper foil master pattern.



COMPONENTS

30V UNIT

Shop Talk
See page 636

Resistors

R1	47k
R2	1.5k 0.5W
R3	100
R4, R9, R10	470 (3 off)
R5	10 2.5W wirewound
R6	300k 1% (2 off—see text)
R7	220
R8	560
R11	2k2
R12	10

All 0.3W carbon film, except where stated

Potentiometers

VR1	22k skeleton preset, horiz.
VR2	100 skeleton preset, horiz.
VR4	4k7 skeleton preset, horiz.
VR3	10k rotary carbon, lin.

Capacitors

C1	2200μ axial elec. 63V
C2	10n metal film
C3	10μ tantalum 35V
C4	100n metal film
C5	220μ axial elec. 25V
C6	22μ axial elec. 25V

Semiconductors

REC1	S005 2A bridge rectifier
REC2	W005 1.5A bridge rectifier
D1	10V 400mW Zener
D2, D3	1N4148 signal diode (2 off)
D4	5.1V 400mW Zener
D5	1N4002 1A 100V rec. diode
TR1	2N3055 *npn* silicon power
TR2	BFY51 *npn* silicon
TR3, TR4	BC182 *npn* silicon (2 off)
TR5, TR6	BC107 *npn* silicon (2 off)

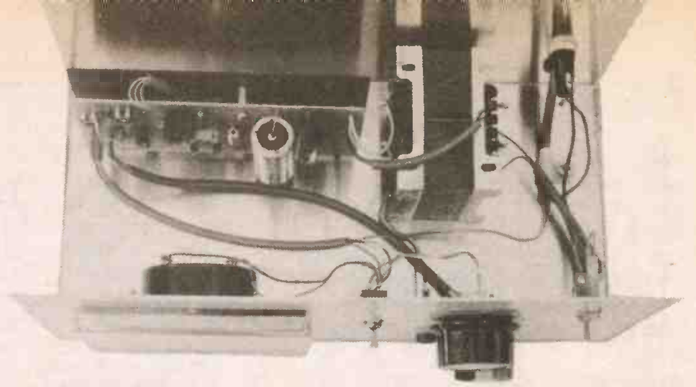
Miscellaneous

S1	2-pole 250V. 1A toggle (or slide)
S2	d.p.c.o. miniature toggle
T1	Mains transformer, 32V and 15V secs. (Trent type 00494)
ME1	50μA moving coil meter

Printed circuit board, available from *EE PCB Service*, code EE657; case to choice, see text, 16s.w.g. aluminium heatsink; corrugated TO heatsink; terminals, 4mm type 1 black, 1 red; 500mA fuse; connecting wire, solder etc.

Approx. cost Guidance only £32

Completed early prototype showing relettered panel meter.



Close-up showing mounting of heatsink/circuit board.

turn drives the base of TR2. This, along with series controller TR1, forms a Darlington pair which controls the effective resistance of TR1 and so regulates the output against unwanted variations in the manner already described.

The current limiter this time is TR3 which senses the voltage developed across resistor R5, a part of which is tapped off by way of preset VR2. In this way the maximum output current can be set to 1A, or anything smaller if you so desire. The output is smoothed by capacitor C3 and protected against reverse input transients by diode D5.

CONSTRUCTION

The 0-30V unit is built in exactly the same way as the previous project. All components except the mains transformer T1, the voltage adjust potentiometer VR3, the meter and the meter switch S2 are assembled on a printed circuit board. This board is also available ready-drilled from the *EE PCB Service*, code EE000.

The component layout and full size copper foil master pattern is shown in Fig. 4.9 and should, by now, need little explanation. All the important points to watch are identical with those mentioned earlier. The meter multiplier resistor R6 is made up from two 300kΩ, 1 per cent resistors in series — if you are using the specified meter that is.

Interwiring from the circuit board to off-board components can be carried out by referring to Fig. 4.9 and the photographs. Two pairs of leads from the points *Z-Z* and *X-X* go to the mains transformer secondary windings of 32V and 15V respectively.

Four leads from points *A*, *B*, *C* and *D* on the board go to the meter switch S2, which this time is a double-pole changeover miniature toggle (or you may use a slide type if you wish); two leads are taken to the voltage adjust potentiometer VR3, one of which is common to the output positive lead; and the positive and negative outputs themselves. Use at least 16/0.2mm flexible wire for the transformer connections and the output leads.

After completing the board and drilling the two fixing holes marked *F*, mark these through on to the heatsink, and drill these and the TO3 case fitting holes for TR1 in the same way as was described previously. Transistor TR1 should now be fitted to the heatsink, and the board screwed in place, using ½in spacers; refer back to Fig. 4.6. Three coloured leads from points *C*, *B* and *E* should be soldered to TR1 pins.

The assembly, together with the various other components can then be fitted into a suitable case and the panel layout can again follow that suggested in Fig. 4.7. The meter this time, of course, is calibrated 0-50V, 0-1A (see "Meter Scale" Section).

TESTING

Set preset VR1 and rotary control VR3 fully anticlockwise (all in), presets VR2 and VR4 to mid-position. Note that VR3, the front panel voltage control, is wired so that all the track resistance is in circuit with the wiper fully anticlockwise viewed from the front.

Set the meter switch S2 to VOLTAGE and after switching on, advance the voltage control carefully. The voltage output should rise and when the control is fully clockwise, preset VR4 should be adjusted until the meter reads exactly 30V f.s.d.

To calibrate the current reading, switch to CURRENT on the meter switch and connect a load resistor in series with an ammeter across the output terminals. Adjust VR1 until the panel meter reads identically to the external ammeter.

If you don't have another ammeter as a checker, connect a known resistance (say 10Ω, 3W) across the output terminals and advance the voltage control to provide, say, 5V output (as seen on the voltmeter). The current will now be 0.5A, so switch over to CURRENT and adjust VR1 accordingly. If you don't fancy all this, just replace VR1 with an 18kΩ, 1 per cent resistor (0.5W) and the current reading will be sufficiently accurate not to lose any sleep over.

CURRENT LIMIT

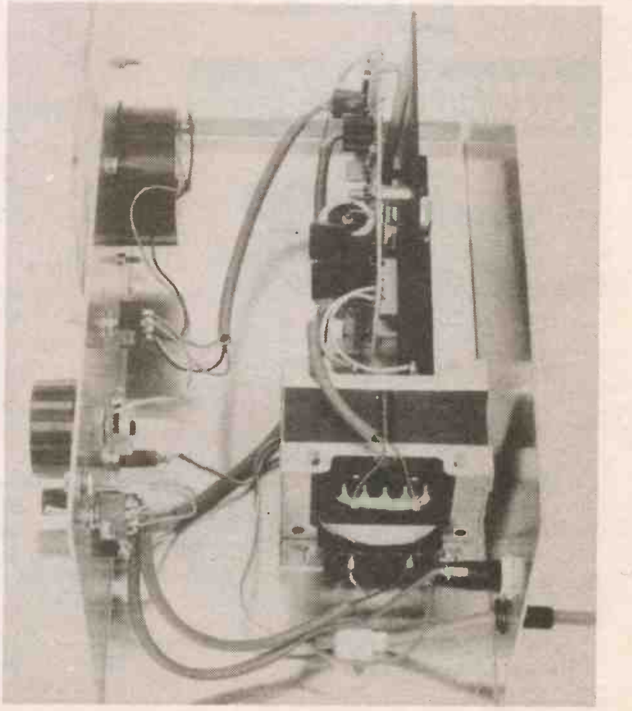
The current limit of 1A now has to be set. Turn the voltage control to minimum, switch over to CURRENT, and put a short-circuit across the output. Advance the voltage control so that the meter goes over to f.s.d. or there-abouts, then adjust VR2 until the current is *just below* the 1A reading.

What you aim for is a f.s.d. reading of 1A when the output is shorted — nothing more. If the meter cracks over, you haven't adjusted VR2 properly.

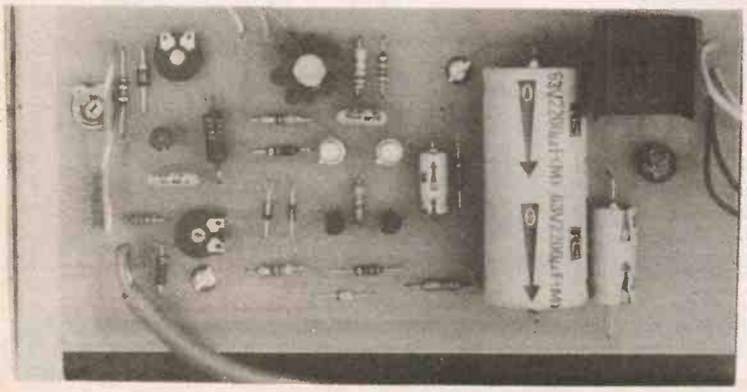
You can, if you wish, set the current limit to any value less than 1A; simply adjust VR2 to give you that limit when the output is short circuited. Like the previous design, the voltage will then not increase above the point at which the current has reached its limiting value.

Next Month: A Variable Stabilized Power Supply, with four switched current limits up to 2A will be described.

(right) completed power supply showing interwiring and positioning of components.

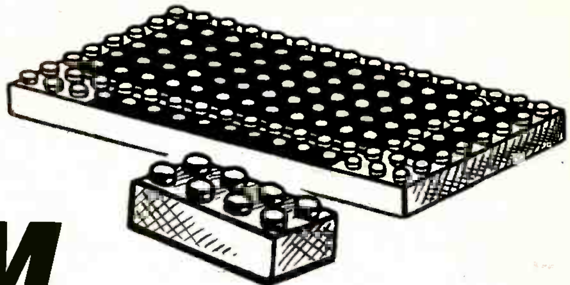


(below) Layout of components on completed printed circuit board.



New Series

LOGO, LEGO AND THE SPECTRUM



ALAN HARPER

Part 1

Build this interface card and introduce your Spectrum to the excitement of Legoland

THE objective of the project described below was to provide an environment for experimentation in simple robotics which would enable my three children (and myself) to extend the experience in the turtle graphics language LOGO which the children had begun in school.

To meet this objective an interface was constructed to enable our Spectrum computer to control robots constructed from Technical Lego. The interface is a simple 8 bit latch/buffer configuration which drives up to eight relays and can receive inputs from up to eight mechanical switches. As the equipment is intended for unsupervised use by youngsters the mechanical and electrical robustness formed a key element of the overall design.

The construction of viable robots from Technical Lego requires an elementary appreciation of the principles of gears and levers. This is dealt with briefly later in the article. Several simple LOGO procedures are described which enable LOGO to switch the Lego motors via the relays and read the states of the switches which can be configured, for example, as collision indicators.

Though configured for a Spectrum and the LOGO language the interface described below could easily be adapted for any home computer. All that is required is appropriate address decoding. In addition to LOGO this article also includes some simple BASIC routines which are useful for quick tests on the interface.

MOTIVATION – THE LOGO LANGUAGE

In many schools the first and sometimes only computer language that students use is the turtle graphics language LOGO. The LOGO language, at its most elementary level, allows the student to "drive" a turtle around the screen. The commands are simple and are entered in a direct mode.

For example:

> FD 10 LT 90

This will cause the turtle to move forward ten units and turn left (anticlockwise) through a right angle. (">" is the prompt.)

> REPEAT 4 [FD 10 LT 90]

This will draw a square of side ten units.

In addition new instructions can be defined.

> TO SQ :X
> REPEAT 4 [FD :X LT 90]
> END

This defines a new procedure which draws a square of side "X" units. You enter > SQ 20 to draw a twenty unit square.

The language is totally procedural. (No line numbers/no GOTO's.) In most school configurations the instructions may also be given to a floor turtle in which a retractable pen is mounted so that the output can be drawn on large sheets of paper.

The advocates of LOGO claim that it teaches good structured programming from the outset but more importantly, in a teaching environment, it provides concrete experience rather than abstract mathematical ideas. By working in small groups students learn to communicate with each other using the language of mathematics rather than mathematics being an isolated activity.

If LOGO achieves half these broad objectives it will be well worth the effort involved. To continue this worthwhile activity within the home we bought the LOGO language as soon as it was released for the Spectrum. Even though the school uses BBC and Commodore computers most releases of LOGO are very similar. Any variations are in general extensions to the common core of functions.

Initially we used LOGO in a screen turtle mode. Clearly the next move had to be the extension to the outside world. After some thought it was decided to construct a simple latch/buffer interface driving relays and reading switches which could control robots constructed from Technical Lego of which a large supply was readily available. By this means it is hoped to extend the boundaries of LOGO in a manner consistent with the basic principles of learning by involvement and experimentation.

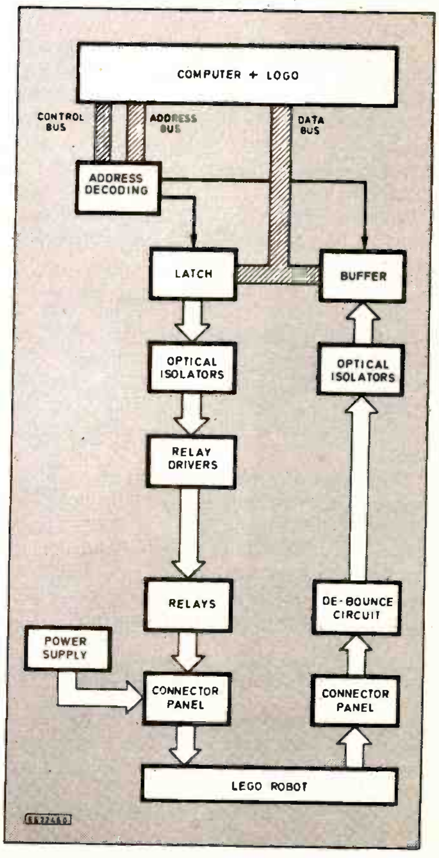
Initially it is envisaged that the students involvement will be at a software level as with the standard system though the turtle may have changed its shape and tasks capabilities significantly (e.g. a wandering robot with a gripper) however the use of Lego and the configuration of the interface permits the students' involvement to easily extend into the electro-mechanical aspects of the robot construction and motor wiring.

THE INTERFACE – OVERALL DESIGN

The system block diagram is shown in Fig. 1. The computer control and address buses are input to address decoding logic. The decoding logic produces two enable signals which control a latch and a tri-state buffer. The latch and buffer are connected to the computer data bus.

The outputs of the latch and the inputs to the buffer are electrically isolated from the remaining circuitry using optical isolators. This prevents any subsequent mis-wiring of the robot motors and collision detection switches from damaging the computer. The latch/optical isolator is followed by a relay driver and eight relays which control the supply of power to the Lego motors. Since the inputs to the buffer originate from mechanical switches they are first passed through a de-bounce circuit.

Fig. 1. System block diagram.



PHYSICAL CONFIGURATION

The elements described above are physically split between two units. The address decoder, latch, buffer, optical isolators and relay drivers are mounted on an interface card which is connected to the Spectrum edge connector. The remaining components, including a 5V power supply, are located in an interface box which is connected by ribbon cable to two ten-way connectors on the interface card. The Lego robot connects to the interface box using ribbon cable and an array of 1mm sockets.

My Spectrum configuration is somewhat novel. It was motivated primarily by the requirement to separate lively children from vulnerable p.c.b.s. The configuration is shown in Fig. 2. The Spectrum is located in a wooden cabinet (white chipboard construction). A backplane, which is adapted from an Amstrad Motherboard, is connected horizontally via a standard 2×28 way connector to the Spectrum edge connector. This motherboard provides locations for up to six DIN41612 (2×32) connectors to which various interface cards are attached.

At present three locations are used. One card controls a remote keyboard and joystick, and another contains an escape interface (from the *On Spec* series) which provides for recovery from machine code crashes (useful when developing the robot interface software) and the third is the interface card for the Lego robot. A twenty way ribbon cable then connects the robot interface card to the interface box.

A colour TV is mounted on top of the wooden cabinet. The cabinet top is attached with quick release catches to permit easy access to the motherboard. This configuration provides complete protection for the motherboard and interface card which are probably the items most at risk.

Interface cards don't bend and CMOS chips don't appreciate a friendly poke! In addition all mains supply is well away from inquisitive fingers. The overall appearance is much like an "up market" PC. Also, as all of the usual jungle of wires are well hidden it meets with domestic approval.

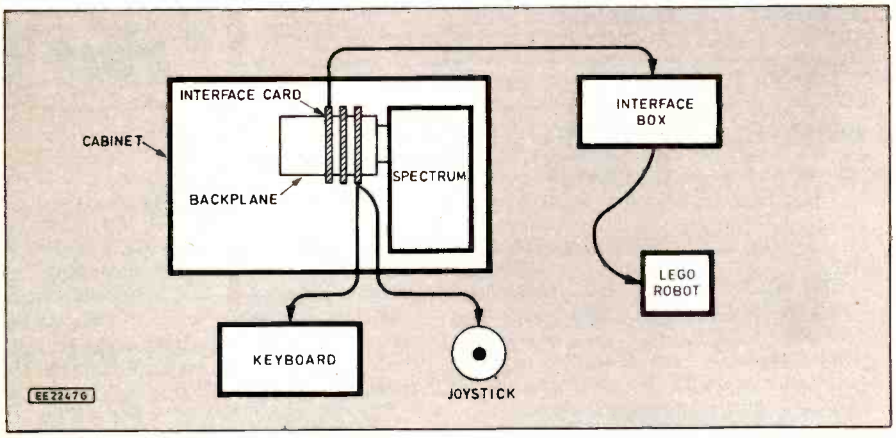


Fig. 2. System set-up. The Spectrum is housed in a wooden cabinet together with the Interface Card.

CIRCUIT DESCRIPTION

A detailed circuit diagram is shown in Fig. 3. There is little that is particularly original. It is mostly an assembly of basic building blocks taken from EE articles together with bits and pieces from R. A. Penfold publications. For newcomers to computer interfacing I thoroughly recommend R. A. Penfold's *Micro Interfacing Circuits Book 1* published by Bernard Babani Ltd. (Available from the *EE Direct Book Service* order code BP130.)

Address Decoding

The concept used for address decoding is a variation on one described in the R. A. Penfold publication referred to above. IC1 (an 74LS30) is an 8-input NAND gate which provides a negative signal when all inputs are high. This is used to provide a negative chip select output for the following bit pattern on the Spectrum address bus:

A0	A1	A2	A3	A4	A5	A6	A7	CS	
1	1	1	1	1	X	X	1	0	X=1 or 0

This means that IC1 output will be low whenever any of the decimal addresses 159, 191, 223 and 256 are present on the address bus. (These correspond to 9F, BF, DF, FF respectively in hexadecimal). This represents the top half of the address map available for Spectrum add-on due to the requirement to keep A0 to A4 high.

IC2 and IC3 (74LS138's) are three to eight line decoders. However by using the enable inputs (pins 4, 5 require a negative enable and 6 a positive enable) the chip can be used to decode six inputs. Two such decoders are used to decode five inputs (Pin 6–E3 is kept high by a connection to the 5 volt line). One chip provides a negative enable pulse when the Spectrum wishes to read data from the buffer and the other provides a negative enable pulse when output data is to be sent to the latch. This is achieved by the following connections to the decoder.

Pin	1	2	3	4	5
Name	A0	A1	A2	E1	E2
Connection	CS	A5	A6	XX	IORQ

Pin 1: CS is the chip select line from IC1

Pins 2 & 3: A5 and A6 are the remaining two bits of the address bus.

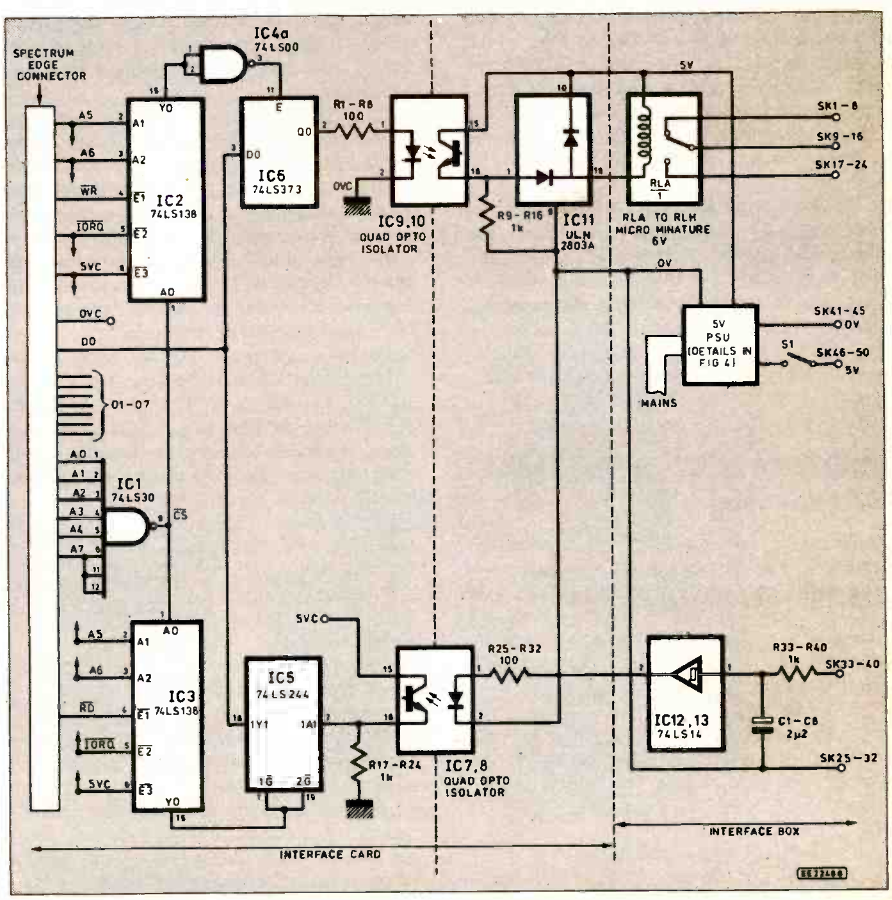
Pin 4: XX is either the Spectrum Read line or Write line. Both lines produce low pulses when they wish to perform their respective functions.

Pin 5: IORQ is the Spectrum Input/Output request line which is low when the Spectrum wishes to read an external device.

When the Spectrum wishes to either read or write to an external device with one of the four decimal addresses 159, 191, 223, 256 the state of the respective decoders output lines are determined from the state of the input lines as follows

Input	A6	A5	Cs								
Pin	3	2	1	15	14	13	12	11	10	9	7
Name	A2	A1	A0	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
Address											
159	0	0	0	0	1	1	1	1	1	1	1
191	0	1	0	1	1	0	1	1	1	1	1
223	0	1	0	1	1	1	1	0	1	1	1
256	1	1	0	1	1	1	1	1	1	0	1

Fig. 3. Full circuit diagram for the complete system.



The output which becomes low is in fact the decimal value of the three bit binary word (A2+A1+A0). For example A2=1, A1=1, A0=0 give (4+2+0)=6, hence Y6 (Pin 9) goes low.

For this project only one output line from each decoder is required. However, this configuration provides effective decoding of all read/write requests in the upper half of the input/output map. In my own configuration the remaining signals are routed via the edge connector to the spare lines on the motherboard. This will make further address decoding for subsequent projects trivial.

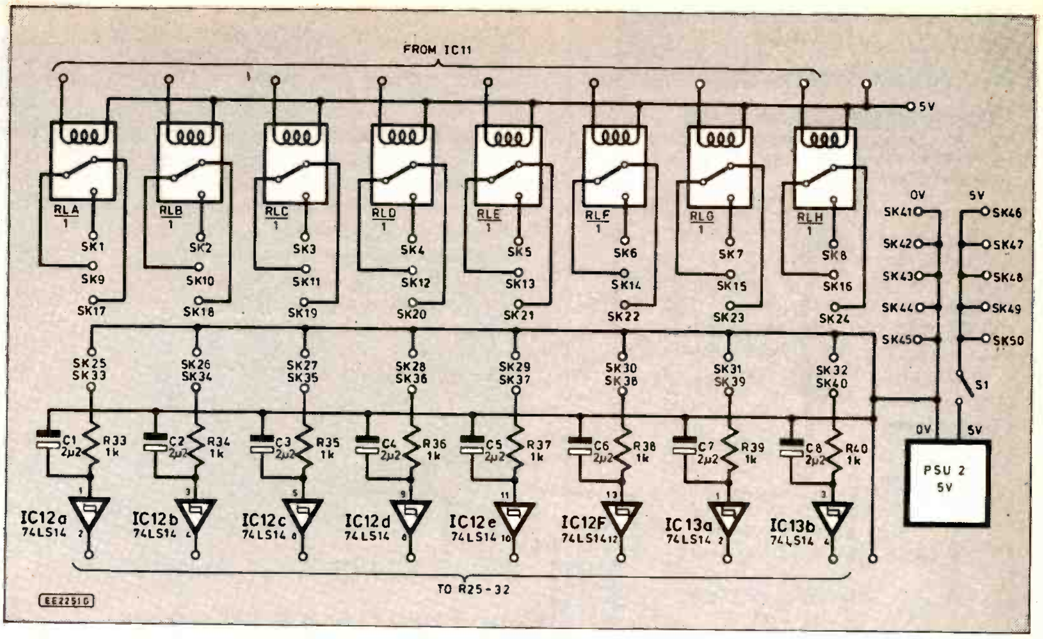


Fig. 5. Circuit diagram for the interface box.

Latch/Buffer

IC5 (74LS244) is a tri-state buffer. The chip has two independent sections. However for this application this feature is ignored and the enable low signal is connected to both pins 1 and 19. When the enble signal from the decoder output is low the eight inputs are connected through to the Spectrum data bus.

IC6 (74LS373) is Octal D-type Latch. This device requires a positive enable pulse at pin 11 to latch the data bus signals into the output ports. This was obtained by using one element of IC4 (74LS00–four 2-input NANDS). For clarity, Fig. 3 shows **only the connections to one element of the data bus–DO.** Connections to D1-D7 follow logically to the remaining pins of each device.

miniature p.c.b. mounting relays. The device used is 6V s.p.d.t. as shown in Fig. 3. The operating voltage range is 4.5V to 7.8V. Clearly these relays provide a further level of electrical isolation.

The eight relay outputs connect to a matrix of 3×8 1mm sockets mounted on the top of the interface box.

De-bounce circuits

Mechanical switches do not always make and break "cleanly". They can suffer "contact bounce" which produces a series of noise spikes which can cause problems in digital systems. The problems will depend on how quickly the inputs are read and how these signals are interpreted by the software.

To avoid any possible problems a de-bounce circuit was included in the input lines. The resistor/capacitor network (R33/C1 etc) smooths the input signal which results from closing a switch between SK25 and SK33. The smoothing eliminates some of the noise. Further protection is provided by the hysteresis of IC12 (74LS14) which is a Schmitt trigger. (There are six Schmitt triggers in each 74LS14 so two devices are required for the eight inputs).

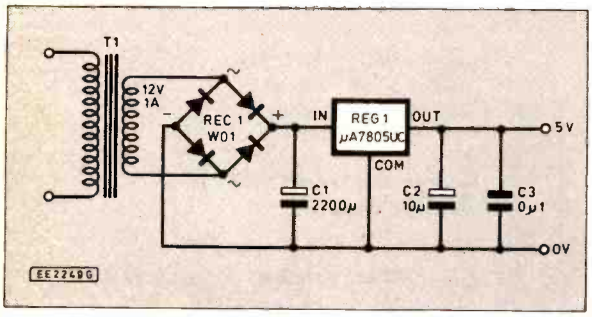


fig. 4. Suggested circuit diagram for the two power supply units (P.S.U.'s).

Optical Isolators

The outputs of the latch (IC6) and the inputs to the buffer (IC5) are electrically isolated from the subsequent circuitry by optical isolators. These ensure that no damage can be done to Spectrum by any incorrect wiring at the interface box sockets. The device used contains four isolators in a 16 pin d.i.l. package.

Relay Driver and Relays

The optically isolated latch outputs from IC9 and IC10 are connected to a relay driver IC11 (ULN2803A). This device provides eight outputs which can each supply up to 500mA at up to 50V. The device includes internal diodes to prevent the back e.m.f. of inductive loads damaging any preceding circuitry. This specification makes this device particularly suitable as a relay driver for this application.

Some relays can be somewhat bulky. To avoid this problem use was made of ultra-

5V POWER SUPPLY

Two separate power supply units (p.s.u.s) are required.

One p.s.u. (PSU1) powers IC1 to IC6 and the left hand sections (see Fig. 3) of IC7 to IC10. This can be derived either directly from the computer 5V rail available at the edge connector. Alternatively if this supply is becoming stretched an auxiliary 5V stabilised source is recommended.

The other p.s.u. (PSU2) must power the right hand sections of IC7 to IC10, IC11 to IC13, the coils of the eight relays and all the Lego motors (four or five perhaps). The i.c.'s need a stabilised 5V, the relay coil will operate from 5V and, although the Lego motors usually use 3×1.5V (4.5V), they work without any problems at 5V. Hence a stabilised 5V supply meets all the requirements.

The elements of PSU 2 are shown in Fig. 4. This is a common basic design though any design for a 5V 1A p.s.u. would be suitable. If an auxiliary supply is also required for PSU 1 an identical design could be used. It is suggested that these supplies are built to the design shown last month in the *Stabilized Power Supplies* series–see page 584 Sept. 89 EE. A 12V 1A mains transformer can be used for each 5V supply. The p.c.b. is available from the *EE PCB Service*.

CONNECTIONS

The array of 1mm sockets on the surface of the interface box (SK1 to SK50) is shown in Fig. 5. SK1 to SK24 are the connections to the relays. They are arranged in a 3×8 array. The least significant bit on the data bus switches RLA. When RLA is switched the connection of SK9 toggles between SK1 and SK17.

The inputs are connected to SK25 to SK40. Joining SK25 to SK33 together by a switch such as a collision detector will cause 5V (a "1") to appear on the least significant bit of the data bus.

SK41 to SK50 provide power for the Lego motors. By routing the 5V supply to the motors via the relays the signals on the data bus may be used to control the action of the motors. Some ideas for motor/relay wiring are given later.

A panic button (S1) which switches off power to the motors is included. This is particularly useful when the software crashes since without such a switch it can leave a robot heading for the top of the stairs with no quick way of stopping it.

COMPONENTS

Interface Card and Interface Box

Resistors

R1 to R8 100 (8 off)
R9 to R24 1k (16 off)
R25 to R32 100 (8 off)
R33 to R40 1k (8 off)

Potentiometers

VR1, VR2 10 2W cermet type mounted adjacent to Lego motors (2 off)

Capacitors

C1 to C8 2.μ2 elect. 63V (8 off)

Semiconductors

IC1 74LS30 eight input NAND gate
IC2, IC3 74LS138 3 to 8 line decoders (2 off)
IC4 74LS00 quad 2-input NAND gate
IC5 74LS244 octal buffer
IC6 74LS373 octal D-type latch
IC7 to IC10 quad opto-isolator (4 off)
IC11 ULN2803A octal Darlington driver array
IC12, IC13 74LS14 Hex Schmitt trigger inverter (2 off)

Relays

RLA to RLH 6V ultra-miniature relay (Maplin FM91Y or similar)

Sockets

SK1 to SK8 1mm black (8 off)
SK9 to SK16 1mm red (8 off)
SK17 to SK24 1mm black (8 off)
SK25 to SK45 1mm black (21 off)
SK46 to SK50 1mm red (5 off)
Plus 10 black and red 1mm plugs (you may need more eventually).

Miscellaneous

Suitable case; S1 s.p.s.t. toggle switch; ribbon cable (20 way); 2×10 way p.c.b. ribbon cable connectors; p.c.b. available from the *EE PCB Service,* order code EE660; 2×28 way Spectrum edge connector; i.c. sockets; connecting wire, etc.

Approx. cost Guidance only **£60**

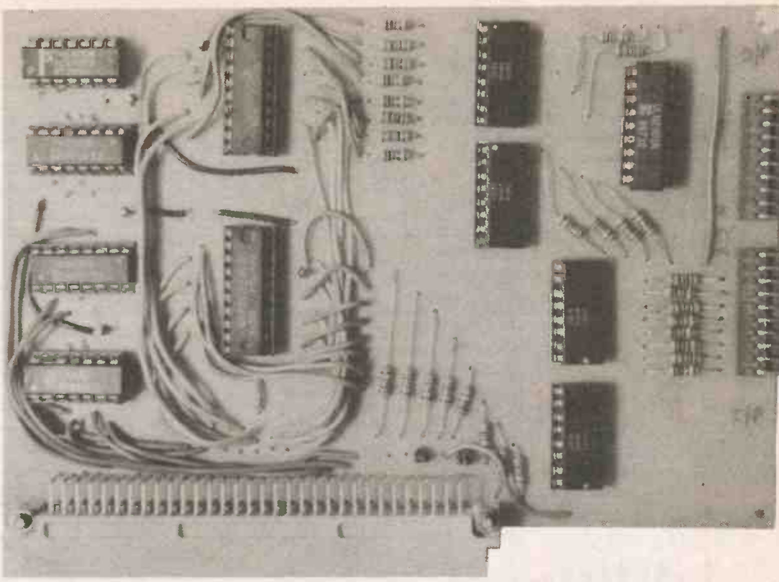
INTERFACE CARD CONSTRUCTION

As indicated earlier the project is split into two separate sections. The interface card was constructed as a home made p.c.b. and carries IC1 to IC11 as indicated in Fig. 6. The board is available from the *EE PCB Service,* Order Code EEXXX.

Address decoding could have been achieved using CMOS chips. However, since for test purposes the board required repeated handling after insertion of the address decoding logic this option was rejected.

When constructing a project of this complexity much time and frustration can be saved by a policy of progressive testing during construction. I firmly believe that provision for testing should form part of the basic circuit design.

Construction proceeded as follows: test all p.c.b. tracks for continuity. Then insert



Interface Card PCB notes

1) The p.c.b. layout connects power to all chips.
2) The data bus is re-arranged (by wire links) into numeric order prior to connection to IC5 and IC6.
3) Wire links.

The board contains many cross track wire links on the component side of the p.c.b. Some of these are shown on the diagram. However, to prevent confusion a wiring plan for the 2×28 way Spectrum edge connector and the latch and buffer chips (IC5 and IC6) is given in tabular form below.

Edge Connector Name	Pin	to IC	Pin	and IC	Pin	Comments
D0	6A	5	3	6	3	IC5=LS244–Input Buffer
D1	7A	5	5	6	4	IC6=LS373–Output Latch
D2	8A	5	7	6	7	
D3	11A	5	9	6	8	Connections are made via the
D4	12A	5	12	6	13	"unscrambled" data bus pads.
D5	10A	5	14	6	14	
D6	9A	5	16	6	17	
D7	3A	5	18	6	18	
A0	9B	1	1			IC1=LS30 –NAND gate
A1	10B	1	2			IC2=LS138–Decoder
A2	11b	1	3			IC3=LS138–Decoder
A3	12B	1	4			
A4	24B	1	5			
A5	23B	2	2	3	2	Connections are made first
A6	22B	2	3	3	3	to IC3 then to IC2
A7	21B	1	6			
IORQ	17A	(5	2)	5	3	Connection to IC2 is via a p.c.b. track
RD	18A	4	3			Be certain to get these two
WR	19A	4	2			the right way round.
0V	6/7B					Provision is made on the p.c.b. for the power to be provided from either the Spectrum or an auxiliary p.s.u. by connection to p.c.b. pins. Do not mix up these connections–this is an expensive area for errors.
5V	3B					

4(Inputs to and outputs from IC5 (Buffer) and IC6 (Latch).

The data bus connections to IC5 and IC6 are given above. The path through these chips is indicated below. The pins given in brackets are the pins to which the edge connector is connected as defined in section 3 above.

	IC5	– Buffer Pin	IC6	– Latch Pin
D0	(3)	– 17	(3)	– 2
D1	(5)	– 15	(4)	– 5
D2	(7)	– 13	(7)	– 6
D3	(9)	– 11	(8)	– 9
D4	(12)	– 8	(13)	– 12
D5	(14)	– 6	(14)	– 15
D6	(16)	– 4	(17)	– 16
D7	(18)	– 2	(18)	– 19

Wire link connections to the optical isolators and relay drivers follow logically and are visually obvious.

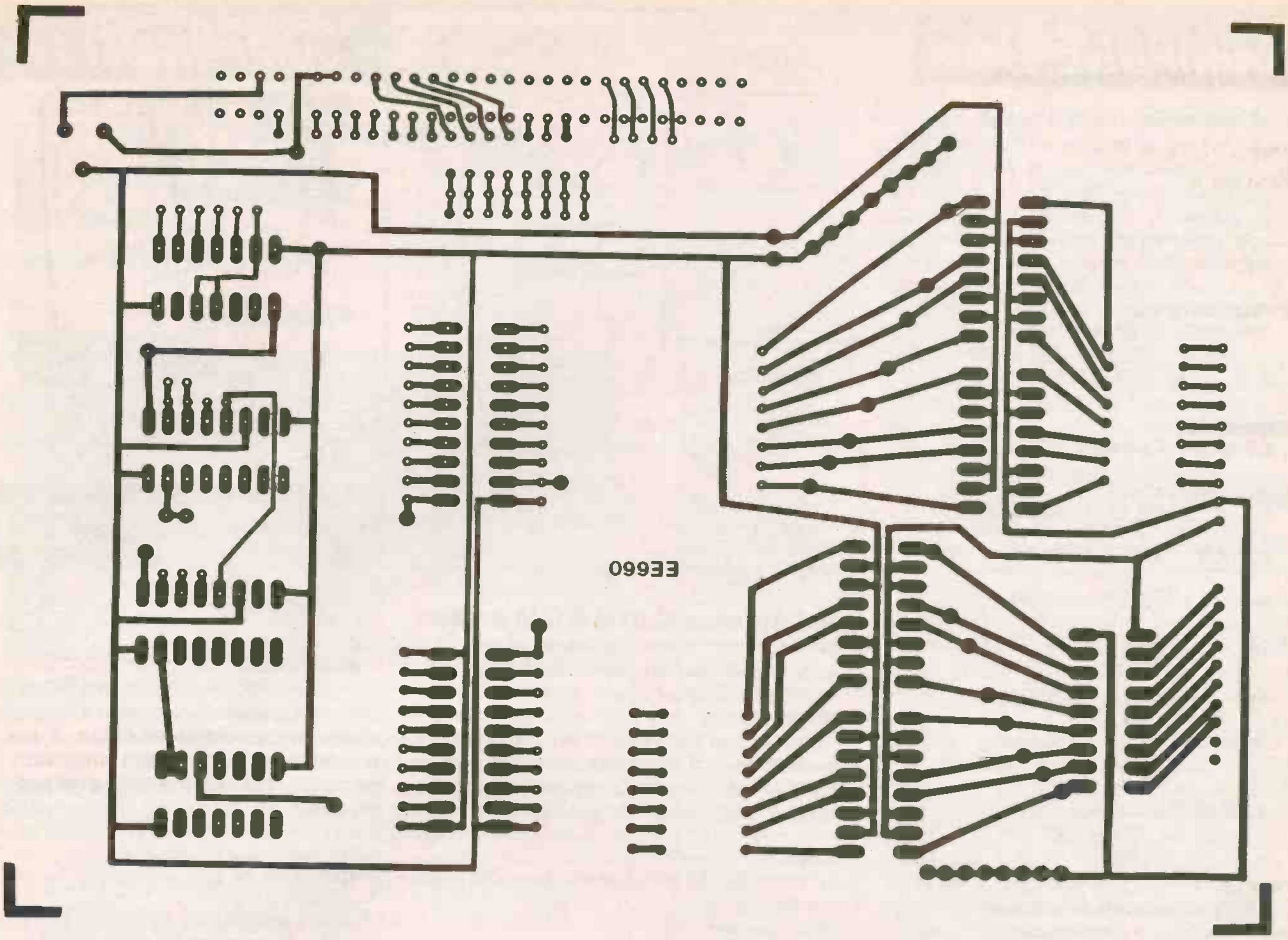
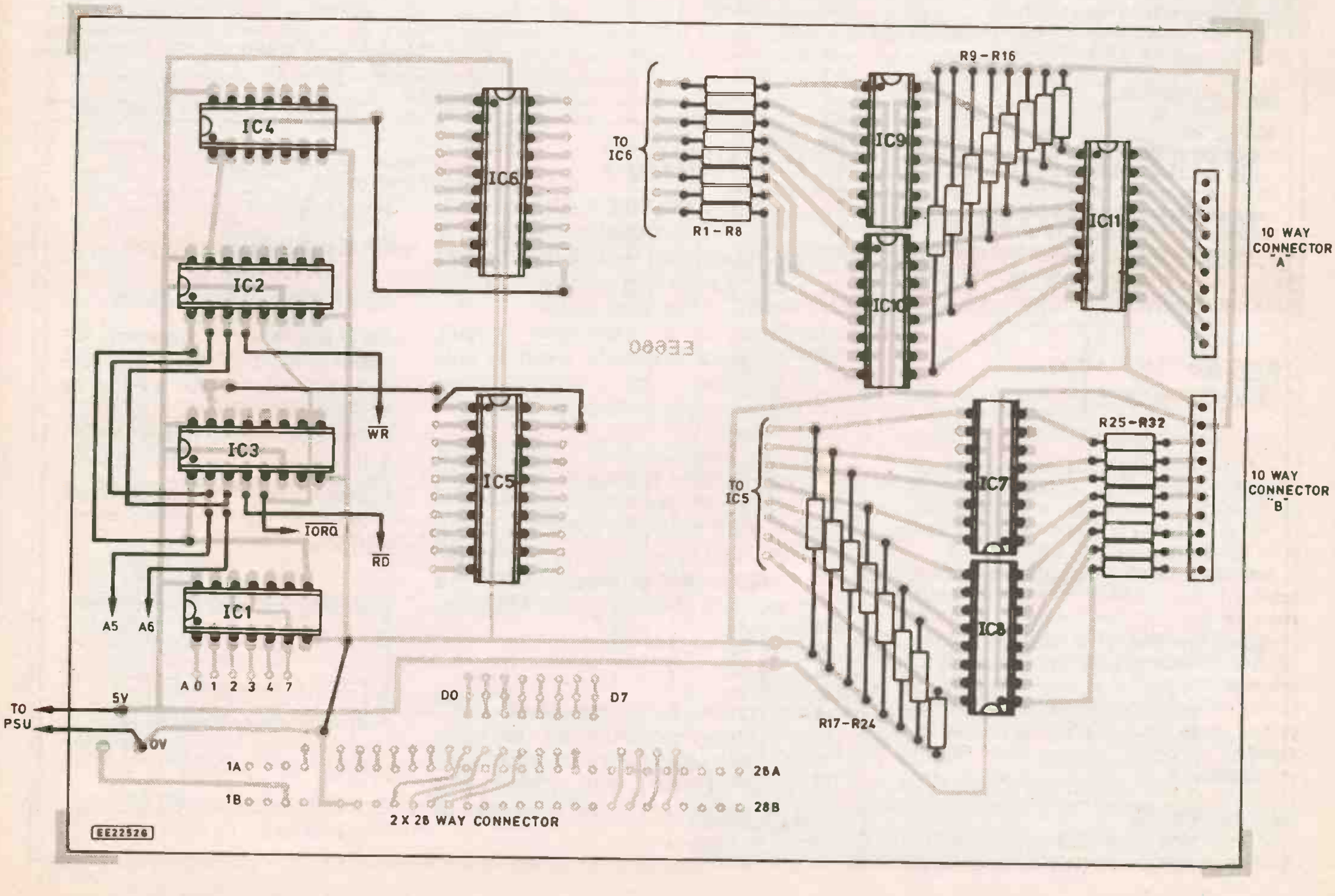


Fig. 6. Component layout and full size printed circuit board copper foil master for the Interface Card.



APPENDIX
A PULSE DETECTOR

When testing circuits which produce single very short positive or negative pulses a simple pulse detector is an invaluable tool. (I'm surprised they are not included in the standard multimeter.) A suitable design is shown in Fig. A1. Essentially it is a flip-flop which is reset by S2. This brings the l.e.d. on. SK1 and SK2 are connected to the power rails of the circuit under test.

To detect a low pulse connect S1 to SK3 and connect SK3 to the chip output which is expected to produce a low pulse. When the low pulse occurs the l.e.d. will go off. To detect a high pulse S1 is connected to the pin 8 of IC1d and SK2 is connected to chip output which is expected to produce a high pulse. (IC1d just inverts the high pulse.)

This unit can either be built on some scrap Veroboard or housed in a small box with smart terminals and probes. If the latter solution is adopted the cost will be about four pounds.

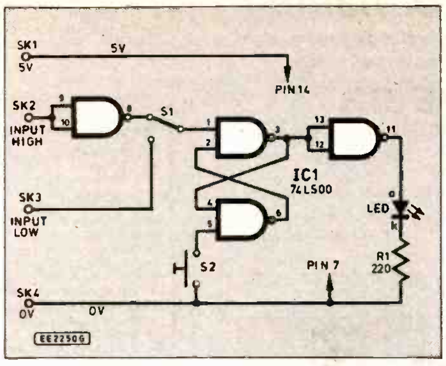


Fig. A1. Circuit diagram for a Simple Pulse Detector.

COMPONENTS

PULSE DETECTOR

Resistor

R1	220

Semiconductors

IC1	74LS00 quad 2-Input NAND
LED1	light emitting diode (red)

Miscellaneous

S1	s.p.s.t. toggle switch
S2	push to make switch
SK1 to SK4	4mm sockets (4 off)

Suitable case and probes (if required); small piece of Veroboard; i.c. socket; connecting wire, etc.

Approx. cost Guidance only £4

all i.c. sockets, edge connectors and cross track wiring. Test continuity throughout. This is your last chance to find those simple dry joints or broken wires before they cause a frustrating array of peculiar faults (I write from bitter experience!).

Check and insert all resistors. Check again. Check capacitors, this can be crudely done by charging them up with a battery and then testing with a voltmeter. Then insert the capacitors.

Insert the decoding chips IC1, IC2, IC3, and IC4. To test the decoding logic it is necessary to first connect the interface card to the Spectrum. Ensure the Spectrum is switched off first. If this precaution is ignored it is possible by a half space misalignment to effectively connect all the expansion socket connections together! **This can virtually destroy the Spectrum.**

When the BASIC instruction OUT 159,255 is executed pin 15 of IC2 should go briefly to 0V. We now meet the first problem. The length of the low enable pulse is too short to detect with a voltmeter. If an oscilloscope is available then it could be used. Alternatively, if you cannot spare the money for an oscilloscope I recommend my "poor mans' oscilloscope" shown in the Appendix. This is a pulse detector which can be built at very little cost using some Veroboard and an 74LS00. See the Appendix for details. This instrument will indicate a low or high pulse by the switching off of an l.e.d. This device can also be used to test for a low enable pulse at pin 15 of IC3 which should occur when the instruction LET X= IN 159 is executed. Once this test is complete disconnect the interface card from the Spectrum.

Insert Optical Isolators IC7 to IC10 and test. This requires two power supplies for testing purposes (4.5V batteries will do). When power is applied to the end of resistor R1 check that the correct voltage appears at pin 16 of IC9. Similar checks can be conducted on all isolators. Insert IC11. Repeat the above tests through to the output of IC11. Insert the latch and buffer IC5 and IC6. Re-connect to the Spectrum. Test the latch IC6 as follows:

```
10 INPUT NN
20 OUT 159,NN
30 GOTO 10
```

Try NN=1,2,4,8,16,32,64,128 in turn and check that the appropriate voltages appear at the outputs of IC's 6, 9, and 11. For this test the Spectrum will power half the board. PSU 2 can now be used to power the other half. Be careful of the mains wires if they are still exposed. To test the tri-state buffer enter the programme,

```
10 PRINT IN 159
20 GOTO 10
```

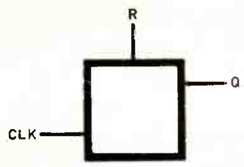
Apply 5V to the input ends of R25 to R32 in turn and check that the PRINT on the screen reads 1,2,4,8,16,32,64,128 in turn.

Stage by stage testing is tedious. However, by following something like the system indicated above it is possible to construct a reasonably complex circuit with a good degree of confidence in the final product. It can save much time at a later date.

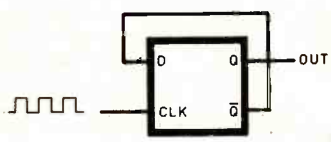
Next Month: Interface box, final assembly and software routines.

INTRODUCING DIGITAL ELECTRONICS
Answers to Part 12

1.



2.



3. Combinational logic devices lack memory, they are the primitive logic elements which, by the application of feedback, can be configured to form sequential logic functions.
4. Input data at the D input is transferred to the Q output after receipt of a pulse at the CLK input.

For both the CMOS 4013 and TTL 7474 flip-flop devices the *bit* on D is transferred to Q on the positive going edge (the low to high transition) of the clock pulse.

5. This is a sequential circuit because it contains memory and operates by automatically sequencing through a number of states.
6. The arrangements in sets 1, 2, 3 and 4 form the basic gates NOT, AND, OR and EXOR respectively. NAND, NOR and EXNOR may be derived by connecting an inverter (e.g. a set 1 arrangement) to the outputs of sets 2, 3 and 4 respectively.

Note.

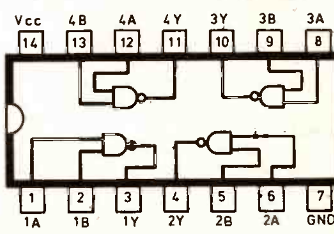
The City and Guilds objectives in Section 9 of the logbook, those relating to health and safety, must be completed in addition to the work done in this series at your local Assessment Centre.

PLEASE TAKE NOTE

Part Eleven (*August 1989*)

Page 523. In the "Appendix N" panel the i.c. pinout information for the 7400 device is shown incorrectly.

The two NAND gates at pins 8-10 and 11-13 have been transposed. The correct outline is shown below:



QUAD 2 INPUT NAND GATES
TTL 7400 (CMOS 4011)

Sent 1/6 20/10/89

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Airvision

Until recently, Brits only got the chance to enjoy inflight entertainment if they went on long haul flights to America or further afield. Now things are changing. Like airlines in Japan and the US, airlines in Europe, are now starting to get in-flight entertainment on short haul flights.

On long haul flights you get a selection of audio entertainment, on headphones, and either one or two films, usually projected on a screen at the front of the cabin.

Projection used to be from Super 8 film, now it's from video, usually Beta format because Sony has close ties with systems supplier Trans Com of California – in fact Sony now owns the company, having bought it from parent company Sundstrand. Standard Beta tapes give better pictures than standard VHS tapes, and with Beta now failed as a domestic format, there is less risk of tape pilferage.

Some airlines install TV monitors in the passenger cabin, either instead of a video projector and screen, or they use monitors to fill in "blind" areas of the cabin where passengers cannot get a good view. The latest trend is to give passengers individual screens.

British Airways has been testing *Airvision,* a personal viewing system jointly developed by Philips and Warner Brothers. A small l.c.d. (liquid crystal display) colour screen is built into the back of each seat and a push button control panel lets passengers choose between six video programmes simultaneously sourced from six VHS recorders. BA is testing Airvision in tourist class for a very good reason – in club or first class passengers have more leg room, so the seat in front is too far away for the small l.c.d. screen.

It's unlikely Airvision will catch on, because the cost of providing every seat with an l.c.d. screen and control panel is very high compared with the cost of installing one video projector or several monitor sets.

Skyview

British Airways is also testing two other personal video systems, this time for first class passengers. Skyview from Fieldtech, and a similar system from Avicom. Both rely on an l.c.d. screen which is mounted on an adjustable arm fixed to the seat armrest. The armrest houses an 8mm video playback unit and passengers are offered a choice of 8mm cassettes to watch during the flight.

Both systems use American NTSC Video 8 hardware, rather than European PAL, Fieldtech hit on the clever idea of buying unsold stock from Kodak, who had previously contracted Matsushita (Panasonic) in Japan to produce domestic Video 8 equipment for sale in the USA.

Kodak's venture failed and the company flogged off remaining hardware at cut prices. It will be interesting to see how much Fieldtech has to pay for further supplies direct from Matsushita, if BA places a big order – especially as Matsushita is itself expanding its own in-flight interests.

A different approach to personal video is adopted by Virgin. Each top class passenger gets to borrow one of Sony's Video Walkman units for the duration of the flight. Again the cabin crew comes round with a selection of 8mm video cassettes.

Inevitably pilferage will be a problem with these personal systems. The fact that someone flies first class does not necessarily mean that they are honest and can resist the chance of an easy theft.

Some airlines use VHS cassettes, even though they are larger than Beta or Video 8. Usually this is for political reasons, for instance because the system has been installed by Matsushita's Avionics division. Matsushita, of course, is the parent company of JVC, developer of the VHS system.

It is most likely that VHS users will probably soon upgrade to the new Super VHS format, which gives better picture quality. Already Sony is upgrading the latest Trans Com systems to Hi-8, the improved quality variation of Video 8.

In-flight developments all ride on the top of domestic video developments. The in-flight market is too small to encourage bottom-up innovation.

Despite all this emphasis on new technology, I have to say (as someone who does a lot of long haul flying, e.g. visiting factories and going to seminars and exhibitions round the world) that a lot of the benefits never seem to reach the customer. On a Virgin flight recently, tourist class, I was put in a seat where it was quite impossible to see the screen. Video projectors are often badly aligned, so that the picture suffers from colour fringing.

Japanese short haul, internal, flights show golfing films, and often have a video camera at the front of the plane to give passengers a pilot's view of take-off and landing. So do some American airlines.

Plenty of flights around Europe, either to holiday locations or business city centres, are quite long enough for a few short films. Apart from anything else, many airlines now put the compulsory safety instructions on video, instead of having the crew demonstrate how to use life jackets etc.

Sound Systems

The sound is always relayed to passengers through headphones. These used to be awful acoustic stethoscopes, which pipe sound up plastic tubes from tiny loudspeakers hidden inside the seat rest. Stethoscopes are not only uncomfortable, they reproduce no sound over around 10kHz and give virtually no bass response.

Many airlines have now gone over to electromagnetic head-sets, often made by German company Sennheiser – with non-standard plugs to discourage people from pinching them. Unbelievably, TWA still provides stethoscope head-sets even to passengers in first class.

Even if short haul flights in Europe do not introduce video entertainment, they are likely to offer passengers the chance to listen to music – hopefully through electromagnetic headphones.

The first sound system used a clumsy endless loop cartridge developed by Trans Com – rather like a bulky metal version of the old eight-track car cartridge. These loops of tape ran for an hour, with four audio tracks.

The cartridges, which cost around $500 each, had to be sent back to Trans Com for re-recording and needed internal lubrication. The lubrication used to shed, clogging the heads and trimming treble response. When the lubrication failed, the tape suffered from wow and they finally jammed.

There was also a system that used a cartridge with 1in tape that shuttled backwards and forwards past a playback head. The tape held 32 tracks and the 16-track head switched sideways at the end of each shuttle, rather like an auto-reverse cassette recorder, to give 16 tracks at any one time. These could be allocated to eight stereo programmes, 16 mono, or a mix of both.

Around five years ago Matsushita introduced a new system, which uses standard Philips cassettes, albeit with a slightly modified track format. The tape has four equal sized tracks running in the same direction, whereas with conventional cassettes there is a guard band in the middle between two track pairs, which run in opposite directions for flip-over playing.

It is probably no coincidence that Matsushita launched this system when the Philips patents on the original cassette ran out, and the company could no longer control the tape track standard through royalty free licences.

The surprisingly small Matsushita playback unit has six drives, arranged in back to back pairs. As three drives play a total of twelve channels, the three other drives re-wind their tapes. Tones at 30Hz control switching, with phase comparison tricks to prevent the music misleading the machine.

With C-120 cassettes, the system can give listeners a choice of 12 two hour audio channels, either 12 mono programmes, 6 stereo or a mix of both. Audio quality is improved by the use of BDX noise reduction.

Hell Ride

Trans Com has now gone one stage further, using compact disc players as well as Philips cassettes.

The latest plan is to provide passengers with word processors, a telex, fax and telephone link. The idea is that long haul flyers will be able to take messages from the office back home, telling them to work all night.

Personally, it's my idea of hell. I regard a long haul flight as one of the few times I can get away from the telephone and catch up on reading while listening to music and watching films I never have time to see back home.

MUSIC ON HOLD

DAVID BUTLER

Prevents telephone from picking up unwanted background conversations. Indicates to caller that he/she has not been forgotten! No direct electrical connection to telephone.

THE MAIN reason for this project was discovered while making telephone calls at work. While waiting for people to come to the phone the receiver is usually just left on the desk where it does a fine job of relaying all conversations around the office back down the line.

On several occasions the retort of "Oh no, not him ringing again!" was heard. It certainly is remarkable how well the phone can pick up these unwanted comments, and on a more serious note, those which may be of commercial interest.

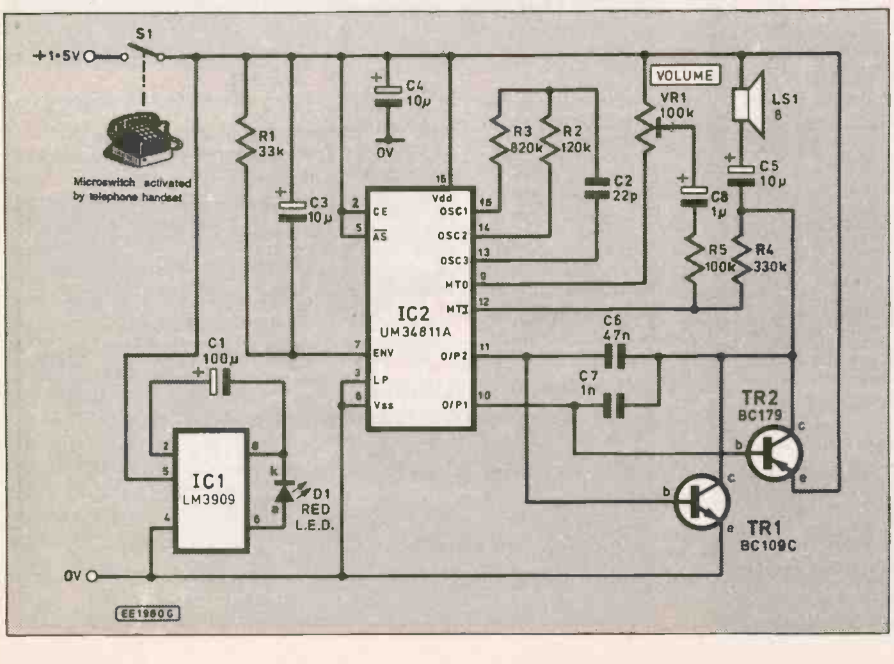
This project blocks out this unintentional "eavesdropping", whilst on hold, by simply playing a series of tunes to the caller. It also reassures the caller that someone is about to attend to them and not forgotten that the handset is lying on the desk.

The electronics consist of a melody generator i.c. and a l.e.d. flasher, all operating from a single 1.5V battery. The construction is reasonably straightforward, the only critical part being the mechanical arrangement for resting the telephone handset on the microswitch above the loudspeaker.

CIRCUIT DESCRIPTION

The full circuit diagram for the *Musical On-Hold* unit is shown in Fig. 1. The heart of this circuit is built around IC2, the multitune chip type UM34811A.

Fig. 1. Complete circuit diagram for the Music On-Hold.



This device requires very few external components to provide a 16-tune repertoire, see Table 1. The tunes are pre-programmed to produce one of three instrument sounds, namely: piano, mandolin or organ.

Table 1: Tune Selection

1	Twinkle, Twinkle Little Star
2	Cuckoo Waltz
3	Eency Weency Spider
4	Lullaby
5	Santa Lucia
6	Oh My Darling Clementine
7	Are You Sleeping
8	Rock-a-Bye Baby
9	London Bridge is Falling Down
10	Little Brown Jug
11	Butterfly
12	Long Long Ago
13	Cuckoo Waltz
14	Mary Had A Little Lamb
15	The Train Is Running Fast
16	Dream of Home and Mother

The tempo and tones of the tunes are defined by capacitor C2 and resistors R2 and R3. These are connected to the three oscillator pins 13, 14 and 15 of IC2. The resistor R2 and capacitor C2 set the internal oscillator, whilst resistor R3 from pin 15 to the junction of R2/C2 makes the oscillator less susceptible to supply voltage fluctuations.

The decay between notes or "envelope" is set by resistor R1 and capacitor C3, connected to IC2 pin 7. Changing the values of these components alters the charge/discharge time of the internal pre-programmed envelope circuit.

The circuit, as it stands, is programmed to play all tunes in sequence, but this can be changed to single tune and stop by altering the connections to pins 3 and 5 as follows:

Pin	Function
3	Connected to positive supply line (V_{dd}); plays ONE tune only.
	Connected to negative supply (V_{ss}); plays ALL tunes.
5	Connected to positive supply line (V_{dd}); tunes REPEAT continuously
	Connected negative (0V) supply; tunes STOP at end.

The internal preamplifier outputs from pins 10 and 11 are fed to transistors TR1 and TR2. These transistors are arranged as a push-pull output stage for driving the miniature 8 ohm loudspeaker LS1.

The output volume of the unit is controlled by potentiometer VR1. This control may be an on-board miniature preset or a case mounted rotary type.

Finally IC1, an LM3909 l.e.d. flasher/oscillator, and D1, a red l.e.d., are employed to indicate that the unit is in use. Capacitor C1 sets the oscillator rate which in turn flashes the l.e.d.

Both i.c.s consume little current (IC1<0.5mA, IC2 <12μA standby) and so the project may be powered from a single AA or D size 1.5 battery.

CONSTRUCTION

Construction of the *Musical On-Hold* project is mostly straightforward and can be built on a printed circuit board or Veroboard. The only real problems likely to occur may be the mounting of the microswitch S1 and the miniature loudspeaker LS1.

COMPONENTS

Shop Talk
See page 636

Resistors
- R1 33k
- R2 120k
- R3 820k
- R4 330k
- R5 100k

All 0.6W 5% carbon.

Potentiometer
- VR1 100k enclosed preset, vert.

Capacitors
- C1 100μ elec. 10V
- C2 22p ceramic
- C3 10μ elec. 10V
- C4 10μ elec. 10V
- C5 10μ elec. 10V
- C6 47n polyester
- C7 1n ceramic
- C8 1μ elec. 10V

Semiconductors
- D1 3mm red l.e.d.
- TR1 BC109C *npn* silicon
- TR2 BC179 *pnp* silicon
- IC1 LM3909 l.e.d. flasher/oscillator
- IC2 UM34811A melodies generator

Miscellaneous
- LS1 8 ohm miniature loudspeaker 40mm dia.
- S1 miniature microswitch, with operating lever
- B1 1.5V battery, AA or D size

Printed circuit board (*EE PCB Service*, code EE646) or 0.1in. matrix Veroboard (approx. 28 strips×25 holes); case, diecast aluminium 120mm×95×30mm; 8-pin d.i.l. socket; 16-pin d.i.l. socket; battery holder (AA size); plastics strips, approx 90mm × 30mm×15mm; l.e.d. clip; metal brackets (3 off); wire mesh; card; connecting wire; solder; nuts and bolts, etc.

Approx. cost
Guidance only **£18**

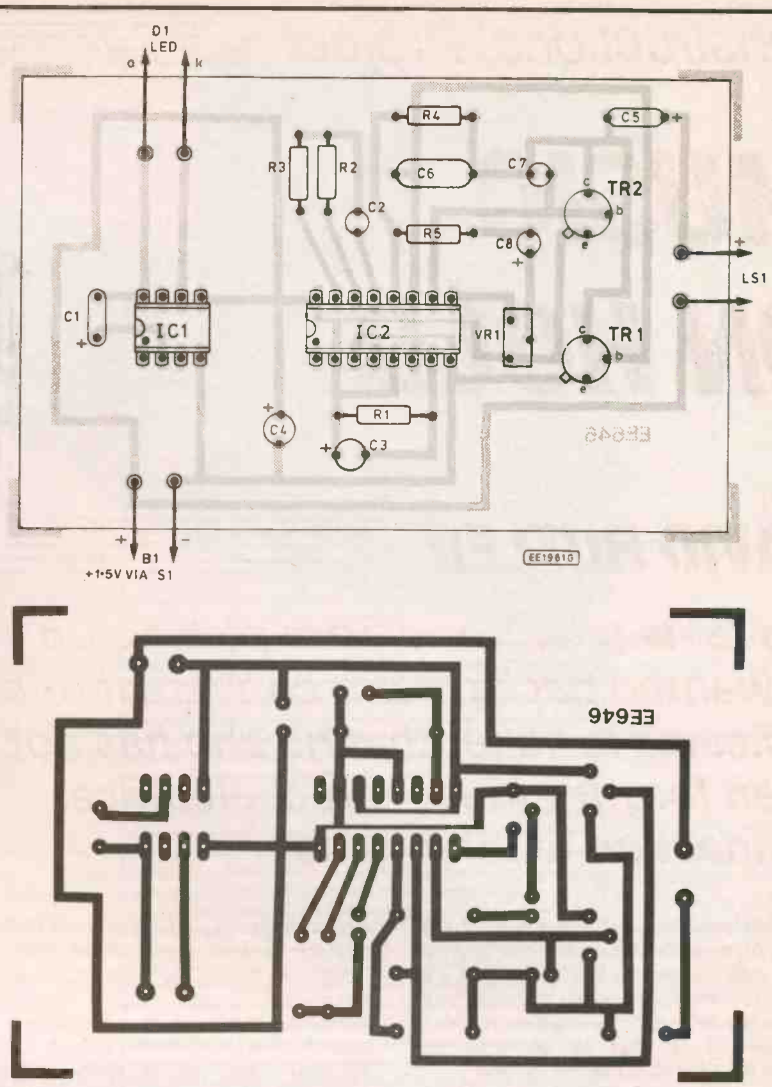


Fig. 2. Printed circuit board component layout and full size copper foil master pattern.

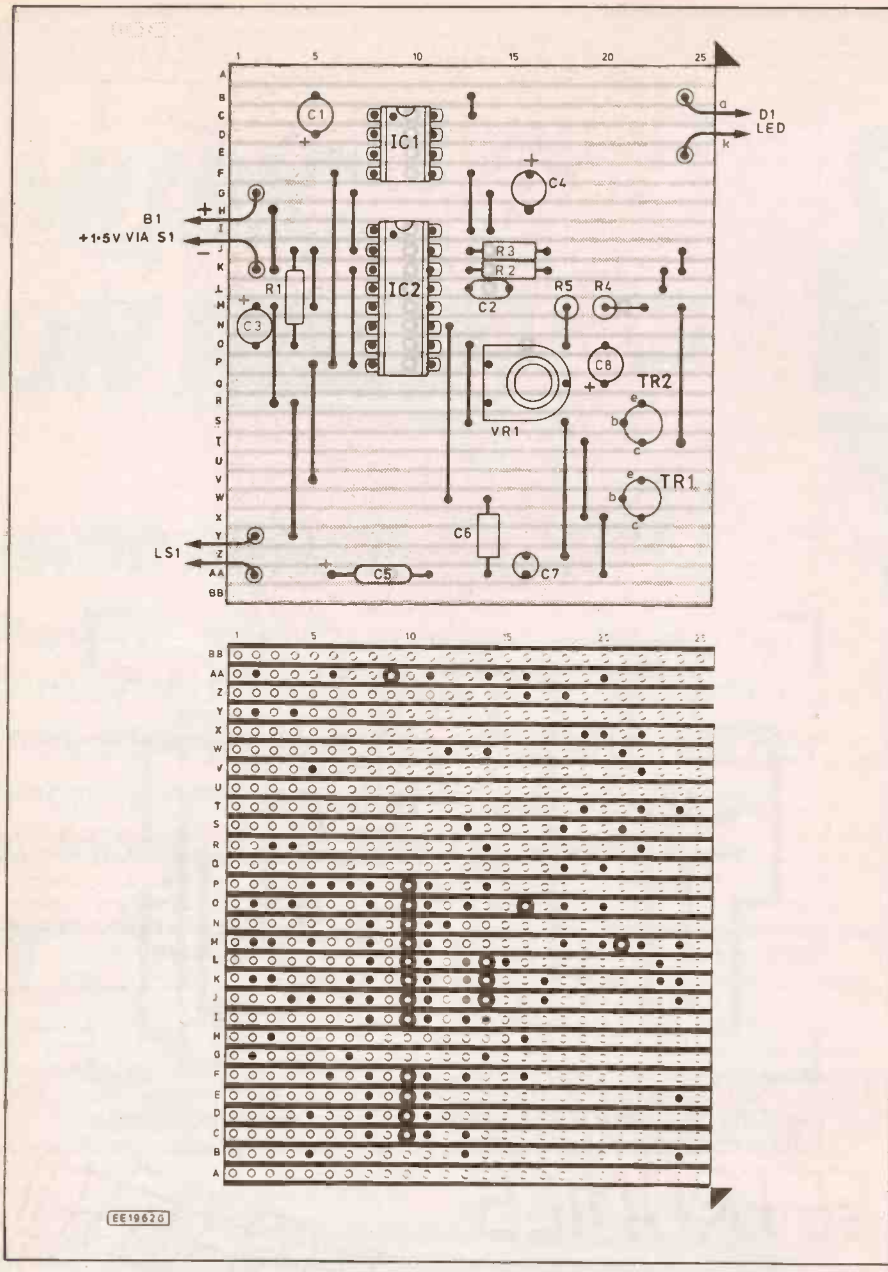


Fig. 3. Component layout and details of breaks required in the underside copper strips for the Veroboard version.

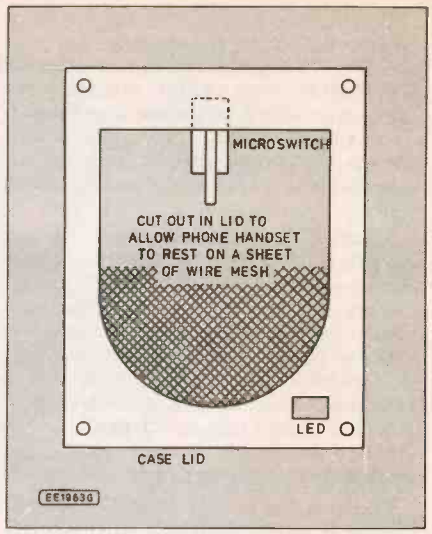


Fig. 4. Suggested layout and cutout details for the case lid.

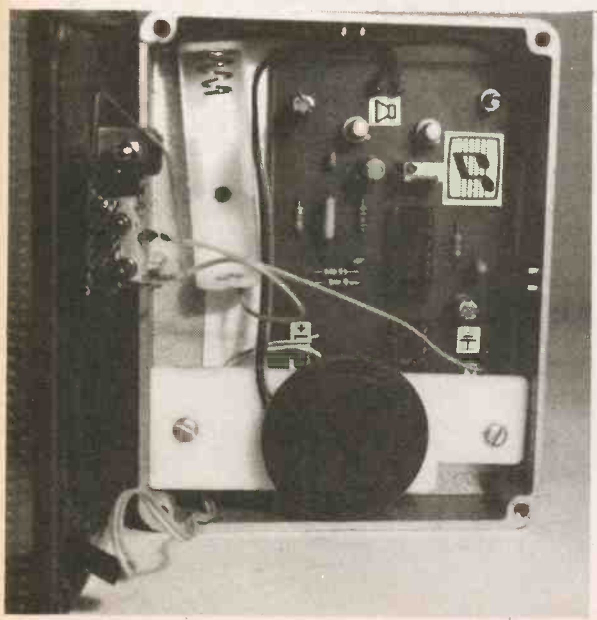
Commence construction by first selecting either the p.c.b. or the Veroboard version. The component layout and full size copper foil master pattern for the p.c.b. version is shown in Fig. 2. (This board is available from the *EE PCB Service*, code EE646). The Veroboard component layout and details of breaks required in the underside copper tracks is shown in Fig. 3.

Mount and solder the two i.c. holders and the four solder pins in position. Do NOT at this stage insert IC1 and IC2 in their respective holders, leave these until last.

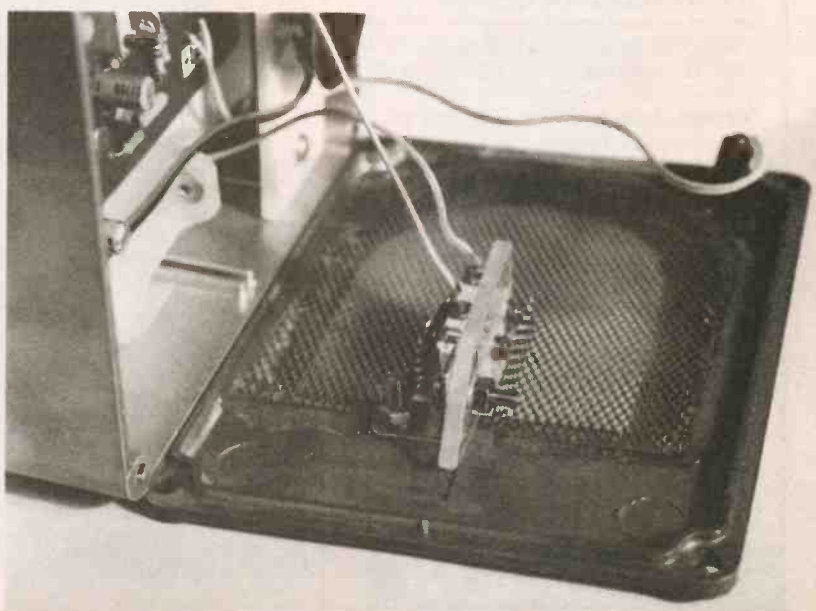
Next solder all resistors in place followed by the preset VR1, capacitors and the two transistors TR1 and TR2. Take particular care to ensure that the electrolytic capacitors and the transistors are inserted correctly. Finally, attach lengths (approx. 150mm) of connecting wires to the four solder pins and also to the l.e.d. pads on the circuit board.

Those building the circuit on Veroboard should double-check that all 18 breaks in the copper strips have been made. Also confirm that there are 19 wire links on the board.

Layout of components inside the case.



Mounting the microswitch on the lid using a plastics strip and metal bracket.



CASE

Once the circuit board has been checked out it should be put to one side and a suitable case should be prepared to take the loudspeaker, battery holder and microswitch. The prototype model used a shallow metal diecast case (to withstand daily office life!) with a cutout in the lid to take the telephone handset, see Fig. 4.

The cutout is covered with a wire mesh glued to the underside of the lid and sits above the loudspeaker. The microswitch is also mounted on the lid using a metal bracket and plastics strip.

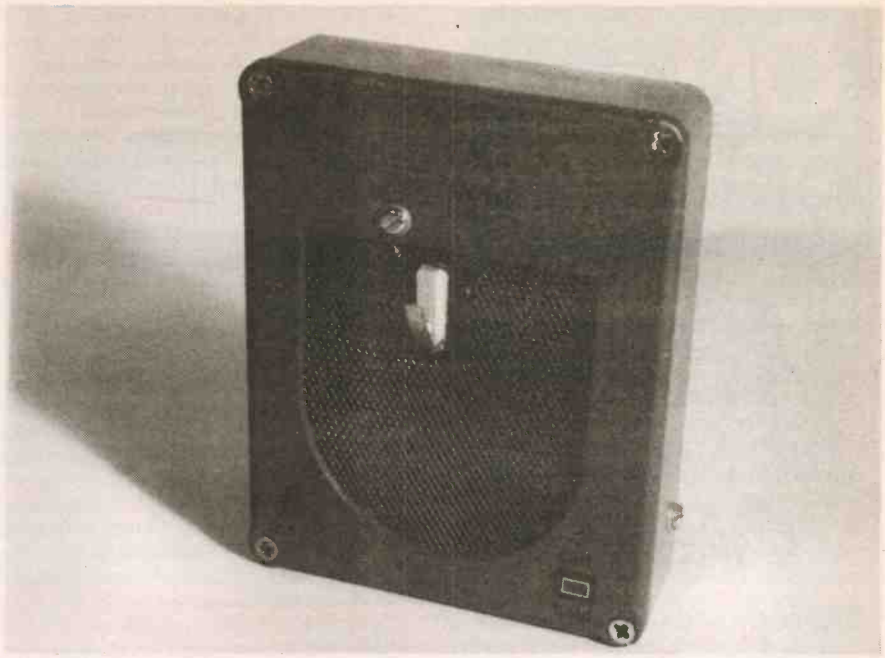
The microswitch is arranged so that the operating lever just protrudes through the wire mesh and any object placed on the mesh will automatically operate the switch. The only other component mounted on the lid is the red l.e.d. which should be positioned in one corner, see photographs.

A piece of card, about 110mm×76mm, should be placed in the bottom of the case to one side. This card sits under the p.c.b. and stops the board's copper tracks from shorting out.

The board is held in place by two sets of nuts and countersunk bolts. A single AA size battery holder should now be fixed in position to one side of the board.

A piece of 90mm×30mm plastics strip, with a small 20mm diameter hole cut in it to "cradle" the loudspeaker, is mounted above the circuit board at one end. The strip also has a small corner cut out at one end to allow the l.e.d. to pass when closing the lid.

Once all the components have been mounted in the case the lengths of connecting wires should be soldered to the battery holder, loudspeaker, l.e.d. and microswitch.



Completed unit showing the microswitch lever protruding through the wire mesh.

The two i.c.s should now be pressed into their holders and the battery inserted into the holder. Before closing the lid the unit can be checked for operation by pressing the microswitch lever. The close packing of components may necessitate some slight adjustments before the lid will close up, the position of the microswitch is particularly important in this respect.

IN USE

When the phone is placed on the box the l.e.d. should start to flash, along with the start of the tunes. The volume control preset VR1 should be adjusted to a comfortable level to avoid any possible damaging effect to the ears of the caller. □

ON SPEC

a regular feature for the Spectrum Owner...

by Mike Tooley BA

THIS month, in preparation for some forthcoming constructional projects, we shall be taking a detailed look at the hardware of MGT's exciting new **SAM COUPE.** We also have details of a new electronic drawing package from **BESofT** which will appeal to any electronics enthusiast who needs to produce neatly drawn circuit diagrams. We begin by opening up an old topic which may be of interest to those who own Issue 2 Spectrums.

Extra RAM

N. Allen writes from Alcester with some further information concerning the potential extra 32K of RAM present within the early "16K" versions of the Spectrum. Mr. Allen writes:

"Your article on RAM chips (May 1989) intrigues me. My Spectrum is an Issue 2 so I thought the potential extra 32K worth investigating. The link to select the upper or lower half of the 64K chips (the 4532's located in two rows of four just below centre on the board) is between the ULA (the large i.c. next to the modulator) and the upper left hand 74LS157. The link restricts the RAMs to a 7×8 matrix instead of the possible 8 ×8 address bits (giving 32K).

Before continuing, both halves of the 4532s can be checked by first POKEing an address into the top 32K (such as 40000) with zero, then PEEKing the address. Now try POKEing 255 and PEEKing. A return of the POKEd number indicates that at least half of all eight RAMs is working (one chip for each bit). Now turn the link round and repeat the PEEKs and POKEs.

I have replaced the link with a pull-up resistor of 47k and taken the central hole of the three to pin 4A of the edge connector (pending future developments such as using an output port to switch a 74LS373 to page the extra memory in or out)."

Although I have not personally tried Mr. Allen's suggested modification, I do know of several other Spectrum users who have successfully made use of the unused 32K RAM in Issue 2 machines by similar means. It is, however, worth pointing out that only the later Issue 2 Spectrums may have been fitted with *fully* functional 32K RAM chips.

Early models are quite likely to have chips which have defective memory cells (in one half of the matrix). This does not, of course, preclude users from making the modification and then identifying and replacing the faulty chip (or chips). For those who wish to follow this route, a simple method for checking and identifying suspect RAM devices was described in the May 1989 instalment of *On Spec*.

Hardware Expansion and the SAM COUPE

Version 1.1 of MGT's **SAM COUPE** manual recently dropped through my letter box. The document contains much of interest to both hardware and software developers and, by studying its contents, one can at last begin to form a realistic impression of what MGT's new machine will be capable of. The COUPE provides a number of sophisticated I/0 facilities not previously found on Sinclair/Amstrad Spectrum machines and all connections to the COUPE (with the exception of the removable internal disk drives) are made via the rear panel.

Bus expansion

A standard 64-way Euroconnector (with rows A-C fitted) provides access to the principal bus signals. With a few notable differences, this connector provides a similar function to that associated with the Spectrum edge connector. The usual data and address bus signals are available as are the control bus signals; RD, WR, INT, NMI, HALT, RESET, IOREQ, MREQ, BUSREQ, and BUSACK.

Also present are two ROM chip selects, AUDIO LEFT and AUDIO RIGHT, RED, GREEN and BLUE, CSYNC, VSYNC, and MIC/EAR. This last named signal is also available from a single 3.5mm jack connector. We shall include further details of the particular connector in a further instalment of *On Spec.*

Cassette jack

A 3.5mm (mono) jack socket provides the combined MIC/EAR signal. The signal is bi-directional; output is via the cassette recorder's MIC socket when SAVEing data whilst input is via the unit's EAR socket when LOADing. It makes no difference to the COUPE if EAR and MIC are connected together but readers should note that not all cassette tape recorders will tolerate this!

SCART

The 21-way SCART connector provides both RGB and composite video signals together with left and right audio outputs. This connector will thus facilitate connection of a wide range of video monitors, both analogue and digital. The pin connections are as follows:

Pin	Signal	Pin	Signal
1	AUDIO RH	2	SPEN
3	AUDIO LH	4	AUDIO GND
5	BLUE GND	6	BLUE TTL
7	BLUE LIN	8	RED TTL
9	GREEN GND	10	GREEN TTL
11	GREEN LIN	12	BRIGHT TTL
13	RED GND	14	CSYNC GND
15	RED LIN	16	CSYNC
17	C. VID GND	18	POWER IN
19	C. VID	20	POWER IN
21	GND		

Light pen

The light pen connector is a standard 5-pin DIN socket. The connector has a dual function; not only does it provide a light pen (or light gun) input but it also provides stereo audio output for connection to a domestic Hi-Fi system (via an AUX input). The pin connections are as follows:

Pin	Signal
1	0V
2	AUDIO LEFT
3	SPEN INPUT
4	AUDIO RIGHT
5	+5V

Joystick

The joystick connector is a standard 9-pin D-connector. The connector follows the Atari convention except that an extra strobe line is available for a second joystick together with a line carrying +5V. MGT intend to facilitate dual joystick operation by means of a second joystick fitted with a special plug-socket connector. The joystick is read by the keyboard port (port address 254 decimal) and overlays numeric keys 1 to 5 for the second joystick and 6 to 0 for the first joystick. The joystick connector is wired as follows:

Pin	Signal
1	UP
2	DOWN
3	LEFT
4	RIGHT
5	0V
6	FIRE
7	+5V
8	STROBEL 1
9	STROBEL 2

Mouse

The mouse interface employs a standard 8-pin DIN connector. MGT's three button mouse interrupts the CPU to request a read of its X and Y signal lines. The software driver is contained within the ROM and overlays the cursor keys. The mouse input can be read from the keyboard port (address 254 decimal) with address lines A8 to A15 set high. The mouse connector is wired as follows:

Pin	Signal
1	LEFT
2	UP
3	RIGHT
4	MSE INT
5	RDMSEL
6	0V
7	+5V
8	DOWN

MIDI INPUT

MIDI input is via a 7-pin DIN connector. The input is serial data at 31.25Kbaud which is fed via an opto-isolator to a serial-parallel convertor. The MIDI interface interrupts the CPU when a data byte has been assembled within the MIDI-IN register (address 253 decimal). This INPUT can also be read by bit-7 of the VMPR (address 252 decimal) and is also used by the NETWORK. The connections are as follows:

Pin	Signal
1	NET-LOOP
2	not connected
3	NET+LOOP
4	MIDI+IN
5	MIDI−IN
6	NET−LOOP
7	NET+LOOP

MIDI OUTPUT

MIDI output also employs a 7-pin DIN connector. By writing a data byte to address 253 decimal (the MIDI-OUT register) the MIDI interface outputs a current of

7.5mA at 31.25Kbaud. When transmitting, bit-4 of the STATUS register (address 249 decimal) is set. This OUTPUT can also be driven by bit-7 of the VMPR (address 252 decimal). An internal through connection is made from MIDI IN to MIDI OUT by setting bit-6 (THROM—through MIDI) of the BORDER register (address 254 decimal). MIDI OUTPUT is also used by the NETWORK. The connections are as follows:

Pin	Signal
1	NET−LOOP
2	GND
3	NET+LOOP
4	MIDI+OUT
5	MIDI−OUT
6	NET−LOOP
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ELECTRODRAW

In May's *On Spec*, I reviewed the ingenious **PCB Designer** package from **Kemsoft.** The popular computer press often refers to packages of this type as "productivity software"; a very apt title for programs which can be instrumental in saving the user many hours of toil! I was, therefore, interested to learn of another package which puts the Spectrum to excellent use serving the needs of the electronics enthusiast. This program is from a relatively new company, **BESofT,** and is entitled **ELECTRODRAW.**

ELECTRODRAW is a versatile electronic drawing aid which allows users to draw, edit, store, and print electronic circuit diagrams. The program is available in either tape or microdrive versions, the latter having obvious advantages when storing and retrieving diagrams.

ELECTRODRAW contains a number of features which make it easy to use. The program has symbol, label, line and box drawing facilities and includes a magnifier which produces a four-times normal size image of the area around the cursor for precise alignment of symbols and conductors. Symbol editing and creation can be carried out from within the main program and a "symbol merge" facility allows symbols from one diagram to be transferred to another. All microdrive functions (except MOVE#) are supported from within the main program.

ELECTRODRAW runs on any 48K or 128K Spectrum (including the Plus-2 in 48K mode without any add-ons (but some facilities require a printer and some require a microdrive). The following printer interface opions are supported: ZX or Alphacom-32, Centronics interface, and Sinclair Interface One RS-232 output.

The program comprises 11K of pure machine code (there is no BASIC loader). It is important to note that, although the cassette version supports all the microdrive facilities, the program itself cannot be transferred to microdrive. The cassette version can, however, be exchanged for a microdrive version for a small fee. Owners of the cassette are asked to return the cassette version with payment.

The software is supplied with a 12-page A5 format manual. The manual is neatly presented and includes sections entitled "Getting Started", "The Main Menu Options", "The Drawing Process", "The Symbol Design Routine", "Tape/Microdrive Options", and "Handling Very Long Diagrams".

Symbols

Successful use of any technically oriented drawing package depends very largely on the availability of an adequate library of commonly used symbols. Drawing packages should, ideally, be supplied with a number of symbols libraries (one for each application) and should also allow the user to define his or her own personalised set of symbols. ELECTRODRAW contains a library of fifty electronic symbols which are immediately available whenever the program is loaded. These symbols (which can be mirrored and rotated) will be adequate for most drawings, however, there will be occasions when additional symbols will undoubtedly be required.

Symbol definition is straightforward within ELECTRODRAW. The program allows approximately 17Kbytes of memory for symbol definition. This space is sufficient for about 500 symbols of 2×2 character squares. The fifty symbols supplied with the package take about 2.5Kbytes and this leaves over 14Kbytes free for the user's own symbol library (sufficient for approximately 400 symbols of average size!).

In use

I tested the cassette version of ELECTRODRAW in conjunction with a Spectrum Plus and Epson printer. In order to speed up loading of the program, I also took a "snapshot" of the program (and drawings) using the 48K snapshot facility of MGT's Plus-D interface. No problems were encountered in using the software when transferred to disk. However, since the software transferred was from tape (rather than microdrive), all storage operations reverted to cassette. BESofT are, hopefully, investigating the viability of producing a version of the program from Disciple and Plus-D users.

My overall impression of ELECTRODRAW is that it is a pleasure to use; most of the operations are quite intuitive, the cursor control is good, and the mirror and rotate facilities are excellent. I did find it necessary to re-draw a few of the symbols, though this was simply a matter of personal preference rather than reflecting any serious shortcomings of the symbol library.

Since ELECTRODRAW is clearly intended for low-cost applications, the program does not support output to a plotter. The quality of printed output is, however, perfectly adequate for many applications. Furthermore, subject to the usual constraints associated with dot-matrix printers, the output proved to be comparable (though not superior) to that produced by much more expensive packages (e.g. **GFA Draft** on the **Atari-ST** when using a dot-matrix printer as an output device.

In Conclusion

Fully blown "professional" CAD packages can cost many hundreds (if not thousands) of pounds. ELECTRODRAW is not in the same league as these highly sophisticated packages but, for those who require a simple package for straightforward electronic drawing and don't require fancy features (such as scaling or multiple layer drawing), ELECTRODRAW is in a class of its own.

The quality of the artwork produced is perfectly adequate for most purposes and the program should be instrumental in dramatically improving the presentation of such things as project reports, equipment handbooks, and manuscripts. At less than £20 this particular "productivity package" must be considered a real bargain!

ELECTRODRAW costs £17.50 (cassette version) or £19.00 (microdrive version) including postage and packing. BESofT are at 20, Ashville Road, Leytonstone, London, E11 4DT. Tel: 01-558-3469 (evenings only).

Next month: I shall be dealing with a bumper crop of queries together with some more hints and tips received from readers. We also have details of Andy Wright's **SAM BASIC** (Andy will be well known to many readers as the author of **Beta BASIC**) and will be delving into the memory map of the SAM. In the meantime, if you would like a set of our *Update* sheets, please drop me a line enclosing a large (250mm×300mm) and adequately stamped (currently 42p for UK postage) and addressed envelope. Please note that I can no longer provide individual replies to queries but instead will do my best to provide answers in future instalments of *On Spec*.

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

Pocket Money Project

SIMPLE L.E.D. TIMER

CHRIS BOWES

A low cost, easy-build unit that can be adapted to many simple timing applications

THIS PROJECT is essentially a variation on the chaser circuit, featured last month, in which a series of l.e.d.s are made to come on in sequence. This display format has been adapted to provide an indicating function which is used to show an elapsed preset time period. An audible output is triggered when the last l.e.d. is illuminated and the circuit is latched so that the alarm continues to sound until the circuit is turned off.

Although the component values have been chosen to suit a timing period of about four minutes, the circuit can be easily adapted so that the period is altered to suit other applications. The author uses his model as an audio/visual egg timer.

As with all of the circuits in the "*Pocket Money*" series, the design is intended to operate from a standard 9 volt battery. The circuit shown includes a buzzer but this can be replaced with any of the audible output circuits featured in this series, although it may be necessary to alter the transistor to one of a higher power to ensure that correct operation occurs.

HOW IT WORKS

The circuit really contains three standard circuit building blocks, some of which we have already met in this series.

The first standard circuit block is the 555 timer astable circuit which is used, in this case, to provide a series of pulses which are used to "clock" the rest of the circuit through. The standard layout of the 555 timer astable is shown in Fig. 1a and in this configuration produces an output waveform as shown in Fig. 1b.

The duration and interval between pulses produced by this circuit are determined by the values of R_A, R_B and C as shown by the two formulae given in Fig. 1b. By altering the values of the components in accordance with the given formulae the timer can be adapted to suit other applications.

The second building block is a standard "chaser" circuit using a 4017 Johnson Counter i.c. This very useful i.c. provides a sequential series of outputs, which are used to drive the indicator l.e.d.s, which change

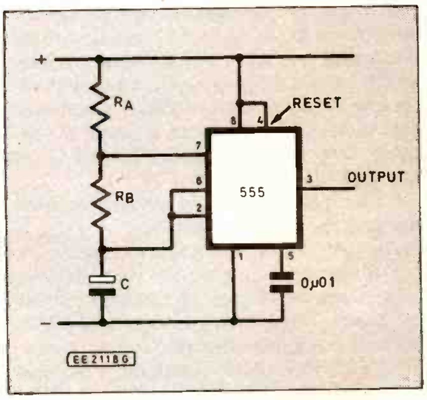


Fig. 1a. Using the 555 timer in the astable mode.

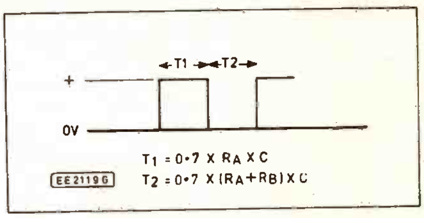
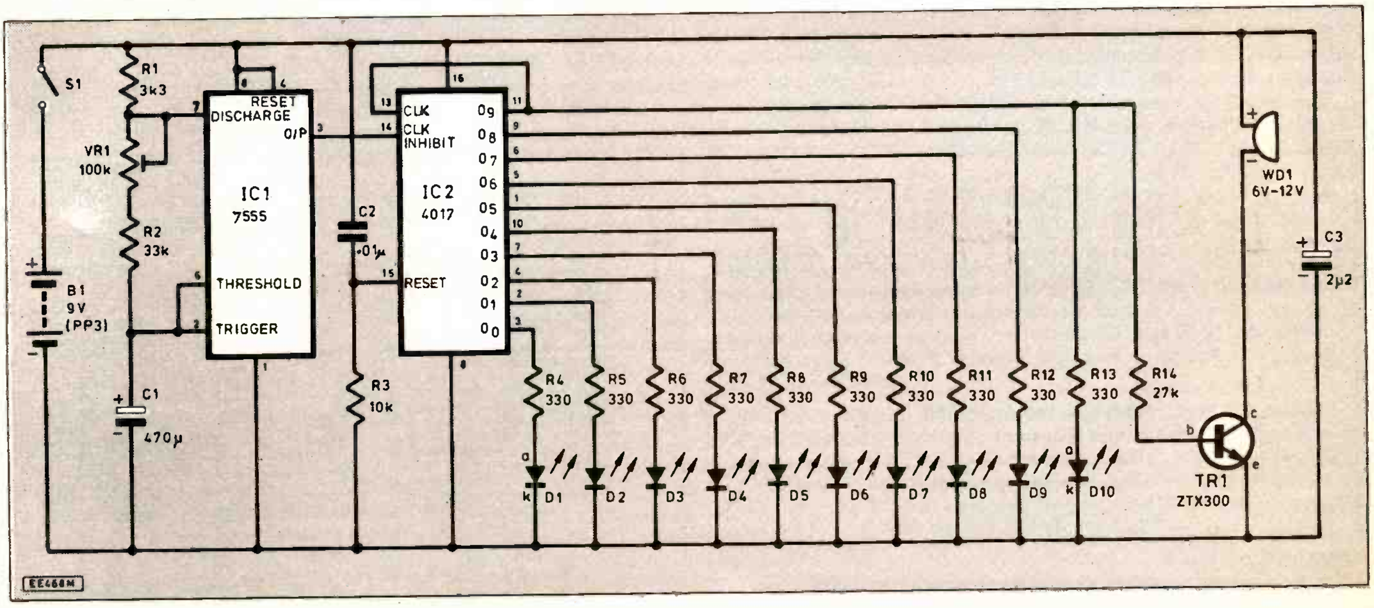


Fig. 1b. 555 timer astable timing diagram.

Fig. 2. Complete circuit diagram for the Simple L.E.D. Timer. The diodes D1 to D10 are contained in a ten-way l.e.d. module.



every time a clock pulse is received from the astable circuit.

The i.c. is provided with a "clock enable" input which is connected to the last output so that when this output is energised the clock is "locked". This provides a latching function which is used to keep the last building block (the alarm) operating until the circuit is switched off.

The final building block is a simple, single transistor current amplifier which is used to provide the current needed to drive the output buzzer, which requires more current than could be provided by the Johnson counter.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Simple l.e.d. Timer is shown in Fig. 2. The clock pulse required to advance the "chaser" circuit is provided by IC1, R1, R2, VR1 and C1. This is virtually the same as that shown in Fig. 1a with the combination of preset VR1 plus resistor R2 taking the place of R_B. The addition of VR1 to the fixed resistor enables the time between the clock pulses to be adjusted, for instance, if used as an egg timer it can be calibrated to give exactly the correct time period which is in fact spread over the nine pulses required for the sequence.

Because IC2 is a CMOS device, the bipolar 555 timer can *not* be used in this project and IC1 *MUST* be the CMOS version, i.e. ICM7555 or TLC555C. There is however, some gain in the fact that the CMOS timer does not require the connection of a capacitor between the 0V power supply rail and pin 5.

The "chaser" function for the display is provided by IC2, which is a 4017 Johnson Counter. This i.c. has two inputs which can be configured in different ways so as to provide a number of different functions.

In this circuit the output from the IC1 is connected to pin 14 (one of the clock inputs) of IC2, and pin 13 (used in this case as a clock enable input) is connected to output 0_9 (pin 11) of IC2. Whilst 0_9 is at the logic 0 (0 volts) level, pin 13 is also held at logic 0.

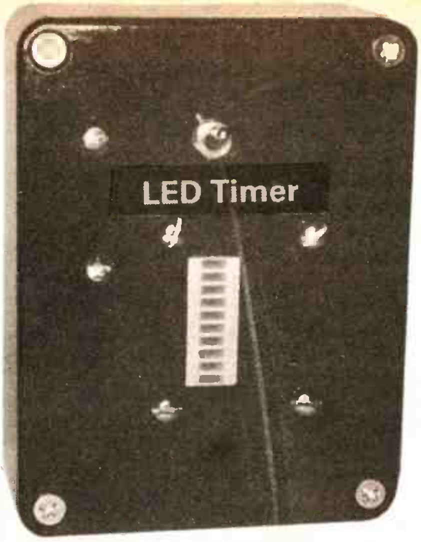
In this condition the outputs 0_0 to 0_9 of the 4017 each go to the logic 1 (battery voltage) state in turn, changing every time that the clock pulse at pin 14 changes from the logic 0 state to the logic 1 state (the change going from logic 1 to logic 0 state is ignored) for as long as pin 13 is in the logic 0 state. This continues until 0_9 (pin 11) is energised going to the logic 1 state. Because this output is connected to pin 13, which acts as a clock enable input this is also forced to the Logic 1 state, causing IC2 to latch in its existing state, keeping pin 11 in the energised state and causing all further pulses at pin 14 to be ignored.

Capacitor C1 and resistor R3 form a very simple pulse circuit which makes the Master Reset input (pin 15) go momentarily to the logic 1 state. This causes the 4017 to be reset so that output 0_0 (pin 3) is energised, as soon as the timer is turned on.

DISPLAY

The ten outputs from the 4017 are each connected to an indicator l.e.d. (D1 to D10) through a 330 ohm dropping resistor (R4 to R13). The l.e.d.s work in the same way as ordinary diodes, by allowing a current to flow through in one direction, but not in the other. When a current flows through the l.e.d. it glows.

It is important that the l.e.d. is not subjected to excessive current and the dropping resistors are included to restrict the



current flowing through the l.e.d. to a safe level. The l.e.d.s are made to illuminate in turn as each of the outputs of IC2 goes to the logic 1 state

CURRENT AMPLIFIER

Output 0_9 from IC2 is also connected via resistor R14 to the base of TR1. This transistor is used as a simple current amplifier to energise the audible warning device, WD1. When a current is allowed to flow through the base/emitter junction of TR1 it causes a larger current to be drawn through WD1 and the collector/emitter circuit of TR1, causing the buzzer to sound.

Capacitor C3 is a tantalum capacitor which is used to provide smoothing (decoupling) of the power supply rails in all CMOS circuits. This component is necessary to ensure correct operation of the circuit.

CONSTRUCTION

The timer project is easily made up using two stripboards as shown in the photographs and in Fig. 3 and Fig. 4. You will probably find it helpful to look at those whilst you make up the circuit.

The first task is to cut two pieces of stripboard to the correct size. You will need one piece, used for the main circuit board, which is 16 strips deep and 29 holes wide and another, used for the display, which is 16 strips deep by 14 holes wide. The sizes allow for drilling 4mm mounting holes in the postions shown, before starting to construct the circuit.

Similarly, before any components are mounted on the stripboards, you will need to break the copper tracks, as shown Fig.3 and Fig. 4. It is important that these track breaks are made completely so that not even the merest sliver of copper remains to bridge any tracks.

Although it does not make any difference to the operation of the circuit which order you make up the two boards or which order you insert the components into the boards you will probably find it best to make up and test the display board first and then go on to the main circuit board. The making up of both boards is easier to do if the components are inserted and soldered in ascending order of size.

DISPLAY BOARD

The display board is the simpler of the two boards to make up. The prototype of this project used a ten-way l.e.d. module as the display but there is no reason why you should not make use of ten single l.e.d.s instead if you prefer. The first stage of making up this board is to connect the wire links shown in Fig. 3.

COMPONENTS

Resistors

R1	3.k3	
R2	33k	
R3	10k	
R4 to R13	330 (10 off)	
R14	27k	
All 0.25W 5% carbon		

Shop Talk
See page 636

Potentiometer

VR1	100k min. skeleton preset, horizontal

Capacitors

C1	470μ p.c.b. elec. 10V
C2	0μ01 Mylar 16V
C3	2μ2 tantalum 10V

Semiconductors

D1-D10	10-way bar l.e.d. array (or 10× single l.e.d.s)
TR1	ZTX300 *npn* silicon
IC1	CMOS 7555 timer
IC2	4017 10-stage Johnson counter

Miscellaneous

S1	s.p.s.t. switch
WD1	6V-12V solid state buzzer
B1	9V battery (PP3 type)

Stripboards, 17 strips×29 holes (main board) and 16 strips×14 holes (display); 16-pin i.c. socket; 8-pin i.c. socket; plastic case; self adhesive stand-offs (7 off); battery connector; connecting wire; solder, etc.

Approx. cost Guidance only £10.50

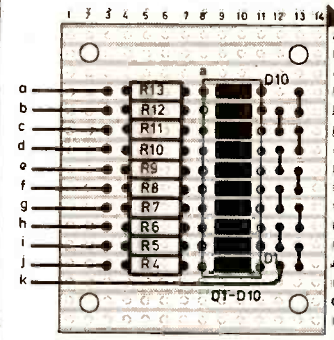
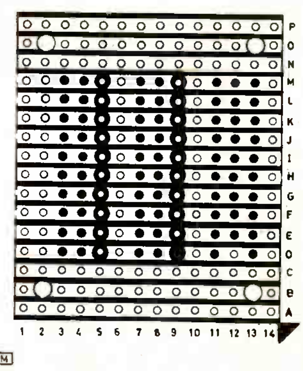
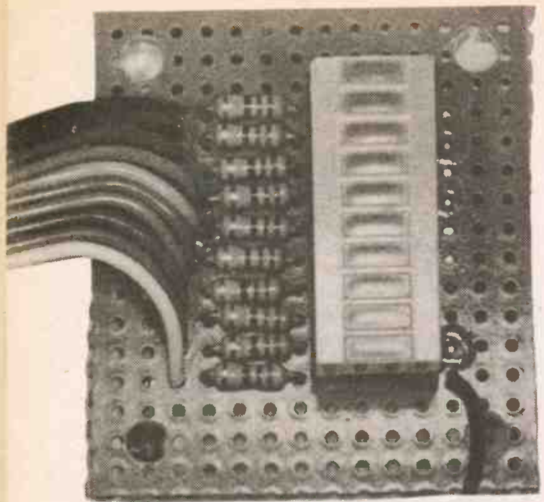
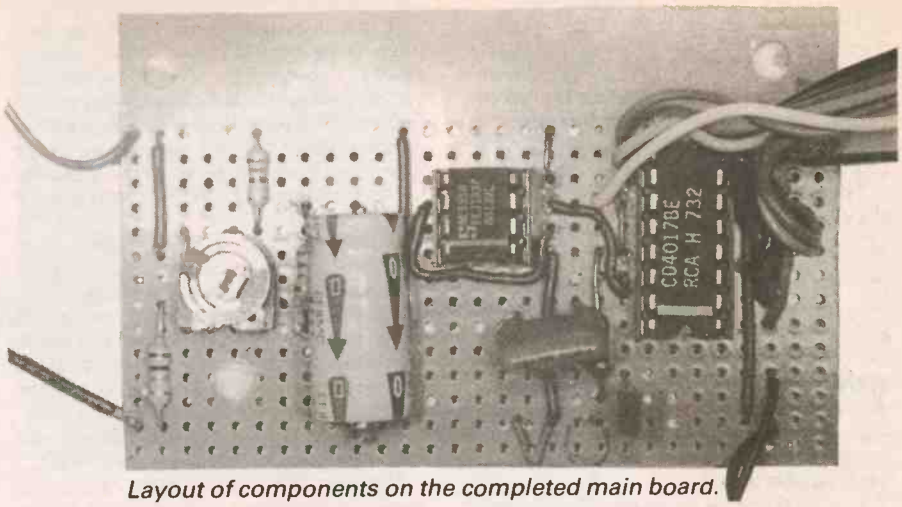


Fig. 3. Display board component layout and details of copper tack cuts.





Completed display board showing the 10-way l.e.d. module.



Layout of components on the completed main board.

There are a number of wire links required to make the common 0V connection to the l.e.d. cathodes (k) and you may prefer to make these connections by means of a single bare wire soldered to the underside of the stripboard.

The next stage is to insert the d.i.l. socket used for the l.e.d. display, followed by the display itself. If discrete l.e.d.s are being used, insert them into their correct places and solder them in place. These l.e.d.s are polarity sensitive so it is important to ensure that they are connected the correct way round, or else they won't work.

Also at this stage the wires linking the two boards together can be attached to the display board. Although the board has been designed so that ribbon cable can be used stranded, single-core wire can also be used successfully. If single wires are used then construction will be made easier if different coloured wires are used for this purpose.

Testing and fault finding of the timer should be carried out prior to inserting the boards in a suitable case.

DISPLAY BOARD TESTING

It is advisable to test the display board separately *before connecting it to the main driver board*. This is simply done by connecting the negative of the battery to the *common* connection on the board and touching *each* of the wires connected to the anodes (a) of the l.e.d.s, via the associated dropping resistors to the positive connection of the battery in turn.

Each l.e.d. should light up as the connection is made. If none of the l.e.d.s light up then the most likely causes are either that the 10-way l.e.d. module (if you are using one) is inserted into its holder the wrong way round or that there is a faulty connection in the common wire connecting all the cathodes (k) to the battery negative.

The first fault can be cured by rotating the module through 180 degrees. The second fault will have to be traced by testing the continuity (using the meter's "ohms" range) between the battery end of the common wire and its connections on the board.

If some of the l.e.d.s light but not all then it will be first neccessary to check whether there is a pattern as to which diodes light and which do not. If there is a point in the sequence up to which they light and then the rest do not then it is likely that there is a break in the links joining the commoned cathodes together. This can be traced as described above.

If there is no pattern as to which l.e.d.s light and which do not then it is most likely that there are individual faults in each of the circuits leading to the anodes of the l.e.d.s, via the associated series resistor. The complete circuit, from the wire leading to the main board, through the series resistor and the connection to the anode's should be thoroughly checked with a meter to ensure complete continuity of the circuit. If neither of these checks reveal any explanation as to why a correctly installed l.e.d. does not light then it must be assumed that it is faulty and should be replaced.

MAIN BOARD

After the display board has been made and checked it is now time to construct the main board, starting by inserting the wire links as shown in Fig. 4.

The next task is to put the resistors in their correct places by first bending the wires of the resistor at right angles to the body of the component, so that they will fit through the holes, as shown in Fig. 4. Also fit preset VR1 into the correct position and solder it into place.

The next item to be inserted into position is the i.c. holder. Although it is possible to solder the i.c. directly into place using a socket will both make the construction simpler and make for easier replacement if a fault should occur. It is important that you take care to make sure that the notch on the IC holder is facing towards the bottom of the stripboard as this will help you when inserting the ICs into place.

Next come the capacitors. C2 is a non polarised capacitor so it does not matter which way round it is inserted but C1 and C3 are electrolytic capacitors so it is important that they (the −ve connection usually marked on the component case − see photographs) are connected as shown in Fig. 3. Similarly care must be taken when mounting the transistor to ensure that its orientation corresponds with that shown in Fig. 3. and the photographs.

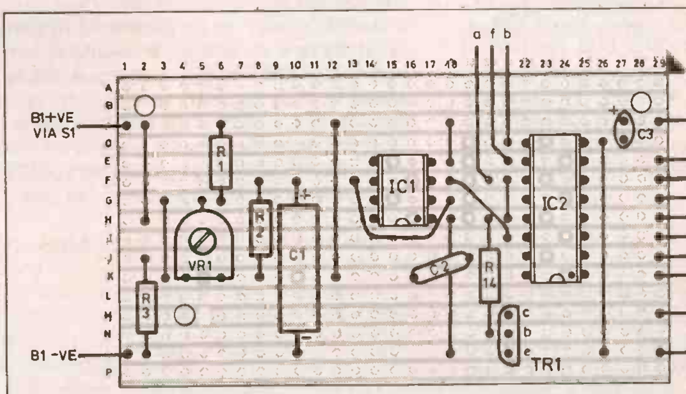
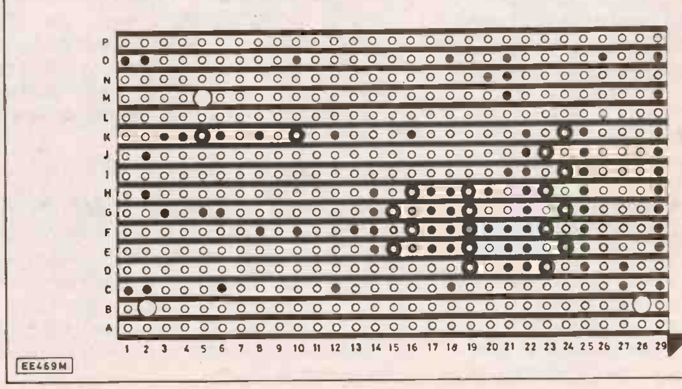


Fig. 4. Main stripboard component layout and details of breaks required in the underside copper tracks.



The final component to be mounted is the buzzer or other audible warning device. This device is often polarity sensitive so care must be taken, if the device is marked with polarities on the case or by means of red and black coloured wires, to make the connections with the correct polarity.

The wires connecting the battery to the circuit board can then be tinned and soldered into place. The black wire from the battery connector goes to the point on the stripboard and the battery connector's red wire will need to go to one of the switch terminals. Another wire is connected between the other switch terminal and the B1+V connection on the stripboard. The tested display board can now be connected to the main board taking care to ensure that the connections match exactly those shown in the board layouts.

The final step is to insert the i.c.s into their holders, making sure that the notch or indentation on the i.c. corresponds with the notch on the i.c. holder. Some i.c.s do not have a notch in one end but have a slight, circular dent near pin one.

MAIN BOARD TESTING

Before connecting the battery and testing the circuit you should carefully examine the stripboard to make sure that all of the components are inserted into the correct places, are the correct way round and that there are no blobs of solder shorting out the tracks. Once the board has been checked then the battery should be connected and you should be able to see the l.e.d.s turning on in turn and be able to set the rate of this by adjusting VR1.

If the circuit does not operate correctly it will be necessary to check for faults. You will probably find that you will need the aid of a multimeter to perform this stage of the process.

CLOCK GENERATOR

Check that the clock generator circuit, comprising R1, VR1, R2, C1 and IC1, is operating correctly. The best method of doing this is to use a voltmeter to measure the output voltage at pin 3 of IC1. If the clock circuit is operating correctly then the meter needle should be seen to register a slow pulse at approximately 30 second intervals.

If this does not happen then the next stage is to perform some basic voltage checks. You should be able to measure the battery voltage between any 0 volt connection and both pins 8 and 4 of IC1 as well as between the Battery + connection to the board and pin 1. If these voltages are not present this will indicate faulty wiring up of the stripboard.

If this does not produce a satisfactory solution then the output voltage at pin 3 of IC1 should be checked. If this is locked permanently at a fixed voltage then you should remove the i.c. from its socket and check the voltage at pin 3 connection again. If the voltage persists with IC1 removed then the fault does not lie with IC1 but most possibly with the wiring associated with the i.c. and the output to IC2 or its associated wiring.

The next step is to replace the i.c. and check the voltages at pins 2, 6 and 7. The voltage at pin 7 should be fluctuating slowly around a value which is roughly between ⅓rd and ⅔rds of the battery voltage. The voltages at pins 2 and 6 should be identical (because these two pins are connected together by a wire link) and these should also be fluctuating but at a voltage slightly less than that found at pin 7.

If both of these voltages are not present then the most likely cause is that the circuit from the + voltage rail, through VR1, R1 and R2 is not correctly made. This is best checked by measuring the voltage present between 0 volts and each of the points in the component chain through VR1, R1, R2 and C1 and investigating at the junction where no voltage is measured.

If a voltage is present between 0 volts and pin 7 but no voltage, or only a very small voltage, is measured between the 0 volts rail and pins 2 or 6 of IC1 then you should check that the resistance between pins 7 and 6 of IC1 is roughly equal that of resistor R2. If this is correct then check the resistance of capacitor C1 with the resistance range of your meter.

If the resistance is very low (less than about 500 ohms) then you should replace C1. If there is no voltage measurable between pins 6 and 2 of IC1 then this could be caused by a short circuit between the connections of C1 or by a short circuit within C1 or its connections to the stripboard.

If voltage is present at pins 2 and 6 of IC1 but it does not fluctuate then the likely causes are that C1 is not correctly connected, is faulty or that IC1 is faulty. To check C1 you should touch connect another capacitor of similar value across the connections to see if this cures the fault. If this does not cure the fault check that the connection between the positive connection of C1 and pins 2 and 6 of IC1 is correctly made.

COUNTER

If voltage switching is taking place at the output of IC1 then the i.c. is working correctly and the fault is most likely to lie in the area of IC2 and its associated components. The first stage is to check that the power supply is correctly connected to pins 8 and 16. In case this voltage cannot be measured then you should check the connections to pin 8 and 16 and ensure that the wire links have been correctly made.

The next stage is to check that the clock pulses from pin 3 of IC1 are being correctly received at pin 14 of IC2. As these pulses are somewhat slow you may find it helpful to replace capacitor C1 with a lower value capacitor at this stage.

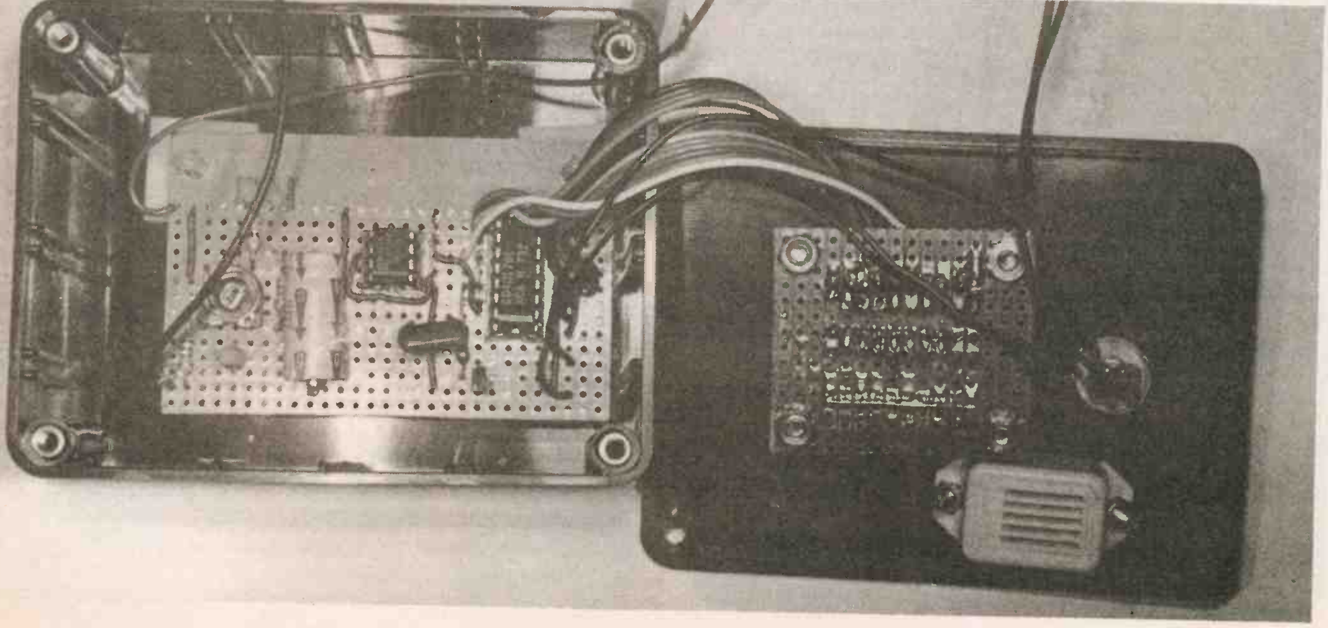
If the clock pulses are being correctly received at pin 14 of IC2 then it is neccessary to check that pin 15, the master reset input, is at logic 0. If a logic 1 state exists at this point the circuit will be locked with output 0_0 permanently in the high state. If a logic 1 state is found at pin 13 then you should check very carefully for solder bridges between pins 15 and 16 of IC2.

If the clock pulses are being received at pin 14 and pin 15 is in the logic 0 state, then the counter should advance by one for every clock pulse received, provided that pin 13 (the count enable input) is in the logic 0 state. Because this pin is connected to pin 11 of IC2 then the counter should advance until pin 11 is forced to the logic 1 state.

Now check the Logic state of pin 3, which should be at logic 0 (0 volts). If the logic state at pin 13, is logic 1 or an indeterminate logic state then the connections between pins 13 and 11 (which is a wire link) should be carefully checked.

If this connection is correct, with no accidental connection between either of these pins and the battery supply line, then the states of the output pins of IC2 should be checked. You should find that only one of the outputs (pins 1, 2, 3, 4, 5, 6, 7, 9, 10 and

The two circuit boards mounted inside the case and case lid. Note the audio buzzer mounted on the underside of the lid.



11) should be in the logic 1 state and all other outputs should be in the logic 0 state.

Immediately the device is switched on pin 3 should be at the logic 1 state. If this is not the case then the problem may possibly be that the master reset input (pin 15) is not receiving a quick reset pulse from the circuitry made up of capacitor C2 and resistor R3. The connection between the battery supply rails and these two components as well as that between the junction of R3 and C2 and pin 15 of IC2 should be checked.

If more than one of the outputs is in the logic 1 state then one must suspect that IC1 is faulty and must be replaced. Assuming that the l.e.d. display board has been checked and connected up to the main board beforehand then the states of these outputs may be monitored by observing the illumination of the l.e.d.s on the display board to the main board. If more than one l.e.d. lights at the same time then the connections between the ribbon cable joining the display to the main stripboard should be carefully checked to ensure that there are no solder bridges between adjacent tracks.

ALARM

The final part of the project to check is the alarm. This is very simple since it comprises a resistor, a transistor and an audible warning device. If the audible warning device does not sound when the last l.e.d. is illuminated then the circuitry associated with TR1 should be checked.

An initial test is to short out the emitter and collector of TR1, with a small piece of wire, and see whether the audible warning device sounds. If this produces no effect then WD1 should be inspected to ensure that it has not been connected with the wrong polarity. If the polarity is correct, the connections from the positive power supply rail to WD1 and from the warning device to the collector of TR1 and from the emitter of TR1 to the strip carrying the battery negative connection should be checked.

If the audible warning device is working correctly then the operation of the transistor can be checked by making a temporary link, with IC2 removed from its socket, between pins 16 and 11 of IC2. This should produce a battery voltage measurable between the end of resistor R14 furthest away from the base of TR1 and 0 volts. If this does not occur then the connection between pin 11 and the i.c. end of R14 should be investigated.

With a battery voltage present at the junction of resistor R14 and pin 11 of IC2, a voltage of approximately 0.7V should be measurable between the base and the emitter of transistor TR1. If no voltage is measurable here then the resistance of R14 should be measured to ensure that it is actually acting as a resistor and not an open circuit. If this does not produce a resistance reading, close to the value specified for R14 and TR1 is connected the correct way round, then TR1 must be suspected of being faulty and should be replaced.

CASE

This project has been designed to fit inside a case. The first stage of preparation of the case is to cut, carefully, a hole in the case lid, the correct size to accommodate the l.e.d. display. This should be carefully measured, taking into account the need to allow for stand-offs into which the mounting holes on the stripboard containing the display will fit. For this reason the positioning of the display should be done with some care. It is also neccessary to drill a hole in the case lid to accommodate switch S1. Once the necessary holes have been drilled in the case lid it can then be lettered and the lettering protected with several layers of clear, spray on varnish.

Self adhesive stand-offs should be mounted on the component side of the display board and the board offered up to the inside of the case lid. When the display is correctly seated in the hole cut for it then the pads may be pressed firmly into place to hold the board in the correct position.

Self adhesive stand-offs can also be fitted to the main board (with the pads on the track side this time). The main board can be offered into place and the self adhesive pads pressed firmly onto the bottom of the case to hold the stripboard into the correct position. The battery can now be replaced in the battery clips, the circuit tested and preset VR1 adjusted to give the correct timing period before finally screwing down the case lid.

IN USE

The timer is very simple to use. All that is neccessary to do is to operate switch S1, at which point D1 will come on. The remaining l.e.d.s will then come on in order, at approximately half minute intervals, until D10 is illuminated at the time that you have preset by adjusting VR1. When D10 comes on the audible warning device will sound and will continue to sound until S1 is switched off. □

eb...Beeb...Beeb...Beeb...Be

... Disk Interfacing ... Disk Interfacing ... Disk Interfacing ... Disk Interfacing .

I THINK it is true to say that the BBC computer has one of the better cassette interfaces. Having used many home computers with a variety of cassette recorders, the only computer in my experience that gives more reliable results is the Dragon 32 (and the short lived Dragon 64 that followed it). An excellent but little copied feature of the BBC cassette interface is that when searching for a file it tells you what files it has found, and it gives a progress report as it goes through each file.

Once loading, if an error should occur you only need to wind the tape back a little and try again, rather than having to start from scratch. This makes loading programs and data from cassette about as painless as it possibly could be.

Disk Drive

Despite the BBC computer's good cassette storage system, a disk drive is still a tremendous advantage. Apart from the increased convenience, a lot of the more sophisticated BBC software is only usable on a disk based system.

This is usually due to memory restrictions necessitating the use of overlays. This is where only part of the program is ever in memory. If you call up a program function and the relevant part of the program is not in memory, it is automatically loaded from disk and executed. Any overlay already in that part of memory is over-written, and must be reloaded from disk if it is needed again.

This system is far from fast, with the same program sections often being loaded from disk time and time again. Its saving grace is that it enables the computer to run software of a complexity and sophistication that would otherwise be out of the question.

Such a system is not really practical with a cassette based system since locating and loading the overlays would take far too long. A disk system can quickly locate and load a file on the disk. The serial nature of a cassette system, plus its low loading/saving speed, render it far less versatile.

Slipped Disks

I must admit to having had my BBC model B computer for a number of years before I eventually fitted it with a disk interface and hooked on a twin disk drive. It was one of those things I had always meant to do, but considerable slippage occurred because I had gained the impression that it was a major job that required the removal of the main p.c.b. plus a lot of intricate soldering.

In fact the board can be left in-situ, and no soldering is involved. The disk interface socket is (of course) already present on the board, and it seems that the passive components are also ready-fitted, as are holders for the integrated circuits. Fitting a disk interface is basically just a matter of taking off the computer's lid and plugging in the eleven missing integrated circuits.

It is a little more difficult than this in that the integrated circuit holders are mostly tucked away beneath the keyboard and behind the keyboard cable and connector. You therefore need to remove the three nuts and bolts that hold the keyboard in place so that it can be removed to give easy access to the holders.

The eleven integrated circuits are as follows:—

IC78	8271
IC79, IC80	7438 (2 off)
IC81, IC86	74LS393 (2 off)
IC82	74LS10
IC83, IC84	4013BE (2 off)
IC85	4020BE
IC87	74LS123

Acorn DFS ROM (fit in any sideways ROM socket).

The integrated circuit holder indicates the correct orientation for each device (they are all fitted with pin 1 towards the rear of the computer). These integrated circuits are standard types apart from the 8271 disk controller and the Acorn DFS ROM.

The 8271 is actually obsolete and has not been manufactured for some years, but it is still available. Like all disk controller chips it is a complex device, and is not exactly cheap. In fact this component accounts for what is probably about 75 per cent of the disk interface's cost! The Acorn DFS ROM seems to be available from the usual stockists of Beeb bits and pieces.

There are actually alternative DFS ROMs that can be used, such as the popular Watford type (which is the type I fitted). The real Acorn ROM is the safest option though, and all disk software should run without difficulty using this chip. Comparing the prices of sets of components bought individually with the cost of complete DFS kits, a kit represents a more convenient way of buying the components, and could be cheaper as well.

Complications

In order to get the disk interface to operate properly there are one or two minor details to be attended to. Just what you need to do depends on the issue number of the board in your computer. My Beeb has an issue 4 board, which is probably the most common type. On issue 4 (or higher) types you only need to locate and cut link S9 on the board. This link is about 2.5cm to the left of pin 1 on the 8271 chip (IC78).

On issue 1, 2, and 3 boards matters are slightly less straightforward. The track running from IC27 pin 9 to the right hand pad of link S9 has to be cut. Then pin 9 of IC27 has to be cut as close to the board as possible, and lifted upwards slightly so that it is clear of the board. Thin insulated connecting wire is then used to connect IC27 pin 9 to the right hand pad of link S9! This may sound a bit odd, but I am assured that this is the correct procedure. Presumably this process gets rid of one or two unwanted connections to IC27 pin 9.

Note that this modification assumes that the computer is a model B (not a model A) and that it is fitted with a series 1 operating system. Model A and early model B computers require a small amount of updating before they can take this modification. If you have one of the few machines in these categories it would probably be as well to get an authorised dealer to fit the disk interface and check that everything is as it should be.

Incidentally, this upgrade equips the computer with the standard (single density) DFS, not the more advanced ADFS type. However, for most purposes the DFS interface should be perfectly satisfactory.

Optimising

On the BBC keyboard p.c.b., about 5cm to the right of the spacebar, there is provision for an octal d.i.p. switch or link wires to be fitted. These control a few start-up options, one of which pertains to the disk drives.

Switch 1 selects the master filing system if the DNFS ROM is fitted. Normally this switch is set to the open position, but closing it selects the econet system (if fitted). Switch 2 is unused.

Switches 3 and 4 are used to select a DFS operating speed to match the disk drives. The table below shows the effect of the four switch setting combinations.

Switch 3	Switch 4	Head Settle Time	Head Step Time	Head Load Delay
Closed	Closed	16	4	0
Closed	Open	16	6	0
Open	Closed	50	6	32
Open	Open	20	24	64

The original Acorn drives were quite slow, and require the default setting of both switches/links open. Most modern drives, including the popular Mitsubishi and current Tandon drives, require the fastest speed (both switches/links closed).

If in doubt, using the default settings seems to give satisfactory results with fast or slow drives, but will give less than optimum performance with fast drives. A little trial and error is perhaps the best way of finding the best settings in the absence of any definite information on your drive or drives.

An auto-boot option is provided by switch 5. This is not normally needed, and this switch is usually set to the open position. Pressing SHIFT-BREAK then produces an auto-boot. Switches 6, 7, and 8 select the initial screen mode. All switches closed selects mode 0, running through to mode 7 with all switches open. Note that all these functions are under software control via the *FX255 operating system command.

Connections

One reason for the success of the BBC computers is that, unlike many home computers of the early eighties, they use mainly standard interfaces. The disk interface is of the standard type, with a 34-way IDC socket at the computer end which connects to a 34-way edge connector at the disk drive. There are a lot of BBC compatible drives available, including some inexpensive types suitable for the DIY enthusiast. 5.25 inch drives are probably the best choice as most BBC disk software is on disks of this size.

The BBC computer will work with 40 or 80-track drives, single or double sided. Double sided 40-track drives are a safe option and are quite abundant. If you get 80-track drives it is advisable to buy a type that can be switched to 40-track operation so that they can read any software supplied only in 40-track format.

Using a 34-way IDC connector, a 34-way (2 × 17 way 0.1 inch pitch) IDC edge connector, and about 0.6 metres of 34-way ribbon cable it is not too difficult to put together your own cable. The main point to watch is that you do not get the connections crossed over. Pin 1 of the BBC computer's disk connector is at the top left hand corner when looking onto this port from the front of the computer. Pin 1 should be marked on the male edge connector of the disk drive.

For a twin drive system two edge connectors must be fitted to the cable. The first is fitted at the end of the cable in the usual way, while the second is fitted the same way round and about 100 millimetres in from the end of the cable. This assumes that the two drives will be fitted in the same case stacked one above the other. Different mounting arrangements could require greater separation between the two edge connectors.

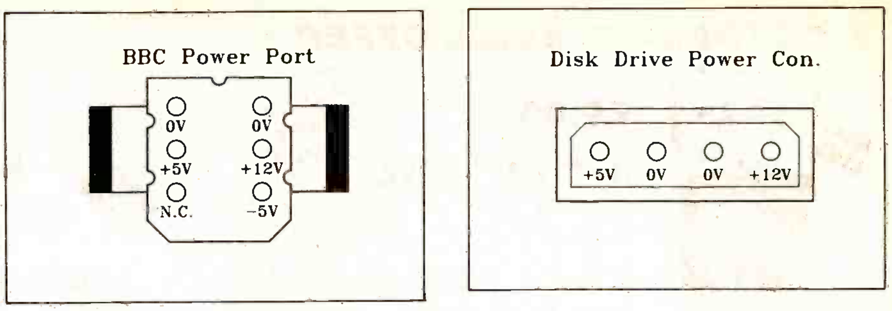


Fig. 1. Details of the BBC's power port and the standard five-way connector used on disk drives.

Power

The power port of the BBC computer is designed primarily for powering a disk drive, although many users prefer disk drives which have their own mains power supply. This leaves the computer with plenty of spare capacity to power other add-ons and add-ins. Also, the power port of the computer is only guaranteed to be able to power one disk drive, but many users wish to fit two drives (the power port can in fact power twin drives, but only if they are both low consumption types).

Anyway, Fig. 1 gives details of the BBC computer's power port and the standard five way connector used on disk drives. Unfortunately, both types of plug are difficult to obtain, but you might be able to obtain them from one of the larger Acorn stockists. Alternatively, ready made BBC disk drive power cables are readily available, as are the main disk drive cables.

Drive Settings

In books and articles on disk drives it is normal to refer readers to the information leaflet for their drives in order to get information on the correct settings for the jumper leads. I have bought about half a dozen "bare" drives over the years, and in my experience disk drives are simply not supplied with any technical information. With luck you might be able to squeeze some out of your supplier.

The main thing to get right is the drive number setting. Usually there are jumper terminals marked something like "DS0", "DS1", "DS2", and "DS3", which are the drive select terminals. If you only have one drive, then this should have the "DS0" terminals linked with a jumper. If it is a double sided drive, then its two sides are effectively drives 0 and 2.

If a second drive is fitted, this should have the "DS1" terminals linked. It then effectively drives 1 and 3 if it is a double sided type. If you are using single-sided drives, it is possible to have four of them acting as drives 0 to 3 by linking a different set of drive select terminals on each drive.

Other terminals that are usually found on a disk drive are the "MUX" (or just "MX"), "MS", and "HM" types. The "MUX" (multiplex) terminals are linked if only a single drive is used. "HM" (head motor) are always left open, and "HS" (head select) are always fitted with a jumper. There may well be several other pairs of terminals, but you can usually get away with simply leaving these at their default settings.

Termination Resistors

One further complication is that disk drives are fitted with termination resistors of about 150 ohms in value that can be switched in or out of circuit (or fitted/unplugged in some cases). The idea is that these resistors should only be in-circuit on the drive at the end of the cable. With a single drive, these resistors should therefore be in-circuit. With a twin drive system they should be in-circuit on the drive at the end of the cable, and out of circuit on the other drive.

On my Mitsubishi drives these resistors are in the form of an octal 150 ohm resistor in a standard 16 pin d.i.l. encapsulation. This is fitted in its socket or unplugged, as required.

I must admit that I only recently learned about the use of termination resistors in disk drives. I have been using twin drives with both of them fitted with the termination resistors. Although technically incorrect, the drives have worked faultlessly for about four years!

Robot Roundup

NIGEL CLARK

With the start of a new school term it is again time to see what is on the market. As usual every effort is made to ensure that the information is accurate but the prices (quoted ex-VAT) are approximate and most companies offer education discounts so it is best to check with suppliers for exact prices.

ARMS

Armdroid HS 1B **(Hasfield Systems)** 5-axis plus gripper, servo-driven with steel-reinforced belt transmission. Lift 250gms. Control by BBCs, Commodores and IBM. £750.

Alfred **(Research Development Associates)** 5-axis plus gripper, servo-driven with toothed belts, lift 170gms. Has work cell. Between £200 and £250.

Atlas II **(LJ Technical Systems)** 5-axis plus gripper, stepper driven with toothed belts. Lift 1kg. On-board micro and teach pendant for stand-alone system. Wide range of operating software. Controllable from BBC and IBM compatible machines. Work cell available. Arm costs £3,300, IBM interface £350.

Beasty Plus arm **(Commotion)** 3-axis plus gripper, servo-driven, lift 75gms. Supplied with kit and instructions on how to build four different configurations and comprehensive user guide. Kit costs £120 and £35 for interface.

Cyber 310 **(Computer Voice)** 5-axis plus gripper, stepper driven with belt and cable transmission. Lift 250gms. Software for all usual micros. Staged a recovery in last year and now has a work cell. £700.

ESA 1010 **(Feedback Instruments)** 4-axis plus gripper. Updated version of Powertran's Armatrol. Only machine able to work off the ZX81 as well as most of the other micros. £1,100.

EMU **(LJ Technical Systems)** 4-axis plus gripper, servo-driven with direct mechanical linkages, lift 100gms, software for BBC and LJ's Emma. £425, workcell extra.

HRA 934 **(Feedback Instruments)** 5-axis plus gripper, hydraulically powered. Lift 2.5kgs. On-board processor and can be controlled by BBC, Apple, C64. £3,200.

MA 2000 **(Tecquipment)** 6-axis plus gripper, servo-driven with toothed belt transmission, pneumatic gripper. Lift 1kg. Software for BBC and Open University's Hektor, was developed for Open University courses. Gripper is fitted to take pneumatic tools and wired for sensors. Can be linked with the MA 3000 more robust industrial version. Sells at £5,500 for export including basis software, discounts available for UK.

MA 3000 **(Tecquipment)** 5-axis arm plus gripper. Larger but simpler version of MA 2000. Can be linked with MA 2000 as part of system. £10,750.

MARS **(Research Development Associates)** Also known as Modular Automation Robot System. Modules can be fitted together in a number of ways including normal 5-axis arm and SCARA. Servo-driven can lift 1kg. Uses same on-board processor as Alfred and can be controlled by most of the popular micros except Atari. £2,400. Larger industrial version developed recently costing £4,000.

Mentor **(Cybernetic Applications)** 5-axis plus gripper. Servo-driven, lift 1kg. Can be controlled by small-scale model simulator. Software for BBC, IBM and Apple. Can be networked with up to three other Cybernetic machines and work cell. £900.

Naiad **(Cybernetic Applications)** 5-axis plus gripper, lift 500gms, powered by hydraulics (water). All axes driven by different kinds of hydraulic piston, all cylinders made of see-through plastic. Gripper can be powered by hydraulic system or pneumatic piston for which supply provided at extra cost.

As with Mentor can be controlled by simulator and networked with up to three other Cybernetic machines and work cell. Software for BBC, IBM and Apple. £1,750.

Neptune I **(Cybernetic Applications)** 5-axis arm plus gripper. Electro-hydraulically powered (water) lift 2.5kgs. Software for BBC, IBM and Apple and on-board processor. As with Mentor can be controlled by simulator and networked with up to three other Cybernetic machines and work cell. £4,040.

Neptune II **(Cybernetic Applications)** 6-axis plus gripper. Rest of specifications same as for Neptune I with addition that it can be controlled by touch sensors on all axes. £5,490.

Robotarm **(Logotron and Resource)** 5-axis plus gripper, bucket or magnet pick up, servo-driven, battery-powered and has two standard Atari joystick ports for control. Sold as educational package with interface for BBC. £99.95.

Teach robot **(Remcon Microelectronic)** 5-axis plus gripper, lift 200gms. Four of axes driven by linear rams, feedback by shaft encoders on motors. Available with software and interface for IBM and compatibles. £995.

SCARA ARMS

IVAX 901 **(Feedback Instruments)** 4-axis plus pneumatic gripper, servo-driven, lift 500gms, software for on-board processor, IBM, BBC and Apple. Work cell available. £3,600.

PW801 **(Feedback Instruments)** 4-axis plus gripper, servos on all axes except end rotation which has a stepper motor, lift 2kgs. Software for IBM and Apricot. Work cell available, interchangeable gripper jaws. £7,350.

RTX **(UMI)** 6-axis plus gripper, servo-driven, lift 4kgs, software for IBM. £7,480.

RTX 100 **(UMI)** More robust version of RTX, intended for light industry. £9,100.

Serpent I **(Cybernetic Applications)** 4-axis plus gripper, servo-driven with pneumatic power for vertical movement of gripper, height of arm set manually, software for BBC, IBM and Apple. Can be networked with up to three other Cybernetic machines and work cell. £2,700.

Serpent II **(Cybernetic Applications)**. Same as above except that it has longer reach. £2,735.

Others

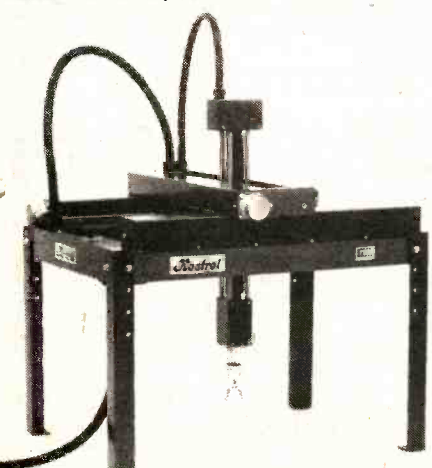
Kestrel **(Cybernetic Applications)**. Gantry supported arm with 4-axes plus gripper, stepper driven, works in x, y and z co-ordinates, lift 2kgs, vacuum or two-fingered pneumatic gripper. Software for IBM, can network with up to three other Cybernetic machines and work cell. £4,250.

MOBILES

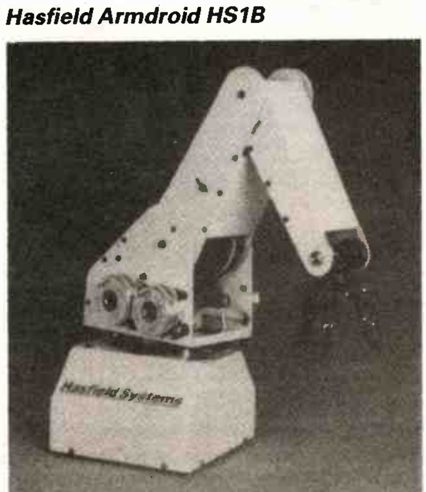
Jessop Turtle **(Jessop Microelectronics)** also known as the Edinburgh Turtle, it looks like an upturned mixing bowl, one of the earliest turtles controlled by a version of Logo. Powered by servos with optical encoders, includes pen. Linked to computer by umbilical cord. Software for BBC, Apple RML and IBM. £220.

Lego Buggy **(Lego and Resource)** Two-wheeled servo-driven, built from

Kestral from Cybernetic



Hasfield Armdroid HS1B



Lego kit with Resource control board attached. Maze following, detecting obstacles, speed control and bar code reading can be done. Software in Buggy Basic, Control and Control IT. £30 for buggy alone, £50 for control board.

Roamer **(Valiant Technology)** Two-wheeled, servo-driven, stand-alone mobile, uses Logo-like language with instructions entered by keypad on top of the Smartie-shaped machine. Pen holder. Can be customised with the kits supplied. £90 retail, £70 educational.

Trekker **(Clywd Technics)** Two-wheeled servo-driven. Developed by children at North Wales secondary school and given extensive in-house testing before being put on market with substantial software and documentation. Software for BBC and Commodores and extension pack for junior schools. £180.

Valiant Turtle **(Valiant Technology).** Two-wheeled servo-driven with pen, remote-controlled via infra-red link, designed to resemble a turtle. Uses version of Logo and software for BBC, Apple, IBM. Microworlds being created in which it can be used. £300 retail, £250 educational.

HEROS

Hero 2000 **(Maplin Professional Supplies)** is the only one left of the range which used to include Hero I and Hero Junior. Large mobile. Has light, sound and motion detectors, rangefinder and speech. 5-axis arm driven by stepper motors, lift 1lb. Gripper has touch sensor to adjust gripping force. Easily built and dismantled to show how it works. £2,500 in kit.

ADDRESSES

Clwyd Technics, Antelope Industrial Estate, Rhydynwyn near Mold, Clwyd.

Commotion, 241 Green Street, Enfield, Middlesex EN3 7TD

Computer Voice, Cherry Trees, Milwich, Stafford ST18 0EG.

Cybernetic Applications, West Portway Industrial Estate, Andover, Hampshire SP10 3LF.

Feedback Instruments, Park Road, Crowborough, East Sussex TN6 2QR.

Hasfield Systems, The Old Rectory Stables, Hasfield, Gloucester GL19 4LG.

Jessop Microelectronics, Unit 6A, 3 Long Street, London E2 8HJ.

Logotron, Dales Brewery, Gwydir Street, Cambridge.

LJ Technical Systems, Francis Way, Bowthorpe Industrial Estate, Norwich.

Maplin Professional Systems, PO Box 77, Rayleigh, Essex.

Remcon Microelectronic, PO Box 81, Chislehurst, Kent BR7 6LP.

Research Development Associates, BTC, Bessemer Drive, Stevenage, Hertfordshire.

Resource, Exeter Road, off Coventry Grove, Doncaster DN2 4PY.

Stevenage Adventure Workpacks, 29 Lytton Fields, Knebworth, Herts SG3 6BA.

Tecquipment, Bonsall Street, Long Eaton, Nottingham NG10 2AN.

Tribotics, 27 Crawley Mill Industrial Estate, Witney, Oxfordshire.

UMI, UMI House, 9-15 St James Road, Surbiton, Surrey.

Valiant Technology, Gulf House, 370 York Road, Wandsworth, London SW18 1SP.

KITS

Numerous suppliers provide collections of components including motors which can be used to build robotic models. However, only **Fischertechnik, Lego, Tribotics** and **Stevenage Adventure Workpacks** provide kits which can be linked to a computer.

Fischertechnik was first in the market with its computing kits including d.c. motors, potentiometers, switches plus a large collection of parts for a variety of models including plans for two arms. The plans have been recently expanded to include a number of other models including a simulation of a welder.

Lego with Technic series includes kits from which an arm, a plotter and a buggy can be made. Servos with optical encoders are available as are programs and an interface for the BBC and a battery-powered controller. Special kits and packages for schools.

Tribotics provides a larger-scale series of models based around drain-piping. Variety of devices including an arm, mobile with caterpillar tracks and walking robot.

Stevenage Workpacks provide kits of varying complexity. Some only include the electronics and mechanics with templates from which the wooden components can be made. £500.

Prices of all the kits vary and it is best to enquire what each pack contains at the different price levels.

DOWN TO EARTH

BY GEORGE HYLTON

SKIN EFFECT

AT THE instant when an electrical circuit is energised, does current begin to flow through the centres of the wires, or do the outside layers of the wire conduct first, or does the entire mass of metal in the wire carry current right from the start?

The question may seem purely academic. I have to admit that, when I first came across it, I was reminded of medieval theologians asking how many angels can dance on the point of a pin. However, the pioneer electrical engineers who asked it had good reason to want to know. They realised that it had a bearing on the behaviour of telegraph lines and cables.

The answer is that current starts to flow in the first outer layers of the wire. I can't remember who first produced convincing reasons for thinking so, and as I write this I'm far from home or libraries, but I have a feeling it may have been Heaviside.

Whoever it was, the consequences for the radio engineer are anything but academic. Because the current starts on the outside and works its way inwards, the resistance of the wire is not constant but increases with frequency.

The reason for this stems from the fact that when two conductors are parallel, a change in current in one of them tries to cause a current to flow in the other. If it can actually flow, this induced current is in the opposite direction to the primary current.

A solid wire can be thought of as made up of many smaller parallel wires. A change of current in any of these tends to create an opposing current in its neighbours. In Fig. 1, if A is the outermost layer of a conductor and carries a current in the direction shown, any change in current tries to force an opposing current through the next inner layer B. Switching on a current is itself a change, so the effect occurs even in d.c. circuits.

In time, the temporary opposition is overcome, and A and B conduct in the same direction. This combined current tries to produce a reverse flow in layer C. When this opposition dies away, layer D replaces C, and so on, layer by layer until, in the end, all layers conduct in the same way.

This process of filling up the wire with current is very rapid. But it is not instantaneous. It takes time to complete. In an a.c. circuit, the current keeps reversing. So there may not be time. Reversal may take place before the middle of a wire is fully conducting. The higher the frequency the less complete is the conduction. At extremely high frequencies current never penetrates deeper than the outermost layers, the "skin" of the wire. For this reason the behaviour is called skin effect.

SKIN DEPTH

If only the skin conducts, the rest of the wire may as well not be there. At high frequencies a hollow tube would be just as good as a solid wire. The effective resistance of the solid wire is the resistance of the tube, which is clearly higher than the d.c. resistance of the wire since there's less metal to act as a conductor. The high-frequency resistance of a wire is greater than the low-frequency resistance.

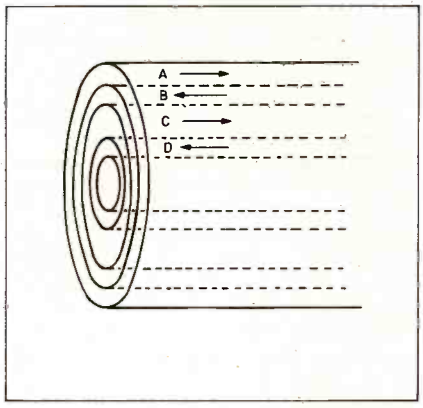


Fig. 1. Cross section through wire. When current starts to flow in A as shown an induced current tends to flow in the opposite direction in layer B, and so on.

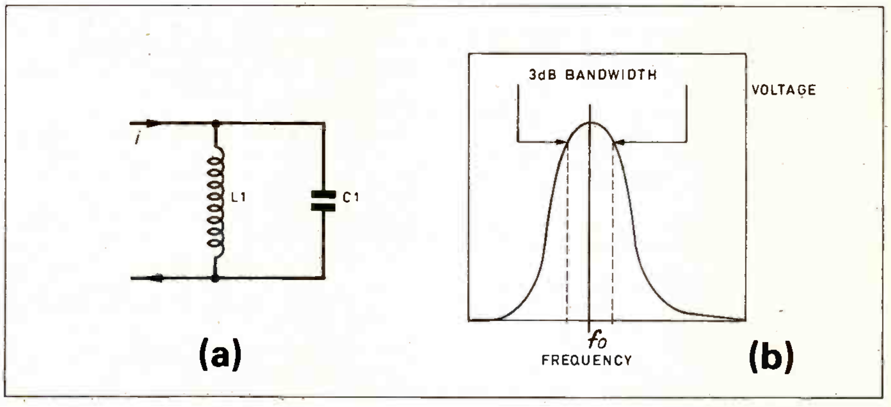


Fig. 2 (below). Parallel-tuned LC circuit (a). Frequency response (b). The bandwidth between points where the response has fallen by 3dB is f_o/Q.

Of course, a solid wire isn't really made up of separate layers, so the skin effect is not clear-cut but blurred. High-frequency current doesn't just penetrate to a fixed depth beyond which no current fows at all. What happens in real life is that as you move from the outside towards the centre of a wire you encounter less and less high frequency current, though there's always *some* current, even right at the centre. When radio engineers talk of the "skin depth", they mean the depth at which the current has fallen to a particular fraction of the outer current (actually to 1/*e* of the outer current where *e* is the same number as the base of natural logarithms.

REDUCING RESISTANCE

Skin effect is important to the design of inductors. In radio, the goodness of an inductor is often expressed as a quality factor or Q-factor for short. When the inductor is used in a parallel-tuned *LC* circuit (Fig. 2a) the selectivity is high when the Q-factor is high. The usual yardstick for selectivity is the 3dB bandwidth (Fig.2b) that is the interval between the two frequencies where the response falls by 3dB (by about 30 per cent). Obviously, 3dB isn't much of a reduction, but it gives an easily computed figure. If the peak frequency is f_o, then the 3dB bandwidth is f_o/Q. So if an LC circuit tuned to 450kHz has a Q of 45 then 3dB bandwidth is 10kHz.

Now, Q goes down as the h.f. resistance goes up. If one coil has a resistance of 1 ohm and another, otherwise identical coil has a resistance of 10 ohms, the Q of the 1 ohm coil is 10 times the Q of the 10 ohm coil.

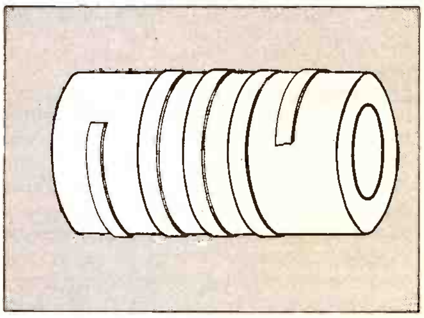


Fig. 3. Tape-wound inductor.

One way of fighting skin effect is to use, instead of one thick wire a number of thin wires in parallel, all insulated from one another. The insulation puts space between the small wires and allows each one to act on its own. This kind of stranded-insulated wire is called litz wire (from its German name, Litzendraht).

Parallel wires, even when insulated, are still not completely isolated from one another. They interact electromagnetically like the layers of a solid wire. As the frequency is raised, the effect gets worse. This reduces the value of stranding and at really high frequencies solid wire is just as good.

Designers of h.f. inductors know that the current in one turn affects the current distribution in an adjacent turn, reducing the Q. Interaction can be reduced by spacing out the turns. However, more turns are then needed and the resulting increase in length of conductor itself gives increased resistance. There is a broad optimum spacing which gives the highest Q at a particular frequency.

Another strategy is to use flat tape instead of round wires (Fig. 3). This reduces resistance but also inductance, so it's only useful where a low inductance is sufficient.

SILVER-PLATE

A third ploy is to use a conductor material which has less resistance than the usual copper. The only useful material is silver, which is expensive. However, silver-plated conductors improve Q at extremely high frequencies where the skin depth is so low that even a very thin layer of high-conductivity material brings benefits. Microwave components are often silver-plated.

You might think that the ultimate answer would be to wind coils using superconductive wire with no resistance at all. There are several snags. One is that at present all known superconductors must be kept very cold. Another is that the higher the conductivity the greater the skin effect.

In a superconductor, alternating currents are confined to a very thin surface layer. The current density in this layer is high, and the resulting high magnetic field strength may itself destroy the superconductivity.

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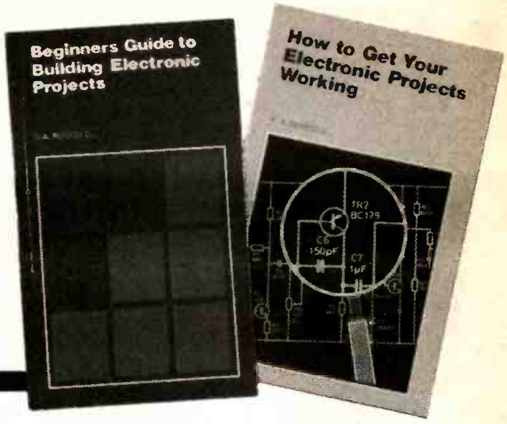

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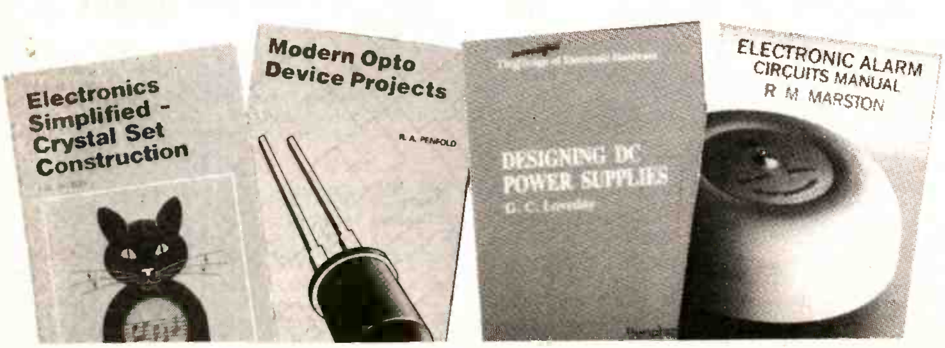

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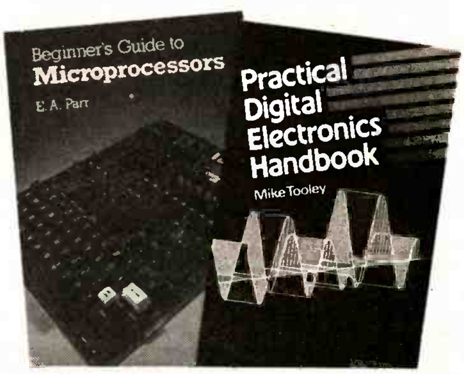

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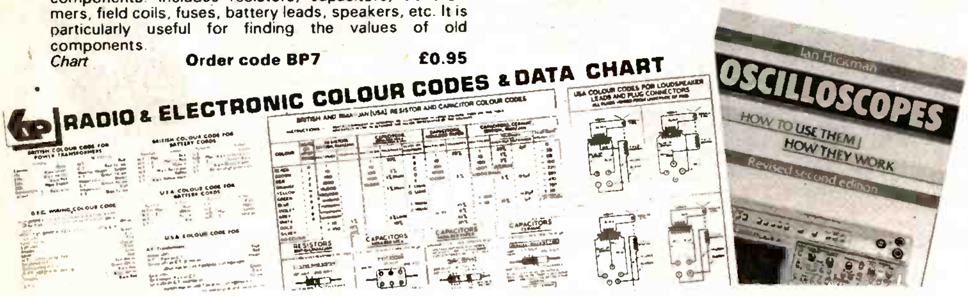

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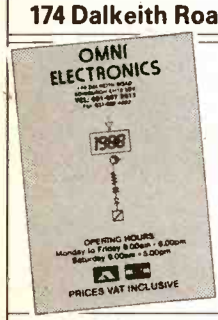

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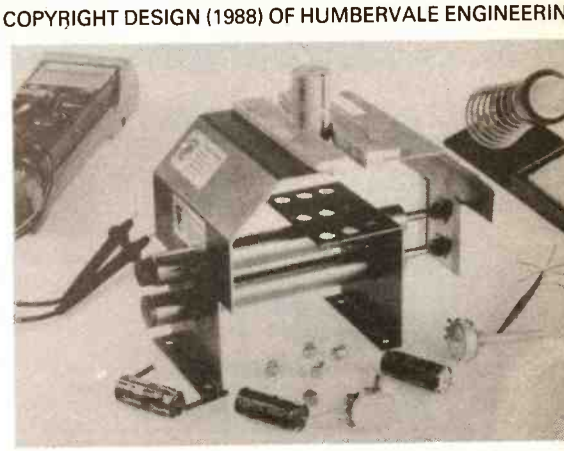

THE BENCHHAND CLAMP IS A SPRING OPERATED DEVICE, WHOSE SPRING IS SET AT OPTIMUM, BUT IS ADJUSTABLE. THE CLAMP GRIPS ARE MADE OF CAST ALLOY. SHAPED GRIPS ARE FITTED AS STANDARD AND CAPABLE OF HOLDING MOST SHAPES WITH A FIRM HOLD TO CARRY OUT A VARIETY OF FUNCTIONS SUCH AS SOLDERING, ETC. TWO 'D' CONNECTOR SIDE ENTRY SLOTS ARE ALSO INCORPORATED. UNSHAPED GRIPS ARE ALSO AVAILABLE FOR SHAPING AS AN OPTIONAL EXTRA. THE CLAMP CONSTITUTES A ROBUST, DIVERSE AND VERSATILE TOOL, A VALUABLE AID IN MANY FIELDS, SPARE PARTS ARE AVAILABLE. PERSONS WITH SOME DISABILITY MAY FIND IT USEFUL ALSO.

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SPECIFICATION:	
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Jaw opening	7 cm
Width	12 cm
Height	12.5 cm
Weight	1 kg

HUMBERVALE ENGINEERING
PO Box 15,
Hessle,
Humberside
HU13 0HP

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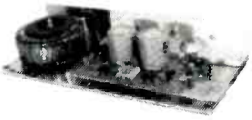

OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 1Hz – 100KHz –3dB, Damping Factor, >300, Slew Rate 45V/uS, T.H.D. Typical 0.002%, Input Sensitivity 500mV, S.N.R. –125dB. Size 300 × 123 × 60mm.
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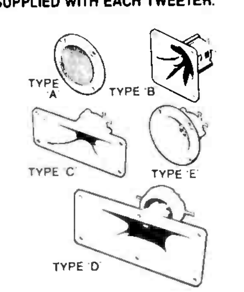

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