EVERYDAY ELECTRONICS

NOVEMBER 1990

INCORPORATING ELECTRONICS MONTHLY

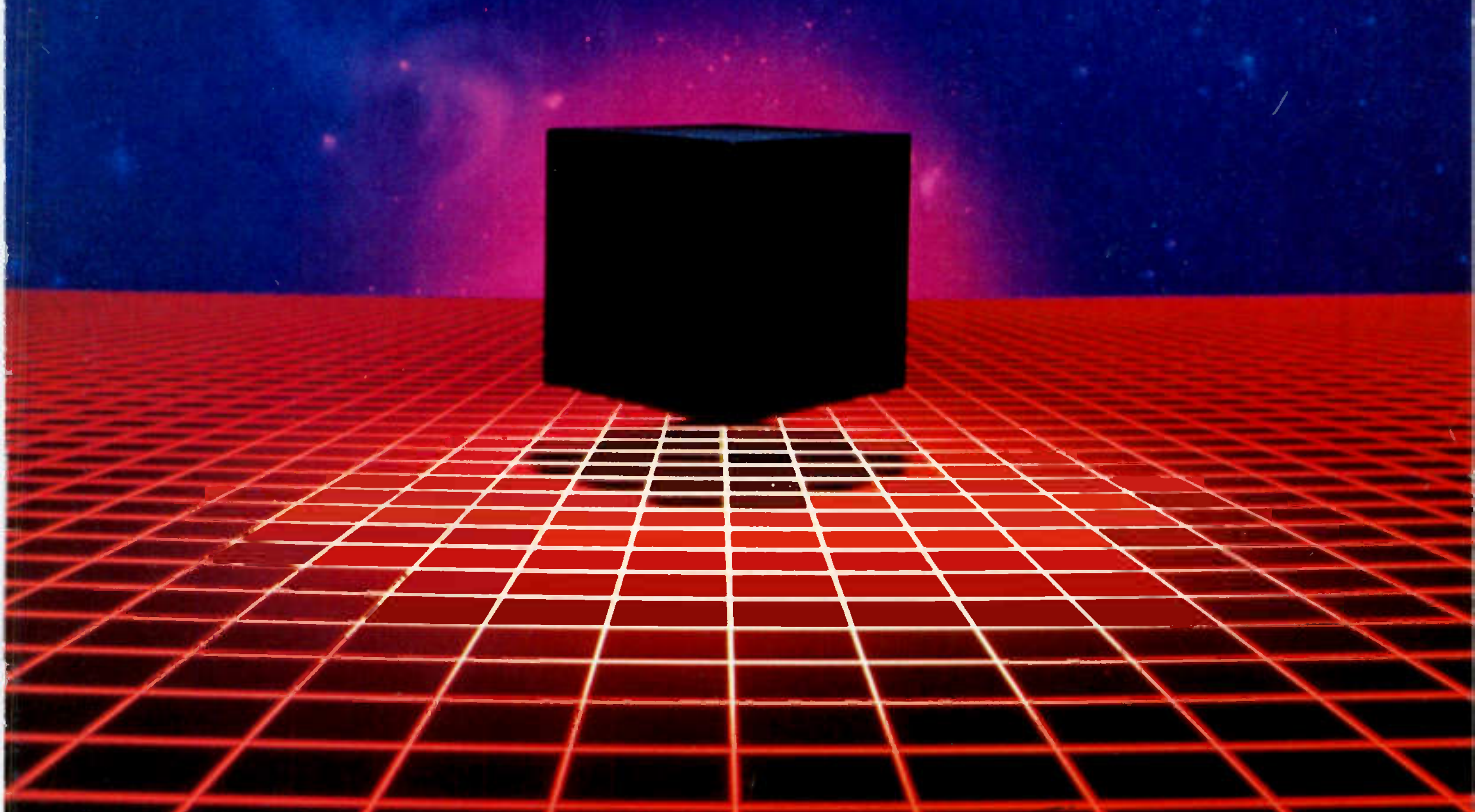
£1.50

EE MUSKETEER

A complete home entertainment controller in one handheld unit—replaces up to four separate controllers

IN LINE DIMMER

Simple dimmer for lamps



CYCLE REAR LIGHT MONITOR

For safety at night

ISSN 0262-3617

The No.1 Magazine for Electronic & Computer Projects

ONE POUND PACKS

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

BD2 5 13A spurs provide a fused outlet to a ring main where devices such as a clock must not be switched off.
BD9 2 6V 1A mains transformers upright mounting with fixing clamps.
BD13 12 30 watt reed switches, it's surprising what you can make with these – burglar alarms, secret switches, relay, etc., etc.
BD22 2 25 watt loudspeaker two unit crossovers.
BD30 2 Nicad constant current chargers adapt to charge almost any nicad battery.
BD32 2 Humidity switches, as the air becomes damper the membrane stretches and operates a microswitch.
BD42 5 13A rocker switch three tags so on/off, or change over with centre off.
BD45 1 24hr time switch, ex-Electricity Board, automatically adjust for lengthening and shortening day, original cost £40 each.
BD49 5 Neon valves, with series resistor, these make good night lights.
BD56 1 Mini uniselector, one use is for an electric jigsaw puzzle, we give circuit diagram for this. One pulse into motor, moves switch through one pole.
BD67 1 Suck or blow operated pressure switch, or it can be operated by any low pressure variation such as water level in water tanks.
BD103A 1 6V 750mA power supply, nicely cased with mains input and 6V output leads.
BD120 2 Stripper boards, each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc.
BD132 2 Plastic boxes approx 3in cube with square hole through top so ideal for interrupted beam switch.
BD134 10 Motors for model aeroplanes, spin to start so needs no switch.
BD137 1 6½ inch 4 ohm speaker 10W rating
BD139 6 Microphone inserts – magnetic 400 ohm also act as speakers.
BD148 4 Reed relay kits, you get 16 reed switches and 4 coil sets with notes on making c/o relays and other gadgets.
BD149 6 Safety cover for 13A sockets – prevent those inquisitive little fingers getting nasty shocks.
BD180 6 Neon indicators in panel mounting holders with lens.
BD193 6 5 amp 3 pin flush mounting sockets make a low cost disco panel.
BD199 1 Mains solenoid, very powerful, has 1in pull or could push if modified.
BD201 8 Keyboard switches – made for computers but have many other applications.
BD211 1 Electric clock, mains operated, put this in a box and you need never be late.
BD221 5 12V alarms, make a noise about as loud as a car horn. Slightly soiled but OK.
BD252 1 Panostat, controls output of boiling ring from simmer up boil.
BD259 50 Leads with push-on ¼in tags – a must for hook ups – mains connections etc.
BD263 2 Oblong push switches for bell or chimes, these can mains up to 5 amps so could be foot switch if fitted into pattress.
BD268 1 Mini 1 watt amp for record player. Will also change speed of record player motor.
BD305 1 Tubular dynamic mic with optional table rest.
BD653 2 Miniature driver transformers. Ref. LT44. 20k to 1k centre tapped.
BD548 2 3.5V relays each with 2 pairs changeover contacts.
BD667 2 4.7 µf non-polarised block capacitors, pcb mounting.

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

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

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

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

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

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

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

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

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

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

POWERFUL IONISER

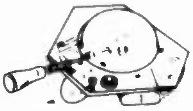
Generates approx. 10 times more IONS than the ETI and similar circuits. Will refresh your home, office, workroom etc. Makes you feel better and work harder – a complete mains operated kit, case included. £18. Our ref 18P2.

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

REAL POWER AMPLIFIER for your car, it has 150 watts output. Frequency response 20hz to 20Khz and signal to noise ratio better than 60dB. Has built in short circuit protection and adjustable input level to suit your existing car stereo, so needs no pre-amp. Works into speakers ref. 30P7 described below. A real bargain at only £57.00. Order ref: 57P1.

REAL POWER CAR SPEAKERS. Stereo pair output 100W each 4Ohm impedance and consisting of 6½" woofer, 2" mid range and 1" tweeter. Ideal to work with the amplifier described above. Price per pair £30.00. Order ref: 30P7.

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



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

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

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

SINCLAIR C5 WHEELS
Including inner tubes and tyres. 13" and 16" diameter spoked poly carbonate wheels. Finished in black. Only £6.00 each. 13" Ref 6P10, 16" Ref 6P11

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

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

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

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

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

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

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

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

VERY POWERFUL 12 VOLT MOTORS. 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. Our ref 20P22.

AS ABOVE with gearbox £40. Ref 40P8.

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

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

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

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

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

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

SPECTRUM AND COMMODORE SOFTWARE Pack of 5 different tapes only £3.00. Ref. 3P96 for Spectrum and 3P97 for Commodore 64.

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

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

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

BULL ELECTRICAL

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

MAIL ORDER TERMS: Cash, PO or cheque with order. Monthly account orders accepted from schools and public companies. Please add £2.50 postage to orders. Minimum order £5.
Phone (0273) 203500 Fax No. (0273) 23077

POPULAR ITEMS — MANY NEW THIS MONTH

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

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

JOYSTICKS for BBC, Dragon, only. All £5.00 each. All brand new, state which required.

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

SUB-MIN PUSH SWITCHES Not much bigger than a plastic transistor but double pole PCB mounting. 3 for £1.00. Our ref BD688.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

BBC JOYSTICK INTERFACE Converts a BBC joystick port to an Atari type port. Price £2.00. Our ref. 2P261.

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

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

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

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

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

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

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

STC SWITCHED MODE POWER SUPPLY. 220V or 110V operation giving 5V at 2A – 24V at 0.25A – 12V at 0.15A and + 90V at 0.4A £12.00 each. Ref 12P21

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

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

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

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

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

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

STROBE LIGHTS Fit a standard edison screw light fitting 240V 40/min. flash rate available in yellow, blue, green and red. Complete with socket. Price £10 each. Ref. 10p80 (state colour required).

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

EXTENSION CABLE WITH A DIFFERENCE It is flat on one side making it easy to fix and look tidy. 4 core, suitable for alarms, phones etc. Our price only £5.00 for 50m reel. Ref. 5P153.

1990 CATALOGUE NOW AVAILABLE PLEASE SEND 6" X 9" SAE FOR FREE COPY

VOL. 19 No. 11 NOVEMBER 1990

EVERYDAY ELECTRONICS

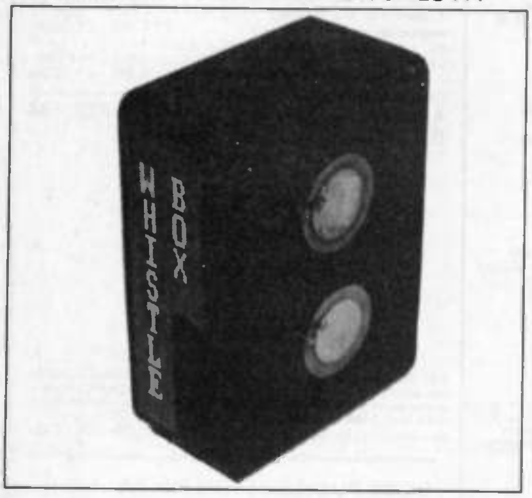
INCORPORATING ELECTRONICS MONTHLY

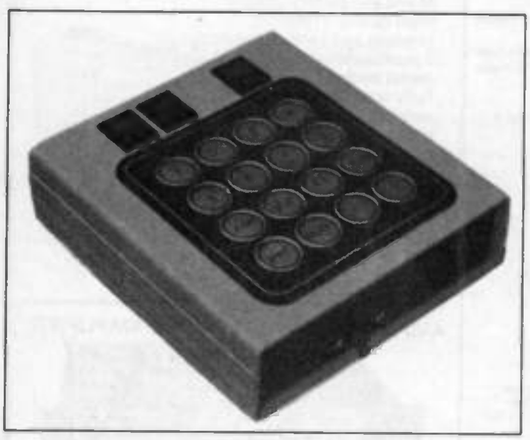
ABC

The No 1 Magazine for Electronic & Computer Projects

ISBN 0262 3617

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





Our December '90 issue will be published on Friday, 2 November 1990. See page 699 for details.

Projects

Series

Features

FREE WITH THIS ISSUE

Greenweld Electronic Components 1991 catalogue, banded to all copies.

RTVC HAVE DONE IT AGAIN!

We have secured all stocks of nearly new factory refurbished car stereos, manufacturer approved, at unrepeatable prices. We also offer a 6 month guarantee with all units (this only applies to products marked ★ on this page.)

Alba digital auto reverse push button AM/FM / LW car stereo with separate bass/treble control APPSS on tape. 25 watts per channel output, with line output for car components use.

★£79.40 + £2.30 pp

Sparkomatic Phoenix Digital auto reverse AM/FM/LW car stereo, with tape volume and balance control. 9 watts output per channel

★£52.40 + £2.80 pp

Sparkomatic Auto reverse AM/FM car stereo with tone, volume and balance control

★£44.20 + £2.80 pp

IN-CAR STEREO BOOSTERS

In-Car Stereo Hi-power booster ampifiers. 300W output. 150W x 2 inputs for low power car stereos and phono inputs short circuit protection

£94.95 + £2 pp

150W output 75 x 2 inputs as above

£46.00 + £2.00 pp

IN CAR WOOFERS

6½" 40W Nominal, 60W Max, 4 ohm Goodmans woofer. **£9.95** + £1.90 pp

8" 60W Nom. 90W Max, 4-5 ohm Richard Allen woofer **£33.80** + £3.50 pp

10" 100W Nom. 150W Max 4-5, ohm Richard Allen woofer **£41.50** + £3.50 pp

12" 100W Nom. 250W Max, 4-5 ohm Richard Allen woofer **£43.50** + £4 pp

15" 100W Nom. 250W Max, 4-5 ohm Richard Allen woofer **£79.35** + £5 pp

TWEETERS AND MID RANGE FOR IN-CAR USE

4½" 100W 4-5 ohm sealed back mid range. Goodman **£5.50** + £1.50 pp

2¼" 65W 4-5 ohm Ferro fluid cooled dome tweeter with housing. Audax **£5.00** + £1.20 pp

3½" 100W 8 ohm Ferro fluid cooled dome tweeter for 4-8 ohm use **£8.95** + £1.20 pp

ACOUSTIC REAR PARCEL SHELF

To get the best sound from your car woofers, replace your rear hatchback parcel shelf with one of these 14mm thick fibreboard units, tailor made for your car, supplied with grille cloth and fixings. When ordering please state make, model, and year of reg. **£39.80** + £6 pp

30 + 30 WATT GRAPHIC EQUALISER BOOSTER AMPLIFIER

Improve the sound and output of your low power car stereo unit with this 60 watt graphic equaliser booster. It has 10 slider controls so can accurately select the tonal quality of the music and a fader control to adjust the front to back volume; LCD power display and stereo headphone jack

£24.20 + £3 pp

MAIL ORDER £1 BARGAIN PACKS BUY 20 GET 1 FREE

Please state pack(s) required

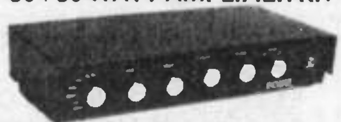
No.	Qty. per pack	
BP015B	1	30W dome tweeter. Size 90x66mil *JAPAN made*
BP017	3	33000µf 16V d.c. electrolytic high quality computer grade *UK made*
BP019	20	20 ceramic trimmers
BP020	4	Tuning capacitors, 2 gang dielectric a.m. type
BP021	10	3 position, 8 tag slide switch 3 amp rated 125V a.c. *made 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
BPu29	6	Stereo rotary potentiometers
BP030	2	10k wire wound double precision potentiometers *UK made*
BP031	6	Single 100k multitum pots, ideal for varicap tuners *UK made by PHILIPS*
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*
BP033A	4	6"x⅜" High grade Ferrite rod. *UK made*
BP034	3	AM IF modules with diagram *PHILIPS UK made*
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
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*
BP045A	2	Mono Cassette Record and play heads
BP046A	2	606 Mains transformers, PCB mounting. Size 42x33x35
BP047	1	24V 0.3VA mains power supply. Brand new boxed *UK made by MULLARD*
BP047A	1	25V DC 150mA mains adaptor in black plastic case with flying input and output leads new units made for famous sound mixer manufacturer. Size 80x55x47
BP049	10	OC44 transistors. Remove paint from top and it becomes a photo-electric cell (ORP 12) *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 (red)
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"x2¾"
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 chassis socket

VIDEO SENDERS NOW IN STOCK

Transmit your video signal into the next room

£18.95 + £1.50 pp

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.

- 30Wx2 (DIN 4 ohm)
- CD/Aux, tape I, tape II, tuner and phono inputs.
- Separate treble and bass
- Headphone jack

Size (H.W.D.) 75x400x195mm

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.

RADIO AND TV COMPONENTS ACTON LTD
21 HIGH STREET, ACTON, LONDON W3 6NG

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 Overseas readers write for quote on delivery
Phone 071 723 8432 or 081 992 8430
Callers 323 Edgware Road, London W2 Closed Sun
21 High St. Acton, London W3, closed Sun, Mon Tues & Wed

HIFI WOOFERS

10" round 100 watt Goodmans Hifi woofer 2" coil, paper cone, foam rubber surround 4½" magnet, frame size 10⅞" imp 8Ω **£17.50** + £2.80 pp

8" round 100 watt Audax Hifi woofer, 1" coil with fitted fuse plug, Hiteck TPX polimar core with rubber surround 4¾" magnet, die cast chassis, size 9¼" 8Ω imp **£34.90** + £4 pp

8" square 80 watt Audax Hifi woofer, 1¼" coil, polypropylene cone, rubber surround, 3¼" magnet, chassis size 8⅜" square 8Ω imp **£19.70** + £2.50 pp

8" round 70 watt Peerless Hifi woofer 1" coil, treated paper cone, foam rubber surround, 3¼" magnet, 8Ω imp **£12.50** + £2.50 pp

5¼" 45 watt Audax Hifi woofer 1" coil, Bextrene treated cone, rubber surround, 4" magnet, 8Ω imp **£9.80** + £3 pp

5¼" 35 watt Goodmans Hifi woofer, 1" coil, treated paper cone, rubber surround, 3½" magnet, 8Ω imp **£7.20** + £2.50 pp

4½" square 35 watt Audax Hifi woofer, 1in coil, paper cone, rolled surround, 2¾" magnet, 8Ω imp **£7.50** + £2.50 pp

HIFI TWEETER AND MID RANGE

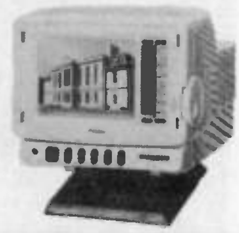
4⅜" square 100 watt Goodmans sealed back mid range, 1" coil, treated paper cone, 2⅞" magnet, 8Ω imp **£5.50** + £2.50 pp

4" square 75 watt Audax sealed back mid range ¾" coil treated paper cone, Ferrofluid cooled coil, chassis size 3⅞" 8Ω imp **£7.95** + £1 pp

4" round 130 watt Peerless 1" metal dome Hifi tweeter, 1" coil, 2¾" magnet, rec crossover freq 3KHz **£15.90** + £1.60 pp

4¼" x 2¼" 75 watt ¾" direct drive dome tweeter, Ferrofluid cooled ¾" voice coil rec crossover, freq 4.5KHz as above but with 3⅝" face plate **£6.90** + £1.30 pp

4.5" ROSS MONO TV WITH AM/FM RADIO



4.5" Ross mono Television with AM/FM Radio for battery or mains use, supplied with mains adaptor/charger, 12v car plug with lead, earphone, stand and extension aerial socket battery component holds 8 x UM2 batt. Alkaline or NiCads (batts not included). Control volume, tone and tuning for radio and television **£49.95** + £4.10 pp

ROSS PUSH BUTTON RADIO

Mains and battery operated.
High quality VHF/FM,
Medium and Long Wave reception.
6 pushbutton selected preset stations
Fully retractable telescopic aerial.
Headphone/earphone jack socket.
Size 230H x 150W x 65D
Ref RE-5500
Brand new.
Listed price over £30.00

£14.95 + £2.80 pp

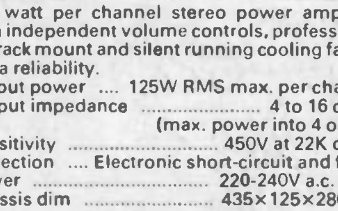
AMPHONIC 125+125 POWER AMPLIFIER

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 435x125x280mm

£142 + £7.00 p&p

GEMINI 2200 DISCO MIXER



This versatile little mixer has a high reputation with DJ's.
Its simplicity and quality sound reproduction makes it ideal for bedroom or high power gigs

Features: Fader control • 2 phono inputs • 1 monitor headphone circuit with high power output • Talk switch • VU meters

Specification: 5n ratio mic less than 1mv (745dB).

Phono: 0.4mV less than (755dB) • Talkover -12dB • Power AC220-240 at 3 watts • Size 10¼" x 8½" x 2½" • Weight 4½ lbs

£89.95 + £5 pp

NEXT MONTH

FREE INSIDE!

40 PAGE MAGENTA ELECTRONICS CATALOGUE

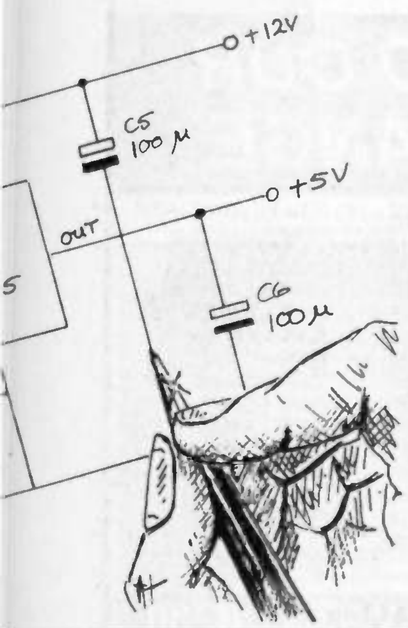
A unique range of kits and components for EE projects plus educational books, test gear, motors, microprocessors etc.

EIGHT CHANNEL LIGHT CONTROLLER

A microcomputer controlled multi-function sequencer with 99 sequences built in, plus nine user programmable sequences (each up to 16 steps). 1000W per channel load capability with full opto isolation and zero voltage switching. Keypad control of functions including manual, single step, speed, program select and program enter.

ELECTRONIC DIPSTICK

This Pocket Money Project will enable you to measure the depth of any aqueous liquid in a container. The depth of the liquid is indicated by means of 10 l.e.d.s arranged in bar display. it may therefore be used for remote sensing of liquid in, for example, the washer bottle of a car.



TEACH-IN '91

DESIGN YOUR OWN CIRCUITS

This ten part series not only aims to dispell some of the perceived mystery of electronic circuits but it also shows how even the relative newcomer to electronics can, with the right approach, design and realise quite complex circuits. Each part will incorporate a ***design problem*** *together with a complete* ***practical project****; each practical project will stand on its own. The series will employ an absolute minimum of mathematics, furthermore, the traditional analytical approach (based on circuit theorems) will largely be replaced by experiential learning.*

EVERYDAY ELECTRONICS

DECEMBER ISSUE ON SALE FRIDAY 2ND NOVEMBER 1990

MARCO TRADING

ELECTRONIC COMPONENTS & EQUIPMENT

MAIL ORDERS • WHOLESALE RETAIL

SEND ORDERS TO – DEPT 11

MARCO TRADING
THE MALTINGS, HIGH STREET, WEM
SHROPSHIRE SY4 5EN
Tel: (0939) 32763 Telex: 35565
Fax: (0939) 33800
ELECTRICAL & ELECTRONIC COMPONENT SUPPLIERS

24HR ANSAPHONE

LATEST 1991 132 Page CATALOGUE ONLY £1.50

NOVEMBER SPECIAL OFFER

CX2000 BATTERY CHARGER

CX2000 TECHNICAL DATA	
RECHARGES	QTY
Combinations of RX3, RX6, RX14, RX20	up to 8
RX22	1 to 3
CHARGING TIMES	HOURS
RX3, RX6, RX14, RX20, RX22	14-16

UNIROSS
HAWKER SIDDELEY

PRICE **£15.99**

POST PACKING £1.75
ALL PRICES INCLUDE 15% VAT

LOOK OUT FOR NEW SPECIAL OFFER *EVERY MONTH* WITH EVERYDAY ELECTRONICS

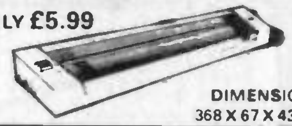
VISIT OUR OTHER BRANCHES

SUPERTRONICS
Tel: 021 666 6504
65 HURST STREET
BIRMINGHAM B5 4TE

WALTONS
Tel: 0902 22039
55A WORCESTER ST
WOLVERHAMPTON
WV2 4LL

12V TWIN FLUORESCENT LAMP 12" DOUBLE TUBES

ONLY £5.99



DIMENSIONS: 368 X 67 X 43MM

FM TRANSMITTER

Very High Quality "MINI-BUG" – Ideal for baby alarms ectil reception on any FM radio. Frequency 105-109MHz FM. power PP3 9V battery (not included). Dimensions 4.25" x 2.25" x 0.76". Code SO.004

£9.99

TDK CASSETTES

AD 90, used once. Bulk erased, good as new, fully guaranteed.

£7.50 for 10
£60.00 for 100

ANTEX IRONS

C-15W IRON	£8.37
CS-17W IRON	£8.48
XS-25W IRON	£8.59
XS-KIT 25W	£11.98
CS-KIT 17W	£11.87
C-KIT 15W	£11.98

ALL BITS FOR IRONS – £1.62
ELEMENTS £4.10 STANDS £3.24

NI-CAD RECHARGEABLE BATTERIES

	PRICE 1+	EACH 10+
AAA	£1.50	£1.30
AA	95p	85p
C	£1.95	£1.80
D	£2.00	£1.85
PP3	£3.90	£3.75

VIDEO HEAD TESTER

A video head tester for determining whether a video head is in good condition by detecting the wear state and displaying it on a meter. Complete with carrying case and leads.

SPECIAL PRICE £39.50

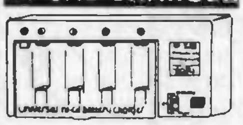
MARCO KITS

Ceramic 50V (125)	£3.99
Electrolytics Red (100)	£8.50
Fuse 20mm Q.B. (80)	£4.75
Fuse 20mm A.S. (80)	£8.50
Preset Pots Horiz (120)	£7.75
Preset Pots Vert (120)	£7.75

RESISTORS

0.25W Popular (1000)	£6.99
0.25W 5 off (305)	£3.75
0.25W 10 off (610)	£5.10
0.5W Popular (1000)	£10.75
0.5W 5 off (365)	£5.40
0.5W 10 off (730)	£8.75
1W 5 off (365)	£15.25
2W 5 off (365)	£25.00
Zener Diodes 5 off (55)	£3.99

NI-CAD CHARGER



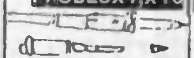
Charges AA, AAA, C, D & PP3 Ni-Cads 240V AC

£4.99

QUARTZ HALOGEN SPOT LIGHT

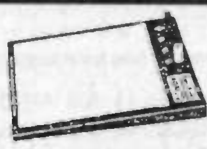
£5.75

PROBES X1, X10



Useful set of X1 and X10 probes. One unit which is switchable.BNC connectors. Price £14.95

SOLDERLESS BREADBOARD

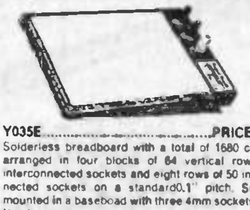


Y035G

PRICE £19.99

Solderless breadboad with a total of 2420 contacts arranged in six blocks of 64 rows of 5 interconnected sockets and ten rows of 50 interconnected sockets on a standard 0.1" pitch. Supplied mounted on a baseboad with four 4mm sockets.

No of contacts	2420
Contact material	Silver plated nickel silver
Dims	243 x 195 x 20mm



Y035E ...PRICE 13.95

Solderless breadboard with a total of 1680 contacts arranged in four blocks of 64 vertical rows of 5 interconnected sockets and eight rows of 50 interconnected sockets on a standard0.1" pitch. Supplied mounted in a baseboad with three 4mm sockets.

No of contacts	1680
Contact material	Silver plated nickel silver
Dims	224 x 150 x 20mm

22SWG RESIN SOLDER

500gm. REEL.	1+	10+
	£4.99	£4.75

ALSO 18SWG at £4.95 500gm

Orders of 5 or more reels please add a further 75p P&P

HOME ALARM PACKAGE

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

ONLY £127.50

BACK-UP LEAD ACID BATTERY 12V 1.9Ah **£14.00**

LEAD ACID CHARGER **£19.99**

CLOSED CIRCUIT TELEVISION SYSTEM

Complete price £175 PLUS £10 CARR

EIGHTWAY SPLITTER

8-way splitter amplifier to supply 8 TV's from one antenna. White plastic box with aluminium panel. On/off switch with neon

Band width	40MHz-860MH
Gain	3dB per channel. Total 21dB
Impedance	75Ω
Max. output	80mV (38dBmV) signal/cross modulation = 6dB
Noise	6dB
Isolation between outputs	40dB min
Power	240Vac 50Hz
Dims	250 x 100 x 60mm

£29.99

BRS TURNTABLE

These need no introduction, brand new, complete with cartridge and stylus. Also, complete with turntable belt. 12V 0.06A motor fitted. Simply construct your own plinth. Absolute bargain.

ORDER CODE/ SO/BSR

ONLY £9.99

DESOLDERING PUMP

£3.50

STAR BUY

ORDER CODE TOOL/DESOL

RED LED'S 5MM

SPECIAL LIMITED OFFER
100 PACK £4.00
1000 PACK £25.00

DRILL PRESS

5-speed single phase ¼hp motor drives 13mm chuck bolt

£99

SWITCH MODE P.S.U. SPECIAL

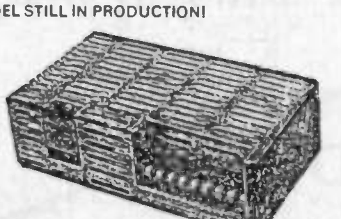
WEIR – HIGH PERFORMANCE SWITCHED MODE POWER SUPPLY TYPE: HSS 100/11

Probably the highest quality switched mode power supply on the market!
The unit is operable on 110V or 240V a.c. and capable of 100W output if convection cooled or 150W with forced air cooling. (Minimum air-flow rate 20CFM). Overvoltage protection is provided on output 1 by a latch circuit. Full spec. sheets available upon request.

WEIR MODEL: HSS 100/11

REMEMBER ALL BRAND NEW. THIS MODEL STILL IN PRODUCTION!

* *Input* 110-240V a.c. 50-60Hz
* *Output* 1 +5V at 12A
* 2 –12V at 1.3A
* 3 +12V at 3.5A
* 150 Watt Max (forced air cooled)
* *Size* 214 x 117 x 60mm
* *Weight* 1.2Kg
* BT Approved
* Fully enclosed with mains terminal shroud.



Normal list price is £121.00 each!!!

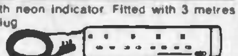
ORDER CODE: SO/WEIR

PRICE **£35.00** (HURRY, HURRY, only a few hundred available)

4-WAY – WITH LEAD & PLUG

4-Way 13 amp socket, fused with neon indicator. Fitted with 3 metres cable terminating in 13A fused plug

Price White £6.75 each



OSCILLOSCOPES

TEKTRONIX 2215. Dual Trace 50MHz, Delay Sweep with manual. New Probes. Limited quantity
£500 Inc. VAT (Carriage £15)

TELEQUIPMENT D755 OSCILLOSCOPE Dual Trace, 50MHz Delay Sweep, Secondhand – Excellent Value – Solid State Full Manuals Supplied.
£300 Inc. VAT (Carriage £15)

ALSO OTHER SCOPES IN STOCK. PLEASE RING

PHILIPS (PM326) SCOPE (Secondhand) 100 Meg Dual Beam Delay Time Base
£950 (Carriage £15)

HARTLEY SCOPE (Used) (CT436) Dual Beam with Manual
£50 (Carriage £15)

AVO 8 METER Complete with Carrying Case and Leads (Used)
£49 (Carriage £3.50)

Hobbykit Electronics

JUST A SMALL SELECTION FROM OUR RANGE OF OVER 120 KITS

Kit No	Description	Price £ (ea)
1001	0.2 WATT FM TRANSMITTER	4.16
1004	LIGHT SWITCH	5.83
1006	800 WATT MUSIC-TO-LIGHT	4.99
1009	1 WATT FM TRANSMITTER	5.42
1011	MOTORBIKE ALARM	8.33
1013	AM-FM-VHF RECEIVER	13.33
1014	3x700 WATT WIRELESS MUSIC-TO-LIGHT	10.82
1018	GUITAR TREMELO	7.08
1020	0-5 MINUTE TIMER	5.42
1022	METAL DETECTOR	4.16
1026	RUNNING LIGHTS	8.33
1028	4 WATT FM TRANSMITTER	14.16
1029	4 SOUNDS ELECTRONIC SIREN	4.99
1030	LIGHT DIMMER	4.59
1034	CAR BATTERY CHECKER	2.92
1036	TRANSISTOR TESTER	3.75
1037	DISCO STROBE LIGHT	11.25
1038	AM-FM AERIAL AMPLIFIER	2.92
1044	GRAPHIC EQUALIZER	12.91
1045	SOUND EFFECT GENERATOR	6.66
1047	SOUND SWITCH	9.58
1049	ULTRASONIC RADAR	14.98
1055	FM RECEIVER USING TDA7000	12.49
1059	TELEPHONE AMPLIFIER	8.33
1065	INVERTER 12V D.C. TO 220V A.C.	20.82
1069	12V D.C. FLUORESCENT TUBE UNIT	5.42
1073	VOX	6.24
1074	DRILL SPEED CONTROLLER	4.99
1075	ELECTRONIC DICE WITH L.E.D.'s	6.66
1084	TV LINE AMPLIFIER	3.34
1091	GUITAR PRE-AMPLIFIER	7.50
1098	DIGITAL THERMOMETER WITH L.C.D. DISPLAY	20.82
1111	LOGIC PROBE	3.75
1114	ELECTRONIC LOCK	7.50
1117	TV PATTERN GENERATOR	9.17
1119	TELEPHONE LINE RECORDING	4.16
1122	TELEPHONE CALL RELAY	6.66
1124	ELECTRONIC BELL	4.99
1125	ELECTRONIC LOCK	6.66
1129	NEGATIVE ION GENERATOR	14.16
1130	TELEPHONE "BUG" DETECTOR	3.34
1133	STEREO SOUND-TO-LIGHT	9.52
1203	MINI FM TRANSMITTER WITH MIC. (SUPPLIED READY ASSEMBLED)	4.16

All kits contain a Silk-Screened high quality p.c.b., components, solder, wire and FULL instruction sheet.

Plastic boxes with silk screened front panels are available for some of the kits. Full details are given in our catalogue.

DIGITAL LCD METER

Major features include:

- ★ Up to 20A AC and DC
- ★ DC volts up to 1000V
- ★ AC volts up to 700V
- ★ HFE and Diode Testing
- ★ 3½ digit LCD display
- ★ 30 position rotary switch
- ★ Push button ON/OFF switch
- ★ Complete with leads, battery

M-3800 Digital Multimeter
Price £32.20

ECONOMY MULTIMETER

- ★ Up to 10A DC
- ★ Diode Testing
- ★ DC 200V/AC 500V
- ★ Leads and Battery

EC-METER £14.38

LOGIC PROBE

- ★ Use on TTL or CMOS
- ★ Detect pulses of 25nS
- ★ LED Indicators
- ★ 2 Tone sounder

LO-PROBE £9.14

Economy Side Cutters......£2.13
Economy Top Cutters......£2.13
Economy Pliers......£2.13
Light Duty Cutters......£1.61
Automatic Wire Striper......£3.34
Mains Soldering Iron 17W......£6.84
De-Soldering Pump......£2.88
De-Soldering Braid......£0.58
6 Piece Screwdriver Set......£5.69
7 Piece Screwdriver Set......£6.33
8 Piece Screwdriver Set......£7.76
PVC Tape (Assorted Pack of 5)......£1.04
Large Snap-Off Blade Knife......£0.58
Small Snap-Off Blade Knife......0.40
Pack Large & Small Knife......£0.83
Tweezer Set (Set of 4)......£3.80
Heavy Duty Side Cutters......£2.60
Heavy Duty Long Nose Pliers......£2.60
Heavy Duty Bent Nose Pliers......£2.60
Butane Gas Pencil Torch......£5.00
Crimping Tool......£1.84

Insulated Crimp Terminals: (Pack of 20)

Ring	Red	£0.62
	Blue	£0.68
Spade	Red	£0.62
	Blue	£0.68
Push-on Male	Red	£0.62
	Blue	£0.68
Push-on Female	Red	£0.62
	Blue	£0.68
Butt Connector	Red	£0.62
	Blue	£0.68

★★ JUST ARRIVED ★★

Twin 360K 5.25" Floppy Disc Drive complete with Power Supply. Enclosed in a professional white case complete with mains lead. Connections are via a 37 Pin "D" Socket. Full connection details supplied.
TWIN FDD + PSU £68.95

For comprehensive details of all our tools, test equipment and electronic components please see our catalogue. Please follow the information given below.

★ ALL PRICES INCLUDE VAT ★

UK Orders:
Add £2.00 carriage

Europe & Eire:
Deduct 15% VAT (divide price by 1.15)
Add £5.00 carriage.

Outside Europe
Deduct 15% VAT (divide price by 1.15)
Add £10.00 carriage.

Hobbykit Ltd.

CREDIT CARD HOTLINE
☎081-205 7485
VISA

UNIT 19
CAPITOL INDUSTRIAL PARK
CAPITOL WAY
LONDON NW9 0EQ
FAX NO: 081-205 0603

For a comprehensive Kit Catalogue plus our new Tools, Test Equipment and Component Catalogue please send an A4 envelope stamped:
UK: £0.45
Europe & Eire: £1.00
Outside Europe: £2.75

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. Laakage resistance of up to 100 Megohms can be read easily. One of our own designs and extremely popular.

KIT REF 444

£21.89

PET SCARER

EE MAY 89

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

KIT REF 812

Mains Adaptor £1.98

£14.49

DIGITAL CAPACITANCE METER

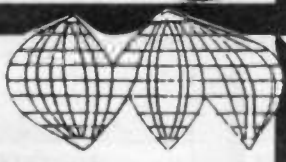
EE DEC 85

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

KIT REF 493

£46.46

3 BAND SHORT WAVE RADIO



EE AUG 87

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

KIT REF 718

£29.66

DIGITAL FREQUENCY 200 MHz METER

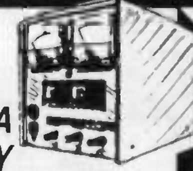
EE NOV 86

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

KIT REF 563

£69.95

MOSFET VARIABLE BENCH 25V 2.5A POWER SUPPLY



EE FEB 88

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

KIT REF 769

£55.61

MINI STROBE

EE MAY '86

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

KIT REF 529

£15.50

ACOUSTIC PROBE

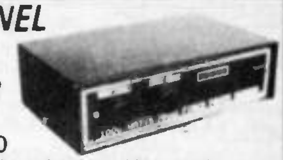
EE NOV '87

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

KIT REF 740

£19.58

4 CHANNEL LIGHT CHASER



EE Jan '90

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

KIT REF 833

£31.45

EE EQUALISER

EE MAY '87

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

KIT REF 707

£17.37

MUSICAL DOORBELL

EE JAN '86

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

KIT REF 497

£20.95

EPROM ERASER

EE OCT '88

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

KIT REF 790

£27.90

LIGHT RIDERS

EE OCT '86

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

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

EE TREASURE HUNTER

EE AUG '89

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

KIT REF 815 £41.95

Headphones £1.99

STEPPING MOTOR INTERFACE

EE AUG '85

This interface enables 4 phase unipolar 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

£9.40

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

The No.1 Magazine for Electronic & Computer Projects

VOL. 19 No. 11 November '90

Editorial Offices:
EVERYDAY ELECTRONICS EDITORIAL,
6 CHURCH STREET, WIMBORNE,
DORSET BH21 1JH
Phone: Wimborne (0202) 881749
Fax: (0202) 841692. DX: Wimborne 45314.
See notes on **Readers' Enquiries** below – we regret that lengthy technical enquiries cannot be answered over the telephone.

Advertisement Offices:
EVERYDAY ELECTRONICS ADVERTISEMENTS,
HOLLAND WOOD HOUSE, CHURCH LANE,
GREAT HOLLAND, ESSEX CO13 0JS.
Phone (0255) 850596

INTERFACE

A couple of months ago we asked you to interface with us on the subject of the possible demise of our *On Spec* and *BBC Micro* pages. Well response has not been overwhelming but it does indicate the wide variety of computers that readers are interested in. In view of the response we have decided that both of these features will come to an end (*On Spec* actually stopped last month) and they well be replaced by a new regular feature entitled *Interface* (what else!)

Interface will deal with interfacing ideas and problems, add on circuits and just about any technical computing subject any reader cares to throw at us – provided it is interesting and for a reasonably popular computer. In short we are widening the coverage of computers and readers with Ataris, Amigas, Amstrads, Commodores and IBM compatibles will now be up there with the Spectrum and Beeb owners with something, hopefully, for everyone over a period of time.

If you care to read the last part of this month's *BBC Micro* article (read it all if you wish!) you will find a better explanation of all this by Robert Penfold, who will be writing *Interface* for us. So, if you have any ideas or wants which could fit into *Interface*, why not drop Robert a line via this office. We cannot guarantee to produce something for every need but ideas and comments are always welcome.

GCSE PROJECTS

If you are about to undertake a GCSE project for next year's technology examination then do not miss our new series – starting in the January '91 issue – *Project Development for GCSE Technology*. This short series which is designed to help teachers and students to devise, design and develop electronics projects, has been written by a GCSE assessor specially for EE and is based on his experience of the common pitfalls and problems encountered by students. The timing of the articles has been programmed to fit in with the development of projects in the school year.

By the way, our new book *Teach-In No.4* – now available from your newsagent – also covers a vast amount of information which would be of value to all beginners and to any technology students. At just £2.95 for 112 A4 pages it is also excellent value for money.

SUBSCRIPTIONS

Annual subscriptions for delivery direct to any address in the UK: £17.00. Overseas: £21.00 (£39 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 £1.70 (£2.20 overseas surface mail) – **£ sterling only please** – inclusive of postage and packing per copy. Enquiries with remittance, made payable to Everyday Electronics, should be sent to Post Sales Department, Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH. In the event of non-availability one article can be photostatted for the same price. *Normally sent within seven days but please allow 28 days for delivery.* **We have sold out of Sept., Oct. & Dec. 85, April, May, Oct. & Dec. 86, Jan., April, May & Nov. 87, Jan., March, April, June & Oct. 88, & March 90.**

BINDERS

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

Editor: MIKE KENWARD

Secretary: PAMELA BROWN

Deputy Editor: DAVID BARRINGTON

Business Manager: DAVID J. LEAVER

Editorial: WIMBORNE (0202) 881749

Advertisement Manager:
PETER J. MEW, Frinton (0255) 850596

Classified Advertisements:
Wimborne (0202) 881749

READERS' ENQUIRIES

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

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

COMPONENT SUPPLIES

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

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

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

ADVERTISEMENTS

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

The Publishers regret that under no circumstances will the magazine accept liability for non-receipt of goods ordered, or for late delivery, or for faults in manufacture. Legal remedies are available in respect of some of these circumstances, and readers who have complaints should first address them to the advertiser.

TRANSMITTER/BUGS/TELEPHONE EQUIPMENT

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

Constructional Project

EE MUSKETEER

CHRIS WALKER

A complete home entertainment controller in one handheld unit. Will replace up to four separate controllers whilst retaining all the commands of the originals.

If you own a television set, video cassette recorder, midi hi-fi unit, graphic equaliser, satellite TV decoder or even if you have constructed the author's *Mains Appliance Remote Control System* (EE June – September '90) then chances are that you also possess at least one infra-red remote control handset designed to make operation of these types of appliances as convenient as possible.

The problem is that as you buy more appliances you also acquire an arsenal of these handsets, all of which should be readily available for use on the armchair if they are to fulfil their intended function. Some manufacturers have created systems which control TV/Teletext and video from a single handset but you are restricted to purchasing the dedicated TV/Video combination.

What would you say to a single device which could replace up to *four* separate controllers whilst retaining all the commands of each one? Read on.

IMPERSONATION

The early attempts at TV remote control resulted in the control box being linked to the main unit by a multi-cored trailing lead. Later "wire-less" versions used an ultrasonic link but, after realising that such ultra-sound drove the pet dog crazy, the designers of most current handsets now make use of the high efficiency infra-red emitters and receivers commonly available these days.

Now, what the EE Musketeer "Infra Red Remote Control Emulator" can do is to record the infra-red (IR) output from different handsets and assign each function to a different button. In fact, it can record 64 different functions spread over four images of a 16-button keyboard. Later, on command, it will play back the appropriate IR pattern and fool the appliance (TV, video, or whatever) into thinking that is receiving signals from its own handset.

In other words, this device mimics or *emulates* IR handsets in rather the same way that a TV impersonator mimics famous people; if he is good enough you *may* believe that you are actually looking at and listening to the real star!

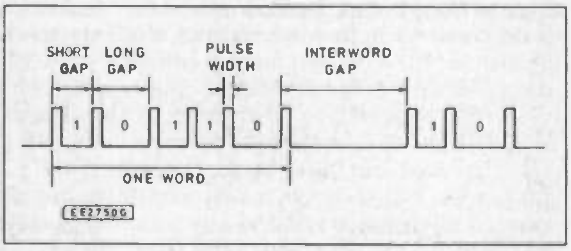
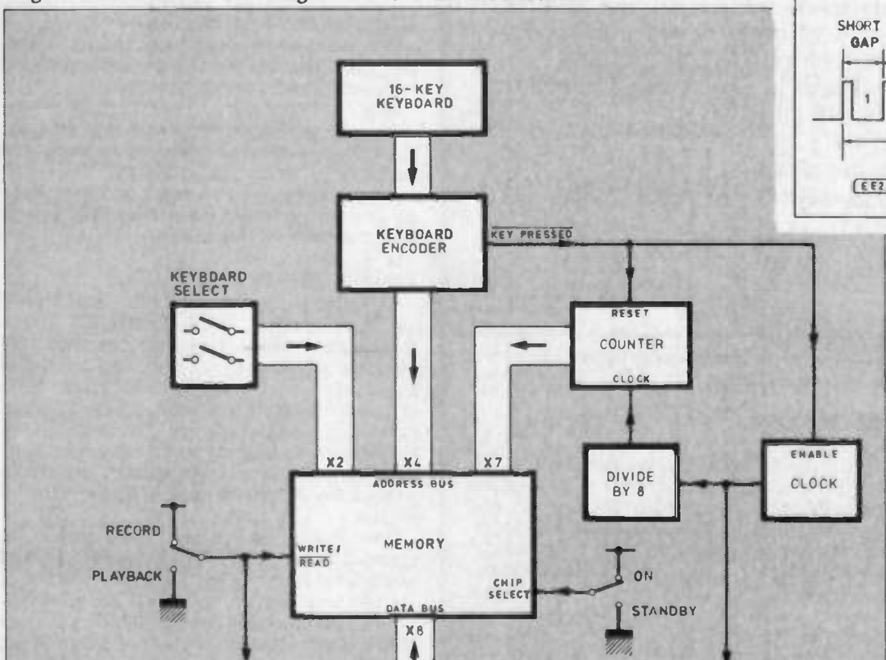


Fig. 1. Pulse position modulation (p.p.m.) word format.

Fig. 2. Schematic block diagram for the EE Musketeer.



WORD FORMAT

When a button on an infra-red transmitter is pressed the encoder chip within the handset serially sends data words to the infra-red emitters. Each word consists of several pulses of 40kHz carrier frequency; this frequency originates from the days of the ultrasonic transducer which resonates at 40kHz but most IR handsets still make use of it.

The data is usually encoded by pulse position modulation (p.p.m.) where the time intervals between successive pulses are either "short" or "long" to represent a logic 1 or logic 0 in the transmitted word.

The form of a complete p.p.m. word is shown in Fig. 1.

The transmitter will usually output a continuous stream of data words as long as the button remains pressed and the receiver waits to receive at least two identical and consecutive words before responding so that the chance of receiving errors are greatly reduced. A few types of infra-red control send the data word only once with each press of the button but follow this with a regularly repeating "continuation pulse" whilst the button is held down. This allows the receiver to distinguish between a button which is repeatedly pressed and one which is pressed and held.

SAMPLING

In the record mode the EE Musketeer "looks" at the infra-red output from the original handset and, every 0.12 milliseconds, it samples and stores the state of the output, i.e. whether infra-red is present or not. The unit makes 1024 samples, synchronising the first sample with the start of IR transmission.

Thus the total sample time lasts $1024 \times 0.12 = 123$ms. Over this length of time it is possible to store two whole words from most of the commonly available handsets such as those outlined below.

When deciding on a sample rate it is important to sample faster than the highest expected frequency. This ensures that the shortest data pulses are not "missed" because they have come-and-gone between two successive sampling points.

During the research for this project a large number of TV, video and hi-fi infra-red handsets were investigated. These bore manufacturers names such as Ferguson, Rediffusion, JVC, Saisho and Sanyo. It should be fair to assume that they represent a valid cross-section from the majority of types available.

The pulse widths vary between 0.2ms and 0.6ms whilst the length of one data word lies between 15ms and 70ms with inter-word gaps in the region 10ms to 40ms. Thus, sampling once every 0.12ms is sufficient to catch the shortest pulse width.

One particular handset, sold under the Japanese name "Salora", had a very different data transmission rate with pulses of width 0.05ms and a word length of only 3ms. Sampling once every 0.12ms would be far too slow to record this bit pattern although it could be accommodated if the sampling rate was increased to at least once every 0.05ms, i.e. a frequency of 20kHz.

However, the entire sample time would now be reduced to $1024 \times 0.05 = 51$ms and this is too short to store the more common formats described above! Using the component values shown it is safe to say that the unit is compatible with *most* controllers but there are bound to be a few exceptions.

BLOCK DIAGRAM

Referring to the schematic block diagram of Fig. 2, let us consider how bit patterns are recorded in the EE Musketeer.

The Keyboard Encoder converts a key depression into a 4-bit binary code which forms part of the address bus of the memory. The remainder of the memory address is controlled by two "Keyboard Select" switches and a 7-bit binary counter.

The entire 13-bit address bus can access a total of $2^{13} = 8192$ memory locations, each one containing a unique byte of information which can be inserted or extracted from memory via a bi-directional 8-bit data bus. Thus a total of $8192 \times 8 = 65536$ bits can be stored.

A "Key Pressed" output from the Keyboard Encoder goes high upon a key selection and this enables the system clock, which proceeds to shift sampled infra-red data into a shift register (the clock frequency thus determines the sampling rate). After eight bits of data have been serially shifted in, the whole byte is loaded into the memory via the data bus and the 7-bit counter increments to the next address location, whilst the shift register proceeds to gather the next eight data bits and so on. This continues for the 128 possible output states of the counter after which a total of $128 \times 8 = 1024$ bits have been stored.

As the 7-bit counter strobes through the memory locations it can be seen that the remaining six bits of the address bus are held in a state determined by the actual key pressed and the position of the Keyboard Select switches. There are four combinations of these two select switches and it is thus possible to store in the memory four images of sixteen keys, each one containing a 1024 bit data pattern.

DATA RETRIEVAL

In the playback mode, data bytes are loaded from memory into a second shift register and each bit is serially shifted out by the system clock. The serial output (which is a copy of the original bit pattern from the infra-red handset) is fed to an oscillator where the 40kHz carrier frequency (removed when the bit pattern was sampled) is re-applied before transmission.

As long as a key is held down the counter cycles continuously and the recorded bit pattern is repeatedly transmitted. For some remote control functions this is useful, for example a "Volume Up" command, since the sound level will "crescendo" as long as the appropriate button is pressed.

For other functions repetition may be a nuisance. Holding down an ON/OFF key may cause the appliance to repeatedly toggle on and off. Unfortunately there is no simple way in this project of equipping some keys with a repeat function whilst keeping others as a "one-shot". Therefore all keys repeat and, in practice, this proves quite easy to manipulate.

DATA STORAGE

Several points have to be considered when deciding on the type of memory to use in this application. First of all, we require a memory capacity of 65536 bits stored as 8192 8-bit data bytes. There are several single chip memories which will fulfil this need, but they are available in a variety of breeds.

Random Access Memory (RAM) is very versatile since data can be written to the chip and updated or erased at any later time. They are volatile, however, meaning that an uninterrupted power supply to the chip is required if the stored data is not to be corrupted.

Also, RAM's are available as "static" or "dynamic" types. The former would be required in this design since dynamic memory requires its contents to be "refreshed" every few milliseconds.

An Erasable Programmable Read Only Memory (EPROM) might appear to be a better choice than a RAM since they are non-volatile and retain their data when the power supply is removed. In fact the only way to erase them is to expose the chip to ultra-violet light.

However, this erasure is total and wipes the *whole* memory clean, there is no way of selectively re-writing a small section. So, if a mistake is made during the recording of bit patterns one would have to wait for the whole chip to be erased (a process which takes about 20 minutes, assuming that you possess a UV light source) before re-programming again. Let us NOT use an EPROM!

The absolutely ideal contender is an Electrically Erasable Programmable Read Only Memory (EEPROM) or sometimes known as E^2PROM). These are non-volatile but data can be updated electrically just like a RAM. In fact, and EEPROM *would* have been used in this project but for the cost: a 64K chip costs about £25 compared with £5 for a RAM of the same storage capacity.

So, all points considered, it was decided to use a type 6264 static RAM with permanent battery backup to prevent loss of stored data.

POWER SOURCE

The complete circuit diagram for the EE Musketeer infra-red remote control emulator is shown in Fig. 3.

Six 1.5V cells, B1 to B6, supply 9V to voltage regulator IC11 via the On/Standby switch S17a. The other half of this switch (S17b) is connected to the "Chip Select" terminal of the RAM, pin 26 of IC6.

When in Standby mode, this terminal is tied down to 0V reducing the power consumption of the RAM to well under 20µA. Under these conditions the bottom three cells B1 to B3 maintain about 4.5V directly to the RAM power supply pin 28 via diode D12 and this is sufficient to retain the stored data indefinitely.

In normal power-up mode the voltage regulator provides 5V to the entire circuit. The RAM receives power through Schottky barrier diode D11 which has a lower forward voltage drop than an ordinary *p-n* silicon diode. This ensures that the power supply to the RAM stays within specified operating limits, i.e. between 4.5 and 5.5V.

Data will be lost of course when the batteries are changed but this should not be a regular act. In standby mode alkaline cells will supply the necessary 20µA for several years.

When switched ON the circuit consumes about 2.5mA, 2mA of which is gobbled by the voltage regulator. Manufacturers, please flood the market with low quiescent current consumption voltage regulators!

Integrated circuit IC1 is a keyboard encoder which scans 16-keys wired in a 4 × 4 matrix as shown in Fig. 4. This i.c. also consumes a relatively large battery current of about 0.4mA and it is for these two reasons that the unit should be switched to Standby when not in use, in order to preserve battery life.

The binary output from IC1 (pins 14 to 17) forms part of the address bus for IC6. Capacitors C1 and C2 set the keyboard scan rate and debounce period respectively. The "Key Pressed" output (pin 12) is inverted by gate IC10d to become $\overline{\text{Key Pressed}}$ and this is used to ensure that when a key is *not* pressed binary counter IC2 and divide-by-8 counter IC3 are reset and the clock generator IC4 is disabled.

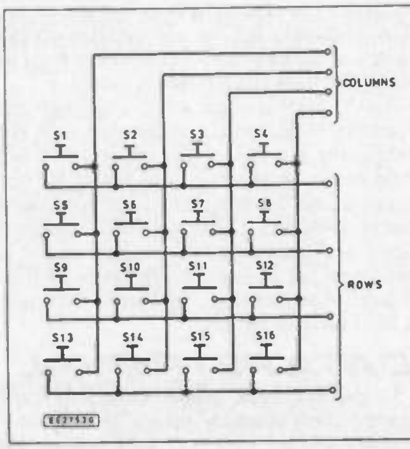


Fig. 4 (left). Circuit representation of the 4 × 4 matrix keyboard wiring.

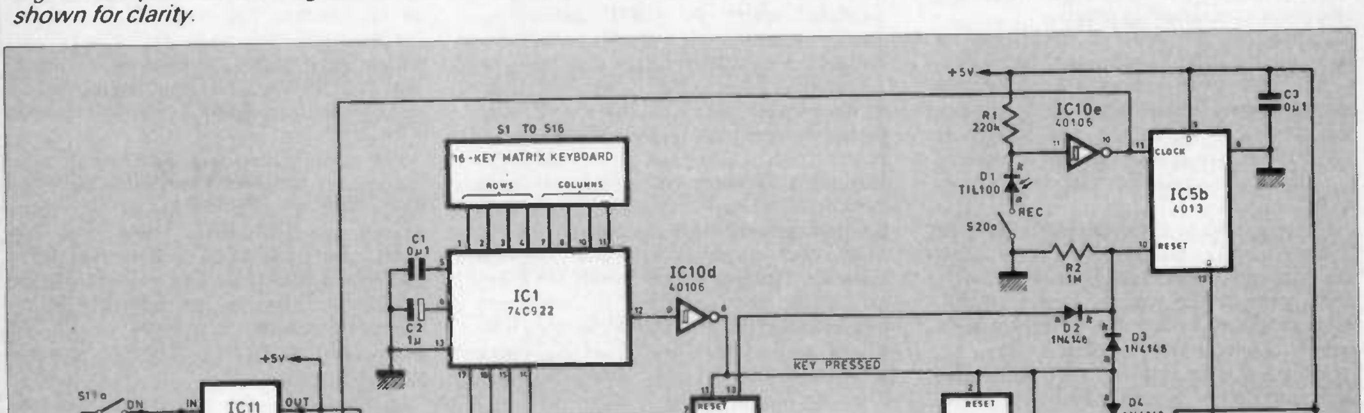
RECORDING PROCEDURE

Imagine that the Record switch S20 is closed and a keypad button is pressed and held. The $\overline{\text{Key Pressed}}$ line will, therefore, be at 0V.

The clock generator IC4 is enabled by either a logic 0 at pin 4 or a logic 1 at pin 5. Pin 4 is held high by the Record switch S20b and, initially, the output from latch IC5b pin 13 is low. Therefore, the clock is not running and the circuit is in a "primed" state.

The infra-red output from the handset whose bit-pattern is to be recorded is held near to the infra-red sensitive diode D1

Fig. 3. Complete circuit diagram for the EE Musketeer. With the exception of IC6, the power supply to each i.c. has not been shown for clarity.



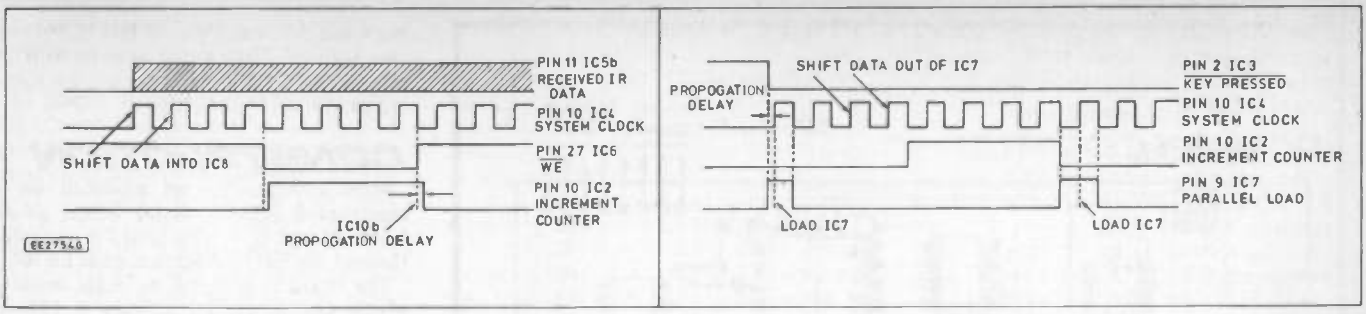


Fig. 5. (a) Timing diagram for the circuit in Record mode. (b) Playback mode timing diagram.

and the appropriate button on the handset is activated. The received signals are cleaned up by Schmitt trigger IC10e and immediately they trigger the latch IC5b.

The pin 13 output of this latch goes high and the system clock (IC4) starts to run. The clock output is available at pin 10 IC4. The timing diagram for the circuit in Record mode is displayed in Fig. 5a.

The received data from gate IC10e is also fed to the serial input (pin 2) of shift register IC8 and this data is shifted in on the rising edge of the clock which is fed in at pin 3. Incidentally, the combined capacitance of the IR sensor and the Schmitt trigger input together with resistor R1 act to filter out the received 40kHz carrier frequency. This is later added before re-transmission.

Divide-by-8 counter IC3 is triggered by the *falling edge* of the clock signal and on every eighth falling edge there is a high-to-low transition at the output pin 9 which increments the 7-bit binary counter IC2. The short but significant propogation delay introduced by gate IC10b ensures that the Write Enable pin 27 of the RAM is taken high *before* the counter outputs change. Therefore, the data byte which is present on the eight parallel outputs of shift register IC8 during the period of the eighth clock pulse is loaded into memory and *then* the memory address is incremented ready for the next byte.

After 128 counts from IC2 its pin 13 output goes high which resets the latch IC5b and stops the clock. This completes the loading procedure for one key on the emulator.

During the period whilst the latch output is high l.e.d. D6 is switched on to indicate that data is being sampled. In practice, the entire sampling time only lasts 123ms so D6 appears to flash once briefly upon receipt of data.

The clock frequency is set by capacitor C4 and resistor R4:

$$f = 1/(4.4 \times R4 \times C4)$$

For long term stability the capacitor is a silvered mica type and the resistor used is of metal film construction. The clock frequency may be changed as mentioned earlier to suit unusual handsets.

PLAYBACK

With the Record switch S20 open, the $\overline{\text{WE}}$ pin 27 of IC6 is held high via diode D8 whilst the $\overline{\text{OE}}$ pin 22 is taken low. Therefore, the RAM can output data onto the data bus. The IC8 data outputs are in a high impedance state since its Output Enable pin 15 is also low.

Pressing a keyboard button causes the Key Pressed line to go low which, in turn, allows pin 4 of IC4 to drop to 0V. This enables the system clock. Refer to Fig. 5b for the timing diagram of this part of the circuit.

Data is loaded from the RAM into the output shift register IC7 on the rising edge of the clock signal at pin 10 provided that pin 9 (Parallel Load) is at +V. To load the *initial* data byte the Parallel Load pulse is produced by the falling edge of $\overline{\text{Key Pressed}}$ at the instant a keypad selection is made.

This transition is passed in the form of a negative-going pulse via capacitor C6 to gate IC10c whose output is used to Set latch IC5a. The pin 1 output of this latch forms the Parallel Load pulse for IC7.

Pin 1 IC5a stays high whilst the rising edge of the clock loads data into IC7. The *next* falling edge of the clock resets Parallel Load to logic 0 and each following rising clock edge then shifts data out of IC7 from pin 3.

After eight clock cycles the shift register is then empty but the next Parallel Load pulse is generated by the output of gate IC10b, the falling edge of which increments the binary counter IC2. The clock runs freely and data is shifted out as long as a keyboard button is pressed.

The output from IC7 pin 3 is used to modulate the 40kHz oscillator formed by IC9 and associated components. The out-

COMPONENTS

See SHOP TALK Page

Resistors

R1	220k
R2, R3, R6, R7	1M (4 off)
R4	120k
R5	390
R8, R9, R10	10k (3 off)
R11	27k
R12	1k
R13	1Ω5

All 0.6W 1% metal film

Capacitors

C1, C3, C10	0µ1 polyester layer (3 off)
C2, C9	1µ tantalum 35V (2 off)
C4	220p silvered mica
C5, C6, C7	220p ceramic (3 off)
C8	22µ tantalum 16V
C11	220µ axial elect. 10V

Semiconductors

D1	TIL100 or sililar infra-red sensitive photodiode
D2 to D5	1N4148 signal diode (4 off)
D6	3mm l.e.d.
D7 to D10	1N4148 signal diode (4 off)
D11	BAR28 Schottky barrier diode
D12	1N4148 signal diode
D13, D14	TIL38 or similar high power infra-red emitting diode (2 off)
TR1	BC548 *npn* silicon
TR2	BC337 *npn* silicon
TR3	BD135 *npn* silicon
IC1	74C922 keyboard encoder
IC2	4040 12-stage counter
IC3	4024 7-stage counter
IC4, IC9	4047 multivibrator (2 off)
IC5	4013 dual D-type latch
IC6	6264 64k CMOS static RAM
IC7	4014 shift register
IC8	4094 shift register
IC10	40106 hex Schmitt trigger
IC11	78L05 +5V 100mA voltage regulator

Miscellaneous

S1 to S16	16-key matrix keypad (see text)
S17	d.p.d.t. rocker switch
S18, S19	s.p.d.t. rocker switch (2 off)
S20	d.p.d.t. slide switch

Printed circuit board available from *EE PCB Service*, code EE706; plastic case, 129mm × 134mm × 38mm or similar; battery boxes: 4 × AA and 2 × AA; AA size batteries (6 off); interconnecting wire etc.

Approx cost guidance only **£30**

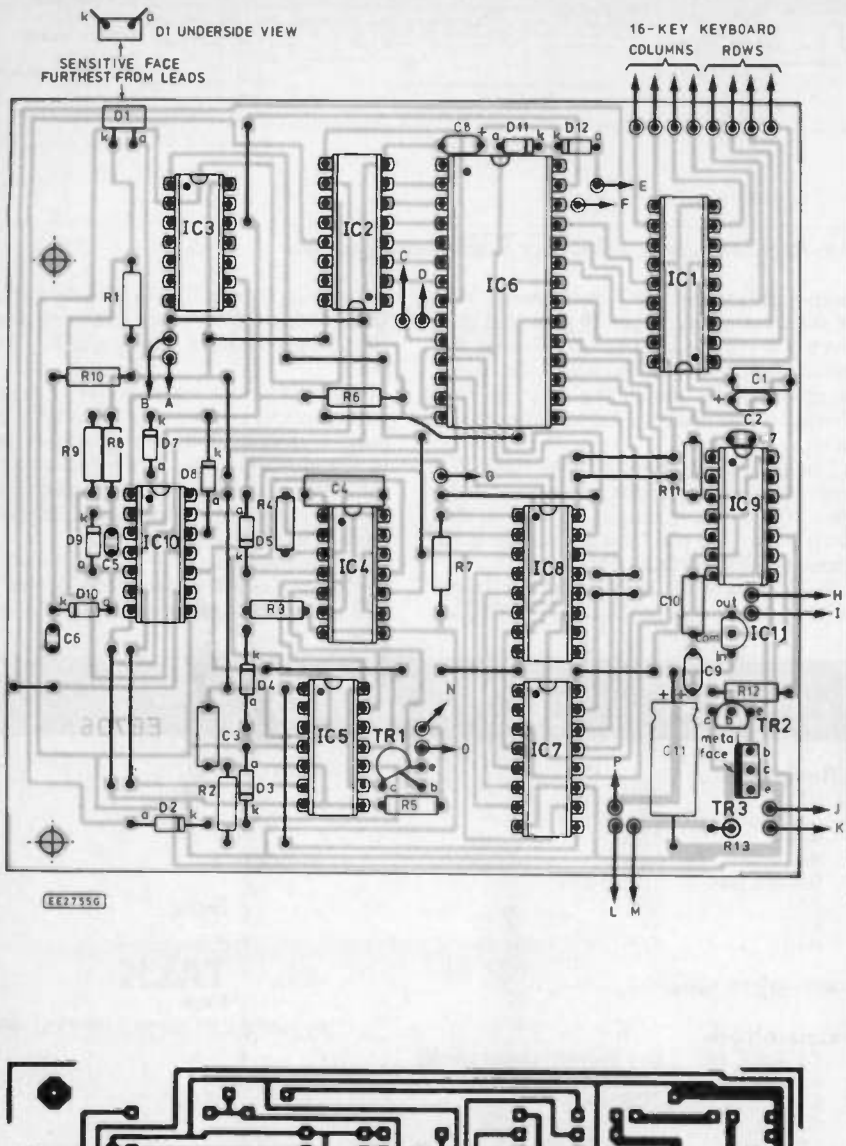


Fig. 6. Printed circuit board component layout and full size copper foil master patern. Refer to Fig. 4 for keypad wiring.

put from this stage, pin 10 IC9, feeds current into the Darlington pair formed by transistor TR2 and TR3 which drive infrared emitters D13 and D14.

CONSTRUCTION

Most components arc mounted on a single-sided printed circuit board as illustrated in Fig. 6. This board is available through the EE PCB Service, code EE706.

The board is designed to locate inside a plastic case measuring 129mm × 134mm × 38mm which just about qualifies as a handheld box. The infra red emitters are mounted in the front panel whilst the sensor diode D1, Record switch S20 and Data l.e.d. D6 go on the rear panel. Switches S17 to S19 are located on the top of the case.

The prototype uses a 16-key membrane keypad also mounted on the top panel. These type of keyboards are self-contained low-profile units which are convenient to use since they stick onto the *outside* of the case panel and eliminate the need to cut several tricky holes for sixteen discrete switches. They do tend to be expensive though, and there is no reason why constructors cannot cut costs and make their own keyboard using individual s.p.s.t. push button switches wired as described in Fig. 4.

Assembly of the printed circuit board is straightforward but the constructional sequence described below is recommended as it allows some intermediate tests to be made on the circuit before it is all completed.

The use of d.i.l. sockets is essential for the integrated circuits as several voltage checks will be made at the pins of empty sockets *before* the i.c's are inserted. Twenty wire links are required; use insulated wire for the longer links to prevent unwanted shorts. The extra work involved in making a double-sided p.c.b. was not thought to be worthwhile just to reduce this number of link wires.

Complete the p.c.b. assembly, taking care to correctly locate the Schottky diode D11. Also, check the orientation of all diodes and polarised capacitors.

After construction it is well worth inspecting the copper side of the board for inadvertent solder splashes across the closely packed tracks. Use a magnifying glass to be absolutely sure.

Use terminal pins for the flying lead connections and complete the off-board wiring according to Fig. 7 before starting any tests. The membrane keypad used in the prototype has a flexible plastic tail which connects to the board via an 8-way plug/socket arrangement. Connectors for these keypads vary; purchase one to suit your particular type, if required.

PROGRESSIVE TESTS

Testing of the completed EE Musketeer should be carried out in the following sequence, together with the controller to be replaced.

(1) Do not insert any of the d.i.l. integrated circuits at this stage. Insert the batteries but leave switch S17 in the OFF (or Standby) position. Don't forget the connection labelled "E" on Fig. 7 from the circuit board to the 4.5V tap on the battery box.

Using a voltmeter measure the potential difference between pins 14 and 28 of the RAM socket (IC6). The meter should read slightly under 4.5V.

Switch S17 ON and this voltage should rise to about 5V. Check for 5V at every other i.c. socket's power pins, remembering that IC1 and IC2 are "upside-down" relative to the other chips.

Now connect the negative lead of the voltmeter to 0V on the circuit and use the positive probe to check that the $\overline{OE}$ pin 22 of IC6 is high (+5V) only when Record switch S20 is closed.

Chip Select (pin 26 IC6) should be high when S17 is ON and low (0V) when in Standby mode. Address pins 9 and 10 should follow the Keyboard Select switches S18 and S19.

(2) Remove power to the board *(always do this before inserting or removing CMOS i.c's, which could be destroyed otherwise)* and insert IC1 (upside-down) and IC10. Switch on and check the Key Pressed line at pin 2 of IC3 (empty socket), this should go low only when a key is pressed.

(3) Insert IC4 and, if you have an oscilloscope or frequency counter, look at the clock signal at pin 3 IC8. This square wave should be present only when a key is pressed in Playback mode.

(4) Add IC3 and monitor the divide-by-8 clock signal at pin 10 IC2.

(5) Insert the D-latch IC5 and switch S20 to Record mode. Press and hold any keyboard switch and fire infra-red signals from the selected appliance handset at sensor diode D1.

There is no amplification of the received signal so you will need to hold the emitter close to D1. Also, shield the sensor from bright light which would swamp the infra-red data.

The l.e.d. diode D6 should light and stay on until the EE Musketeer key is released.

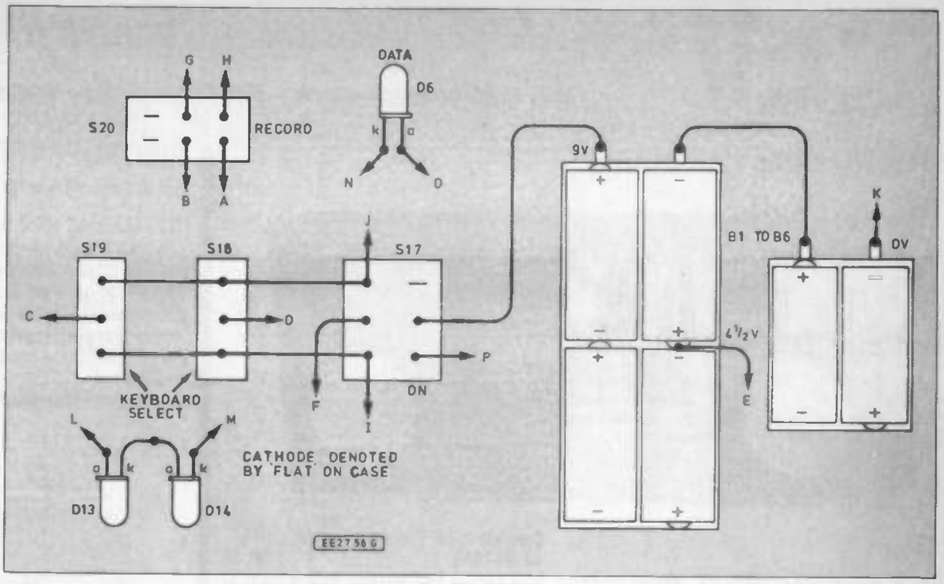


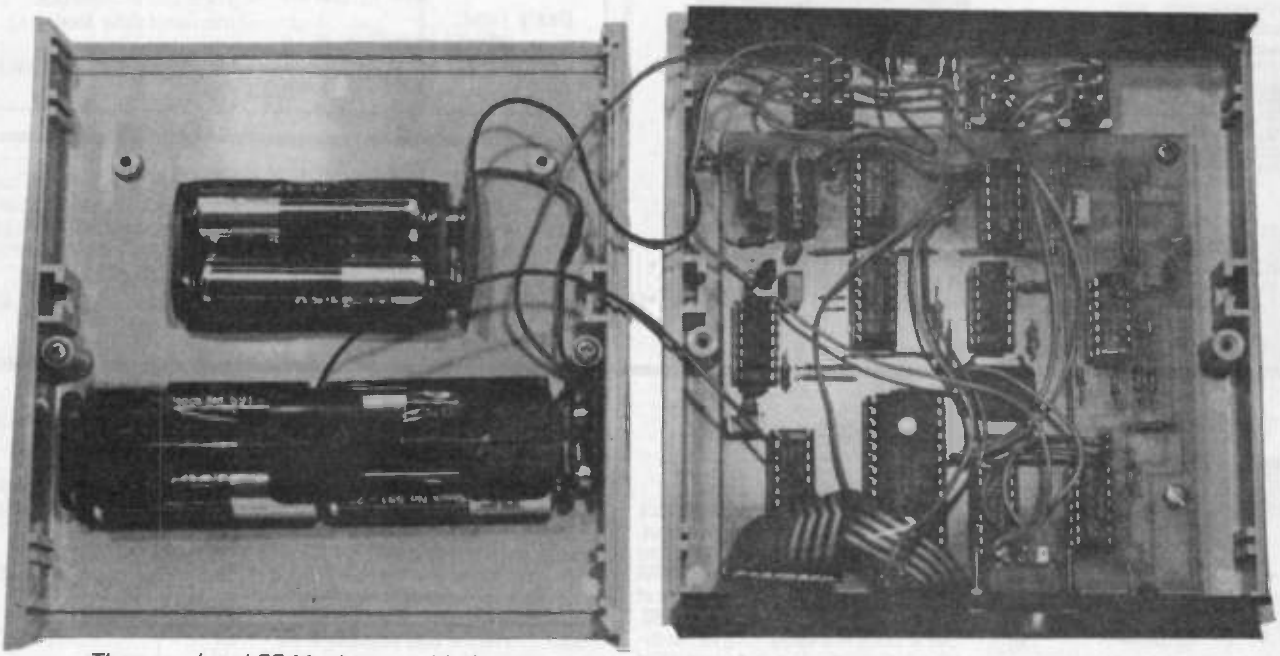
Fig. 7. Interwiring to the off-board components. The leads terminated with letters go to identical letters on the circuit board.

It is also possible to monitor the Parallel Load pulse on an oscilloscope connected to pin 9 IC7.

(6) Insert counter IC2 (upside-down) and repeat test 5. This time, because the counter resets latch IC5b after 128 counts, the l.e.d. should flash briefly only once upon receipt of infra-red data.

(7) Insert the remaining four i.c's and program some handset codes into the EE Musketeer. Remember, the programming sequence is as follows: switch S20 to Record; press and hold the appropriate key down and then fire the infra-red code, from the selected controller, at D1. The l.e.d. D6 indicates the acceptance of data. Finally, switch S20 to Playback and try controlling your appliance from the EE Musketeer.

It is recommended that you program even the *unused* keys on every keyboard image since a "proper" transmitter word has a very small mark-to-space ratio. The random data stored in an un-programmed key may have a substantially higher ratio which could damage the infra-red emitters (which are normally over-run for an increased range) if such keys are pressed down for a long period. □



The completed EE Musketeer with the case top removed to show the battery packs mounted in the base and the circuit board and switches mounted in the top. The "flexible" p.c.b. lead connects to the keyboard contacts.

(below) The "front" and "rear" faces of the controller showing the infra-red sensor/transmitter devices.

ELV

Technik für Kenner - Made in Germany

We deliver from stock - The fastest way to order is a fax !

ULTRASONIC CAR ALARM

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

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

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

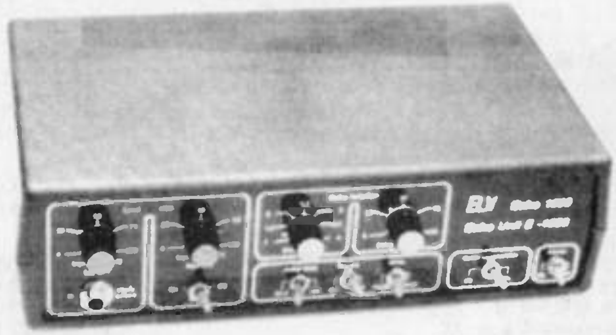
DIGITAL PROFESSIONAL ECHO 1000

(Elektor Electronics June 89)

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

Complete kit
44.255BKL .... £ 99.50

Ready assembled module
44.255F .... £ 134.50



Specification

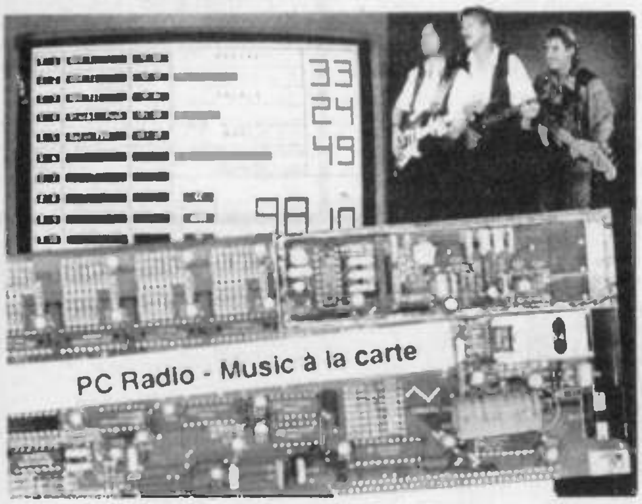
Input sensitivity:
Input 1 : 2 mV
Input 2 : 200 mV

Dealy Time:
variable from 60 ms to 1 s

Bandwidth :
100 Hz to 12 kHz

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

PC Radio (Elektor Electronics Febuary 1990)



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

Complete kit
44.544BKL .... £ 82.75

Ready assembled module
44.544F .... £ 137.30

VM 1000 Video-Modulator (Elektor Electronics March 90)

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

Complete kit
44.546BKL .... £ 36.90

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

RFK 7000 RGB-CVBS Converter

(Elektor Electronics October 89)

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

Complete kit
44.525BKL .... £ 66.50

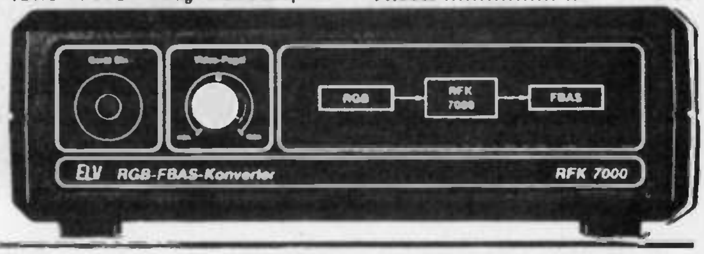
Ready assembled module
44.525F .... £ 119.50

FRK 7000 CVBS-RGB Converter

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

Complete kit
44.509BKL .... £ 66.50

Ready assembled module
44.509F .... £ 119.50



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

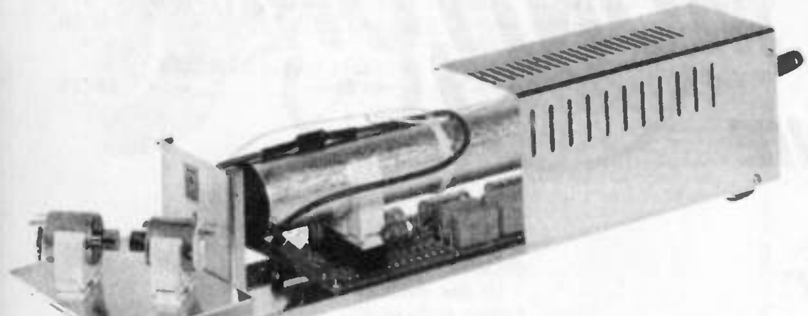
Technik für Kenner - Made in Germany

ELV

We deliver from stock - The fastest way to order is a fax !

LPS 8000 / LC 7000 Low Cost Show Laser

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



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

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

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

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

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

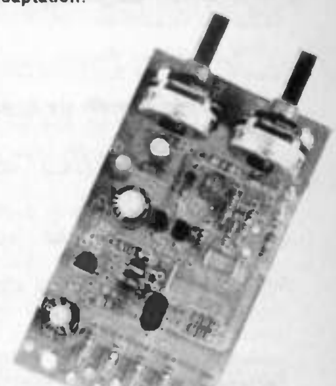
LC 7000 Laser Controller, ready assembled module
Version 12 Volts DC
44.427F..................... £ 104.30

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

VIDEO RECORDING AMPLIFIER

(Elektor Electronics April 89)

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

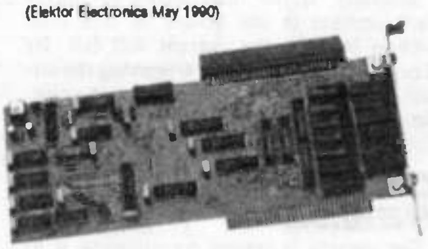


Complete Kit
(including Box, PCB and all parts
44.324BKL .... £ 14.75

IBM PC Service Card

(Elektor Electronics May 1990)

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



Complete kit
44.517BKL .... £ 77.95

Ready assembled module
44.517F .... £ 137.95

TA 1000 Telephone Answering Unit

(Elektor Electronics January 1990)

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

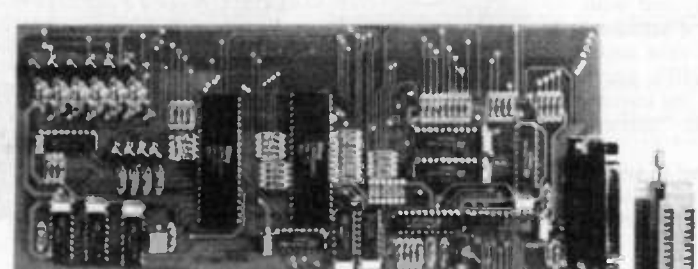
Complete kit
44.433BKL .... £ 45.65

Ready assembled module
44.433F .... £ 87.25

IC TESTER for IBM-PC-XT/AT

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

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



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

Ready Assembled Module
4.474F .... £ 113.00

Software, single
44.474SW .... £ 17.85

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

Constructional Project

CYCLE REAR LIGHT MONITOR

T. R. de VAUX-BALBIRNIE

Don't be left in the dark! Detect weak batteries or lamp failure before it is too late.

RIDING a bicycle at night is a hazard especially if the lights are not working properly. Although the user should always check the efficiency of the lights before setting out on a journey, sudden bulb failure, a poor connection or run-down batteries will soon put the rider in trouble with the law, or cause an accident. The rear light presents the greater problem since it is not seen while riding and is easily forgotten.

The Cycle Rear Light Monitor circuit monitors the efficiency of the rear light and signals the rider with a pulsed high-pitched tone if a fault develops. This tone is loud enough to be heard from the riding position even where considerable traffic noise is present. It is assumed that the rider will carry a spare bulb and batteries and will get off the road on hearing the signal.

The circuit is housed in a small box situated close to the rear light and clipped to the bicycle frame. It is designed for use with a standard bicycle light using a 3V supply (for example, two off 1.5V "D" size cells) and a bulb requiring approximately 0.4A (400mA). *Note that it is NOT suitable for use with dynamo lighting sets.*

HOW IT WORKS

The Cycle Rear Light Monitor receives power from an independent supply since ageing cycle light batteries may not operate a buzzer effectively. Also, buzzers operating at between two and three volts are unusual.

While the circuit is switched on and under standby conditions, the buzzer requires less than 100μA. While sounding, it requires 8mA. In normal use, therefore, the life of the battery will be well in excess of one year.

For this reason, the use of a *lithium* PP3 battery is recommended. Although expensive, this type has superior characteristics over an extended period compared with an alkaline battery. However, a standard PP3 battery could be used to save costs. Using the specified bleeping audible warning device not only minimises the current drain but gives a sound which "carries" effectively above road noise.

The user will need to remember to switch the unit on when the rear light is to be used. However, if the cycle light is switched off at the end of the journey with the unit still on, the buzzer will sound. Note that for use in wet conditions, some waterproofing will be required.

OPERATING CURRENT

The circuit works by sensing the current flowing through the cycle rear light bulb. When the batteries are new, their e.m.f. (off-load) voltage is high and the internal resistance low. The full operating current is then available for the lamp. As the battery ages, the on-load voltage reduces and the current falls to the point where the lamp becomes dangerously dim.

Similarly, if the bulb blows or makes poor contact in the holder or if a connection loosens, the current will fall. By checking this current and triggering the circuit if it falls below a certain preset value, the performance of the light may be continuously monitored.

CURRENT SENSOR.

The current is sensed by allowing it to flow through a fixed value resistor connected in series with the lamp. A voltage will then develop across the resistor and it is this voltage which is detected by the circuit.

In the event of a fault occurring, the falling voltage will trigger the circuit. The voltage appearing across the resistor is effectively lost to the bulb. However, by using a very low value resistor, this loss is small – 300mV (0.3V) approximately in the prototype unit. This has only a very slight effect on the brightness of the bulb.

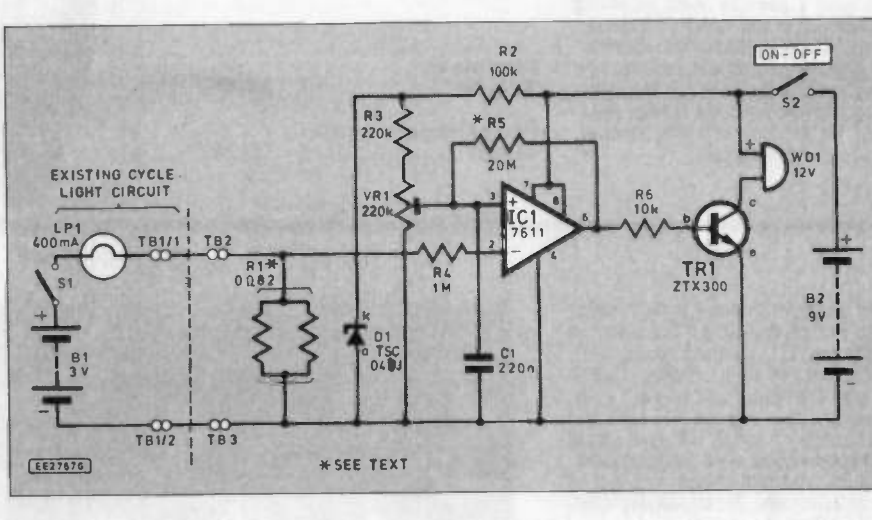
CIRCUIT DESCRIPTION

The complete circuit for the Cycle Rear Light Monitor is shown in Fig. 1. This is based on an operational amplifier, IC1, which is used as a voltage comparator. IC1 is of a type requiring a very low standby current (10μA approximately) and this helps in minimising the total current requirement of the circuit.

The existing cycle light circuit is shown to the left of the dotted line. This consists simply of a 3V battery supply, B1, a bulb, LP1 and an on-off switch, S1, connected in series.

The light circuit is broken at a convenient point and the ends so formed connected to terminal blocks TB1/1 and TB1/2. This is connected using twin wire to TB2 and TB3 hence to resistor, R1, in the main unit. The current flowing through the bulb filament then passes through resistor R1 and the voltage appearing across it is applied to IC1 inverting input, pin 2, via resistor, R4.

Fig. 1. Complete circuit daitram for the Cycle Rear Light.



VOLTAGE REFERENCE.

When switch S2 (ON-OFF) is switched on, the circuit receives power from the 9V battery, B2. Diode D1 is a precision voltage reference device similar to a Zener diode. This provides an output of 1.2V (120mV) across its ends.

The balance of the supply voltage – 7.8 volts approximately – appears across load resistor R2. Diode D1 has been specially chosen because it operates correctly with current as low as 50μA approximately and this is desirable to minimise the continuous current flowing from battery B2 when the unit is switched on.

Preset potentiometer VR1 and fixed resistor, R3, form a potential divider connected across the 1.2V reference voltage. The values have been chosen to provide a voltage at VR1 sliding contact of between zero (with the sliding contact in the minimum position) and 600mV (0.6V) at its maximum position. Thus, at VR1 mid-track adjustment, the voltage at IC1 non-inverting input (pin 3) is 300mV approximately.

In use, VR1 is adjusted so that IC1 non-inverting input voltage is just less than the inverting one. Under these conditions IC1 is off with the output, pin 6, low (negative supply voltage).

When a fault develops in the cycle lamp circuit, the voltage across R1 falls below that existing at pin 3 and IC1 switches on with pin 6 going high (positive supply voltage). Transistor, TR1, then receives base current from IC1 pin 6 through resistor R6.

COMPONENTS

Resistors
R1 0Ω82 (or 1 off 1 ohm and 1 off 4.7 ohm – see text)
R2 100k
R3 220k
R4 1M
R5 20M (or 2 off 10M – see text)
R6 10k
All 0.25W 5% carbon

See SHOP TALK Page

Potentiometer
VR1 220k enclosed preset, vert.

Capacitor
C1 220n ceramic

Semiconductors
D1 TSC04BJ voltage reference
TR1 ZTX300 *npn* silicon
IC1 ICL7611 CMOS op.amp

Miscellaneous
WD1 Pulse tone buzzer (12V operation at 15mA)
B2 9V lithium PP3 battery and connector
S2 Min. s.p.s.t. rocker switch
TB1 Two-way 3A screw terminal block
TB2,TB3 Single-way 3A screw terminal block (2 off)
Stripboard, 0.1in. matrix size 10 strips x 21 holes; plastic case, size 76mm x 58mm x 38.5mm internal; spring clip; twin lead; stranded connecting wire; solder; small fixings etc.

Approx cost guidance only **£9** (EXCL. BATT)

This, in turn, operates the audible warning device, WD1, in the collector circuit.

Resistor, R5, provides a very small amount of positive feedback by allowing a little of the output voltage to be applied to IC1 non-inverting input. This promotes sharp switching of the i.c. at the critical point.

size 10 strips x 21 holes. The component layout and details of breaks in the underside copper tracks are shown in Fig. 2.

Sufficient space has been left on the circuit panel to accommodate various physical sizes of resistor(s), R1. It may be difficult to obtain a single resistor of the required value (0.82 ohms) with a small

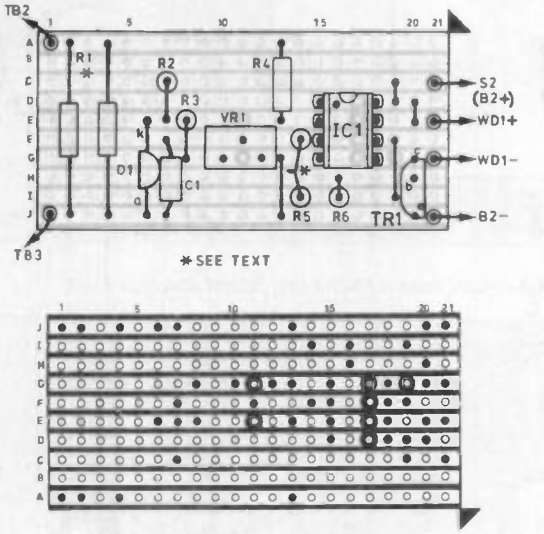


Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks.

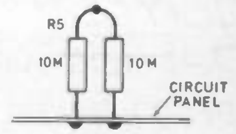


Fig. 3. Using two resistors connected in series to form resistor R5.

Capacitor, C1, keeps IC1 non-inverting input low at the instant of switching on. This prevents any tendency for the op-amp to self-trigger especially when VR1 is critically adjusted.

CONSTRUCTION

The unit should be situated as near as possible to the cycle rear lamp. If it is too far away, there could be an excessive voltage drop due to the resistance of the additional wiring. This could cause the bulb to be appreciably dimmer in service.

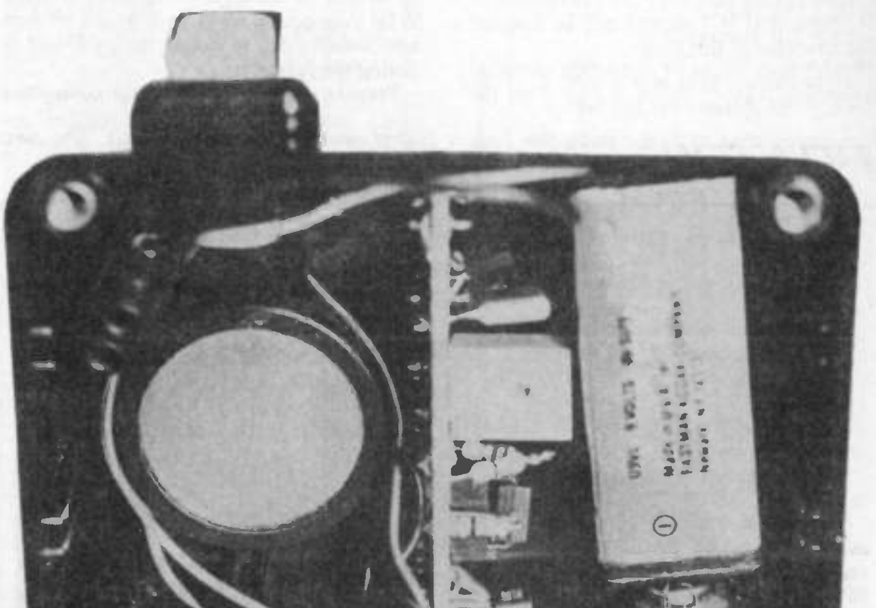
Construction of the Cycle Rear Light Monitor is based on a circuit panel made from a piece of 0.1 in. matrix stripboard

power rating. However, any power rating from 0.25W upwards is suitable but the physical size increases with the wattage.

An alternative method, and the one used in the prototype, is to connect two resistors in parallel at R1 position – one of value one ohm and the other 4.7 ohms. The values are readily available with a power rating of 0.25W.

Resistor R5 has a value of 20 megohms (22M). Since this may be difficult to obtain, two 10M resistors may be connected in series instead – see Fig. 3.

Begin construction by cutting the stripboard slightly larger than the size required then file it to fit the slots of the speci-



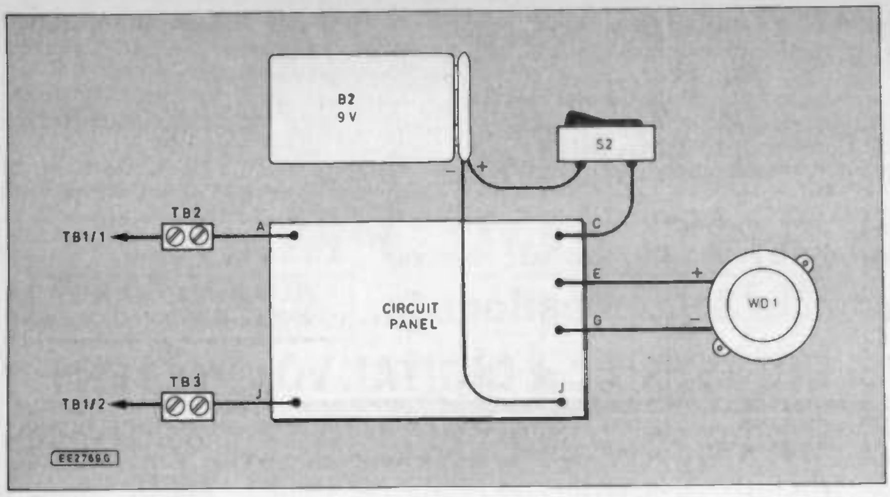


Fig. 4. Wiring from the circuit board to the off-board components.

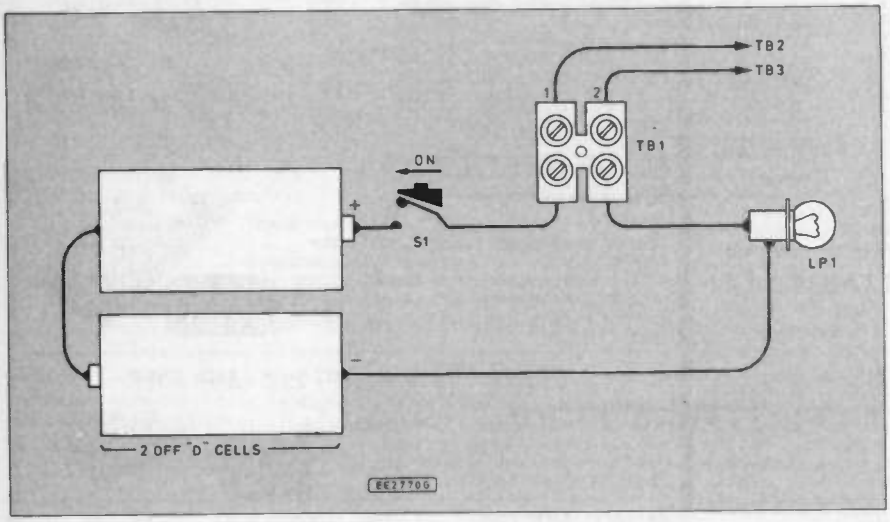


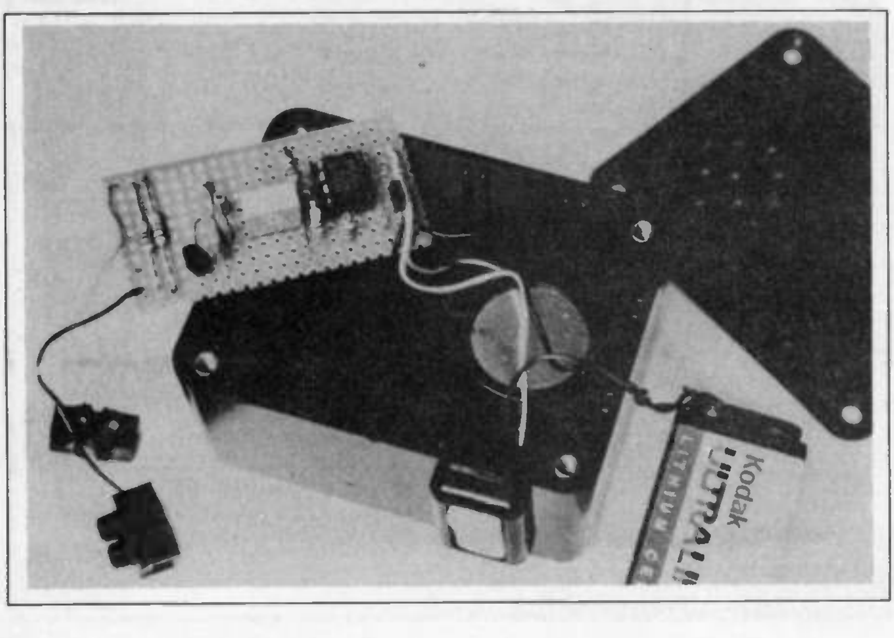
Fig. 5. A typical cycle lamp circuit set-up.

fied plastic box. Make all track breaks and inter-strip links as indicated in Fig. 2 then follow with the soldered on-board components taking care over the orientation of D1. Note that IC1 should not be inserted into its socket at this stage.

Solder 8cm pieces of light-duty stranded connecting wire to strips *A* and *J* on the left-hand side of the circuit panel. Solder a similar piece of wire to strip *C* and the negative connection of the PP3 battery clip to strip *J* at the right-hand side. Shorten WD1 connecting wires to a length of 8cm and solder these to copper strips *E* and *G* noting the polarity.

Prepare the case to receive the completed circuit panel by drilling holes for S2, WD1 mounting and also for the twin wire leading from the unit to the cycle lamp. Drill a matrix of holes in the lid of the box for the sound to pass through and also a small hole for the spring clip which will secure the unit to the bicycle frame. Attach the clip using a small fixing.

The completed monitor with the circuit board removed from the case. The two terminal blocks are also housed inside the case.



Referring to Fig. 4, mount the internal components and complete all wiring. Insert IC1 into its socket with the correct orientation and without touching the pins – this is a CMOS device and touching the pins could cause damage due to static charge which may exist on the body. Adjust VR1 sliding contact fully clockwise as viewed from the lower edge of the circuit panel.

Measure a piece of light-duty twin stranded wire a little longer than the distance between the unit and the rear cycle light when these are in position. Pass this wire through the hole drilled for the purpose and connect it to terminals TB2 and TB3. Leave some slack and apply some strain relief by tying a piece of string tightly around it.

Slide the circuit panel into position – there is plenty of space for wires to pass over the top. Check that no wires are trapped when the lid is held temporarily in position. Check that TB2 and TB3 do not interfere with the buzzer.

Switch off S2, connect the battery and secure it using two adhesive fixing pads. Make certain that it cannot dislodge in service. Provide additional support if necessary.

PREPARING THE LAMP.

Dismantle the cycle rear light sufficiently to expose the internal connections. A typical circuit for the light is shown in Fig. 5. Cut the wire at some convenient place and connect the free ends to the 2-way section of 3A block connector, TB1.

Drill a small hole in the case and thread the twin wire leading from the main unit through to the inside. Tie a piece of string around it tightly to provide strain relief and connect the ends to TB1. The polarity here is important – **the positive wire should lead to strip A on the circuit panel.**

TESTING.

You will need a set of used cycle light batteries which operate the lamp at minimum acceptable brightness. Perhaps such a set of batteries can be borrowed from another piece of equipment. *For reasons of safety, be sure to err with the light on the bright side.*

Switch on the cycle lamp then S2. If the buzzer bleeps it is likely that TB1 connections are the wrong way round – try reversing them.

Rotate VR1 sliding contact slowly anticlockwise to the point where the buzzer *just* begins bleeping. If you have to repeat the procedure, VR1 will need to be rotated clockwise through quite a large angle for the buzzer to be silenced again. Test with a set of fresh batteries in the lamp. The buzzer should now remain silent.

If the unit is left switched on with the lamp off, the buzzer should sound – this can be used as a battery-check. It now only remains to attach the lid, clip the unit into position on the bicycle frame and put the Cycle Rear Light Monitor into service.

Happy Cycling! □

BEEB MICRO BEEB

... Morse ... PD Shareware ... The End! ...

IN AN earlier Beeb Micro article a program was given which enabled Morse code practice by generating random sequences of characters. The program in this issue works on similar lines, and indeed has much actual code in common, but works by translating lines of text typed in into Morse code. This can be used for learning and practising receiving Morse code, and could probably be adapted for sending Morse messages.

Morse Translation

One problem with a program of this type is that Morse code only has 38 characters, or 39 if you count the space, whereas computer keyboards allow many more than this to be entered. One therefore has to provide some method of either filtering out 'illegal' characters or of converting them to legal ones. The problem with conversion is to find some logical way of doing it. Obviously, upper case and lower case letters can be treated as equivalent, but punctuation marks and symbols are more of a problem.

Some form of conversion would have to be considered if files of text were to be translated, but as this program is designed for text which is typed in, the method adopted here is to eliminate unwanted characters at source, by using a VIR, or Validating Input Routine.

In BBC BASIC, such routines are best implemented as functions. In this program it will be found at the very end of the listing. As each character is entered, it is compared to the contents of a string which consists of all the valid characters, using the INSTR function. Only characters in this string are accepted as input and echoed to the screen. Type anything else and you just get a beep. Note that this string (valid$) must contain a space.

This program starts up like the previous one, and you may select from three volume levels and two speeds. It is then simply a question of typing in the lines you want translated. The limit to line length is 254 characters, so they may spread over more than one physical screen line. When you press Return, the Morse code is output. No specific way of ending the program is provided, as it is simpler just to use the Escape key.

Disk Error

The Beeb Micro article in the August 1990 issue gave basic details of the way in which the disk interface functions. I am indebted to *Jonathan Harston* for pointing out one or two errors in this description of the disk interface.

In the disk port connection diagram DS0 and DS1 are labelled the wrong way round. The required drive is activated by taking either DF0 or DF1 high, giving two physical drives. The DFS splits each physical drive into two logical drives using the "side" select output to select the desired logical drive.

A system having twin double-sided drives therefore has four logical drives, which are actually the four sides of the two disks. The ADFS system handles things in a slightly different (and more conventional) way incidentally. Apologies for the mistakes in the original article, and I hope that this makes everything clear. My thanks to Mr.Harston for pointing out these errors.

PD/Shareware

My requests for information about shareware and PD software for the BBC computers initially failed to produce a response. However, Mr.Harston also informs me that he has recently set up a PD/shareware library for the BBC micros. For a catalogue send an S.A.E. to Mr.Harston at this address: – 15 Norris Road, Sheffield, S6 4QR.

As Mr.Harston rightly points out, for this type of library to be successful it requires contributors as well as customers. If you have written any BBC programs that might be of use to others, why not send them in?

For those who are not familiar with PD and shareware programs, I should perhaps explain what these names mean. PD stands for "public domain", and this is software on which no one has the copyright. In other words, you write a program and then make it available to anyone who wishes to use it. They can use it as much as they like, in any (legal) way they choose, and they are free to modify it and use parts of it if they wish. All you get in return is the satisfaction of knowing that people are using your program - there is no monetary return.

Note that if you supply any software of this type it must be all your own work, and not contain any "borrowed" routines. The only exception is where the borrowed routines are themselves PD software.

Shareware is a try before you buy scheme. People buy the software from a library, but at low cost, as they are only paying for the disk/tape plus a copying fee. The idea is that if someone should find the program useful, they should register with the author for the fee mentioned in the documentation for the program. This documentation is in the form of a text file on the disk.

Often there is some advantage in registering and becoming a legitimate user (in addition to piece of mind). This might be an improved version of the program, or perhaps a properly printed manual.

Shareware is effectively ordinary commercial software, but with the buyer having the opportunity to fully try it out, and only pay for it once he or she is satisfied that it is suitable for their requirements. Unless you write a large program that is genuinely as good as commercial software, there is probably no point in trying to market it as shareware.

Few users, if any, will pay a reasonable registration fee for a program that is in any way sub-standard. Few people will bother to pay a small registration fee for a small piece of software. It is probably best just to release your software as a PD program (which is effectively what unsuccessful shareware becomes anyway), unless it is something genuinely exceptional of course.

End Of The Line

The BASIC words "END" and "NEW" sum up very nicely what I have to report here. First the bad news, which is that this is the last article in the *Beeb Micro* series. It is always sad to come to the end of an on-going series, but we have covered just about every port of the BBC model B computers in some detail over the last few years, together with a wide range of add-on circuits to connect to them.

There should be sufficient material there to keep any Beeb enthusiast busy for a considerable period of time. If you find that you have missed something of interest in the series, remember that some back issues are available, as are photo- copies of any article in the series. *(Photo-copies cost the same per article as a back number – see the Editorial page for information – Ed.)*

The good news is that a new computer page *(Interface)* will start next month, and this will include interfacing details, add-on circuits, etc. for any microcomputer that is reasonably popular with *Everyday Electronics* readers. This probably means that computers such as the Amstrads, IBMs and compatibles, Spectrums, Atari STs, and Commodore Amigas will all feature from time to time. The "golden oldies" such as the Memotechs and the MSX machines are unlikely to be covered, as these seem to be used by very few people these days.

The BBC micros are unlikely to feature prominently as they have received a large amount of coverage in past issues of EE, and seem to be less popular with our readers than they once were. It would appear that many BBC micro users have now moved on to 16 bit machines such as the Atari STs, Amigas, and IBM compatibles.

The series will be handled very much on the basis of taking things as they come, rather than working through a list of "approved" computers on a rota basis. If you have any ideas or suggestions for the series, please write in giving brief details of what you would like to see featured. Obviously we can not guarantee to satisfy all requests for circuits, interfacing details, or whatever. All suggestions will be given serious consideration though.

Remember that we can only feature something that will be of interest to a reasonable number of readers. This is particularly important with computer related material, where the percentage of readers who own the particular computer in question could be quite small. Something that only appeals to a few percent of those readers will obviously only be of interest to a very small section of the overall readership.

An article describing a circuit for left handed hang-glider pilots who own an Atari ST is unlikely to be very popular! On the other hand, do not assume that because an idea is unusual that it will have limited appeal. Unusual projects that can be built and used by anyone are often very popular.

Next month *Interface* will start with some details about interfacing to the IBM PCs and compatible computers. These have enormous add-on potential, and interfacing to them is more straightforward than you might have thought.

MORSE TRANSLATION PROGRAM

```
10 REM Morse Translation Program
20 REM for E.E. 9/90
30
40 REM Global Variables
50 Screenful = 40
60 Pitch = 200
70 MaxWordLength = 9
80 DIM TheChar(6)
90 TheChar$=""
100
110 REM Main Program
120 MODE 7
130 PROCTheScreen_Say_Program
140 PROCTheCode_Init
150 PROCTheScreen_Init
160 PROCTheSpeaker_Get_Volume
170 PROCTheSpeaker_Get_Speed
180 PROCTheScreen_Say_Start
190 PROCTheCode_Fill_Buffer
200 REPEAT
210   PROCTheText_Get_Line
220   PROCTheText_Scan_Line
350 UNTIL FALSE
360
370 REM TheCode Methods
380 DATA A,2,2,6,B,4,6,2,2,2,C,4,6,2,6,2
390 DATA D,3,6,2,2,E,1,2,F,4,2,2,6,2
400 DATA G,3,6,6,2,H,4,2,2,2,2,I,2,2,2
410 DATA J,4,2,6,6,6,K,3,6,2,6,L,4,2,6,2,2
420 DATA M,2,6,6,N,2,6,2,O,3,6,6,6
430 DATA P,4,2,6,6,2,Q,4,6,6,2,6,R,3,2,6,2
440 DATA S,3,2,2,2,T,1,6,U,3,2,2,6
450 DATA V,4,2,2,2,6,W,3,2,6,6,X,4,6,2,2,6
460 DATA Y,4,6,2,6,6,Z,4,6,6,2,2
470 DATA 1,5,2,6,6,6,6,2,5,2,2,6,6,6
480 DATA 3,5,2,2,2,6,6,4,5,2,2,2,2,6
490 DATA 5,5,2,2,2,2,2,6,5,6,2,2,2,2
500 DATA 7,5,6,6,2,2,2,8,5,6,6,6,2,2
510 DATA 9,5,6,6,6,6,2,0,5,6,6,6,6,6
520 DATA ".",6,2,6,2,6,2,6
530 DATA ",",6,6,2,2,6,6
540 DEF PROCTheCode_Init
550 DIM TheCode_Buffer(38,6)
560 DIM TheCode_Char$(38)
570 ENDPROC
580
590 DEF PROCTheCode_Fill_Buffer
600 FOR ccount = 1 TO 38
610   READ TheCode_Char$(ccount)
620   READ TheCode_Buffer(ccount,0)
630   FOR dcount= 1 TO TheCode_Buffer(ccount,0)
640     READ TheCode_Buffer(ccount,dcount)
650   NEXT dcount
660 NEXT ccount
670 ENDPROC
680
690 DEF PROCTheCode_Get_Char(cv%)
691 LOCAL place
692 FOR place = 1 TO 38
693   IF ASC(TheCode_Char$(place))=cv% THEN char=place
695 NEXT place
710 TheChar(0)=TheCode_Buffer(char,0)
720 FOR dcount=1 TO TheChar(0)
730   TheChar(dcount)=TheCode_Buffer(char,dcount) DIV speed%
740 NEXT dcount
750 TheChar$=TheCode_Char$(char)
760 ENDPROC
770
780 REM Screen Methods
790 DEF PROCTheScreen_Init
800 DIM TheScreen_Buffer$(Screenful)
810 TheScreen_Char$=""
820 ENDPROC
830
840 DEF PROCTheScreen_Say_Program
850 CLS
860 PRINTTAB(9,5);"Morse Translation Program"
870 ENDPROC
1110
1120 DEF PROCTheScreen_Say_Start
1125 CLS
1130 PRINT "Enter the lines to translate"
1135 PRINT "at the >> prompt."
1140 ENDPROC
1150
1190
1200 REM Speaker Methods
1210 DEF PROCTheSpeaker_Sound_Char
1220 FOR digit = 1 TO TheChar(0)
1230 SOUND 1,vol,200,TheChar(digit)
1240 SOUND 1,0,200,2 DIV speed%
1250 NEXT digit
1260 SOUND 1,0,200,4 DIV speed%
1270 ENDPROC
1280
1290 DEF PROCTheSpeaker_Word_Pause
1300 SOUND 1,0,200,8 DIV speed%
1310 ENDPROC
1320
1330 DEF PROCTheSpeaker_Get_Volume
1340 PRINTTAB(5,11);"Please select volume"
1350 PRINTTAB(5,12);"(1-quiet,2-normal,3-loud) ";
1360 REPEAT
1370 choice$=GET$
1380 choice%=VAL(choice$)
1390 UNTIL (choice% > 0) AND (choice% < 4)
1400 IF choice% = 1 THEN vol = -8 :PRINT "Quiet"
1410 IF choice% = 2 THEN vol = -11:PRINT "Normal"
1420 IF choice% = 3 THEN vol = -15:PRINT "Loud"
1430 ENDPROC
1440
1450 DEF PROCTheSpeaker_Get_Speed
1460 PRINTTAB(5,14);"Please select speed"
1470 PRINTTAB(5,15);"(1-slow,2-fast)";
1480 REPEAT
1490 choice$=GET$
1500 choice%=VAL(choice$)
1510 UNTIL (choice% = 1) OR (choice% = 2)
1520 IF choice%=1 PRINT "Slow"
1530 IF choice%=2 PRINT "Fast"
1540 speed% = choice%
1550 ENDPROC
1560
1570 REM TheText Methods
1580 DEF PROCTheText_Get_Line
1590 PRINT ">>";
1595 text$=FNvir
1597 PRINT
1600 ENDPROC
1610
1620 DEF PROCTheText_Scan_Line
1622 LOCAL place
1630 FOR place = 1 TO LEN(text$)
1640   cv%=ASC(MID$(text$,place,1))
1650   PROCTheCode_Get_Char(cv%)
1660   IF cv%=32 PROCTheSpeaker_Word_Pause ELSE PROC
                                  TheSpeaker_Sound_Char
1670 NEXT place
1680 ENDPROC
1685
1690 DEF FNvir
1700 LOCALin,out$
1710 valid$="1234567890 ABCDEFGHIJKLMNOPQRSTUVWXYZ,."
1720 in=GET:*FX15,1
1730 IF in=13 THEN=out$
1740 IF in > 128 THEN 1720
1750 IF in=127 AND out$="" THEN 1720
1760 IF in=127 out$=LEFT$(out$,LEN(out$)-1):VDU127:
                                             GOTO 1720
1770 IF LEN(out$)=254 OR INSTR(valid$,CHR$(in))=0
1780 PRINT CHR$(in);:out$=out$+CHR$(in):GOTO 1720
                                        VDU7:GOTO 1720
```

EE REFERENCE LIBRARY

We have specially selected the four books shown here as very high quality reference books. They are all fairly expensive *but* they are all extremely comprehensive; between them they contain over 8,000 pages of information.

We are not suggesting that many people would require all four books, any one of them would be very useful and interesting. Each of them would make an excellent Christmas present. These reference books would be invaluable to any company, electronics club, group of students or anyone involved in teaching electronics etc.

McGRAW-HILL CONCISE ENCYCLOPEDIA OF SCIENCE & TECHNOLOGY (2ND EDITION)

This single volume is the most authoritative, all inclusive work of its kind, with information on science, engineering and technology.

Hard cover, 2,200 pages, 1,700 illustrations. £95

McGRAW-HILL ENCYCLOPEDIA OF ELECTRONICS AND COMPUTERS (2ND EDITION)

Updated and revised to cover the developments in an extremely fast-growing field, this encyclopedia contains 520 alphabetically arranged articles; 120 of them completely revised for this edition and 45 that are brand new.

Hard cover, 1,250 pages, 1,250 illustrations. £75

McGRAW-HILL DICTIONARY OF SCIENTIFIC AND TECHNICAL TERMS (4TH EDITION)

This completely up-to-date fourth edition of this standard international reference will meet your needs for understanding the language of all areas of science and engineering.

Hard cover, 2,200 pages, 2,900 illustrations. £85

ELECTRONIC ENGINEERS' HANDBOOK by Donald G. Frik and Donald Christiansen (3RD EDITION)

One of the excellent range of McGraw-Hill Handbooks this definitive work covers all aspects of today's electronic engineering. This third edition has been completely revised, updated and expanded.

Hard cover, 2,642 pages. £79.95

Send your order together with a cheque (make cheques payable to Everyday Electronics), P.O. or your credit card number (Visa or Access) and card expiry date to EE Reference Library, 33 Gravel Hill, Merley, Wimborne, Dorset BH21 1RW.

BOOKS FROM THE EE REFERENCE LIBRARY ARE SUPPLIED, BY MAIL ORDER ONLY, POST FREE, TO ALL UK ADDRESSES – overseas readers please add £5 per book for surface mail post. Please allow up to 28 days for delivery.

Special Series

MICRO IN CONTROL

JOHN HUGHES

Part Twelve

Starting from very basic principles this series quickly builds through logic to simple microprocessor control.

IN THIS last session, we'll note the use of look-up tables as used in the train control example, try an even simpler "organ" example, then consider how to pick out individual bits from a data value, illustrating this with a routine to give the Morse sounds of our hex letters. Finally, we'll make up a lift control program so that it can be compared with the direct logic system developed earlier.

S *Have we had ALL the 6502 op-codes now?*

T Not quite, but the more useful (to us) are under our belt. Mentioned previously, the manufacturer's programming manual will fill in the rest should you need them. I'm sure some of you will, for one can easily get "hooked" on machine code programming!

Exercise 25 ("Now hear this!" - continued)

T List 12.1 gives the "Tune player" program. All I need say about it is that it uses the "Readkey" subroutine we met last time, then puts the key value into the X index register in a "Pitch" subroutine. This then reads from the "Note Table" starting at 032B, the appropriate delay constant to give the desired pitch for that key. This constant is then used by the "Delay" subroutine to cause the note to sound while the key is pressed. You'll need to connect a small loudspeaker or earphone (or, better still, an amplifier, to socket PA0 to hear the output (Fig 12.1).

List 12.1. The Tune Player

0030	START	A9	01			Set up Port A
0302		8D	01	C0		
0305		8D	03	C0		
0308	KEY	20	60	FC		Use "Readykey" s/r
030B		C9	08			Wait for key
030D		F0	F1			
030F		20	24	03		Call "Pitch" s/r
0312		20	1B	03		and "Delay" s/r
0315		EE	01	C0		Switch PA0 signal to make a
0318		4C	08	03		tone while key is pressed.
031B	DEL. s/r	A5	00			Pick up delay value for this
031D		85	10			and loop to produce note.
031F		C6	10			Count down for delay period,
0321		D0	FC			
0323		60				and return.
0324	PITCH s/r	AA				Transfer key code to X register.
0325		BD	2B	03		Convert key code into delay
0328		85	00			value via Note Table,
032A		60				and return
032B	NOTE TBL.	60	3D	54	4E	Chosen to give a diatonic
032F		2B	28	39	7E	scale. Change them if you want to!

(You might like to try working this out for yourself first, or at least adding in the mnemonics to check your grasp of the way it operates. It may also amuse you to mark the notes of the scale, d r m f s l t d, against the keys).

S *I see. The delay constant is picked up from locations 032B + 1, 032B + 2, and so on, depending which key.*

T That's right, 032B plus X in fact.

S *And at "KEY" the program waits for a key to be pressed by checking that it's not 08, the "no key" value.*

T Spot on. So try it out, and let's have you all playing something inspiring!

S *(later) Did you say the Train Program uses similar tables?*

T Yes, two of them, one of "ACTION CODES", and the other of "DURATION" codes. The latter are, as you can guess, timer values for a delay sub-routine. There's space for up to 15 "Actions", and the "ACTION" table starts at 0020.

S *So the "DURATION" table will start at least fifteen locations further up?*

T Quite right, it starts at 0030. At location 0004 you can enter the NUMBER OF ACTIONS (up to 15) you want.

S *Presumably the bigger the duration code, the longer that action will last for, but how do we set the actions?*

T That's right. In the sample (ROM) program, the duration codes range from 02 to 0A. The action codes are set by realising that they use only bits 0, 1 and 2, so will go from 00 up to 07 only.

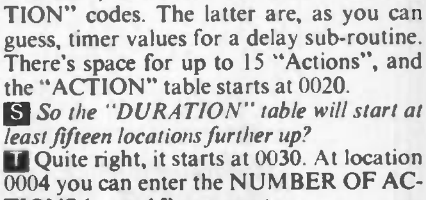


Fig. 12.1. Transistor amplifier circuit. A reasonably high impedance speaker or earphone (say 64 ohms or more) can be connected directly from PA0 to 0V.

Fig. 12.2 Devising a 2-byte pattern for Morse letters

(S/S) Sound/Silence byte | | | | | | | | | 1 = sound, 0 = silence

(DUR) Tone Duration byte | | | | | | | | | 1 = long (3 units), 0 = short (1 unit)

↑ ↑ ↑
1st 2nd 3rd → read this way

Starting at left, one bit is read from each byte, to generate either 1 unit of silence, 1 unit of tone, or 3 units of tone, i.e. a steady tone lasting for the desired number of time units. In Morse code, the hex letters are:

A • —　　D — ••
B — •••　　E •
C — • — •　　F •• — •

Fig. 12.3 The byte pattern for letter C:

Sound and Silence alternate for C, as for all letters, and there are 4 sounds, so the S/S byte is:

S/S | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
— • — •

The first and third sounds are 'dashes', the others are dots (equal in time units to the silences:

DUR | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
↑ ↑ ↑ ↑ ↑ ↑ ↑ ↑
3 1 1 1 3 1 1 1

So the S/S byte will be 1010 1010 = AA in hex.
and the DUR byte will be 1000 1000 = 88 in hex.

Fig. 12.4 The hex patterns:

	Morse	S/S byte		DUR byte	
		Binary Pattern	Hex	Binary Pattern	Hex
A	• —	0010 1000	28	0000 1000	08
B	— •••	1010 1010	AA	1000 0000	80
C	— • — •	1010 1010	AA	1000 1000	88
D	— ••	0010 1010	2A	0010 0000	20
E	•	0010 0000	20	0000 0000	00
F	•• — •	1010 1010	AA	0000 1000	08

The sequence in which these are stored in the program is the result of the key-codes, which arise from the board wiring. Note the 'spare' silences.

S *I suppose 00 means "Stop".*
T If connected as we described last time, it does. And the example uses the codes thus:

Action	Ac. Code	Dur. Code
1 Forward, slow	02	60
2 Reverse, slow	03	40
3 Reverse, fast	07	70
4 Reverse, slow	03	60
5 Stop	00	40
6 Forward, slow	02	80
7 Forward, fast	06	A0
8 Stop	00	20

If you write down the binary patterns for the action codes, you can check for yourself.
S *You said we could alter them. How?*
T The Train Example program at FF40 starts by entering the above values. If you wish to enter different values at the locations stated (0020 for Actions, 0030 for Durations, with the total entered at 0004), then do so, but remember to START to run your program from the main START ADDRESS which is FF06.

Exercise 26 Morse Hex?

T This Exercise will show you a final trick or two; in particular how to "peel off" individual bits from a data value, where each bit has to be dealt with in turn. We'll make the micro read off a Morse code pattern by traversing a data "word" (a byte of 8 bits in our system), then producing the appropriate sound (or silence). A second byte of data will tell it whether to give a short or long sound for a DOT or DASH respectively.
S *I expect we'll use the same amplifier/loudspeaker as for the "Tune Player"?*
T Yes, stick to the same output circuit from PA0.
S *How long should a Morse dash to be compared to a dot?*
S *(another) One dash equals three dots, and a space is just one dot in length.*
T Agreed. That suggests a cunning way to alter the "Duration" value, using bit one only.
S *I suppose we could make a 1 represent "sound" and a 0 represent "silence" in the S/S pattern.*
T That's what I intend, too. Here's a sketch of our two bytes, the "S/S" (Sound or Silence) one and the "DUR" (Duration) one, with the Morse Codes for the six hex letters (Fig. 12.2). See if you can work out the patterns for one of the letters, say "C".
S *(eventually) is this right? (Fig 12.3)*
T Seems OK to me. You intend it to be "read" from left to right, don't you? It could go either way. This is fine. Between us, we should be able to agree on the corresponding patterns for the other letters.
S *We could use this method for ANY letters, couldn't we?*
T We could, though the Tutor board would need extra keys. Numbers couldn't be done, though, as they require more bits than the eight we have here. We'd have to devise a way round that one to cover the whole Morse Code symbols. Let's write out our patterns (Fig. 12.4). Shall I give you a chance to work out a suitable program for yourselves, or at least a flow diagram?
S *Give us a few minutes, then.*
T OK. I'll write out my version privately, then you can refer to it later if you need to. (List 12.2)
S *I see how you've done the long and short sounds. If bit 1 is 0, the timer value is only 0000 00001. If it's 1, the value becomes 0000 0011, which is just three times as much. The extra timing loop allows for an overall adjustment while the inner loop sets the frequency.*
T Just so, and notice the switching as before of bit 0 in the output to give a "square wave" output. Can you see how the individual bits of the S/S byte are picked off in sequence?
S *By shifting them one at a time into the "Carry Flag", and causing this to switch*

List 12.2. Morse Hex

The following values should be entered at the locations listed, to provide "look-up tables" for each character. A small loudspeaker or amplifier is connected between 0V and PA0 (the socket marked S0). Then, when the program is running, pressing any of the six "letter" keys will produce the sound of that letter in the Morse Code. As the whole thing will be in RAM, values can be altered if desired, to give different letters, or to change the pitch or speed of the sounds.

Table 1. Sound codes
0017 AA 28 AA 20 AA 2A

Table 2. Duration codes
0021 88 08 80 00 08 20

(The "spare" locations 001D, 001E and 001F are used as temporary timing values stored in the program.)

The values in the above locations give the sounds, in Morse, of A, B, C, D, E and F respectively, as explained in the text. The main program starts at 0400, with a "BIT" subroutine starting at 042F.

The listing is shown opposite

List. 12.2 . Morse Hex

0400	START	A9	01		LDA	#01	Set up PA0 as output.
0402		8D	03	C0	STA	C001	
0405	WAIT	20	60	FC	JSR	FC60	Call "Readykey" s/r.
0408		F0	F6		BEQ	START	Keep waiting if "9" key
040A		C9	08		CMP	#08	(00) or NO KEY (08)
040C		F0	F2		BEQ	START	or "8" key (07)
040E		C9	07		CMP	#07	otherwise, copy keycode
0410		F0	EE		BEQ	START	value (01 to 06) into
0413		AA			TAX		index register X.
0414		B5	16		LDA	16,X	Look up Table 1; put
0416		85	11		STA	11	s/s value in 0011.
0418		B5	20		LDA	20,X	Use Table 2 for value
041A		85	12		STA	12	of duration; into 0012.
041C		A9	08		LDA	#08	Enter 8 into BIT
041E		85	10		STA	10	COUNTER, 0010.
0420	NXBIT	20	2F	04	JSR	042F	Call BIT s/r.
0423		C6	10		DEC	10	Reduce BIT COUNTER,
0425		D0	F9		BNE	NXBIT	until all 8 done.
0427	NXLET	20	60	FC	JSR	FC60	Call "Readkey" again,
042A		C9	08		CMP	#08	and wait until no key,
042C		D0	F9		BNE	NXTLET	then start over again.
042E		F0	CF		BEQ	START	(subroutine follows)
042F	BIT s/r	A9	00		LDA	#00	Start with accumulator
0431		18			CLC		and carry both empty.
0432		06	12		ASL	12	Move LH bit of 0012
0434		69	00		ADC	#00	into accum. (RH bit).
0436		0A	0A	0A	ASL	A (X7)	Shift to left seven
0439		0A	0A	0A 0A			times, into LH bit,
043D		09	40		ORA	#40	then "OR" it with 40
043F		85	15		STA	15	(01000000) as TIMER.
0441		A9	00		LDA	#00	Clear accumulator and
0443		18			CLC		carry again, and shift
0444		06	11		ASL	11	LH bit of 0011 into RH
0446		69	00		ADC	#00	bit of 0013 as "SOUND-
0448		85	13		STA	13	or-SILENCE" bit.
044A	SOUND	A5	15		LDA	15	Copy TIMER into 001F
044C		85	1F		STA	1F	for "DURATION" loop 3.
044E	LOOP 3	A9	04		LDA	#04	Use preset value in
0450		85	1D		STA	1D	001D for loop 2 delay.
0452	LOOP 2	A9	10		LDA	#10	and preset value in
0454		85	1E		STA	1E	001E for pitch delay.
0456	LOOP 1	A5	13		LDA	13	"AND" RH bits of 0014
0458		25	14		AND	14	and 0013 (S/S bit),
045A		8D	01	C0	STA	C001	then send out to PA0.
045D		E8	14		INC	14	"Click" bit 1 of 0014
045F		C6	1E		DEC	1E	and run down loop 1 to
0461		D0	F3		BNE	LOOP 1	get note of set pitch.
0463		C6	1D		DEC	1D	Loop 2 prolongs it
0468		D0	EB		BNE	LOOP 2	further, and total
046A		C6	1F		DEC	1F	duration depends on
046C		D0	E2		BNE	LOOP 3	output loop 3 (TIMER).
046E		60			RTS		Finally, return.

List. 12.3 The 3-Floor Lift again.

0500	START	A9	03		LDA	03	Set up Port A.
0502		8D	03	C0	STA	DDRA	
0505	STOP	A9	00		LDA	00	Stop motor.
0507		8D	01	C0	STA	PA	
050A	WAIT	A9	30		LDA	30	This value sets pause
050C		85	06		STA	06	length, using delay
050E		20	90	FB	JSR	FB90	s/r at FB90.
0511	CALL	AD	01	C0	LDA	PA	Read input to check
0514		29	FC		AND	FC	for a call, each in
0516		C9	04		CMP	04	turn, branching as
0518		F0	07		BEQ	GND	necessary
051A		C9	10		CMP	10	
051C		F0	13		BEQ	SEC	
051E		C9	08		CMP	08	
0520		F0	23		BEQ	FIR	
0522		D0	ED		BNE	CALL	Keep checking.
0524	GND	AD	01	C0	LDA	PA	Test sensor 0. Stop
0527		29	FC		AND	FC	if lift there, go
0529		C9	20		CMP	20	DOWN if not.
052B		F0	D8		BEQ	STOP	(go back or
052D		A9	02		LDA	20	send outputs)
052F		8D	01	C0	STA	PA	
0532		D0	F0		BNE	GND	Keep testing.
0534	SEC	AD	01	C0	LDA	PA	Test sensor 2 in
0537		29	FC		AND	FC	the same way, but go
0539		C9	80		CMP	80	UP if necessary.
053B		F0	C8		BEQ	STOP	
053D		A9	01		LDA	01	
053F		8D	01	C0	STA	PA	
0542		D0	F0		BNE	SEC	
0544	FIR	AD	01	C0	LDA	PA	Test sensors this
0547		29	FC		AND	FC	time to find where
0549		C9	20		CMP	20	lift is (0 or 2).
054B		F0	05		BEQ	UP	Go UP or DOWN as
054D		C9	80		CMP	80	necessary.
054F		F0	14		BEQ	DOWN	
0551		D0	C7		BNE	WAIT	
0553	UP	AD	01	C0	LDA	PA	Test S1 as before.
0556		29	FC		AND	FC	
0558		C9	40		CMP	40	
055A		F0	B9		BEQ	STOP	Stop when there, or
055C		A9	01		LDA	01	keep going UP.
055E		8D	01	C0	STA	PA	
0561		D0	F0		BNE	UP	
0563	DOWN	AD	01	C0	LDA	PA	Test S1 again, but
0566		29	FC		AND	FC	go DOWN this time.
0568		C9	40		CMP	40	
056A		F0	A9		BEQ	STOP	
056C		A9	02		LDA	20	
056E		8D	01	C0	STA	PA	
0571		D0	F0		BNE	DOWN	

← This part only needed for 3 floors →

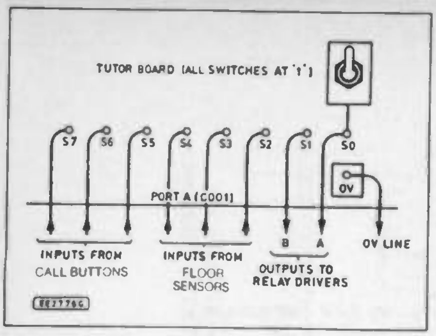


Fig. 12.6. Suggested connections to existing lift circuits for 3-floor version. (Don't forget the 0V link!)

with a "0", so if it's "1" we get a sound, if it's "0" there's silence. Let's try it.

T (later) I'm glad it worked as planned. Some of you got the same result with your own versions. Well done!

Exercise 27
Lift Control by the Micro.

T Now we'd better tackle the lift control exercise. You'll probably find this a doddle after some of the quite complex examples you've been working on.

S *May we assume we have the same two- or three-floor lift as before, with the same driver circuits (A and B) / and call buttons and sensors / and door and limit switches?*

T Sure. Just regard the micro inputs and outputs as replacing the TTL logic chips only.

S *It would be possible to retain some logic chips if we had to, wouldn't it? Such as the bistables to "hold" the call signals.*

T Sure, if you need to. You might compare both approaches and see how software can to some extent replace hardware. Clearly this would affect costs in commercial projects (but don't assume software is cheaper; it usually comes more expensive when you include the programmer's fee!)

Again, I'll write out my suggestions for flow diagram (Fig. 12.5) and program (List 12.3) for you to see later should you need to. Carry on, and good elevating...

S *Would it be wiser to start with a two-floor lift as we did before?*

T By all means, though I've made my program up for the three-floor version. But it's obvious what part could be left out for a two-floor one.

S *We could re-write it to include the door and limit checks, couldn't we?*

T Yes, though, as before, it's comforting to think that the motor power is positively cut off by linking the switches in series. But tackle the exercise by all means. And add any extra lights you wish. You could even control the opening and closing of the doors if your mechanical and electrical ingenuity permits them to be motor controlled.

In fact, you will have realised that a microprocessor unit like this can be adapted to do virtually anything, from controlling your central heating to running all the gadgets in the house, provided the sensors and driver circuits are there or can be added.

S *You mentioned a "turn-key". What does this mean?*

T It's a system, where the act of switching on (the key-turning) starts the built-in program running immediately so that all sensors and buttons are active and all drivers ready to "go". All that's required are a few extra instructions to make the micro set up the data and jump to the correct starting point, with an automatic "reset" signal provided on switch-on. All the extra hardware would also have to be in place as well.

S *Could we make one with, say, the MIDAS unit?*

T Certainly. If you replaced the Tutor board with your own custom- built board, and put your own program into an EPROM in the Controller board. That's why it's made in separate units, and why the "Master board" is available to facilitate such projects.

However, for now, I hope you have caught some of the fun, excitement, frustration (but not too much of that) and satisfaction, which goes with seeking to make the micro take control! □

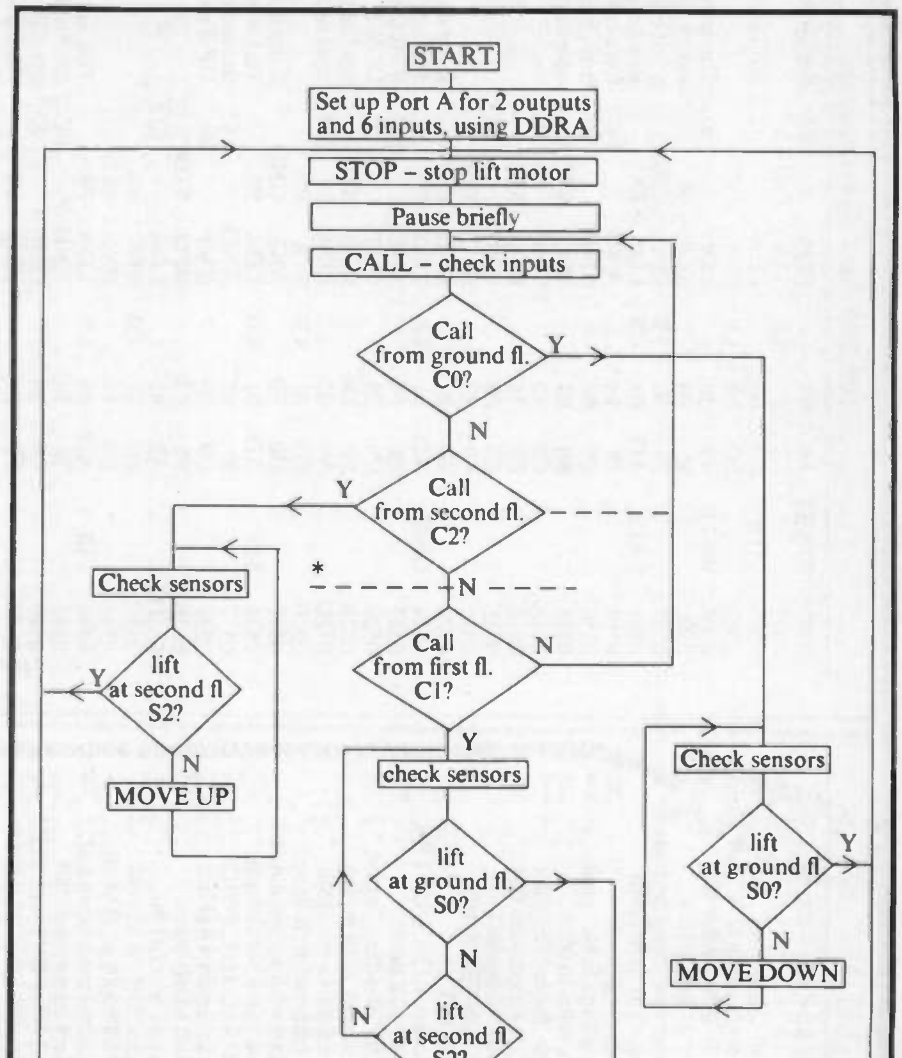


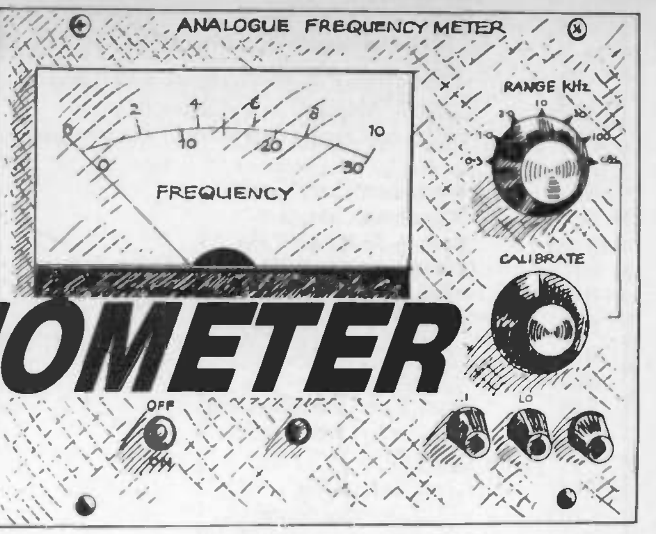
Fig. 12.5 Lift Control (3-floor version)

MCS6501-MCS6505 MICROPROCESSOR INSTRUCTION SET – ALPHABETIC SEQUENCE

ADC	Add Memory to Accumulator with Carry	JSR	Jump to New Location Saving Return Address
AND	"AND" Memory with Accumulator		
ASL	Shift Left One Bit (Memory or Accumulator)	LDA	Load Accumulator with Memory
		LDX	Load Index X with Memory
BCC	Branch on Carry Clear	LDY	Load Index Y with Memory
BCS	Branch on Carry Set	LSR	Shift Right One Bit (Memory or Accumulator)
BEQ	Branch on Result Zero		
BIT	Test Bits in Memory with Accumulator	NOP	No Operation
BMI	Branch on Result Minus		
BNE	Branch on Result not Zero	ORA	"OR" Memory with Accumulator
BPL	Branch on Result Plus		
BRK	Forces Break	PHA	Push Accumulator on Stack
BVC	Branch on Overflow Clear	PHP	Push Processor Status on Stack
BVS	Branch on Overflow Set	PLA	Pull Accumulator from Stack
		PLP	Pull Processor Status from Stack
CLC	Clear Carry Flag		
CLD	Clear Decimal Mode	ROL	Rotate One Bit Left (Memory or Accumulator)
CLI	Clear Interrupt Disable Bit	ROR	Rotate One Bit Right (Memory or Accumulator)
CLV	Clear Overflow Flag	RTI	Return from Interrupt
CMP	Compare memory and Accumulator	RTS	Return from Subroutine
CPX	Compare memory and Index X		
CPY	Compare Memory and Index Y	SBC	Subtract memory from Accumulator with Borrow
		SEC	Set Carry Flag
DEC	Decrement Memory by One	SED	Set Decimal Mode
DEX	Decrement Index X by One	SEI	Set Interrupt Disable Status
DEY	Decrement Index Y by One	STA	Store Accumulator in Memory
		STX	Store Index X in Memory
EOR	"Exclusive-Or" Memory with Accumulator	STY	Store Index Y in Memory
INC	Increment Memory by One	TAX	Transfer Accumulator to Index X
INX	Increment Index X by One	TAY	Transfer Accumulator to Index Y
INY	Increment Index Y by One	TSX	Transfer Stack Pointer to Index X
		TXA	Transfer Index X to Accumulator
JMP	Jump to New Location	TXS	Transfer Index X to Stack Pointer
		TYA	Transfer Index Y to Accumulator

Constructional Project

FREQUENCY METER/TACHOMETER



STEVE KNIGHT

A simple, low cost optical sensor that will turn your frequency meter or counter, analogue or digital, into a tachometer capable of measuring the speed of most rotating objects.

LAST MONTH we gave details of a versatile, low cost, 10Hz to 100kHz Analogue Frequency Meter for the *Frequency Meter/Tachometer* project. This month we offer a Simple Optical Sensor which adds a tachometer facility to the project.

The Optical Sensor does not have to be used in conjunction with last month's Frequency Meter, neither is its application restricted to shaft speeds. It can be used with any standard frequency meter or counter, analogue or digital, to give an output indicating the frequency of any interrupted light source.

The Optical Sensor Unit consists of a general purpose photodiode (type BPX65) connected to an integrated comparator/amplifier, with a light source obtained from a lens-ended filament bulb, the complete assembly being built into a small ABS plastic box.

PHOTODIODE

The construction of a photodiode is similar to that of a conventional diode, except that the casing of the device has a transparent window area so that light is permitted to fall onto the semiconductor junction. A thin wafer of *n*-type silicon has a *p*-type layer diffused into it to a depth of about one micron and this allows light to penetrate to the junction without serious attenuation.

These diodes are usually operated with reverse bias so that a depletion layer is established across the junction. This layer is free of mobile majority carriers and so acts (as it does in any reverse biased diode) as a virtual insulator between anode (*p*-type) and cathode (*n*-type) electrodes.

When a light of sufficient energy enters the depletion layer, the light photons are absorbed and their energy is released by creating hole-electron pairs in the otherwise non-conducting layer. Under the influence of the applied electric field, these carrier-pairs are separated, the electrons moving to the *n*-type cathode (which is held positive) and the holes to the *p*-type anode (which is held negative). Hence a current flows in the circuit even though the diode is reverse biased.

This current, which is effectually an enhanced leakage current, is very small even when the incident illumination is high, so an amplifier is necessary to bring it up to a useful working level.

CIRCUIT DESCRIPTION

The circuit diagram of the Optical Sensor used initially to measure the speed of rotating shafts, or any accessible rotating or vibrating parts for that matter, in conjunction with the Frequency Meter last month, is given in Fig.1. As pointed out earlier, this unit does not have to be used with this particular frequency meter, neither is its application restricted to the measurement of shaft speed.

It can be used with any standard frequency meter or counter, analogue or digital, and will give an output indicating the frequency of any interrupted light source whether reflected from its own internal lamp or received directly from any other source of sufficient intensity. Some practical applications of the sensor will be mentioned later.

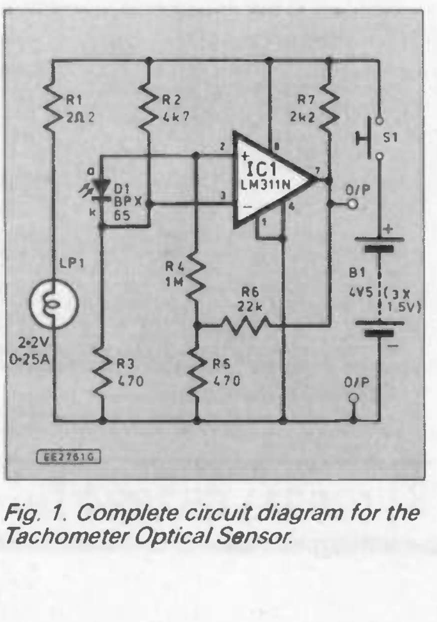


Fig. 1. Complete circuit diagram for the Tachometer Optical Sensor.

In the circuit diagram the cathode (k) of the photodiode is maintained positive with respect to the anode (a), so reverse biasing the device. The inverting input (pin 3) to the comparator IC1, a type LM311N, and the photodiode cathode are held at a fixed potential determined by the resistors R2 and R3, and provided the light incident on the diode junction is below a given level, the output from IC1 will be low, typically about 0.2V.

When the incident light exceeds the preset level, the output switches high. This output, at about 4.5V, is TTL compatible.

There is a small amount of hysteresis built into the circuit so that the switching transitions are clearly defined for both light intensity increasing from dark and decreasing from bright through the switchover levels.

The self contained light source, derived from the lens-ended lamp, LP1, which provides a degree of beam concentration, is used in those applications where external illumination may not be possible or

COMPONENTS

Resistors

R1	2Ω2	
R2	4k7	
R3,R5	470 (2 off)	
R4	1M	
R6	22k	
R7	2k2	

All 0.5W 5% carbon

See SHOP TALK Page

Semiconductors

D1	BPX65 photodiode
IC1	LM311N voltage comparator

Miscellaneous

S1	Push-to-make button switch
LP1	2.2V 0.25A lens-ended bulb
B1	1.5V AA size battery (3 off)

Printed circuit board, available from EE PCB Service, code EE705; ABS case, size 113mm x 63mm x 31mm; 6BA screws and nuts (2 off each); connecting wire; solder etc.

Approx cost guidance only **£14**

desirable. The lamp, rated at 2.2V, 250mA, is run from the internal 4.5V source along with the rest of the circuit, resistor R1 dropping the supply voltage to the level required by the lamp. The current drawn by the amplifier section is negligible.

The circuit is switched on by the push-to-make button type switch S1, which is ON only while being pressed. This is used rather than a conventional toggle or slide type for the reason that the unit is normally handheld and adjusted in distance from a rotating mechanism only for a sufficient time for an output to be read or recorded. For applications where continual monitoring might be necessary, a slide switch could be substituted.

CONSTRUCTION

The assembly of this unit is very easy. All the components including the lamp and the photodiode (but not the on-off push switch S1) go on to a small printed circuit board. This board is available from the *EE PCB Service*, code EE705.

The board is extended beyond the actual circuit area so that the battery supply can also be attached to it; this enables the whole "caboodle" to drop into the plastic case without any bits and pieces floating about on the ends of long wires. The selected case measures 113mm by 63mm by 31mm, but anything larger may be used if, say a larger battery capacity is needed or if such a box is readily to hand.

The printed circuit board component layout and full size copper foil master pattern is given in Fig.2. There are two 6BA clearance holes drilled in the board at points A-A which are used to hold a simple clamp for the battery supply. These same holes are also used to bolt the board to the base of the box, so *before* doing anything else, drop the board into the box and mark these hole positions through.

Now get all the resistors soldered in, followed by IC1 (which may have a holder if you don't like soldering i.c's into circuit), then mount the photodiode and bulb. Bend the leads of the diode through 90 degrees at about 4.5mm (3/16") from the body of the device, see Fig. 3, ensuring that the "tab" on the case, which indicates the *anode* lead, is in the position shown.

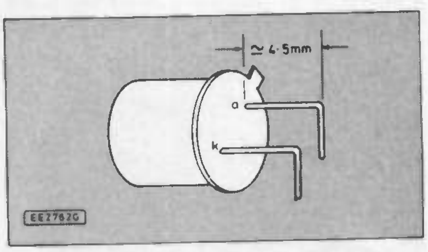


Fig. 3. Carefully bend the photodiode leads through 90 degrees as indicated.

This allows the anode and cathode connections to go correctly into the board holes without crossing over themselves. The window end of the diode should then project about 5mm (3/16") beyond the edge of the board; refer to Fig.2.

The lamp LP1 is not mounted in any sort of holder but is simply soldered to the appropriate board pads with short lengths of wire. Position the bulb so that the filament lies horizontal.

When soldered in, the bulb should lie *just* clear of the board with the lens front in line with the overhang of the photodiode and very *slightly* skewed relative to the direction of the photodiode. Fig. 2 should make this clear, where the approximate spacings are indicated.

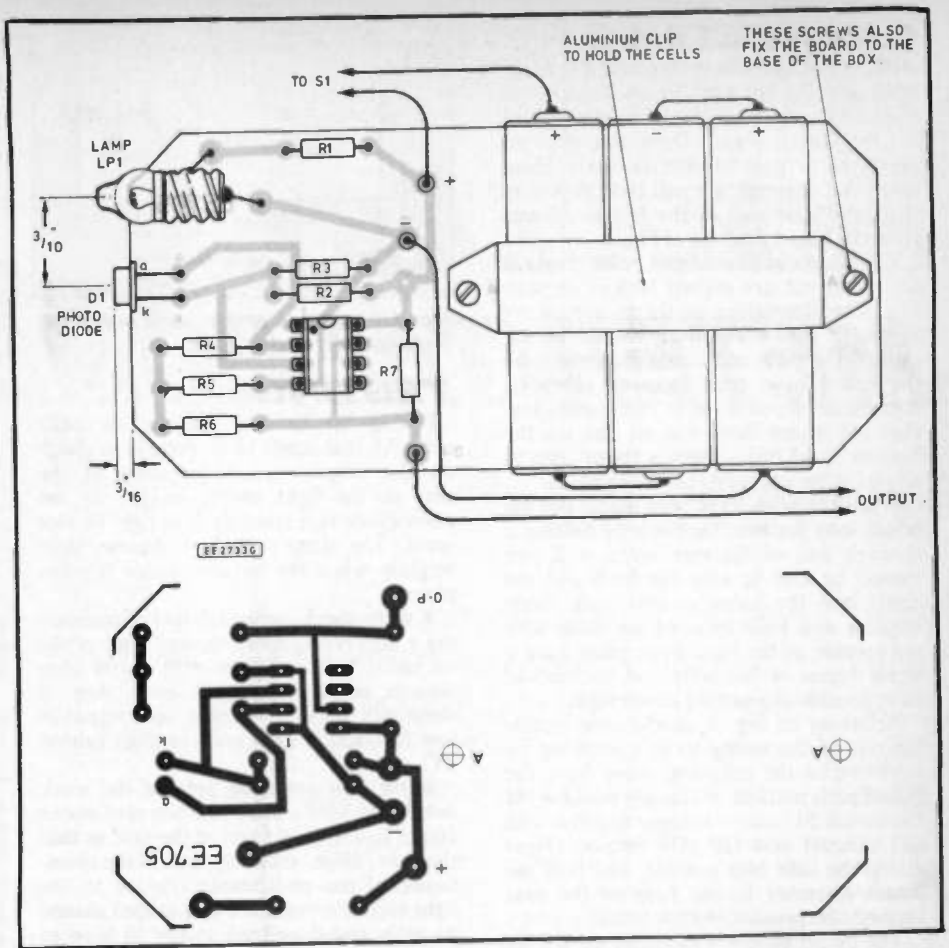
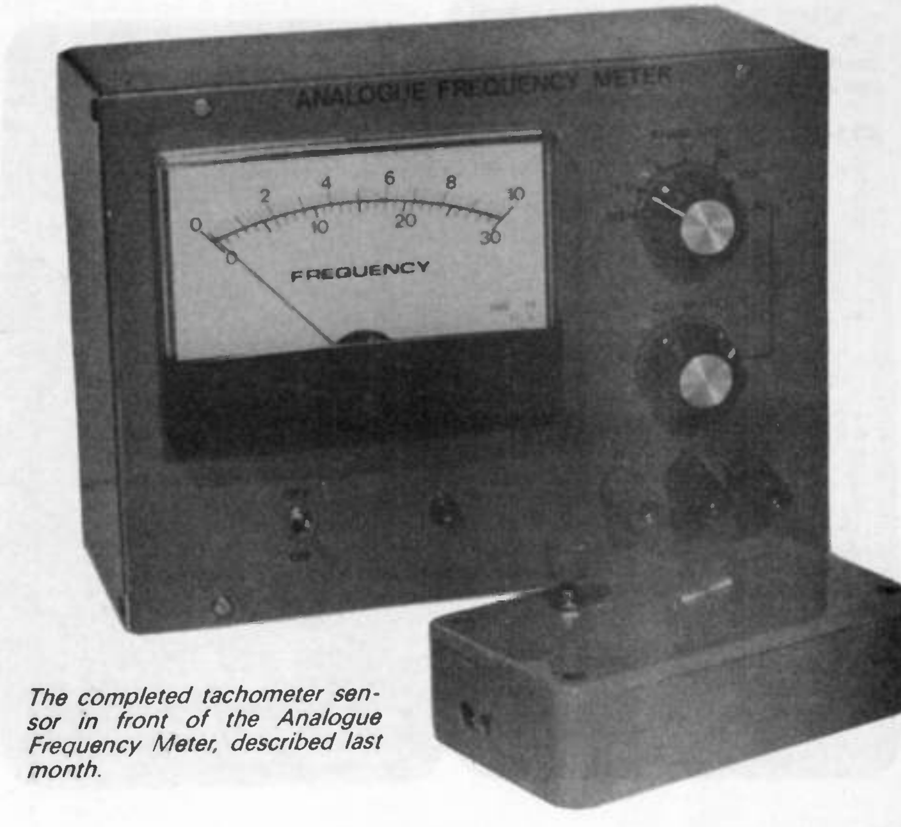


Fig. 2. Printed circuit boad component layout and full size copper foil master pattern. The corners of the board have been trimmed to fit the case and the batteries are held in position with a thin metal "strap".

The battery supply is made up from three AA size 1.5V cells held together initially with a turn of adhesive tape and then connected in series as Fig. 2. shows. It is necessary to use cells of at least the current capacity of the AA size as the bulb is a little greedy (250mA); if you use a larger box you may be able to use a single 4.5V "torch" style battery in this position.

A simple clamp made out of thin aluminium is used to hold the battery to the p.c.b. extension during final assembly. Don't fit the cells at this stage though.



The completed tachometer sensor in front of the Analogue Frequency Meter, described last month.

CASE DETAILS

The next stage is to get the board (less the cells) into the box and cut openings in the ends for (a) the bulb and photodiode, and (b) the output leads. These last pose no problems, a pair of flexible wires being taken out through a small hole drilled in the right-hand end of the box as viewed from the board position of Fig. 2.

The lamp and photodiode holes, made at the other end, are slightly trickier to position. The dimensions on the prototype are shown in Fig. 4 and these should be allright if the bulb and diode mountings on the board have been followed carefully. Remember, if you do your own measuring, that the board does not sit flat on the bottom of the box – there is about 2mm to allow for the underside soldering blobs.

When the holes have been made, put the board into the box, temporarily bolting it through one of the case holes, and you should be able to ease the bulb and the diode into the holes so that both diode window and bulb lens-end are flush with the outside of the box. Both parts have a small degree of flexibility and you should have no difficulty getting things right.

Referring to Fig. 2 should now enable the rest of the wiring to be completed by soldering in the outgoing wires from the board pads marked + (supply positive via the switch S1) and − (supply negative and LO output) and OP (HI output). Next clamp the cells into position and bolt the whole assembly to the base of the case through the pre-drilled 6BA holes.

The on-off switch is mounted on the lid of the box in a position immediately above the near-central base fixing hole. It then clears both the cell assembly and the circuit parts. You need not fix this until you have tested the unit.

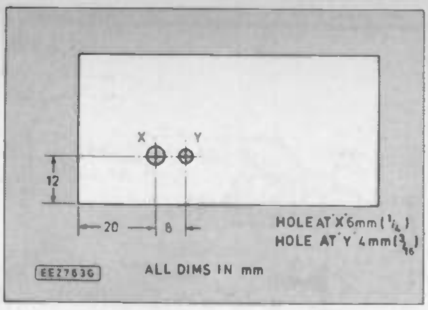


Fig. 4. Lamp and photodiode hole drilling details in end of case.

TESTING

Testing the finished "sensor" is quite easy. All that needs to be done is to check on the proper switching action of the unit as the light input changes at the photodiode face from dark to light or vice versa. The lamp should, of course, light brightly when the battery circuit is completed.

A static check consists simply of connecting a high resistance voltmeter, logic probe or just a l.e.d. in series with a 100 ohm resistor across the output leads. Any of these will indicate whether the output is low (a fraction of a volt) or high (about 4V).

Move into a shaded area of the work bench and hold a piece of white card about 50mm to 75mm in front of the unit so that the light "blob" is clearly seen. If the orientation of the photodiode relative to the light blob is correct, the unit output should go high, and drop back to low as soon as the card is removed.

APPLICATIONS

The Simple Optical Sensor was originally designed for the measurement of shaft

speed but there are a great many other possible applications.

Uses which require the internal light source operate on the principle that the light is reflected from the specimen under investigation and returned to the photodiode as a modulated signal. Fig. 5 illustrates this; stripes of black and white paint are painted as parallel longitudinal equally spaced areas on to an accessible part of the shaft (or on to a sectionalised disc attached to the end of a shaft) and the

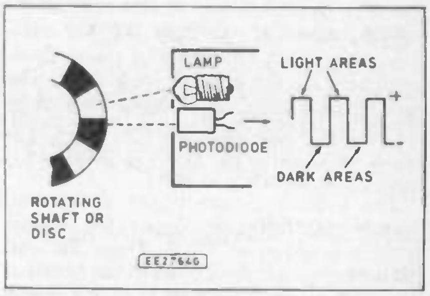


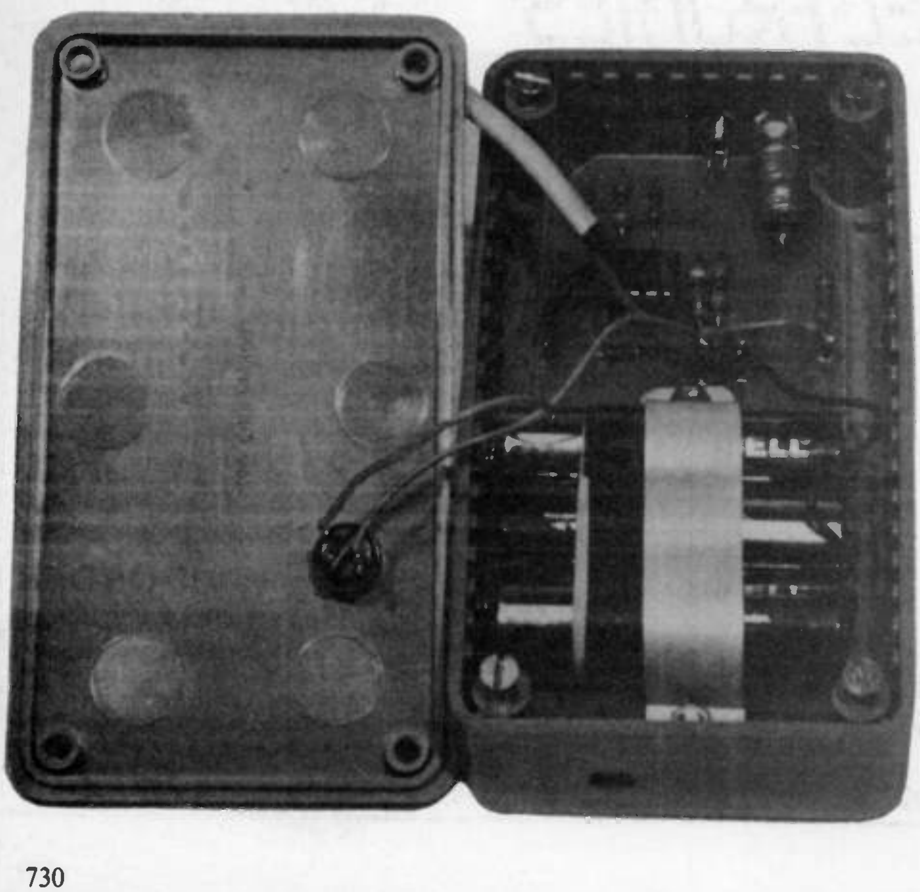
Fig. 5. The principle behind the measurement of rotational speeds.

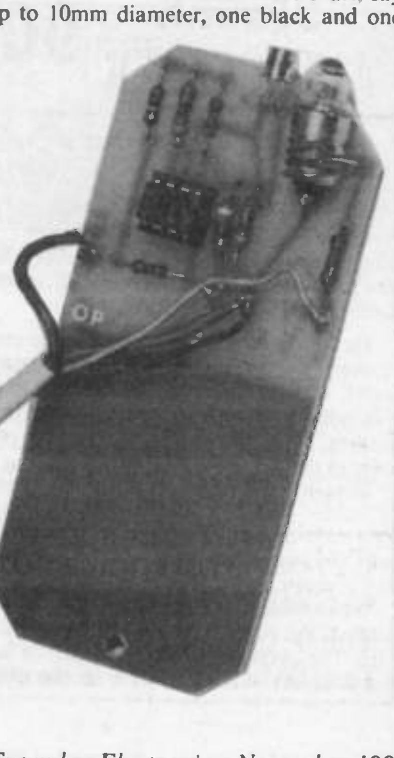
reflected light is then effectively turned on and off to the receiving eye of the photodiode.

The output of the comparator circuit is then a square wave train whose frequency is a function of the shaft speed. This frequency is measured on the meter scale and interpreted in terms of rotational speed. Operation up to 250kHz is possible with the specified photodiode.

The number and width of the stripes are a matter of an estimation of the shaft, say up to 10mm diameter, one black and one

The printed circuit board is held in position in the case by the battery strap mounting nuts and bolts. Two short wires from the board are soldered directly to the bulb, which also holds it in position.





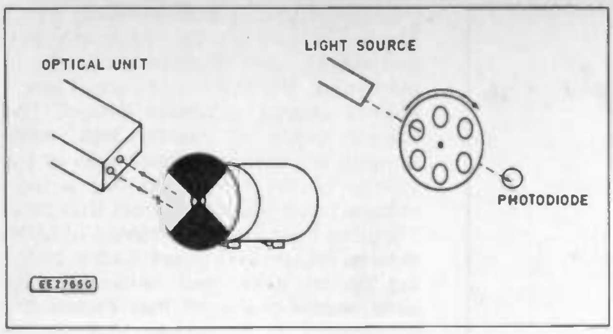
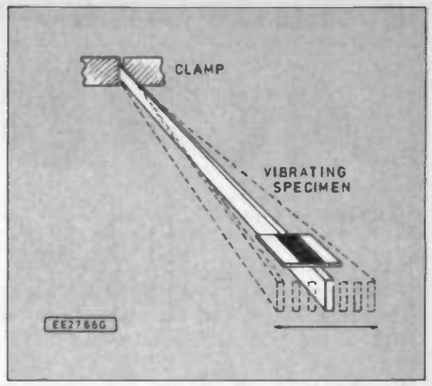


Fig. 6 (left). Two methods of measuring the speed of a motor.

Fig. 7 (right). A method of measuring transverse vibration.



white area would be practicable, but for larger shafts the number should increase.

As the best working distance of the Optical Sensor from the marking is about 50mm-75mm the width of the stripes should be above a certain minimum so that the light beam or "blob" illuminates one dark or one white area at a time. As a rough guide, strips from 10mm to 15mm in width are suitable.

SHAFT SPEED

The calculation of shaft speed from the indicated frequency is simple. Knowing the number of stripes, and the fact that one black plus one white stripe equals one cycle of input to the frequency meter, the relationship is:

$$\frac{\text{number of stripes}}{2} \times \text{revs per sec} = \text{frequency}$$

so that

$$\text{revs per sec} = \frac{2 \times \text{freq}}{\text{Number of stripes}}$$

Thus, for one light and one dark stripe as may be painted on a thin shaft, a frequency output of 30Hz would correspond to:

$$\frac{2 \times 30}{2} = 30 \text{ revs/sec or } 1800 \text{ revs/min.}$$

While on a larger shaft having, say, four light and four dark stripes, the same speed would give an output frequency of 120Hz.

When using the sensor, excessive ambient light should be avoided, particularly light coming from a.c. sources, notably flourescent lighting. The flicker frequency of these devices is 100Hz and this could, in an extreme case, disguise the true frequency reading coming from the shaft markings.

Two other practical applications are shown in Fig. 6 and Fig. 7. In the first of these, the speed of a motor is measured.

Some form of disc is attached to the end of the motor shaft and the surface of this disc is divided into a number of black and white sectors. Two or four are usually sufficient.

As the shaft rotates the light beam reflected to the photodiode is modulated as before and an interpretation of the output frequency enables the motor speed to be calculated. An alternative to this is to have the disc perforated with a number of holes around the circumference and an external light passes through these on to the photodiode. Fig. 6 also illustrates this alternative method.

How the measurement of a fast transverse vibration might be measured is shown in Fig. 7. A piece of card having one black and two white areas is attached to the vibrating specimen so that the black area is facing the photodiode i.e. the centre point of the vibration.

This time two output square waves represent one vibration of the specimen. By feeding the output to an oscilloscope whose timebase is synchronized to the vibration period of the specimen, a good demonstration of damped vibrations can be obtained as the vibrations die away. □

ACTUALLY DOING IT!

by Robert Penfold

JUDGING from comments in readers' letters over recent years, there seems to be a certain amount of misunderstanding about static-sensitive components. In particular, there is some confusion over which components are vulnerable to damage from high voltage static charges, and which are not.

I suppose that strictly speaking a great many components, particularly semiconductor types, are to some extent vulnerable to static charges. However, the risk to most types is negligible, since the static charges needed to damage them would be far larger than would be likely to occur in a normal environment.

The only components that are really at risk are MOSFETs (metal oxide silicon field effect transistors), and the integrated circuits that utilize some form of MOS technology. This means that most semiconductors are not in any real danger of being "zapped" by static charges from carpets, clothing, etc., but there is a significant and an ever increasing number of devices which are at risk.

SAFETY FIRST

If we take the semiconductor devices that you do not need to worry about first, these include all the bipolar transistors. In other words, the popular BCxxx and BFxxx series, ordinary power transistors such as the 2N3055, and the vast majority of transistors infact.

Junction gate field effect transistors (Jfets) are not particularly vulnerable to static charges, and are in the risk-free category. A couple of popular examples of Jfets are the 2N3819 and the BF244. Unijunction transistors such as the TIS43 are little used these days, but these are also not at risk from normal static charges.

Neither are germanium and silicon diodes such as the 0A91 and 1N4148, or rectifiers such as the 1N4001, 1N4002, etc. Many integrated circuits do not use MOS technology, including the standard 74xx series and 74LSxx series TTL logic devices, voltage regulators, audio amplifiers, and the popular µA741C operational amplifier.

Opto devices such as l.e.d.s, phototransistors diodes, and opto-isolators are all non-static sensitive components. As far as I am aware, the only normal opto-components that are vulnerable to static charges are liquid crystal displays (l.c.d.s). With l.c.d.s it is not so much the component being "zapped" that you have to worry about, as relatively small d.c. voltages turning on some of the segments and causing them to rapidly degrade. These components must only be run from a.c. signals, and when not in use none of the segments should be switched on.

SENSITIVE

Components in the static sensitive category include MOSFET transistors, but few of these are used in designs for the electronics hobbyist. The only area of electronics in which MOSFETs seem to be used to any large extent is radio equipment. Radios and other radio frequency equipment often use MOSFETs, usually in the guise of dual gate devices such as the 40673.

Some dual gate MOSFETs (but not the 40673) have integral protection circuits that render special handling precautions unnecessary. Those that do not are normally supplied with a metal clip or a piece of wire short circuiting all four leadout wires to the metal casing. There is no risk of static damage to these components while the clip or wire is in place. Normally they are soldered into circuit with the short circuit in place, and the clip or wire is removed once construction has been completed.

PROTECTION

Some MOSFETs have integral protection circuits, but are also supplied complete with a shorting clip. The reason for this is simply that not all protection circuits are guaranteed 100 per cent effective. Many MOS and CMOS integrated circuits have built-in protection circuits but are still to some extent vulnerable to damage from static charges.

The benefit of having all the leadout wires shorted together by a piece of wire may not be immediately obvious, but the point to remember here is that any damage from high voltages will be caused by a voltage across two or more leadout wires. If they are all connected together, any static charge will simply take all the leadout wires to the same voltage. It does not matter how high that voltage is – with all the leadout wires at the same potential and no voltage differences between them, no harm will come to the transistor. This short circuit method is probably the most common one for protecting static sensitive components.

Apparently, the reason that non-MOSFET components are not at any great risk is that there are relatively low impedances across their terminals. This effectively gives them a built-in shorting clip that prevents any large voltages developing across their terminals.

Bear in mind that although static charges often have very high voltages, perhaps of many thousands of volts in magnitude, the amount of current available is usually extremely limited. The current tends to rapidly leak away through any low impedance path in the vicinity of the charge, so that a high voltage never develops across that path. The ultra-high input impedance of MOS devices results in charges readily building up on their input terminals, possibly reaching a level that causes the component to breakdown and sustain damage.

There are two special types of power transistor that are forms of MOSFET; the VMOS transistors and the power MOSFETs. Neither of these are much used, but they are used in some designs for the electronics hobbyist. VMOS transistors mostly have built-in Zener protection diodes which render special handling precautions unnecessary. The VN66AF, VN67AF, VN10KM, etc., all have this protection diode. However, if you are unsure if a VMOS transistor is protected against static, it makes sense to play safe and assume that it is not.

The power MOSFETs include transistors such as the 2SJ49 and 2SK134, which feature in a number of high quality d.i.y. audio power amplifiers. As far as I am aware, these do not include any form of built-in protection circuit, and they require the normal anti-static handling precautions to be observed.

INTEGRATED CIRCUITS

It can sometimes be difficult to tell whether an integrated circuit is a static sensitive device, and the only certain way of settling the issue might be to consult the manufacturers data sheet for the device in question. There are devices which are quite definitely in the static sensitive category though, and this includes CMOS logic integrated circuits. This does not just mean the 4000 series of integrated circuits, but also the TTL types that make use of MOS technology. These include the 74HCxx and 74HCTxx series, which seem to be rapidly gaining in popularity.

Virtually all computer integrated circuits are based on either MOS or CMOS circuits. This means that microprocessors, memory chips, UARTs, peripheral devices (the 6522, 8255, etc.), all require the standard anti-static handling precautions. There are some exceptions, such as the popular Ferranti digital to analogue and analogue to digital converters (the ZN447 etc.). However, these are the only obvious exceptions that spring to mind, and most of the other converter chips are actually MOS types.

Computer integrated circuits are mostly quite complex, and it seems to be the case that all other complex integrated circuits are of either the MOS or CMOS varieties. Complex chips such as digital voltmeters, clocks, and sound generators are therefore all static sensitive types.

Some operational amplifiers are vulnerable to static charges, but most are not. The ones that require handling precautions are the ones which have MOS input stages, which mainly means the CA3130, CA3140, CA3160, and CA3240. Note that bifet and similar types which have Jfet input stages (TL081, LF351, etc.) are not static sensitive devices. Neither are devices such as the

741C, 748C, NE531, etc., which are based on ordinary bipolar transistors.

ANTI-STATIC PACKING

Integrated circuits that require protection from high static voltages should be supplied in some form of anti-static packaging to protect them in transit. There are several forms of anti-static packing in common use, one of which is conductive foam. This is a plastic foam material that is normally black in colour, and which conducts electricity. It does not actually seem to conduct it very well, but it is adequate to prevent a large voltage difference building up across the pins imbedded into it.

Some retailers use ordinary (ceiling tile type) plastic foam, but with a layer of aluminium foil on top to provide the short circuit between the pins. It is not a good idea to store static sensitive integrated circuits in ordinary plastic foam without a layer of aluminium foil being included. Plastic foam is a material that is often associated with the generation of static charges!

Another form of anti-static packaging is the plastic tube variety. The tubes of this type I have tested do not seem to be constructed from a conductive plastic. Presumably the idea of these is to insulate the devices they contain from any static charges, not to provide a low impedance across the leadout wires.

The only other common form of anti-static packing is the miniature "blister pack" type, which has metal foil over the cardboard backing material. This is in contact with the pins of the integrated circuit, and it consequently short circuits them together.

STANDARD PACKAGING

Possibly one reason for some people getting the impression that some non-vulnerable components are vulnerable to static charges, is that virtually all integrated circuits now seem to be supplied in one of the forms of packing mentioned above. This is probably due to there being economic advantages in standardising on one form of packing, rather than using one type for MOS components, and another for non-MOS devices. You should certainly not assume that a component is vulnerable to static charges simply because it is supplied in some form of anti-static packaging.

ZAPPING AVOIDANCE

The risks of "zapping" components with static charges are sometimes over-emphasised. I have had some of the more exotic integrated circuits supplied with warning notices that suggest they will be instantly destroyed unless they are handled by anything short of earthed personnel in a special anti-static chamber!

Many constructors ignore all the dire warnings and seem to run into no difficulties. I generally do not bother too much about low cost devices of a type where I have some spares immediately available. I am more careful with the more expensive devices, or low cost ones that cannot be quickly replaced. You have to decide for yourself which devices are and which are not worthy of the anti-static handling precautions.

I have already mentioned MOSFETs, and the metal shorting clips that are used to protect them while they are soldered into circuit. Once in a completed circuit, the resistors etc. in that circuit normally provide relatively low impedance paths that effectively protect the device.

Unfortunately, there is no equivalent to the shorting clip for integrated circuits. Presumably a clip that would connect together about eight to forty pins would either be too expensive, or too difficult to reliably remove from all the pins once the component was soldered in place. Consequently, the best advice is to not solder vulnerable integrated circuits into circuit unless it is absolutely essential to do so for some reason. There is not normally any problem if a holder is used for an integrated circuit, but they are not recommended for some devices that are used at very high frequencies.

SOLDERING

I would strongly recommend the use of holders for all d.i.l. integrated circuits regardless of whether they are static sensitive. If you should accidentally fit an integrated circuit round the wrong way, or should need to remove it from a circuit board for some other reason, it only takes a second or two if it is fitted in a holder. If it is not, and even if you have proper desoldering equipment, removing an integrated circuit can be difficult and time consuming. Worse still, there is a real likelihood of damaging the printed circuit board in the process of removing the component.

If the use of a holder is not possible for some reason, use a soldering iron having an earthed bit (most electric irons are of this type these days). It is often suggested that the supply pins should be soldered first, but I am not entirely convinced that this is of any practical help. It certainly is advisable to fit the static-sensitive components last. Otherwise you may be putting them at risk while connecting components that are in electrical contact with them.

HANDLING

Whether a device is soldered directly to the board or socketed, handle it as little as possible. Leave it in the anti-static packing until it is time to fit it into place, and then avoid touching the pins any more than is really necessary.

Fitting d.i.l. integrated circuits is often a bit tricky, and there is little chance of fitting them without touching the pins at all. It is a matter of trying to keep contact with the pins to a minimum.

It makes sense not to wear clothes that are known to be good generators of static electricity. Those that are made from natural fibres, or contain a reasonable percentage of natural fibres, are generally less prolific static generators than those that are wholly made from man-made materials. Do not have any good static generators (such as a portable television) on the workbench.

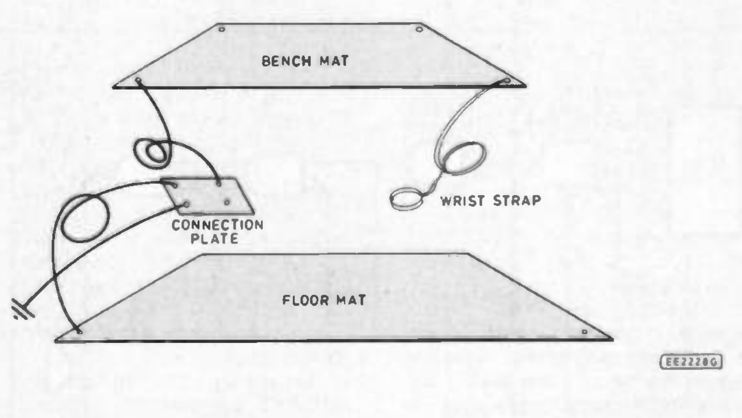
ANTI-STATIC EQUIPMENT

There are anti-static devices available, but much equipment of this type is in a price range that renders it only suitable for those involved in electronics on a commercial scale. Money spent on this type of thing could easily cost several times more than the value of components it would save from being "zapped". There are some low cost devices that could be worthwhile, such as an anti-static wrist strap.

This is basically just a wrist strap which is made from a material that conducts electricity, connected to a length of wire terminated in a crocodile clip. The idea is to connect the crocodile clip to an earth before the voltage builds up to significant proportions. There is a high value resistor in the lead which limits the current flow to a safe level if the user should touch a "live" wire.

These wrist straps should be very effective, but many people adopt the simple alternative of occasionally touching an earthed object (the metal case of a piece of mains powered equipment for instance) before touching vulnerable components.

There is a similar idea in the form of anti-static work mats. This is a mat made from a conductive material which is placed on the worktop when using static sensitive components. It is connected to a wire which has its free end connected to an earth. This helps to eliminate static charges from any equipment or components placed on it, or anyone who touches it. This should be a very effective way of combatting static problems, and I would guess that it would probably not be too difficult to improvise a d.i.y. version of an anti-static worktop.



An example of commercial antistatic work area mats and connections. For d.i.y. enthusiasts a bench mat, possibly made from antistatic foam plus a wrist strap will be suitable.

Constructional Project

WHISTLE BOX TIMER

G. M. WORTHINGTON

You whistle at it — it whistles back — every other second. Very useful in a darkroom!

CIRCUITS for darkroom timers are fairly common, and they all have one feature in common – three switches on the front panel; one turns the timer On/Off, another sets the length of the timing period and a third starts the timing. Working in dim light or darkness this cannot be ideal, so the following circuit reduces the number of switches to one.

The Whistle Box Timer itself has no external controls. The user whistles and the timer switches on, giving a one second beep at two second intervals. He/she can then operate the enlarger lamp, for any length of time from one second upwards, using a single conveniently positioned switch. Another whistle turns the timer off.

The circuit uses CMOS i.c.s so two AA size 1.5V batteries should have a long life. The tiny standby current – about 30μA – means that an on/off switch is unnecessary and the only features on the case are the two piezo transducers. Other benefits include a saving on time and space, while maintaining a comparable level of accuracy to other timers. The one catch is that the user must be able to whistle!

CIRCUIT DESCRIPTION

The circuit (Fig. 1) uses the UM3763 Whistle Control i.c., which responds to input signals greater than ≃10mV peak to peak at a frequency of 1.2kHz – 1.8kHz. After 256 waveforms with frequency 1/10 – 1/15 of the internal oscillator's (about 18kHz, partly set by R1), the output at pin 8 is toggled.

IC2a and IC2b form a slow oscillator, with VR1 allowing adjustment of the frequency to 0.5Hz. The output of IC2b gates the second oscillator (IC2c/IC2d), which is disabled when IC2c, pin 8 goes low. Preset VR2 controls the pitch of the beep.

CONSTRUCTION

Construction should not pose any problem, provided care is taken to avoid static damage. The i.c's are quite well protected, so it would probably be sufficient to first touch an earthed point, like a mains water pipe – also, sockets are used for the i.c.'s, the last components to be fitted. The value of C4 isn't critical and can be considerably reduced. R1 can have any value from 560k to 680k.

A Veroboard layout is given in Fig. 2. The circuit is fairly simple and fits the 10 strips by 29 holes size of Veroboard (costing around 40p), so a p.c.b. was not considered worthwhile.

The case needs two holes, for the leads of transducers X1 and X2. The open style transducer used in the prototype is now difficult to get and an enclosed type is now recommended. For best results, the transducers should be rigidly mounted. The sound from X2, while of low volume, is quite penetrating, nevertheless, Fig. 3 might be useful in some locations, this adds an l.e.d. output.

TESTING AND ADJUSTMENT

The circuit could be tested "one i.c. at a time", or the total supply current briefly measured on, say, a 2.5mA multimeter range. A tiny "kick" should be seen as C4 charges, the current settling to a very low value. If anything more dramatic occurs, the circuit should be instantly disconnected before i.c.(s) and/or meter begin to cook.

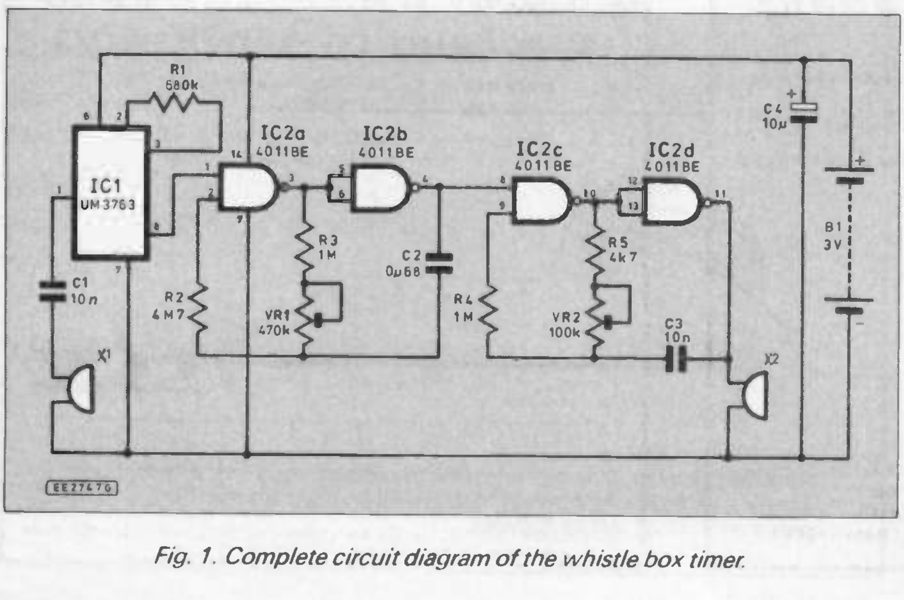


Fig. 1. Complete circuit diagram of the whistle box timer.

COMPONENTS

Resistors

R1	680k
R2	4M7
R3,R4	1M (2 off)
R5	4k7

See SHOP TALK Page

Potentiometers

VR1	470k horizontal preset
VR2	100k horizontal preset

Capacitors

C1,C3	10n polyester (2 off)
C2	680n polyester
C4	10μ elect. 12V

Semiconductors

IC1	UM3763 whistle switch
IC2	4011BE quad 2-input Nand

Miscellaneous

X1, X2 piezo sounder (2 off – see text); Veroboard size 10 strips by 29 holes; plastic case approx 100 x 75 x 40mm; connecting wire, etc.

Approx cost guidance only **£5**

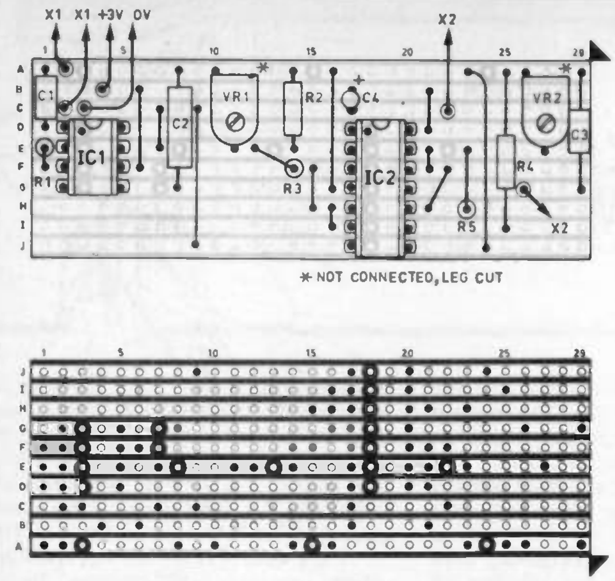
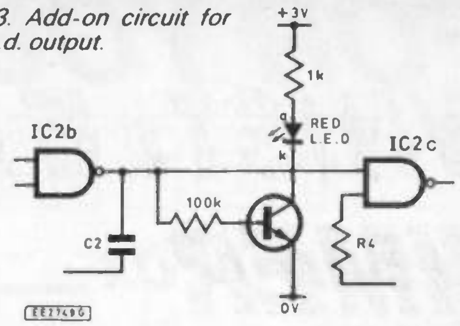
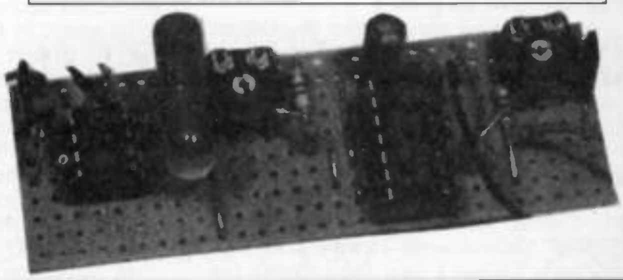


Fig. 2. Veroboard layout and wiring for the Whistle Box Timer.

Fig. 3. Add-on circuit for an l.e.d. output.





The UM3763 seems insensitive to background noise and is quite reliable in use. Any problems would probably result from the whistle being too quiet/short/high/low. If IC1 still seems dead, try linking pins 4 and 6, then momentarily grounding pin 5 – this should trigger the i.c.

Next the two presets will need to be adjusted. The setting of VR2 depends on personal preference, so long as the chosen pitch allows reliable operation of the circuit. VR1 should be set to give a beeping frequency as close as possible to 0.5Hz. Once this keeps good time for a minute or two, adjustment is complete.

IN USE

The unit is simple to use – with a little practice the UM3763 can be triggered first time, and the 0.5Hz signal makes counting easy. ("On!... Two... Four... Six... Eight... Ten... Off!" etc.)

Good quality batteries should last a year without difficulty and a "battery low" indicator was not considered necessary. With weak batteries the circuit becomes unreliable and the pitch of the "beep" alters – about 2.7V would probably be the lower limit. Every couple of months the circuit can be left running for a few minutes and the timing accuracy checked.

The box is mounted a couple of feet from the user and finally, for maximum accuracy, it might be worth using a mains rated, correctly insulated push-switch or micro-switch to control the enlarger. □

FOR YOUR ENTERTAINMENT

by Barry Fox

Backed By BT

You may have noticed that the Cellnet cell phone service now has a new logo. It comes with a completely new management, under new managing director Stafford Taylor who was previously with IBM.

Taylor was known in the trade as "the invisible man". He did not meet the press until May 1990, a full year after taking the Cellnet job. Virtually none of the original Cellnet staff remain and significantly Cellnet's new logo carries the tag "Backed by British Telecom". This is exactly what the previous management had fought against, knowing that in many quarters BT is thought of as big, bad and ugly. They preferred not to remind potential customers that BT owns 60 per cent of Cellnet (Securicor the other 40 per cent).

The "backed by BT" move looks like a desperate gamble by Cellnet to win back cellphone market share lost to competitor Racal-Vodafone. While Vodafone has well over half a million subscribers, Cellnet trails at well under. The word from the trade is that the dealers, selling cellphones, feel happier dealing with Racal. The year's silence from Cellnet did not help.

Stafford Taylor says he is now ready to talk, and that BT's image has now improved so much that the BT tag will be a benefit.

"We are backed by BT, there is no point in trying to pretend that we are not," says Taylor. "It is time to come out of the closet and say so."

Time Will Tell

Cellnet lost subscribers because its service was poor, with congestion meaning that up to one in ten calls did not get through at peak times and connected calls often broke off halfway through. This followed from Cellnet's early decision to engineer the system so that a caller in a congested cell can grab a line from a neighbouring cell, if there is one spare. Racal fought congestion by lobbying the government for more frequencies.

The real solution to congestion is to create more, smaller cells, by building more base station transmitters, each operating at lower power over smaller areas so that the same voice channel frequencies can be re-used many times across the same city. Both networks are splitting cells, so far Racal has been better at keeping ahead of demand than Cellnet.

Cellnet now says it is spending £4 million a week on cell-splitting, and will continue until March 1991. This has increased capacity by 60 per cent; there were 11,000 voice channels spread across Britain in November 1989 and by may 1990 there were 19,000. In the spring there were 570 base stations across the country, with another 200 due to be added by March 1990. The smallest cell in Britain is at Oxford Circus in London, with a range of just 0.5km.

The current plan, says Cellnet, should provide the capacity to cope with one million subscribers. The best way to gauge a cell phone system's quality, says Taylor, is to compare the number of subscribers who have to share the same voice channel.

In November 1989, at Cellnet's worst time for congestion, an average of 35 subscribers were sharing each voice channel. Now the number is 25 per channel. Cellnet aims for 20 per channel or below.

Taylor says he wants "quality" customers, business people who use their cell phones heavily, as a tool, rather than private users who regard the cellphone as a status toy. Profit does not come from the £25 standing monthly charge which all subscribers pay, but form calls which earn Cellnet (like Vodafone) around 40p per minute during business hours in London. Racal with more business customers, creams more profit from calls.

Cellnet's MD Taylor is markedly unenthusiastic about the proposed new pan-European cellphone system called GSM. Although Cellnet is party to the international memorandum of Understanding, which promises a GSM pan-European service in major cities starting next year, Cellnet is spending only £35 million on adding GSM transmitters and computer switches to a few of its existing base stations. This is small beer compared to the £4 million a week which Cellnet spends on installing new base stations for its existing service. Stafford Taylor admits he has doubts about the planned launch of GSM scheduled for June 1991.

"I am sceptical of the manufacturers' ability to supply GSM phones," he says. "There won't be anywhere near the extensive cover offered by existing services and the equipment will not be anywhere near as lightweight. The key question is, what does the customer need of a cell phone service?"

In fact there is one very major benefit offered by GSM. Because speech is carried in compressed digital code, there is no chance of eavesdroppers receiving it on the "scanner" radios which are now widely sold for £200 or less. Whereas there are many legitimate reasons for marketing analogue scanners (e.g. to tune into amateur radio bands) anyone marketing or demonstrating a scanner which decodes digital GSM speech would become an easy target for the law.

But Taylor is not convinced that eavesdropping concerns his customers, even though they may be stockbrokers, estate agents and lawyers dealing with confidential information.

"Does it matter?" asks Taylor. "You are not addressing the question to the right person. There is very little I can do. It hasn't affected business. We have made representations. But is it important?"

Grey Area

Some interesting thoughts on TV sets from Bang and Olufsen's engineers in Denmark. Why, I asked, cover the picture tube with a dark glass screen and reduce picture brightness? The aim, they explain, is to increase contrast, i.e. expand the difference between dark and white.

Remember that black on a TV screen is never true black, because what you are seeing is an area of the screen where the phosphors are not generating light. Although in reality grey, this area looks black in contrast to white areas.

Some manufacturers increase contrast by pumping more power into the electron beam so that white is made brighter. B and O achieve the same result by making black look blacker, by darkening the unlit areas of the screen with dark glass. The advantage of the B and O approach is that it reduces the flicker in bright white areas, like snowscapes, which is often visible on PAL TV sets with 50Hz field rate. The disadvantage is that the overall picture looks less bright. There is a limit to how much power you can pump into the electron beam to compensate for the reduction in white brilliance.

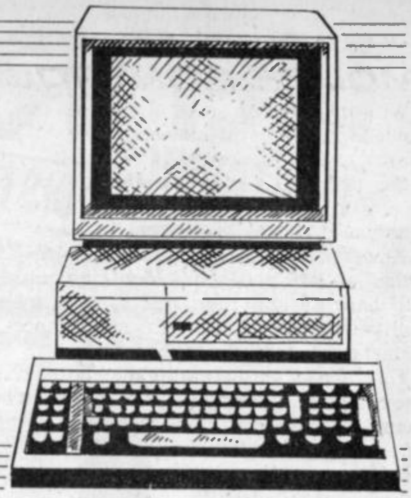
The use of a dark contrast screen has led B and O to stop development of 100Hz "improved definition" TV sets which artificially double the broadcast line structure by using each 625 line image twice.

"In our opinion IDTV does not give value for money" says B and O. "The main incentive for doubling line or field rate is to reduce flicker and we have already achieved that with the contrast screen. The penalty of IDTV is artifacts on motion, caused by using information from the same picture twice.

B and O also has interesting ideas on HDTV and wide screen TV sets. Anyone who sees an HDTV is at first thrilled at the clarity. But later they notice that the picture is very dim. This is because the electron beam must be focused into a very small spot, so has less energy to create light. Also the spot has to travel further to cover the wide 16:9 screen than it does to cover a conventional 4:3 screen. For this reason an IDTV wide screen picture will also be less bright.

One hint for the future - making the electron beam spot oval instead of round can achieve much the same effect as doubling the line structure electronically.

Special Feature



ELECTRONICS and CAD

ROBERT PENFOLD

Microcomputer based Computer Aided Design systems now have respectable performance — we take a look.

FOR MANY years now microcomputer based CAD systems have tended to be taken less than entirely seriously by users of "real" CAD systems based on mini and mainframe computers. While it is true that microcomputer based systems still fall short of the performance of mainframe systems, advances in hardware and software over recent years have transformed their level of performance, and broadened the scope of micro based systems.

These days CAD plays a role in a great many products, including *Everyday Electronics*. It seems to be a main growth area in the computer world, and is likely to be of increasing importance in the future.

WHAT IS CAD?

CAD stands for either "computer aided design", "computer aided drawing", or "computer aided drafting." These last two are much the same, and mean using a computer based system to produce any technical drawings. Computer aided design can mean the production of drawings on a computer, and CAD produced printed circuit designs would certainly fall into this category.

CAD does not necessarily involve any drawing though. An example of non-drawing oriented CAD would be a program for modelling electronic circuits. Details of the circuit diagram are entered into the program, which then analyses the circuit's performance, giving graphs of phase and frequency response over a specified frequency range perhaps.

If we consider CAD in the drawing sense first, not all drawing programs qualify as what is conventionally regarded as CAD software. Probably many *Everyday Electronics* readers have tried out one of the popular paint programs, and these are certainly not in the CAD category. Programs of this type are pixel oriented, and this limits them in two important respects.

The first of these is simply the accuracy of the final output. The drawing is stored by the computer as a bit pattern which has a degree of accuracy that is equal to or not far removed from the screen resolution. This is typically about 320 by 200 to 640 by 480 pixels, and is quite low.

Many modern paint programs can output to scale, and some have printer drivers that try to smooth lines to fully utilize the resolution of the printer. However, the results are still usually quite rough with diagonal lines that suffer from a pronounced "staircase" effect, and curves that are far from smooth. The low basic resolution means that the maximum complexity of drawings is severely limited.

The second problem is that there is only very limited control over elements in the drawing. If you wish to move a circle from one place to another this may well be possible. It will often be impractical though, since this system operates by effectively taking an area of the screen and moving it to a new location. If there is some text in the circle and a line crossing through it, then this text and part of the line will be moved with the circle, whether you wish to move them or not.

SNAP TO IT

A true CAD program is object oriented, which means it stores the drawing in its memory as a list of objects, not as a bit map. A line would be stored as a line from co-ordinate set A to co-ordinate set B. A circle would be stored as a circle having its centre at a certain pair of co-ordinates, and a radius of so many units. With this system the resolution can be as high as you like, and CAD systems are typically capable of handling co-ordinates into the tens of thousands or more at one extreme, and to about six decimal places at the other.

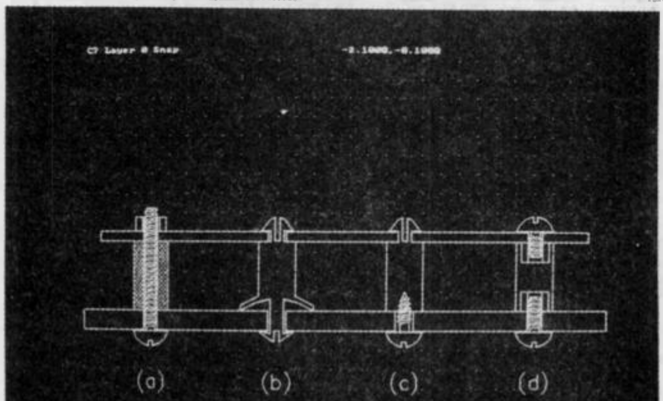
Obviously even a high resolution computer screen can not display a drawing with anything approaching the accuracy with which the program stores the drawing. Most CAD programs actually go well beyond the accuracy of any output device (printer, plotter, etc.).

The program is designed to make the best of the available resolution, and produce the most accurate representation of the drawing that the output device permits. The relatively low resolution of the screen can make it difficult to get detailed and accurate information into the computer in the first place, and there are two main approaches to solving this problem.

The first is a "zoom" facility which enables the user to enlarge a small part of the drawing so that it fills the screen. The degree of zoom available on most systems is very large, and blowing-up a small section of the screen to one hundred times its normal size should present no difficulties.

To aid accurate drawing an on-screen visible grid can be used, together with a "snap" facility. For example, you could have a grid of dots on the screen with a notional spacing of 10 millimetres, plus a snap grid with a notional two millimetre pitch.

The visible grid helps you to navigate around the screen, getting objects the desired size and correctly positioned. The snap grid restricts you to setting the end points of lines etc. only on the snap



A simple 2D drawing for an Actually Doint It *article. Even the more simple CAD programs can handle this type of thing.*

grid points. As you zoom in and out on part of the drawing, the size of the grids can be decreased or increased.

MOUSE CONTROL

With this type of drawing the on-screen cursor is usually controlled with a pointing device such as a mouse, rather than via the cursor keys of the keyboard (which is a rather slow and cumbersome method of control for graphics applications). The keyboard is not totally redundant though, and it can be used to type in commands such as "line", "circle", etc.

However, the more popular method of control is via menus, either on-screen or on a digitising tablet. The keyboard may still have an important role to play, as any true CAD system will permit co-ordinates, angles, distances, etc. to be entered as numeric data from the keyboard.

This offers a very accurate method of entering the drawing into the computer. With some CAD systems it is possible to produce a complete drawing without ever resorting to any form of pointing device. Everything can be entered as co-ordinates, angles, and so on. This is a relatively slow method of working though, and the normal method of producing drawings is to use the pointing device and grids where possible, with data being entered from the keyboard to indicate points that do not fall on grid points.

Despite these methods of precision drawing, large drawings are still awkward to produce on a micro based CAD system. A lot of zooming and panning (shifting the zoomed view to a different part of the drawing) can be needed. A system of "windows" is used on some up-market systems as a means of easing the problem.

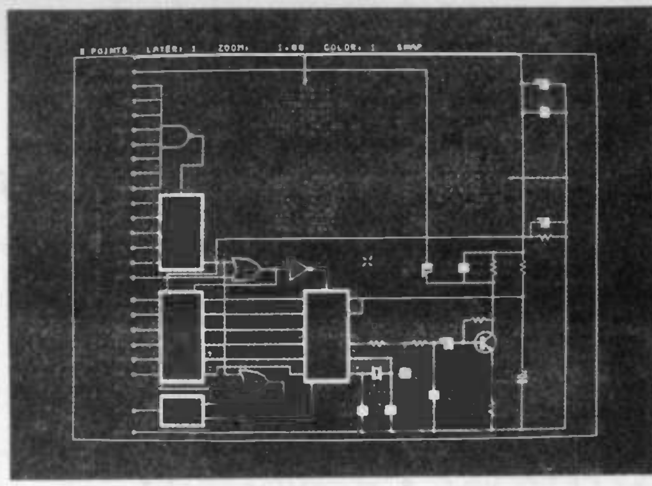
The basic idea is to divide the screen into (say) three windows, with a large one showing the entire drawing, and two smaller ones showing two highly zoomed views. Putting in a line from one end of the drawing to the other is then quite easy. The two zoomed views are set to show the start and finish points, and make it easy to accurately indicate the end points of the line. The window showing the main drawing enables you to check that the right overall effect has been obtained.

An additional form of snap facility provided by good CAD systems is an "object snap" type. This enables lines etc. to be drawn to points on objects, rather than to the normal grid points. Typical object snaps are end and middle points of lines, the intersection of two lines, perpendicular to a line, so many degrees around a circle, and tangent to two circles or arcs.

This type of thing may seem to be of little importance, and is often absent from low cost CAD software. It is the kind of facility that you soon miss when it is not there! Drawing a line tangent to two circles, or a line that ends at the intersection of two other lines is child's play when using a pen and paper, but can be very difficult indeed when using a CAD system which does not have suitable object snap facilities.

SYMBOLISM

One of the great strengths of a CAD system is its symbol facility. With conventional drafting the drawing of objects that are needed time and time again is usually speeded up by using rub-on transfers or stencils. The problem with these methods is that they are only applicable to symbols that are available "off the shelf", or where the cost of having transfer sheets or stencils specially manufactured can be justified.



A CADed circuit diagram as it appears on-screen. It can be printed/plotted in much higher resolution.

With a CAD system you simply draw up your symbols and then save them to disk. You have total control over their appearance, can have as many different symbols as you want, and can easily change them if the need should arise. The "stored" symbols can be almost instantly called up from disk when required, and then scaled, and (or) rotated before being placed at the desired position in the drawing. In an electronic context, symbols are obviously very useful for drawing circuit diagrams, where resistors, capacitors, etc. would all be drawn up as symbols and called up from disk as and when needed.

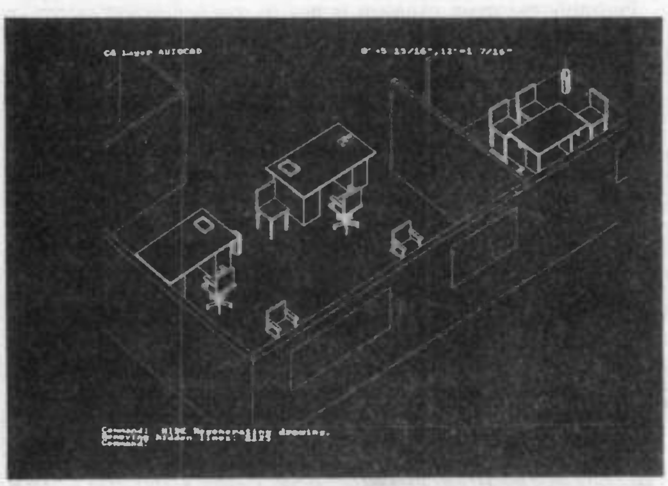
EDITING

The objects provided by a CAD system include everything that is likely to be needed for normal technical drawing, including lines, circles, arcs, ellipses, text in any size, and hatching of an enclosed area with the desired pattern. The more clever systems include hatching that can hatch within a given boundary, but which will hatch around an object within that area

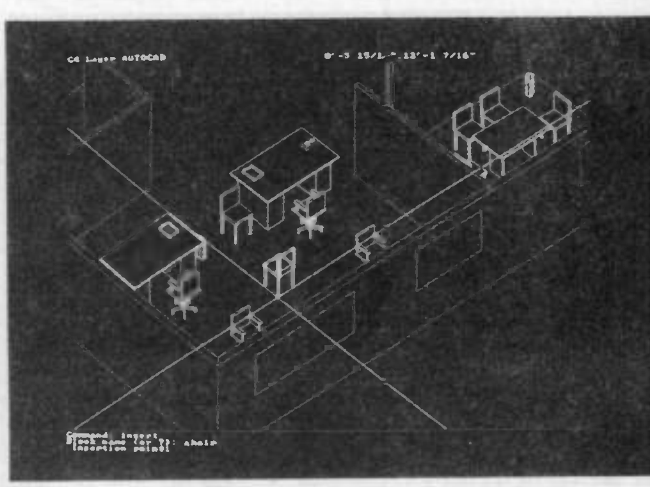
Some systems also include variable width lines. By this I do not simply mean lines that are thick or thin, but that lines can be varied in width along their length. Some very fancy drawings can be produced using a facility of this type.

Probably the main advantage of CAD lies not in what objects can be placed into the drawing, or the speed and ease with which they can be drawn, but what can be done with them once they are there. Like word processing, the idea is to get things right while everything is still in the computer's memory and in an easy to change form, and only commit something to paper once it has been perfected. Low cost CAD systems tend to have quite limited editing facilities, but the more up-market systems are very powerful in this respect.

At the most basic level, if the object just drawn is wrong you can almost instantly delete it. With most systems you can point to any object or group of objects and delete them.



An "Auto CAD" demonstration drawing. This is a genuine 3D drawing, with the "hide" command being used to remove the hidden lines.



The chair on the cross-hair cursor is a symbol being moved into position. Symbols can greatly speed up 2D and 3D drawing.

"Move" and "copy" are two more standard editing features. With the first of these you select an object or objects, and then reposition them on the screen. The more sophisticated systems have a "drag" facility when doing this type of thing. This simply means that the objects are moved around on the screen in sympathy with movement of the pointing device, making it easy to get the repositioning right first time.

The copy facility is much like the move one, but it leaves the selected objects intact, generating a new set which are placed in the desired position. Making multiple copies is usually possible.

An increasingly common and very powerful facility is the "array" type. This is a form of multiple copy command, and it has two forms. The linear variety takes a given object or set of objects, and reproduces it at regular intervals the required number of times in a row. In fact most array commands permit any desired number of rows to be produced (ideal for drawing the holes in stripboard layout diagrams).

The other type is the polar array. This copies the selected object the desired number of times in an arc having a specified centre point and number of degrees. This is ideal for such things as drawing the tags on rotary switches.

Other common editing features are the ability to rotate objects the required number of degrees around a specified pont, a scale facility which enables objects to be enlarged or reduced by a specified factor, and a mirror command which simply generates a mirror image of the selected objects. A fillet facility provides an easy means of rounding off corners.

Although a great rarity at one time, most CAD programs now seem to offer a "stretch" command. This is a form of "move" command, where you draw a box on the screen that surrounds the objects you wish to move. Any objects totally within the box are moved to the new location, and any lines which pass through the box are stretched (or compressed) to maintain the connections to the objects that have been shifted. In other words, it provides a quick and easy means for opening up a space in the drawing where you have not left enough room, or closing up gaps where you have left too much space.

ISOMETRICS

An important facility for much drawing work, especially 3D illustrations, is the ability to trim away bits of lines that are not needed. When drawing by hand, if you are drawing an object that passes behind another object, there is no difficulty in missing out the hidden part of the line behind the foreground object.

You simply lift the pen over the section that must not be inked-in, but there is no equivalent to this in CAD. You must indicate the start and finish points of both sections of the background line, and the easiest way of doing this is often to draw in the whole line, and then use the intersection points to indicate the section of line that is not needed and which should be trimmed away.

Some CAD software is weak in this area, and is strictly intended for true 2D drafting. Other systems provide a lot of help in producing 3D type views, and have an isometric mode.

Isometric views are slightly non-scientific and in some respects not particularly accurate 3D representations. For the uninitiated, they have verticals as verticals, but horizontal lines at 30 degrees from the horizontal.

In the isometric mode a CAD system has the grids suitably angled. Circles in an isometric view become "squashed" into ellipses, and a true isometric mode should have an isometric ellipse generator.

A CAD program that has an isometric mode should have good line trimming capability. Some have a sort of layering system where you can indicate that one object is in front of another, and any hidden lines are then automatically trimmed out (a system that seems to be more common in illustration programs than true CAD software).

Isometric projections represent a very quick and easy means of producing 3D type views, and I have often used them for such things as transistor leadout diagrams. However, this sort of thing is not true 3D drafting, and a system which has this type of facility is usually termed a two and a half-D CAD system.

TRUE 3D

An isometric mode does not constitute true 3D CAD in that the lines only have *X* and *Y* co-ordinates, with no third ("Z") dimension. True 3D CAD systems operate with three co-ordinates per point, and can therefore store objects as genuine three dimensional types.

Obviously the screen can only show a two dimensional representation of the objects in the drawing, as can the printed or plotted output. However, with the drawing stored as a set of *X-Y-Z* co-ordinates, the program can generate a 2D view of the drawing showing the objects as they would be seen from any view point

Some systems, mainly aimed at architectural use, can actually show views from within the 3D model. You can therefore draw up 3D plans for a house, draw in the furniture and fittings, and see what it will look like inside!

Producing a 3D CAD system is one thing – making it usable is much more difficult proposition. Drawing cubes and other simple shapes does not stretch the imagination too far, and does not require any complex commands.

In the real world few things consist of nice and convenient shapes of that type. For instance, how do you go about drawing something like an extruded aluminium heatsink?

Many 3D CAD programs actually have an extrude command. Basically, with the heatsink example you would draw a 2D end view of the object, and then use the extrude command to stretch this into a 3D object of the required length. You then select the desired viewpoint, call up the "hide" command to invoke the hidden line removal routine, and you then have the finished 3D drawing.

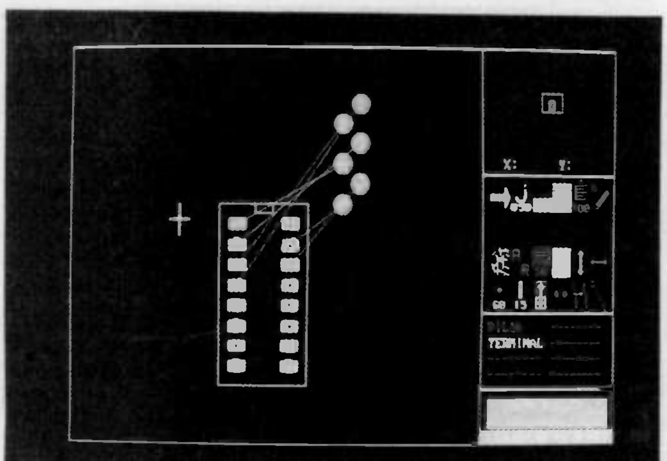
Some quite sophisticated 3D commands are included in some 3D CAD systems. The extrude command might permit changes in scale so that tapered objects can be produced (I once very rapidly drew a reamer using such a facility).

With the more sophisticated systems you can draw basic frameworks, and the program will then produce surfaces on the skeleton you have drawn. The most sophisticated systems will even produce nicely shaded images to give a really good 3D effect. You position notional lights and the viewpoint in order to get exactly the desired effect.

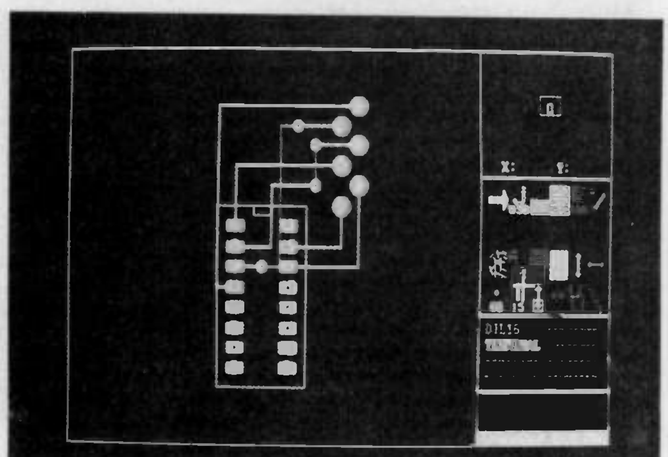
A lot of effort has gone into developing viable 3D micro based CAD systems, but with something less than total success. One problem is that it is difficult for new users to mentally adjust and think in 3D terms.

Any complex CAD system requires a fair amount of learning effort if it is to be properly mastered, but 3D systems require a great deal more learning time. They are not for the occasional user, and represent something of a specialist area of the CAD world.

Probably the main problem is not so much deficiencies in the operators, as the lack of raw computing power in a microcom-



A simple ratsnest ready for routing.



The automatically routed ratsnest. This has been done as a double-sided board by the "PC-B PRO-AR" program.

puter. People who use computers for applications such as word processing often question the need for ever more processing power. Those who wait five or ten minutes while a leading edge 32 bit computer removes the hidden lines from a 3D drawing do not!

CUSTOMISING

Currently there is a strong trend towards customisable CAD programs. In other words, a program that enables the user to design his or her own menus. In fact it goes beyond this, in that each menu command can actually consist of several commands strung together.

A set of commands of this type is called a "macro". Where the user tends to keep using the same command sequence over and over again, a macro can greatly streamline things. Some systems even offer a sort of pseudo programming language, so that a macro can temporarily halt for user input, repeat a certain number of times, and things of this sort.

Going beyond macros, some systems include what is really a true programming language that can be used to define your own commands. The leading CAD program is *"AutoCAD"*, and this comes complete with the AutoLISP programming language which is a subset of the LISP (LISt Processing) language.

This offers tremendous scope for customisation. I have used a system of this type to automatically draw up stripboards of the required size ready for the components to be added. You just invoke the command, specify the number of holes and tracks, and sit back while the computer draws up the stripboard for you!

Another possibility with do-it-yourself commands is intelligent symbols. Returning to our stripboard example, I have used a system where a component such as a resistor can be added simply by indicating the two holes to which it connects.

It does not matter how far apart the two holes are, and neither does the orientation of the component. The computer works out distances and angles, and then draws the component at the right angle with leadout wires of the appropriate length. With conventional (predrawn) symbols it would probably be necessary to resort to numerous versions of the symbol in order to accommodate various connection pitches and orientations.

PCB CAD

The ease with which objects can be shifted around in a CAD system, plus the user definable symbols, makes CAD well suited to printed circuit design. The layering facility of CAD systems is also important for printd circuit board (p.c.b.) work.

Layers are often likened to producing conventional drawings on several pieces of clear film. All layers are visible when the pieces of film are stacked one on top of the other, but any layers that are not required can be temporarily eliminated by simply removing the relevant pieces of film.

In a CAD system the layers are usually displayed in different colours so that they are easily distinguished from one another, and they can be individually switched on (displayed) or off (not displayed). In a p.c.b. context the top and bottom copper layers would be on separate layers, with the component overlay on a third, and possibly other layers used as well (a layer for unrouted tracks for instance).

Printed circuit design is a major use of CAD, and there are numerous systems designed specifically for this purpose. Any CAD system should be usable for drawing up printed circuit boards, but there are substantial advantages in using a dedicated p.c.b. CAD system.

One of these is simply that a p.c.b. CAD system can work to a lower resolution. Most offer a maximum board size of no more than about 32 inches square, with a resolution of 0.01 or 0.001 inches.

This is good enough to permit accurate p.c.b.s to be designed and printed or plotted out, but is way below the resolution of most general CAD programs. For the user the most obvious advantage of the lower resolution is the relatively short time taken for the screen to redraw after panning or zooming.

The degree of help provided by p.c.b. CAD systems varies enormously. At the most basic level, everything is drawn on screen manually, and the system is analogous to traditional taping methods.

Even at this level, the ease with which modifications can be made, during or after the initial design phase, gives CAD systems a tremendous advantage. Neater boards should be produced more quickly.

AUTOMATION

Most systems now offer some degree of automation. This is often in the form of a simple form of automatic track routing.

One way in which this can operate is for the operator to first place all the components on the screen. Then each interconnection is indicated to the program by pointing to pairs of pads using the mouse. The computer then works out a suitable route for the track and draws it in.

You work through the board until all the interconnections have been completed. A similar method involves much the same process, but you indicate all the interconnections, and then the computer works out and draws in the track positions.

There are other means of indicating the required interconnections. Many printed circuit design agencies favour the *"netlist"* method. The netlist is merely a text file which lists all the groups of interconnections.

Every component is given pin numbers so that the computer is able to differentiate between (say) the two leads of a resistor. This is a bit more complex than the other methods described so far, in that the component symbols carry additional information in the form of the component identification number, and the pin numbers.

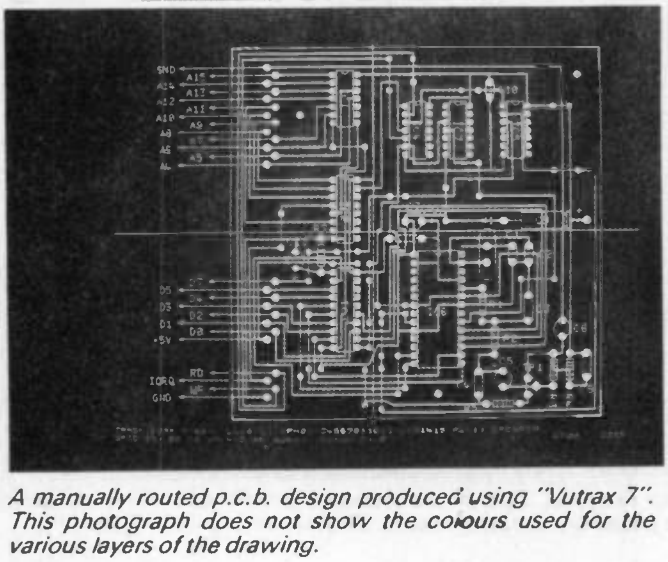
Although the netlist method might seem to be a rather cumbersome way of doing things, it has the advantage of being very reliable. It is easy to check the netlist against the circuit diagram to ensure that the interconnections are all present and correct.

For the ultimate in convenience the schematic capture method is used. With this system you draw the circuit diagram using the p.c.b. CAD program. The circuit symbols are matched with physical component symbols, and this enables the computer to extract the interconnection information from the circuit diagram, and then import it into the printed circuit design. If the systems offers automatic component placement, then (in theory anyway) the design process can be fully automated.

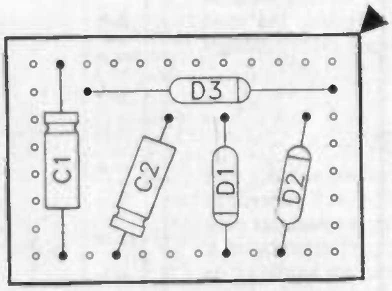
AUTO-ROUTING

In practice matters are not quite as straightforward as this. Automatic component placement usually requires the user to position the main components (sockets, controls, etc.) to give the automatic placement algorithm a safe starting point.

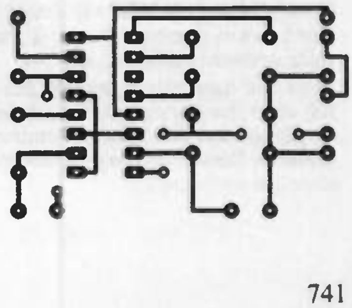
Some automatic routing algorithms are much better than others. Most inexpensive systems use fairly simple algorithms, such as a maze search or grid type. The board is divided into squares (cells)



A manually routed p.c.b. design produced using "Vutrax 7". This photograph does not show the colours used for the various layers of the drawing.



AutoStripboard with some "intelligent" symbols. A program works out lead lengths, angles, etc., and draws in components between two specified holes.



A problem with p.c.b. CAD is getting good hard copy at reasonable cost. This 1:1 output is at 300 d.p.i. and was produced using an HP Inkjet printer. A nine pin dot matrix output is usually unsatisfactory at a 1:1 scale.

which are occupied if they contain a track or pad, or empty if they do not.

Several methods of seeking out a suitable route for each track are possible. With one system the router tries to find a route from one pad to the next by going straight across the board and then up or down to the second pad. If it finds an occupied cell in its way, it tries to go around it and then get back on course again as quickly as possible.

A well designed router of this type should always find a route if one is possible. In practice compromises are usually made, and some routable tracks are left unrouted, and must be handled manually.

There are various causes for this. Mostly it is where a track requires more sections than the program can handle, or the routing algorithm does not provide a facility to backtrack if a track is routed down a "blind alley."

Some algorithms will occasionally fail to route a track even if there is a route straight from one pad to the other! Most simple auto-routers make no claim to provide 100 per cent track routing, and are designed to be used together with manual routing.

Some up-market systems do promise 100 per cent routing, where this is possible. The problem with grid based routing systems is that they "cannot see the wood for the trees."

Someone manually routing tracks looks at the whole board, or a large section, before starting to add any tracks. This way they avoid putting in tracks that are going to get in the way of numerous other tracks. If a track of this type should be laid down, then it would be removed and rerouted instead of taking dozens of other tracks through circuitous routes.

So-called "rip-up and retry" routers have the ability to remove any tracks that are getting in the way, and try an alternative route to see if this gives less problems with track congestion. This gives 100 per cent automatic routing if it is possible, but tends to be very slow.

Even a powerful 32 bit microcomputer can take hours or even days to route a complex board using such a system. The problem is that the process is largely one of "trial and error", which might be a more truthful name for a system of this type.

The design process is not strictly comparable to manual routing, where tracks that will get in the way are avoided as far as possible, rather than be laid down and then rerouted, possibly several times, before the optimum route is found. Of course, even if a system of this type does take a long time to design a complex board, it is still probably much quicker than an experienced design draughtsman doing the job manually.

At least one system now offers a faster way of handling auto-routing that is perhaps closer to the human approach. Taking a broad view of a partially routed board, the system can spot individual tracks or groups of them that will cause congestion as the routing progresses. Rather than ripping up the tracks and rerouting them, they are moved over to give access to pads that are getting boxed-in by tracks.

Printed circuit CAD systems are certainly becoming more sophisticated, with even low cost systems now supporting auto-routers, and the up-market systems using sophisticated techniques that give 100 per cent auto-routing. Unfortunately, the costs involved remain quite high. Low cost software of this type is still usually a few hundred pounds, and the hardware to fully exploit it is likely to cost several times as much.

Prices continue to fall though, and some systems are now coming within the reach of amateur users. If you already have a suitable computer and printer or plotter, the cost of computerising your printed circuit design work could be quite low.

CIRCUIT MODELLING

Circuit modelling is an involved subject, and one which we can only explore at a superficial level in this article. Producing a computer program that will predict the performance of a certain type of circuit, such as an amplifier or filter, is not too difficult. Designing a program that can handle any linear circuit is a much more complex business that involves some complex mathematics.

For the user this is largely academic. You just enter the circuit into the system, and then supply the test conditions (number of test frequencies, frequency range, phase or frequency response testing, etc.).

After some calculating the computer then provides a list of test results, plus an optional graph in most cases. Most systems also provide "Monte-Carlo" modelling, which means you can supply component tolerances, and a range of results will be provided within those tolerances.

Circuits are entered into the system in manners that are similar to some of those used for entering connectivity data into a printed circuit diagram. The most common form of circuit entry is one that is similar to netlisting.

First a components list is entered, and this includes a value or type number for each component. The program understands capacitance, resistance, and inductance values, but active devices must have a predefined model that the program can refer to.

Each model consists of some very detailed data, and defining devices accurately can be difficult. You will not find the necessary data in most data books, but will need a detailed data sheet for the device in question. Fortunately, most systems are supplied with a useful range of predefined transistors and operational amplifiers.

The connections are entered using the node system. This is very simple, and you simply mark each set of interconnections on the circuit diagram with a different number. The exact method of numbering is not usually too important, except that certain numbers are reserved for the input and output (or these might be user definable). You then prepare a text file listing each node number together with the component leads/pins that connect to it.

A large number of tests on a complex circuit can take a minute or five to complete, but circuits can be tested more quickly this way than actually building them up and testing them. For any system of this type to be worthwhile it is important that it provides accurate results, and can handle a very wide frequency range.

The systems I have tried all seem to be excellent in both respects, but you need to bear in mind that with high frequency and (or) high gain circuits the layout of the real thing has a large influence on performance. A circuit modelling program shows you how a circuit should perform - it is up to you to ensure that the real thing actually does so.

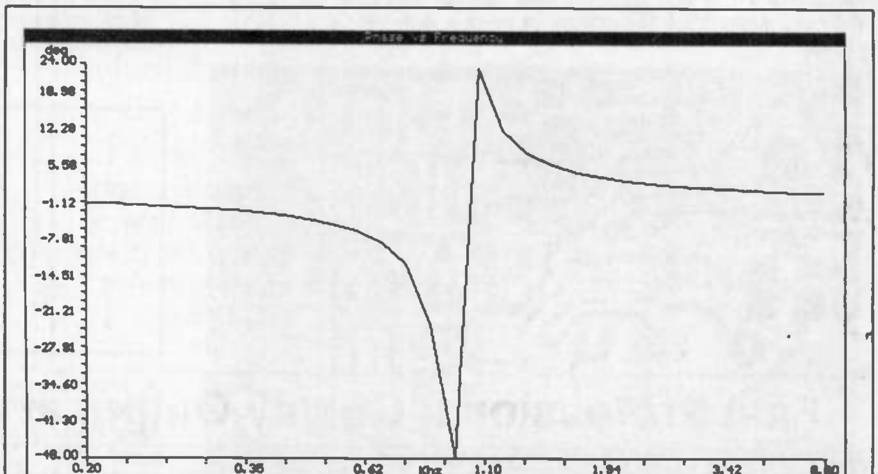
FINALLY

Micro based CAD systems now seem to be firmly established in the commercial world. They are used by everything from one man businesses through to large corporations. Modern CAD programs, even some of the cheaper examples, are now remarkably sophisticated, doing things that look to be beyond the capabilities of the hardware they run on.

CAD could certainly be put to good use by the electronics hobbyist, or anyone who needs to draw up plans of virtually any type. Unfortunately, the cost of a practical system remains relatively high. If you already have a suitable computer, the cost of the software might be acceptable.

The real problem is in getting decent hard copy. However, as printers continue to improve, and advances in the software enable their capabilities to be fully exploited, CAD for amateur users could soon become a more practical proposition.

Another difficulty that should not be overlooked is that it can take a long time to fully master a CAD system and get it set up to your satisfaction. CAD can bring great benefits in the medium to long term, but can be very time consuming initially. □



A circuit modelling example. This phase response graph was produced using "ACIRAN", which gives very accurate results. This circuit is a Twin-T filter.

Constructional Project

IN-LINE DIMMER

T. R. de VAUX-BALBIRNIE

Luxury control for "mood" lighting. Puts you in control!

DIMMER switches replace existing wall switches and are used to set the level of illumination required. Although commonly used to control fixed room lighting, no such device seems to be available for portable lamps. This is unfortunate because the amount of light needed depends on whether the lamp is being used for working, reading or simply for background illumination. These purposes may vary from hour to hour.

As well as adding a touch of luxury, a dimmer saves energy and greatly extends the life of the bulb. The preset circuit replaces the standard in-line switch fitted to many types of lamp (although it does not need to have one to use this circuit).

Built in a small plastic box it provides full-power operation plus three levels of dimming using two rocker switches. The In-Line Dimmer may be used to control all filament bulbs up to 250 watts rating used on a.c. mains supplies. It should be suitable for controlling other low-power appliances such as electric blankets. Note, however, that it is suitable for **non-inductive loads only** and may not be used with flourescent lights. Tests on the prototype unit show that negligible radio-frequency interference (r.f.i) is produced.

CIRCUIT DESCRIPTION

Since most of the circuit is already "on the chip", only a little construction work is needed. However, since mains connections need to be made, it is essential that constructors make a safe job. In any case of doubt, a qualified electrician must be consulted.

The entire circuit for the In-Line Dimmer is shown in Fig. 1. IC1 is a thick-film hybrid integrated circuit made specially for this type of application. Dimming is achieved by the well-established technique of "phase control". Fig. 2. shows how this works. In (a) the whole of the a.c. wave is applied to the load so maximum power is delivered to it. In (b) the circuit "waits" for a time before switching on the load so only the shaded portion delivers power – the lamp therefore operates more dimly. In (c) the switch on point is delayed still further so very little power is delivered to the lamp and it will now be almost extinguished.

At the end of each half-wave, the i.c. switches off and the procedure repeats indefinitely. In fact, operation of the device is not as ideal as has been suggested but the basic principle still applies. Thus, when switched to supply maximum power, a little fails to reach the load but the dimming effect on the lamp here is negligible.

The degree of dimming is controlled by the resistance appearing between IC1 pins 1 and 2. The lower the resistance, the more power is allowed to pass between pins 2 and 3 and hence through the lamp, LP1. Presets VR1 and VR2, in conjunction with

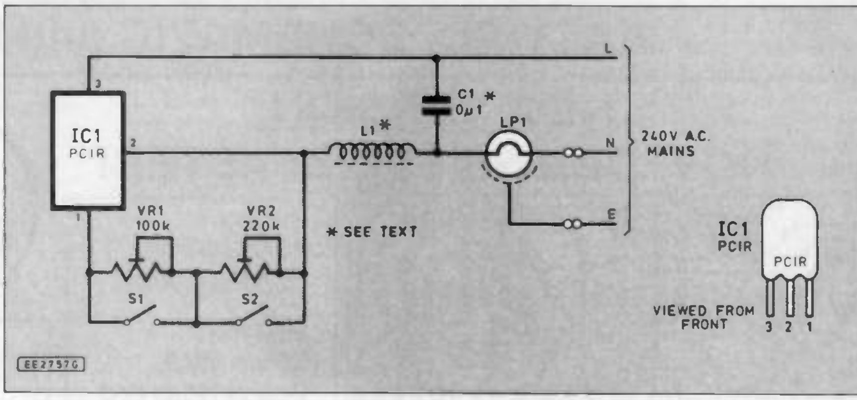
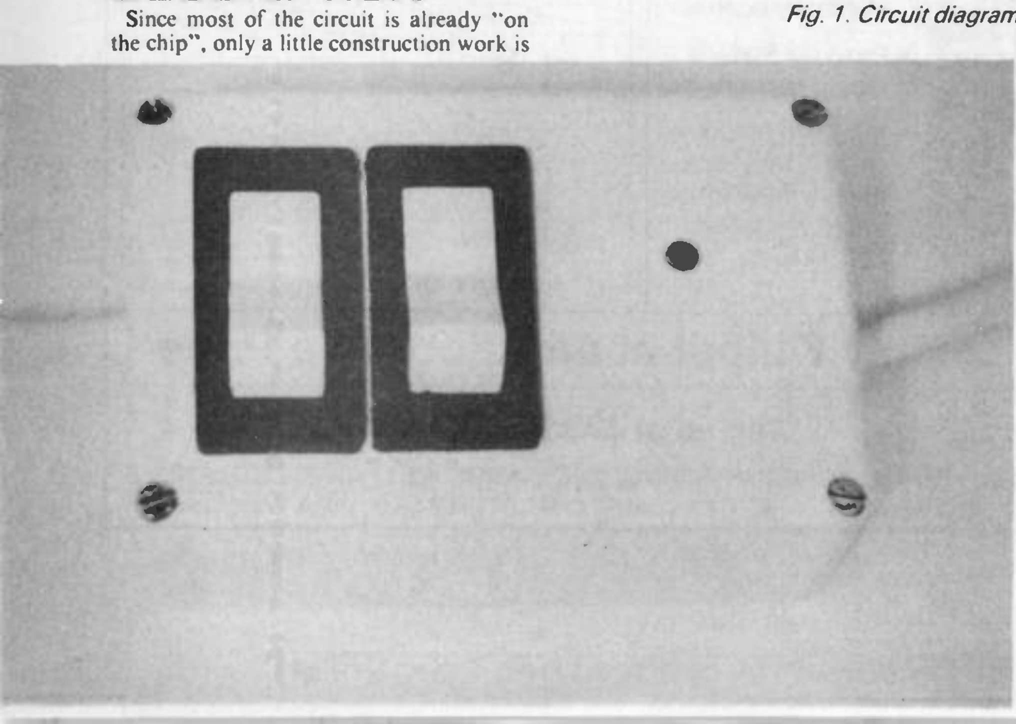


Fig. 1. Circuit diagram of the In-Line Dimmer.



switches S1 and S2, control this resistance. Thus, with both S1 and S2 on, (contacts closed) VR1 and VR2 are short-circuited so there is virtually no resistance appearing between IC1 pins 1 and 2. This allows for maximum operating power.

With S1 off and S2 on, current flows through VR1 and the lamp will operate more dimly. With S1 on and S2 off, current flows through VR2 – this gives a greater degree of dimming since VR2 is adjusted to give a higher resistance than VR1. With both switches off, current flows through VR1 and VR2 to give maximum dimming. VR1 and VR2 are adjusted at the setting-up stage to provide the required light levels. An on-off switch was not provided since there will be an existing one at the lamp holder or mains socket.

Capacitor C1 and inductor L1 are suppression components. These minimise the

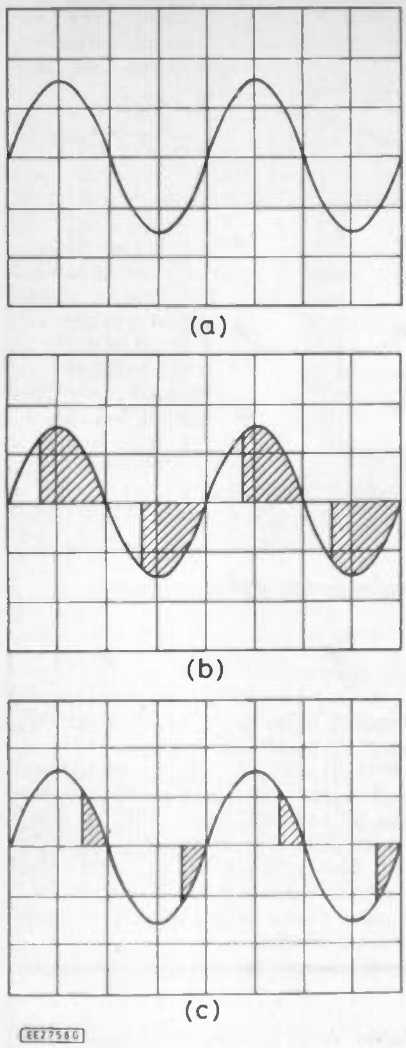
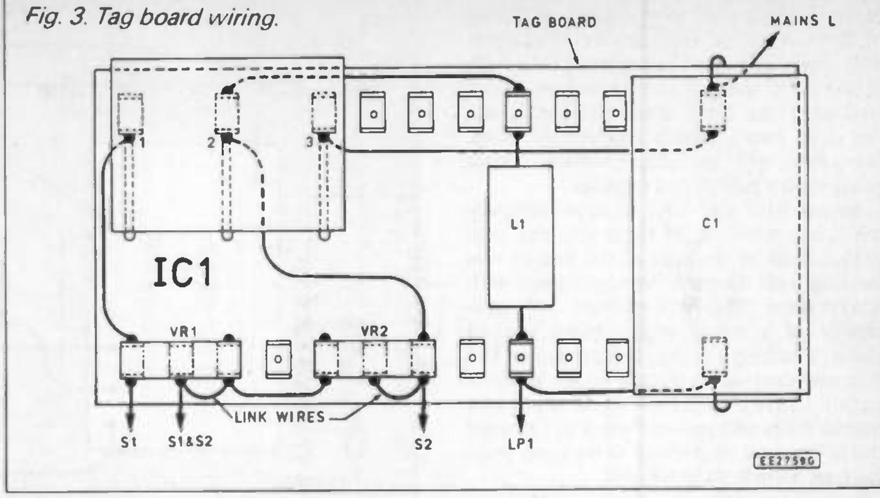
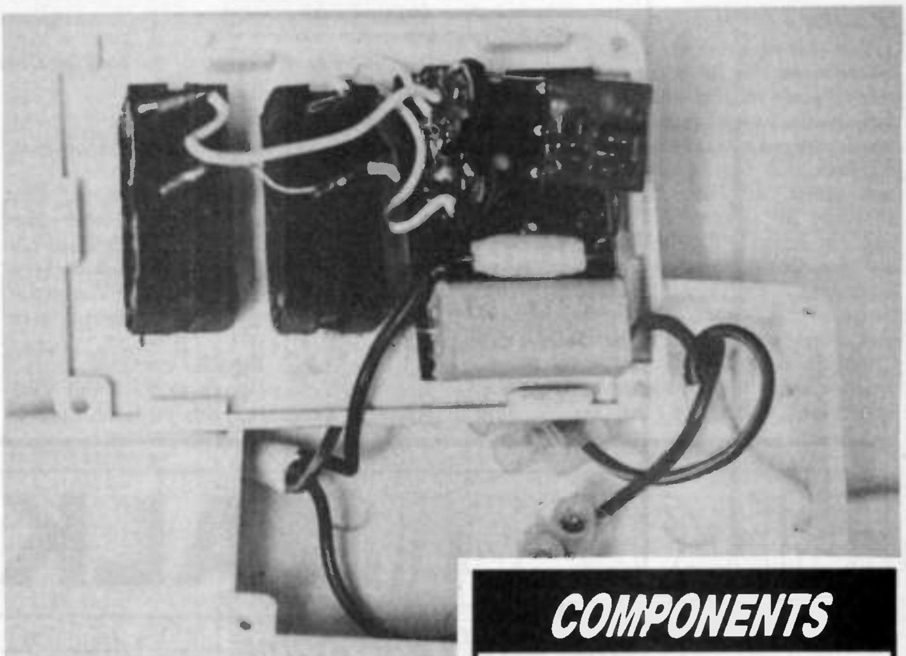


Fig. 2. Illustration of the phase control used by the In-Line Dimmer.

Fig. 3. Tag board wiring.





radio-frequency interference which tends to be produced by this type of circuit. C1 must be of a type designed for direct connection across the amins – **do not use any other type of capacitor** even though the voltage rating appears to be adequate. L1 is a radio-frequency choke capable of carrying 1A. Correct choice of C1 and L1 is essential.

CONSTRUCTION

Construction is based on the tag board layout shown in Fig. 3. ***Remember that mains voltages are present throughout the circuit and care must be taken with construction. If you are not certain of what you are doing, do not attempt to build this project.***

To commence construction, first, make the inter-tag links then follow with the soldered on-board components. To mount IC1, bend its three wire connections over the front face (the smooth side with lettering on it) and solder them into position as shown.

To mount presets VR1 and VR2, carefully bend each centre tag so that it appears between the outer two at the front of the component. Solder the outer tags to the circuit board then solder a short link wire between each centre connection and the right-hand one as indicated. Solder 4 cm pieces of stranded connecting wire to the three preset connections as shown. Make certain that no wires could dislodge in service – use "hooked" connections wherever possible.

Hold the circuit panel in position on the lid of the box as shown in the photograph. Mark the position of an existing hole near L1. Remove the circuit board and drill the marked position in the lid using a 2mm drill. This will be used for circuit panel mounting. Make further holes in the lid for rocker switches S1 and S2. Drill holes in the side of the case for input and output wires. These should be a tight fit for the wire to be used. With great care, shorten the switch connecting tags as necessary so that the lid will close when the switches are in position. Attach the circuit panel using a single 8BA nylon fixing through the hole drilled for the purpose. Check that the bolt shank remains clear of all circuit components. Check also that the circuit panel itself cannot rotate in service.

The unit must be housed in a **completely enclosed plastic case** and there must be **no metal parts which pass through the case**, hence the use of a nylon bolt and the plastic rocker switches.

Refer to Fig. 4. and complete all wiring. Make soldered connections to the switch tags – act quickly here to prevent damage to the plastic. The in and out leads should be made using the existing wire or new wire as desired, cable clamps should be used to secure these wires inside the case. Fit the input wire with a mains plug.

COMPONENTS

Potentiometers
VR1 100k sub-miniature preset – vertical
VR2 220k sub-miniature preset – vertical

See SHOP TALK Page

Capacitor
C1 0µ1 class X suppressor capacitor 240V a.c. mains rating (see text)

Semiconductors
IC1 PCR 1A integrated circuit power controller

Inductor
L1 radio frequency suppressor choke – 1A rating at 240V (see text)

Miscellaneous
S1, S2 miniature s.p.s.t. rocker switches plastic type, mains rated 2A (2 off)

Miniature tag board – 5mm tag spacing with 20mm between rows, 14 tags required; plastic box size 75 x 50 x 25mm; 3A terminal block – 1 or 2 sections required (see text); 2A mains fuse for plug; 8BA nylon fixing; strain relief cable clamps (2 off)

Approx cost guidance only **£10**

Note the single section of 3A terminal block which is used to maintain continuity of the mains neutral connection. If an earth wire exists, this must be continued through to the lamp using a second section of 3A terminal block. Since space is limited inside the case, two separate sections of block connector will be accommodated more easily than a pair joined together.

Adjust VR1 and VR2 to approximately mid-track position. If there are any pre-drilled holes in the base of the box as was the case with the prototype, seal them with epoxy resin. This will prevent any possibility of a metal object being pushed inside, touching a circuit component or live wire and causing an electric shock or short circuit. Leave a little slack in the input and output wires and provide some strain relief inside the case to prevent them from pulling free. Switch on S1 and S2.

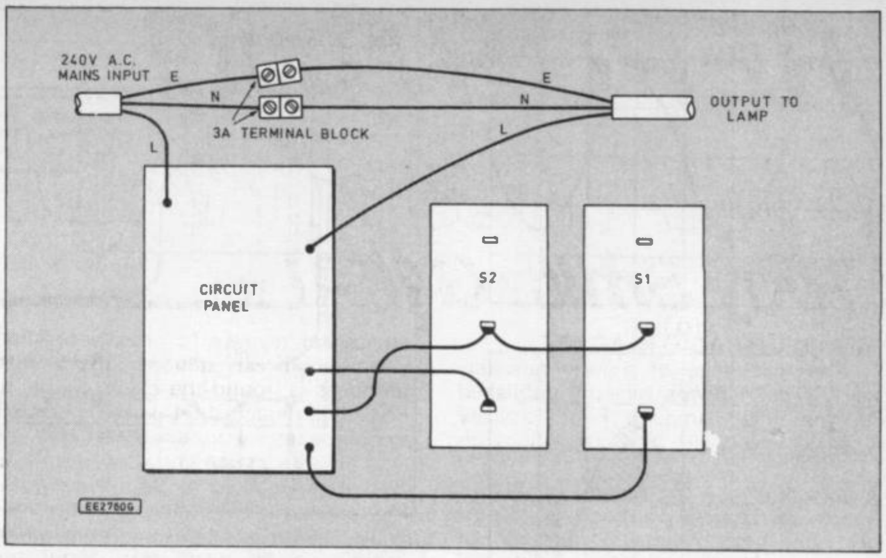


Fig. 4. Wiring of the In-Line Dimmer mains and switch connections.

TESTING

Note that whenever the circuit is connected to the mains, the lid of the case must be on and properly secured. On no account, make adjustments to VR1 and VR2 while the dimmer is plugged into the mains.

Check that the input and output wires are secure. Fit the lid, checking very carefully for trapped wires, short-circuits and for security of the circuit panel and switches. IC1 becomes warm in operation, especially with loads greater than 100 watts, so check that **all wires remain clear of this component**. Fit the mains plug with a 2A fuse and connect the unit to the mains. **Do not use a fuse of higher** rating since, otherwise, failure of the lamp could damage the i.c. The lamp should operate at full brightness.

Switch S1 off – the lamp should dim somewhat. Switch S1 on and S2 off – the lamp should be dimmer. Switch both S1 and S2 off – the lamp should now be very dim or even go off altogether. The exact degree of dimming is unimportant at this stage.

If the circuit behaves correctly, attention may now be given to VR1 and VR2 settings. Remember, this must be done a little at a time *with the unit unplugged from the mains each time an adjustment is made.* Dimming is increased by clockwise rotation of the preset sliding contacts.

With S1 only off, adjust VR1 so that a small degree of dimming is achieved. Now with S2 only off, adjust VR2 so that a greater degree of dimming is produced. With both switches off, the lamp should now be very dim. Further adjustments may be made over a period of time to achieve the required effect. □

SHOP TALK

with David Barrington

EE Musketeer

There are a few "special items" called for in the *EE Musketeer* audio/video entertainment controller that will take some tracking down in local areas.

Todate the only source we have been able to find for the keyboard encoder chip MM74C922N is from **Electromail**, code 307-907. The 4 x 4 or 16-way keypad (331-269) was also purchased from the same supplier. These self-adhesive membrane keypads should also be available from our larger component advertisers.

The 6364 64K CMOS static RAM i.c. and the Schottky barrier diode should be obtainable from most large suppliers of semiconductors. However some difficulty may be experienced with the BAR28 Schottky diode, this was obtained from **Maplin**, code QQ13P.

The printed circuit board for the EE Musketeer is available from the *EE PCB Service*, code EE706 (see page 756).

Frequency Meter/Tachometer

Apart from the photodiode and p.c.b., all the components required to build the Tachometer unit for the *Frequency Meter/Tachometer* project should be readily available over the shop counter.

The photodiode type BPX65 was purchased mail order from **Electromail** (☎ ***0536 204555)***, code 304-346. This device is fairly expensive and for some applications it might be possible to use a general purpose photodiode, with reduced performance.

The small printed circuit board for this project is obtainable through the *EE PCB Service*, code EE705.

Cycle Rear Light Monitor

The TSC04BJ voltage reference used in the *Cycle Rear Light Monitor* could cause local sourcing problems. The one used in the prototype model was purchased from Electromail (☎ ***0536 204555)***, code 283-564.

An alternative voltage reference device which should work in this circuit, but not tried, is the 8069 from **Maplin**, code YH39N (8069CCZR). The 12V pulsed tone siren should be available from most component suppliers. These buzzers usually work from about 9V up to 15V.

The values for resistors R1 and R5 will most likely prove difficult to locate and the use of a combination of two standard value 0.25W carbon resistors will ease these problems. R1 can be made up from 1 ohm and 4.7 ohm resistors wired in parallel and R5 made from two 10 megohm resistors wired in series.

The ICL7611 low power CMOS op.amp is currently listed by **Cricklewood** and **Omni Electronics**.

Whistle Box Timer

The only item that could possibly cause supply problems for constructors of the *Whistle Box Timer* is the whistle switch i.c., type UM3763.

The only source we have been able to locate for the whistle controlled switch is Maplin. When ordering quote code UJ47B (UM3763).

Although it has been rumoured that the PB2720 transducer is no longer available in an uncased form, it is still currently listed by **Cirkit** and **Maplin**. The cased types could also be used, but with reduced sensitivity and be slightly directional, if the "naked" disc elements cannot be obtained.

In-Line Dimmer

We must emphasize and endorse the words of caution about mains voltages in the *In-Line Dimmer* article. ALL parts must be installed in a completely enclosed plastic case and nylon nuts and bolts used wherever they pass through the case to the "outside world". Always disconnect the mains first before removing the case lid to carry out any work on the project.

The 1A power controller PC1R was purchased from Maplin, code QY37S. The suppression Class-X capacitor and the 1A 240V r.f. coke are designed for direct connection across the mains and should be available from most component suppliers. On no account use a different type of capacitor to that specified.

Kitting Up

With the construction season now in full swing, just a glance through the advertisement pages at the excellent construction kits now available should inspire anyone who is at all hesitant about taking their soldering iron out of cold storage. If you are still hesitant then the new ten part "Teach In '91" series, starting next month, entitled "*Design Your Own Circuits*" should dispell some of the mysteries of electronic circuits and give the newcomer the confidence to tackle kit construction.

Some readers may remember the range of Velleman kits, that seemed to disappear from the market, and will welcome the news that **High-Q-Electronics** (☎ ***0707 263562)*** are looking for retailers for these kits.

REPORTING AMATEUR RADIO

Tony Smith G4FAI

AMATEUR RADIO IN EGYPT

The first issue of a new newsletter, *Egyptian Echos*, recently published by the Egypt Amateur Radio Society (EARS), describes how amateur radio was introduced to Egypt in the 1920's by members of the occupying British forces. In the early Thirties they formed the Experimental Radio Society of Egypt, which existed until the outset of WW2 and at that time there were only three Egyptian nationals licensed as radio amateurs.

After the war a few Egyptians obtained licenses, having to overcome various bureaucratic hurdles to do so. Egyptian amateurs formed EARS in 1986, but amateur radio was, and still is, very much a minority hobby. *Egyptian Echos* comments that "Egypt was once the only country in all Africa and the Middle East that had an amateur radio society. Egyptians had even practised amateur radio before some European countries did. But the situation today is deploring. There are only 25 radio amateurs in a country with 55 million inhabitants."

Through its newsletter, intended for wide circulation, including the media, and through activities such as seminars, EARS hopes to attract many more newcomers to amateur radio. They have a difficult task ahead, but as the newsletter itself says, "If we don't do it, who else will?"

INTERNATIONAL SHORT WAVE LEAGUE

The ISWL, which has been in existence for some 40 years, caters for both short wave listeners (SWLs) and licensed radio amateurs. In a recent issue of the League's monthly magazine *Monitor* a member commented on the attitude of some amateurs to those radio enthusiasts who do not happen to be licensed operators, and referred to himself as being "only an SWL". In reply, the editor wrote "we do not look upon someone as being 'only an SWL'. In the ISWL, we are all on equal terms."

To be fair, most amateurs see nothing wrong in someone wanting to listen rather than transmit on the radio bands, and the RSGB has a special class of membership for SWLs. A lot of amateurs begin as listeners, and this has been the traditional way into amateur radio since the hobby began. Many SWLs, however, find great satisfaction and enjoyment in tracking down, listening to and reporting on the wide range of transmissions to be heard across the radio bands without ever wishing to transmit themselves, and to them SWLing is a hobby in itself.

The magazine contains helpful reports on current conditions on the broadcast and amateur bands, changes to broadcast schedules, and articles ranging from equipment reviews to profiles of short wave broadcast stations. ISWL also produces a round-the-clock Guide to English language short wave broadcasts to Europe from around the world. At any time of day you can find details of up to eight stations likely to be receivable on various frequencies at that particular time. There is also a list of DX programmes which can be heard throughout the week.

My copy covers Autumn/Winter 1989/1990 and I checked it out at various times of the day during March. The Guide stresses that if a particular station cannot be found this may be due to seasonal changes and reprogramming, propagation conditions, or interference from stations on the same frequency. Despite this I found most of the stations listed quite easily on my world band receiver. At 2000 hours, for instance I found programmes from the Vatican, Israel, North Korea, China, Iraq, Lebanon, USA and Syria. As a practical aid to finding English language broadcasts this style of presentation is extremely helpful to both casual and regular SWLs.

Membership of ISWL costs £12 p.a. (UK rate) and offers a variety of services to members, including a QSL bureau (extra cost), awards, contests, attendance at exhibitions/rallies, supplies such as QSL cards and logbooks, and a Broadcast Identification service. More information can be obtained from ISWL HQ, 6 Moorhead, Preston Upon The Weald Moors, Telford TF6 6DC. A sample copy of *Monitor* costs 60p (stamps acceptable).

GB2RS NEWS BROADCASTS

I have mentioned before that the RSGB broadcasts amateur radio news bulletins every Sunday on various frequencies using s.s.b. on the 80 metre band and both s.s.b. and f.m. on the 2 metre band. The bulletins are also transmitted in Morse (c.w.) and via the UK packet radio network, with all UK mailboxes carrying the news. To receive these bulletins you need a receiver covering the appropriate frequencies which is also able to resolve the s.s.b., f.m., c.w. or (with the help of a computer) the packet transmissions.

If you have a receiver which covers 7.0475 MHz in the 40m band, however, you can receive the broadcasts in a.m., without the need for special facilities. GB2RS transmits for half an hour on Sundays from Northern Ireland at 0900 hours local time, and from the Midlands at 1100 hours. Depending on band conditions, I can usually receive both these transmissions satisfactorily in London on my Sangean world band radio using its own telescopic antenna, and one, or both, should be receivable in most parts of the UK.

On receivers like this the s.s.b. and c.w. transmission can also be received. The frequencies for s.s.b. are 3.640, 3.650, and 3.660 MHz in accordance with a schedule obtainable from the RSGB. The 2m band s.s.b. and f.m. bulletins can also be received on these radios by the addition of a 2m converter. This takes the input from a 2m (v.h.f.) antenna, converting it to an h.f. signal which can be tuned by an h.f. receiver.

The 2m band, 144-146MHz can then be received over a 2MHz section of the receiver's tuning range, e.g. 28-30MHz, using the b.f.o. for s.s.b. and c.w. reception, F.M. transmissions can be resolved, when the receiver is switched to a.m., by tuning slightly to the side of the signal. This is not as good as using a purpose-built f.m. receiver but it satisfactory for the reception of most reasonably strong signals.

The news bulletins contain up-to-date information about solar and geophysical events which have affected, or may affect, radio propagation, together with forecasts of likely conditions. They also give news of exhibitions, rallies, seminars, courses etc. Information about events on-the-air such as contests, or special activities is provided, as well as details of radio club meetings to be held across the UK during the following week.

INTRODUCTORY BOOKLET REVISED

The DTI recently announced further revisions to the amateur radio licence, including new arrangements for club stations to operate as special event stations without the need to apply for a "GB" call sign; permission for UK amateurs to supervise the operation of their station by a licensed amateur from any other country; log keeping on electronic storage media; and allocation of extra frequencies for unattended operation of beacons, low power devices, digital communications and direction finding competitions.

The DTI booklet *How to become a radio amateur* has been revised to take account of the new changes and can be obtained free of charge form Radio Amateur Licensing Unit, Post Office Counters Ltd, Chetwynd House, Chesterfield S49 1PF. This 40 page publication answers such questions as "What does amateur radio offer me?"; "How do I go about taking the exam?." It includes information about the different types of licence (excluding the new Novice licence which has not yet been introduced), details of the examination syllabus and the amateur Morse test, the terms and conditions of an amateur radio licence, and a list of all authorised amateur radio bands and frequencies.

ROBOT ROUNDUP

Nigel Clark

WORKCELL

The RTX scara arm from UMI has joined most of its UK competitors by getting a workcell. Containing the traditional gravity feeder, conveyor belt and rotary table it has been put together with the assistance of ORT, the technical and vocational training organisation.

Supplied as a self-contained unit the system includes pneumatic pistons for manipulating the workpieces and has space for extra peripherals such as a drill and measuring units. The base of the unit is designed to allow easy reconfiguration of the cell.

A variety of sample workpieces is supplied and a vision system can be added for inspection of components.

The complete system is made up of three modules which can be obtained individually or as a full package. These include the RTX arm with its six axes plus gripper, which is supplied with operating manuals and demonstration disk. The workcell module contains the peripherals, the workbench, sensors, interfaces, software, training text and exercises.

This vision system can be used with the RTX or the workcell individually or as a stand-alone system. The camera and lens have ten steps of grey level and more than 600 lines and the PAL compatible graphics card can produce 512 × 512 pixels. It also includes a monitor, software and manuals.

Control of the system is by way of an IBM PC/AT compatible computer and is said to be particularly user friendly. The software allows for control by menu, making use of a mouse. UMI says that it enables programs to be developed and edited without the need for formal computing skills and accommodates the use of other program routines and subroutines.

The system was developed jointly by UMI and ORT following a long-term feasibility study, which combined the RTX with ORT peripherals and course presentation materials.

The workcell could therefore be based on well proven courseware offering a curriculum reaching to BTech level. However, the makers add that the system's flexibility makes it suitable for education at many different levels.

The managing director of UMI, George Novelli, said that the workcell would give students an opportunity to experience at first hand the application of state-of-the-art engineering and manufacturing technology.

With operations in more than 50 countries, ORT is a worldwide organisation. In Britain it supports, sponsors and operates youth training schemes, ITeCs, schools projects, adult training programmes and mobile technology training units.

OTR has indicated that it is likely to place a number of orders for the new workcell system during this year.

TEACHMOVER

The package is part of UMI's growing range of robotic equipment. In addition to its RTX education arm and the more robust version, the RTX 100, intended for light industry, it has reintroduced the TeachMover arm to the British market.

The move follows its takeover of Microbot, the US company which makes TeachMover. It is also selling Microbot's Alpha II. Microbot's other arm, Mini-Mover, which used to be distributed in this country, along with TeachMover, by Syke Automation, has been discontinued.

One of the oldest arms in the low-cost market TeachMover set the standard for the many that followed. It has five axes, plus gripper, with a maximum lift capacity of 450 gms and a reach of 440 cms.

The base can turn through 180 degrees while the shoulder has movement through 180 degrees, elbow through 150 degrees, wrist roll 360 degrees and pitch 180 degrees.

It is powered by stepper motors with cable transmission. It can be operated as a stand-alone device with instructions entered by way of a teach pendant. Up to 53 positions can be remembered by its on-board processor. It is also possible to link the arm to a computer through its RS232 port but no machine-specific software is available.

Demonstration setup the RTX robot arm from UMI with its new workcell, together with an "overhead" vision system.

Alpha II is stronger, being able to lift a maximum of 1.36kg with a reach of 47cms. It is a traditional articulated arm with the usual five axes plus a variety of grippers to suit whatever task is required.

The base can move through 345 degrees, the shoulder through 145 degrees, elbow 135 degrees, pitch 180 degrees and roll 540 degrees. It is powered by stepper motors with stainless steel cables providing the transmission.

It can be controlled by its on-board processor using the same teach pendant as the TeachMover or by a computer by way of an RS232 port. However, again there is no machine-specific software available. Using the pendant up to 900 individual steps can be entered.

To expand its capabilities the system can control two further motors which can be used in workcell peripherals such as a rotary table or conveyor. It also has 18 I/O ports available for interfacing with sensors.

UMI has developed two specific manufacturing systems around the Alpha II; for dip soldering small components and applying adhesives and other coatings. Both systems allow the arm moves to be entered either by the teach pendant or a joystick, which can then the stored on disk.

PIP MOBILE

Another contender in the Big Trak replacement stakes has come to my attention. It is Pip, a stand-alone mobile from a company called Swallow Systems based in High Wycombe.

This two-wheeled vehicle is powered by two stepper motors and accepts Logo-like commands by way of a membrane keyboard on its top. It can accept up to 39 step instructions but the number of movements can be expanded by the use of the repeat function.

It can travel backwards and forwards up to 10 metres and can turn left or right through up to 999 degrees or almost three complete circles. A full octave can be played. Links for the BBC and Nimbus are available.

The plain rectangular box can be dressed up with modelling or kit material to change its appearance. Special adhesive strips are supplied to allow materials to be stuck more permanently onto the mobile. A pencil holder, which comes with Pip, can be attached.

Duncan Louttit, who developed Pip, said that he wanted to create something that would be easy to use by young schoolchildren. He added that one of its more noticeable features was its strength which was usually demonstrated by standing on it.

The mobile costs about £200 plus VAT but Louttit is offering a 15 per cent discount for cash with order. The BBC and Nimbus connectors are extra. A rental scheme is also available for £8 a week plus VAT.

DOWN TO EARTH

George Hylton

OP. AMP. ASTABLE

RECENTLY I performed the electronic equivalent of painting myself into a corner. In the course of designing a piece of equipment I used up three of the op. amps in a quad chip. This left me with just one op. amp. to do a job which seemed to require two. Either I had to add another chip or somehow wangle matters to make the remaining chip do extra work and so extriciate myself from trouble.

AUDIO-VISUAL INDICATOR

The last of the three op,. amps which I'd already committed was used as a d.c. comparator plus visual indicator (Fig. 1). When the d.c. signal goes more positive than the reference voltage, the amplifier output goes high and lights the l.e.d.

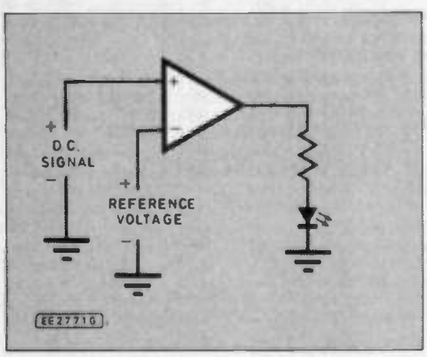


Fig. 1. Comparator plus l.e.d. indicator.

What I now wanted to do was make the same d.c. signal turn on an audio tone, to produce audible indication as a backup to the visual. (The circuit was for a portable instrument which might have to be used in brightly lit places, when the l.e.d. might not be very visible but a tone would still be audible.)

The conventional d.c. - controlled audio indicator (Fig. 2) was inpracticable since it requires a separate oscillator, permanently in action, and a gate. Too much circuitry. In my predicament the remaining op. amp. of the quad must clearly be arranged as an audio oscillator capable of being turned on or off by the previous circuitry.

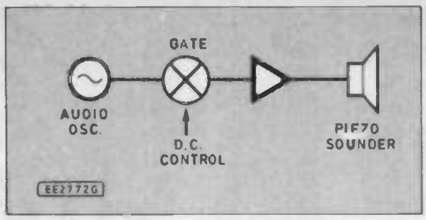


Fig. 2. Conventional audio indicator scheme.

OP. AMP. MULTIVIBRATOR

It usually pays to start with a standard, well-tried circuit then adapt it to do the new job. The work-horse op.amp. audio oscillator is the "astable" or multivibrator" shown in Fig. 3. Here R1 and R2 provide positive feedback. Negative feedback is routed through R3. However, the presence of C1 changes matters. At d.c., when C1 has infinite impedence, negative feedback is a maximum.

Unless R3 is unusually high in value, virtually the whole of the d.c. output voltage is fed back negatively, giving a d.c. gain of one. The circuit is then d.c. stable, that is it doesn't flip into a condition where the output stays at a permanently low (or permanently high) value.

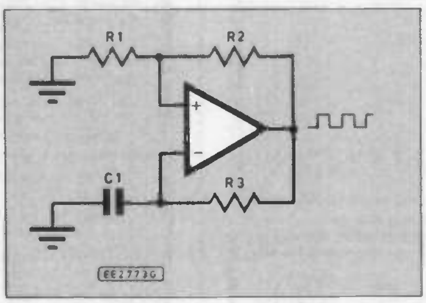


Fig. 3. Astable based on op. amp. (Also called an op. amp. multivibrator.)

If a.c. voltages are present they are attenuated and phase shifted by C1. At infinite frequency , C1 has zero impedance and there is no negative feedback. Since there is still positive feedback via R1 and R2 the circuit can oscillate. At first sight it would seem that the frequency of oscillation must be very high, since negative feedback would then be small. However, the gain of an op. amp. falls sharply with frequency. The upshot is that the circuit settles down to generate a square-wave output at a comparatively low frequency.

With R1 = R2 (a common condition), the frequency is approximately 1/(2.2R3C1). With R3 in megohms and C1 in microfarads the frequency is then in hertz. With R3 = 10k(0.01M), C = 0µ1, the frequency is about 450Hz.

STABILIZATION

If a resistance is added in series with C1 (Fig. 4. VR1), negative feedback is no longer zero at infinite frequency, but takes a value determined by the ratio of VR1 to R3. If VR1/R3 is greater than R1/R2 the circuit has overall negative feedback and should be stable.

It follows that there must be some value of VR1/R3 which sets the circuit to the borderline of stability. Then, any decrease in VR1 will provoke oscillation. It should therefore be possible to use VR1 as means of turning the oscillator on or off.

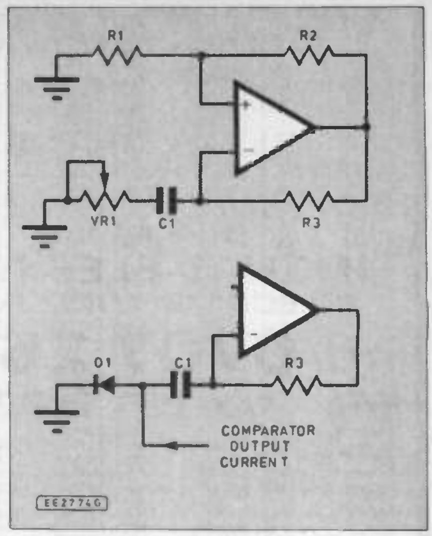


Fig. 4. (a) Adding R4 makes the circuit's stability adjustable. (b) A diode (D1) can be used as a variable resistance to adjust stability.

A test confirmed this. The next step was to arrange for VR1 to be varied by the changing output of my comparator (Fig. 1). Passing the output through a diode would change the effective resistance of the diode. So using a diode instead of VR1 seemed a good bet. In fact, there is already a diode in my circuit (the l.e.d., which is, after all a perfectly normal junction diode, electrically speaking). So why not use the l.e.d. as the control element for the audio oscillator?

It worked, but only when R3 was carefully chosen. Once R3 is fixed the frequency can still be set to any required value (within reason) by changing C1. The circuit displayed a certain amount of "backlash"; i.e. it didn't stop oscillating until the d.c. through D1 was reduced rather more than you'd expect. This however, was tolerable for my application, so I hadn't quite painted myself into a corner after all.

DIRECT BOOK SERVICE

The books listed have been selected as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full ordering details are given on the last book page.

MORE BOOKS NEXT MONTH—MORE BOOKS NEXT MONTH

AUDIO & MUSIC

SYNTHESIZERS FOR MUSICIANS
R. A. Penfold
Modern synthesizers are extremely complex, but they mostly work on principles that are not too difficult to understand. If you want to go beyond using the factory presets or the random poking of buttons, this is the book for you.

It covers the principles of modern synthesis—linear arithmetic as used by Roland, phase distortion (Casio), Yamaha's frequency modulation, and sampling—and then describes how the instruments are adjusted to produce various types of sound—strings, brass, percussion, etc. The theoretical side of synthesis is treated in an easy to understand way—the technical information being restricted to what you need to know to use your instrument effectively.
168 pages Order code PC105 £6.95

AUDIO
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Analysis of the sound wave and an explanation of acoustical quantities prepare the way. These are followed by a study of the mechanism of hearing and examination of the various sounds we hear. A look at room acoustics with a subsequent chapter on microphones and loudspeakers then sets the scene for the main chapter on audio systems—amplifiers, oscillators, disc and magnetic recording and electronic music.
320 pages Order code BP111 £3.95

INTRODUCTION TO DIGITAL AUDIO
Ian Sinclair
Digital recording methods have existed for many years and have become familiar to the professional recording engineer, but the compact disc (CD) was the first device to bring digital audio methods into the home. The next step is the appearance of digital audio tape (DAT) equipment.
All this development has involved methods and circuits that are totally alien to the technician or keen amateur who has previously worked with audio circuits. The principles and practices of digital audio owe little or nothing to the traditional linear circuits of the past, and are much more comprehensible to today's computer engineer than the older generation of audio engineers.
This book is intended to bridge the gap of understanding for the technician and enthusiast. The principles and methods are explained, but the mathematical background and theory is avoided, other than to state the end product
128 pages Order code PC102 £5.95

MAKE MONEY FROM HOME RECORDING
Clive Brooks
Now that you've spent a fortune on all that recording gear, MIDI and all, wouldn't it be nice to get some of it back? Well here's the book to show you how,

It's packed with money making ideas, any one of which will recoup the price of the book many times over. Whether you have a fully fledged recording studio at home, or just a couple of stereo cassette recorders and a microphone, you'll be able to put the ideas in this book into practice and make money.
105 pages Order code PC104 £5.95

TESTING & TEST GEAR

HOW TO TEST ALMOST EVERYTHING ELECTRONIC—2nd EDITION
Jack Darr and Delton T. Horn
Describes electronic tests and measurements—how to make them with all kinds of test equipment, and how to interpret the results. New sections in this edition include logic probes, frequency counters, capacitance meters, and more. (An American book.)
190 pages Order code T2925 £9.05

GETTING THE MOST FROM YOUR MULTIMETER
R.A. Penfold
This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.
In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.
96 pages Order code BP239 £2.95

MORE ADVANCED USES OF THE MULTIMETER
R.A. Penfold
This book is primarily intended as a follow-up to BP239, (see above), and should also be of value to anyone who already understands the basics of voltage testing and simple component testing. By using the techniques described in chapter 1 you can test and analyse the performance of a range of components with just a multimeter (plus a very few inexpensive components in some cases). Some useful quick check methods are also covered.

While a multimeter is supremely versatile, it does have its limitations. The simple add-ons described in chapter 2 extend the capabilities of a multimeter to make it even more useful. The add-ons described include an active r.f. probe, a high resistance probe, an a.c. sensitivity booster, and a current tracer unit.
84 pages Order code BP265 £2.95

TEACH-IN THEORY & REFERENCE

EVERYDAY ELECTRONICS DATA BOOK
Mike Tooley BA
(published by EE in association with PC Publishing)
This book is an invaluable source of information of everyday relevance in the world of electronics. It contains not only sections which deal with the essential theory of electronic circuits, but it also deals with a wide range of practical electronic applications.

It is ideal for the hobbyist, student, technician and engineer. The information is presented in the form of a basic electronic recipe book with numerous examples showing how theory can be put into practice using a range of commonly available "industry standard" components and devices.

A must for everyone involved in electronics!
256 pages Order code DATA £8.95

ELECTRONICS TEACH-IN 88/89—INTRODUCING MICROPROCESSORS
Mike Tooley BA (published by *Everday Electronics*)
A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303). The book contains everything you need to know including full details on registering for assessment, etc.

Sections cover Microcomputer Systems, Microprocessors, Memories, Input/Output, Interfacing and Programming. There are various practical assignments and eight Data Pages covering the most popular microprocessor chips.

An excellent introduction to the subject even for those who do not wish to take the City and Guilds assessment.
80 pages (A4 size) Order code TI-88/89 £2.45

ELECTRONICS TEACH-IN No.4
INTRODUCING DIGITAL ELECTRONICS (published by *Everyday Electronics*) NEW
Michael J. Cockcroft
Although this book is primarily a City & Guilds Introductory level course (726/301), approximately 80% of the information forms a very basic introduction to electronics in general, it therefore provides an excellent introductory text for beginners and a course and reference book for GCSE students.

Full details on registering for C&G assessment, details of assessment centres, components required and information on the course in general are given.

The City & Guilds introduction to module 726/301 reads: "A candidate who satisfactorily completes this module will have a competence to identify basic components and digital integrated circuits and connect them together to form simple working circuits and logic units." This provides an excellent introduction to the book
112 pages (A4 size) Order code TI4 £2.95

ELECTRONICS TEACH-IN No. 3 — EXPLORING ELECTRONICS (published by *Everyday Electronics*)
Owen Bishop
Another EE value for money publication aimed at students of electronics. The course is designed to explain the workings of electronic components and circuits by involving the reader in experimenting with them. The book does not contain masses of theory or formulae but straightforward explanations and circuits to build and experiment with.

Exploring Electronics contains more than 25 useful projects, assumes no previous knowledge of electronics and is split into 28 easily digestible sections.
88 pages (A4 size) Order code TI3 £2.45

THE ILLUSTRATED DICTIONARY OF ELECTRONICS—4th EDITION
Rufus P. Turner and Stan Gibilisco
With more than 27,000 terms used in electronics today, this collection is THE most comprehensive dictionary available. Including all practical electronics and computer terms, it is as up-to-date as the latest advances in the field itself! Tables and data on subjects most often consulted for projects and experiments are included. Other conversion tables include English/metric and metric/English conversions for units of measurement of energy, power and volume, and Fahrenheit/Celsius temperature conversion charts.

Setting this edition apart from other electronic dictionaries is its emphasis on illustration. Featuring more than complete definitions, this fourth edition includes over 450 detailed drawings and diagrams.

All entries are listed in alphabetical order. Abbreviations and initials are listed in sequence with whole words. All terms of more than one word are treated as one word. (An American book.)
648 pages Order code T2900 £23.65

ELECTRONICS—A "MADE SIMPLE" BOOK
G. H. Olsen
This book provides excellent background reading for our *Introducing Digital Electronics* series and will be of interest to everyone studying electronics. The subject is simply explained and well illustrated and the book assumes only a very basic knowledge of electricity.
330 pages Order code NE10 £4.95

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

The book is divided into six basic sections: Units and Constants, Direct-current Circuits, Passive Components, Alternating-current Circuits, Networks and Theorems, Measurements.
256 pages Order code BP53 £3.95

MICROELECTRONIC SYSTEMS N2 CHECKBOOK
R. Vears
The aim of this book is to provide a foundation in microcomputer hardware, software and interfacing techniques. Each topic is presented in a way that assumes only an elementary knowledge of microelectronic systems and logic functions. The book concentrates on 6502, Z80 and 6800 microprocessors and contains 60 tested programs, 160 worked problems and 250 further problems.
Order code NE04N £6.95

TEACH-IN, THEORY & REFERENCE

ELECTRONICS-BUILD AND LEARN
R. A. Penfold
The first chapter gives full constructional details of a circuit demonstrator unit that is used in subsequent chapters to introduce common electronic components–resistors, capacitors, transformers, diodes, transistors, thyristors, fets and op amps. Later chapters go on to describe how these components are built up into useful circuits, oscillators, multivibrators, bistables and logic circuits.

At every stage in the book there are practical tests and experiments that you can carry out on the demonstrator unit to investigate the points described and to help you understand the principles involved. You will soon be able to go on to more complex circuits and tackle fault finding logically in other circuits you build.
120 pages Order Code PC103 £5.95

PRACTICAL ELECTRONICS HANDBOOK
Ian Sinclair
Ian Sinclair has now revised this useful and carefully selected collection of standard circuits, rules-of-thumb, and design data for professional engineers, students and enthusiasts involved in radio and electronics. Covering passive and active components, discrete component circuits (such as amplifiers, filters and oscillators) and linear and digital i.c.s, the book includes many items which are not elsewhere available in a single handy volume. The operation and functions of typical circuits are described, while mathematics is limited to that necessary for deciding component values for any application.
This revised edition contains more details on computers and microprocessors and has been brought up to date throughout.
199 pages Order Code NE06 £7.95

DATA & COMPONENT IDENTIFICATION

TRANSISTOR SELECTOR GUIDE
This unique guide offers a range of selection tables compiled so as to be of maximum use to all electronics engineers, designers and hobbyists.
Section 1: Covers component markings, codings and standards, as well as explaining the symbols used.
Section 2: Tabulates in alpha-numeric sequence the comprehensive specifications of over 1400 devices.
Section 3: Tabulates the devices by case type.
Section 4: Considers particular limits to the electrical parameters when compiling the tables.
Section 5: Illustrates package outlines and leadouts.
Section 6: Consists of a surface mounting device markings conversion list.
192 pages **Temporarily out of print**

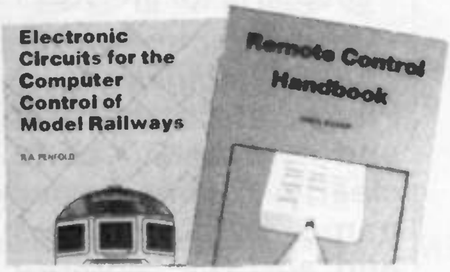
DIGITAL IC EQUIVALENTS AND PIN CONNECTIONS
A. Michaels
Shows equivalents and pin connections of a popular selection of European, American and Japanese digital i.c.s. Also includes details of packaging, families, functions, manufacturer and country of origin.
256 pages **Temporarily out of print**

INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE
A. Michaels
Helps the reader to find possible substitutes for a popular selection of European, American and Japanese transistors. Also shows material type, polarity, manufacturer and use.
320 pages Order code BP85 £3.50

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

CIRCUITS & DESIGN

ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF MODEL RAILWAYS
R.A. Penfold
Home computers may easily be applied to the control of model railways and really quite sophisticated control, which needs only simple programming, is not too difficult to achieve. The main problem lies in interfacing the computer to the layout, but fortunately it is not too difficult or expensive to build suitable interfaces, and this book shows you how.
The projects consist of various types of controller, including a high quality pulse type, as well as circuits for train position sensing, signal and electric points control etc. The use of computers does not have to be restricted to massive layouts. Something as simple as an oval of track with a single siding can be given a new dimension by adding computer control and much fun can be had from these relatively simple set-ups.
88 pages Order code BP180 £2.95



REMOTE CONTROL HANDBOOK
Owen Bishop
Remote control systems lend themselves to a modular approach. This makes it possible for a wide range of systems, from the simplest to the most complex, to be built up from a number of relatively simple modules. The author has tried to ensure that, as far as possible, the circuit modules in this book are compatible with one another. They can be linked together in many different configurations to produce remote control systems tailored to individual requirements. Whether you wish simply to switch a table lamp on and off, or to operate an industrial robot, this book should provide the circuit you require.
226 pages Order code BP240 £3.95

COIL DESIGN AND CONSTRUCTION MANUAL
B. B. Babani
A complete book for the home constructor on "how to make" RF, IF, audio and power coils, chokes and transformers. Practically every possible type is discussed and calculations necessary are given and explained in detail. Although this book is now rather old, with the exception of torroids and pulse transformers little has changed in coil design since it was written.
96 pages Order Code 160 £2.50

30 SOLDERLESS BREADBOARD PROJECTS – BOOK 1
R. A. Penfold.
Each project, which is designed to be built on a "Verobloc" breadboard, is presented in a similar fashion with a brief circuit description, circuit diagram, component layout diagram, components list and notes on construction and use where necessary. Wherever possible, the components used are common to several projects, hence with only a modest number of reasonably inexpensive components, it is possible to build in turn, every project shown. Recommended by BICC-Vero.
160 pages Order Code BP107 £2.95

BOOK 2 – All projects use CMOS i.c.s but the items on component identification etc., are not repeated from Book 1
160 pages Order code BP113 £2.25

ELECTRONIC CIRCUITS HANDBOOK
Michael Tooley BA
This book aims to explode two popular misconceptions concerning the design of electronic circuits: that only those with many years of experience should undertake circuit design and that the process relies on an understanding of advanced mathematics. Provided one is not too ambitious, neither of these popularly held beliefs is true.

Specifically, this book aims to provide the reader with a unique collection of practical working circuits together with supporting information so that circuits can be produced in the shortest possible time and without recourse to theoretical texts.

Furthermore, information has been included so that the circuits can readily be modified and extended by readers to meet their own individual needs. Related circuits have been grouped together and cross-referenced within the text (and also in the index) so that readers are aware of which circuits can be readily connected together to form more complex systems. As far as possible, a common range of supply voltages, signal levels and impedances has been adopted.

As a bonus, ten test gear projects have been included. These not only serve to illustrate the techniques described but also provide a range of test equipment which is useful in its own right.
277 pages Order code NE05 £14.95

AUDIO IC CIRCUITS MANUAL
R. M. Marston
A vast range of audio and audio-associated i.c.s are readily available for use by amateur and professional design engineers and technicians. This manual is a guide to the most popular and useful of these devices, with over 240 diagrams. It deals with i.c.s such as low frequency linear amplifiers, dual pre-amplifiers, audio power amplifiers, charge coupled device delay lines, bar-graph display drivers, and power supply regulators, and shows how to use these devices in circuits ranging from simple signal conditioners and filters to complex graphic equalizers, stereo amplifier systems, and echo/reverb delay line systems etc.
168 pages Order code NE13 £11.95

HOW TO DESIGN ELECTRONIC PROJECTS
R. A. Penfold
The aim of this book is to help the reader to put together projects from standard circuit blocks with a minimum of trial and error, but without resorting to any advanced mathematics. Hints on designing circuit blocks to meet your special requirements are also provided.
128 pages Order code BP127 £2.25

50 CIRCUITS USING GERMANIUM SILICON AND ZENER DIODES
R. N. Soar
Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most simple and inexpensive of components—the diode. Includes the use of germanium and silicon signal diodes, silicon rectifier diodes and Zener diodes, etc.
64 pages Order Code BP36 £1.50

KEY TECHNIQUES FOR CIRCUIT DESIGN
C. G. Loveday C.Eng MIERE
Deals with designing electronic circuits from scratch covering concepts such as target specifications, component selection (passive, discretes and i.c.s), the design cycle, derating and so on. Numerous design examples are given and several reader exercises all with fully worked solutions. The approach is essentially non-mathematical.
128 pages Order code BM1 £6.95

DESIGNING WITH LINEAR ICs
G.C. Loveday
A book that deals with the design of the vital area of analog circuitry covering design with modern linear integrated circuit devices. The first chapter introduces the reader to important design techniques, test strategies, layout, and protection and also includes a section on the use of a typical CAD tool. There are separate chapters that cover in depth the use of op-amps, comparators and timers each with detailed design examples and reader exercises. A final chapter brings all the previous work together in a number of complete design problems with fully worked solutions. The text is essentially non-mathematical and is supported by many diagrams.
180 pages Order code BM3 £8.75

OPTOELECTRONICS CIRCUITS MANUAL
R. M. Marston
A useful single-volume guide to the optoelectronics device user, specifically aimed at the practical design engineer, technician, and the experimenter, as well as the electronics student and amateur. It deals with the subject in an easy-to-read, down-to-earth, and non-mathematical yet comprehensive manner, explaining the basic principles and characteristics of the best known devices, and presenting the reader with many practical applications and over 200 circuits. Most of the i.c.s and other devices used are inexpensive and readily available types, with universally recognised type numbers.
182 pages Order code NE14 £12.95

A MICROPROCESSOR PRIMER
E. A. Parr, B.SC., C.Eng., M.I.E.E.
Starts by designing a small computer which, because of its simplicity and logical structure, enables the language to be easily learnt and understood. The shortcomings are then discussed and the reader is shown how these can be overcome by changes and additions to the instruction set. In this way, such ideas as relative addressing, index registers, etc., are developed.
96 pages Order code BP72 £1.75

POPULAR ELECTRONIC CIRCUITS –BOOK 1
POPULAR ELECTRONIC CIRCUITS –BOOK 2
R. A. Penfold
Each book provides a wide range of designs for electronic enthusiasts who are capable of producing working projects from just a circuit diagram without the aid of detailed construction information. Any special setting-up procedures are described.
BOOK 1 *160 pages* Order code BP80 £2.95
BOOK 2 *160 pages* Order code BP98 £2.95

CMOS CIRCUITS MANUAL
R. M. Marston
Written for the professional engineer, student or enthusiast. It describes the basic principles and characteristics of these devices and includes over 200 circuits.

All the circuits have been designed, built and fully evaluated by the author; all use inexpensive and internationally available devices.
187 pages Order code NE12 £12.95

PROJECT CONSTRUCTION

Published by *Everyday Electronics* in association with Magenta Electronics.
Contains twenty of the best projects from previous issues of EE each backed with a kit of components. The projects are: Seashell Sea Synthesiser, EE Treasure Hunter, Mini Strobe, Digital Capacitance Meter, Three Channel Sound to Light, BBC 15K Sideways Ram, Simple Short Wave Radio, Insulation Tester, Stepper Motor interface, Eprom Eraser, 200MHz Digital Frequency Meter, Infra Red Alarm, EE Equaliser Ioniser, Bat Detector, Acoustic Probe, Mainstester and Fuse Finder, Light Rider – (Lapel Badge, Disco Lights, Chaser Light), Musical Doorbell, Function Generator, Tilt Alarm, 10W Audio Amplifier, EE Buccaneer Induction Balance Metal Detector, BBC Midi Interface, Variable Bench Power Supply, Pet Scarer, Audio Signal Generator.
128 pages **Order code EP1** **£2.45**

HOW TO DESIGN AND MAKE YOUR OWN P.C.B.s
R. A. Penfold
Deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.
80 pages Order code BP121 £2.50

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING
R. A. Penfold
We have all built projects only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.
96 pages **Order code BP110** **£2.50**

ELECTRONIC SCIENCE PROJECTS
O. Bishop
These projects range in complexity from a simple colour temperature meter to an infra-red laser. There are novelties such as an electronic clock regulated by a resonating spring, and an oscilloscope with solid-state display. There are scientific measuring instruments such as a pH meter and an electro-cardiometer. All projects have a strong scientific flavour. The way they work, and how to build and use them are fully explained.
144 pages Order code BP104 £2.95

BEGINNER'S GUIDE TO BUILDING ELECTRONIC PROJECTS
R. A. Penfold
Shows the complete beginner how to tackle the practical side of electronics, so that he or she can confidently build the electronic projects that are regularly featured in magazines and books. Also includes examples in the form of simple projects.
112 pages **Order code No. 227** **£1.95**

TEST EQUIPMENT CONSTRUCTION
R.A. Penfold
This book describes in detail how to construct some simple and inexpensive but extremely useful, pieces of test equipment. Stripboard layouts are provided for all designs, together with wiring diagrams where appropriate, plus notes on construction and use.
The following designs are included:- AF Generator, Capacitance Meter, Test Bench Amplifier, AF Frequency Meter, Audio Millivoltmeter, Analogue Probe, High Resistance Voltmeter, CMOS Probe, Transistor Tester, TTL Probe. The designs are suitable for both newcomers and more experienced hobbyists.
104 pages Order code BP248 **£2.95**

RADIO, TV, SATELLITE

BEGINNER'S GUIDE TO RADIO–9th EDITION
Gordon J. King
Radio signals, transmitters, receivers, antennas, components, valves and semiconductors, CB and amateur radio.
266 pages **Order code NE08** **£6.95**

AN INTRODUCTION TO RADIO DXING
R. A. Penfold
Anyone can switch on a short wave receiver and play with the controls until they pick up something, but to find a particular station, country or type of broadcast and to receive it as clearly as possible requires a little more skill and knowledge. The object of this book is to help the reader to do just that, which in essence is the fascinating hobby of radio DXing.
112 pages **Order code BP91** **£1.95**

A TV-DXERS HANDBOOK
R. Bunney
Roger Bunney is probably one of the leading authorities in this country on the subject. Includes many units and devices which have been designed and used by active enthusiasts, and often, considerable ingenuity and thought have gone into the development of such units to overcome individual problems. A practical and authoritative reference to this unusual aspect of electronics.
128 pages **Order code BP176** **£5.95**

SATELLITE TELEVISION INSTALLATION GUIDE–2nd EDITION
John Breeds
This book is now firmly established as a leading study manual for satellite TV installers, technical colleges who run City & Guilds courses, and training schools in major companies. It will be invaluable to anyone who wants to set up a dish receiver.
It covers all aspects of satellite dish installation: Installation of indoor unit, Geostationary satellites, Site survey, Dish assembly, Signal polarisation, Setting up the dish, Polar mount dish, TV download and relay cable and F-connectors, EIRP footprint contours, Trouble-shooting guide, Glossary of terms and Useful addresses.
56 pages (large format) **Order code JB1** **£11.95**

NEWNES SHORTWAVE LISTENING HANDBOOK
Joe Pritchard G1UQW
Part One covers the "science" side of the subject, going from a few simple electrical "first principles", through a brief treatment of radio transmission methods to simple receivers. The emphasis is on practical receiver designs and how to build and modify them, with several circuits in the book.
Part Two covers the use of sets, what can be heard, the various bands, propagation, identification of stations, sources of information, QSLing of stations and listening to amateurs. Some computer techniques, such as computer morse decoding and radio teletype decoding are also covered.
224 pages Order code NE16 **£12.95**

COMPUTING

SERVICING PERSONAL COMPUTERS–2nd EDITION
Mike Tooley BA
The revised and enlarged second edition contains a new chapter on the IBM PC, AT, TX and compatibles. It is essential for anyone concerned with the maintenance of personal computer equipment or peripherals, whether professional service technician, student or enthusiast.
240 pages (hard cover) **Order code NE15** **£25**

AN INTRODUCTION TO 6502 MACHINE CODE
R. A. & J. W. Penfold
No previous knowledge of microprocessors or machine code is assumed. Topics covered are: assembly language and assemblers, the register set and memory, binary and hexadecimal numbering systems, addressing modes and the instruction set, and also mixing machine code with BASIC. Some simple programming examples are given for 6502-based home computers like the VIC-20, ORIC-1/Atmos, Electron, BCC and also the Commodore 64.
112 pages Order code BP147 **£2.95**

AN INTRODUCTION TO COMPUTER PERIPHERALS
J. W. Penfold
Covers such items as monitors, printers, disc drives, cassette recorders, modems, etc., explaining what they are, how to use them and the various types and standards. Helps you to make sure that the peripherals you buy will work with your computer.
80 pages **Order code BP170** **£2.50**

AN INTRODUCTION TO PROGRAMMING THE BBC MODEL B MICRO
R. A. & J. W. Penfold
Written for readers wanting to learn more about programming and how to make best use of the incredibly powerful model B's versatile features. Most aspects of the BBC micro are covered, the omissions being where little could usefully be added to the information provided by the manufacturer's own manual.
144 pages **Order code BP139** **£1.95**

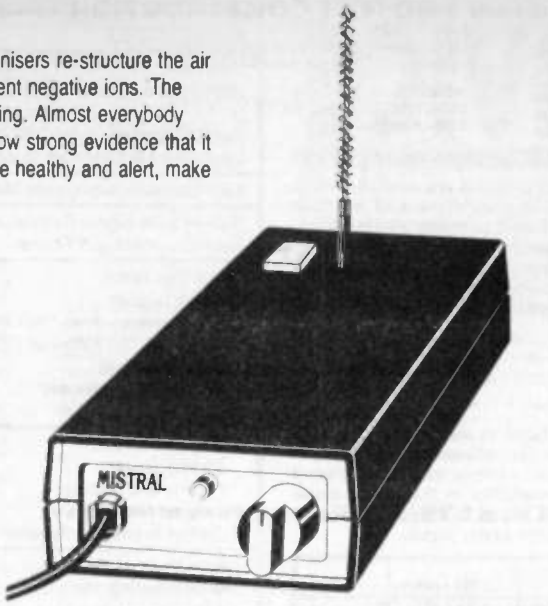
AN INTRODUCTION TO COMPUTER COMMUNICATIONS
R. A. Penfold
Provides details of the various types of modem and their suitability for specific applications, plus details of connecting various computers to modems, and modems to the telephone system. Also information on common networking systems and RTTY.
96 pages **Order code BP177** **£2.95**

THE PRE-BASIC BOOK
F. A. Wilson, C.G.I.A., C.ENG., F.I.E.E., F.I.E.R.E., F.B.I.M.
Another book on BASIC but with a difference. This one does not skip through the whole of the subject and thereby leave many would-be programmers floundering but instead concentrates on introducing the technique by looking in depth at the most frequently used and more easily understood computer instructions. For all new and potential micro users.
192 pages **Order code BP146** **£2.95**

AIR IONISERS

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

THE MISTRAL AIR IONISER ▷



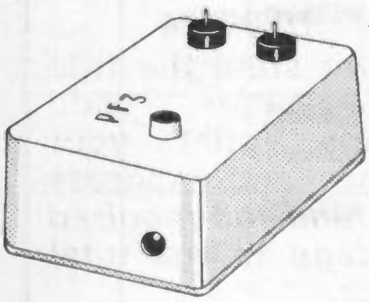
The ultimate air ioniser. The Mistral has variable ion drive, built-in ion counter and enough power to drive five multi-point emitters with ease. Its nine main drive stages, five secondary drives and four booster stages give an immense 15 billion ions per minute output – enough to fill the largest room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

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

MISTRAL IONISER PARTS SET **£32.66** ☐

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

ION FAN (optional) **£11.27** ☐



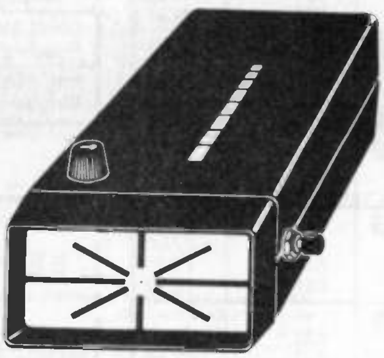
◁ PROPHET PF3

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

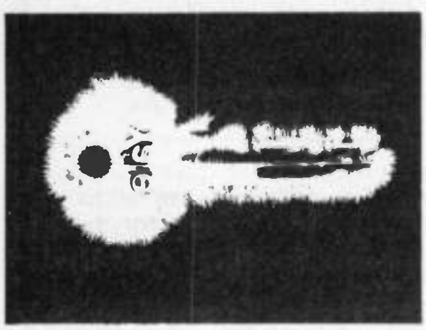
PROPHET PF3 PARTS SET **£21.39** ☐

THE Q-ION ▷

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



Q-ION COMPLETE PARTS SET **£21.16** ☐



◁ KIRLIAN CAMERA

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

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

KIRLIAN CAMERA SET **£19.78** ☐

IONISER EXPERIMENTS

* The Vanishing Smoke Trick

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

* Triffids

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

* The Electric Handshake

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

Specialist SEMICONDUCTORS LIMITED

Tel: (0600) 3715

SALES DEPT., ROOM 111, FOUNDERS HOUSE, REDBROOK, MONMOUTH, GWENT.

ORDERING

All prices include VAT

UK orders: please add £1.15 postage and packing.

Eire and overseas: please deduct VAT and add £5.00 carriage and insurance.

ACCESS

Phone 0600 3715 for immediate attention to your Access order.

PCB SERVICE

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

Boards for some older projects – not listed here – can often be obtained from Magenta Electronics, 135 Hunter St., Burton-on-Trent, Staffs DE14 2ST. Tel: 0283 65435 or Lake Electronics, 7 Middleton Close, Nuthall, Nottingham NG16 1BX. Tel: 0602 382509.

NOTE: While 90% of our boards are now held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail. Please check price and availability in the latest issue before ordering. We can only supply boards listed in the latest issue. Boards can only be supplied on a payment with order basis.

PROJECT TITLE		Order Code	Cost
Noise Gate	SEP'87	577	£4.41
BBC Sideways RAM/ROM	NOV'87	585	£4.10
Pipe & Cable Locator	APR'88	598	£3.00
Multi-Channel Remote Light Dim	MAY'88		
Transmitter		599	£3.00
Receiver		600	£3.07
Door Sentinel		605	£3.00
Multi-Chan Remote Light Dim	JUN'88		
Relay/Decoder		601	£4.86
Dimmer Board		602	£3.07
Power Supply		603	£3.00
Video Wiper	JUL'88	612	£6.75
Isolink		613	£4.21
Tea Tune	AUG'88	609	£3.00
Time Switch		614	£4.84
Suntan Timer		610	£3.07
Car Alarm		615	£3.12
Breaking Glass Alarm	SEP'88	617	£4.27
EPROM Eraser	OCT'88	620	£4.07
Doorbell Delay	NOV'88	616	£3.56
Infra-Red Object Counter Trans	£9.28	622	£4.61
Receiver	as a	623	£3.23
Display	set	624	£3.05
Seashell Sea Synthesiser		625	£4.84
Downbeat Metronome	DEC'88	629	£4.84
EPROM Programmer *(On Spec)*		630	£8.29
Phasor		631	£5.64
Monkey/Hunter Game	JAN'89	634	£3.36
Continuity Tester	FEB'89	619	£2.67
4-Channel Light Dimmer		635	£7.67
Mini PSU		636	£3.23
Sound-to-Light Interface	MAR'89	637	£6.24
Midi Pedal		639	£7.00
Midi Merge		640	£3.00
Audio Lead Tester		641	£5.77
Light Sentinel	APR'89		
Main Control Board		632	£9.20
Remote Interface (4 boards)		633	£4.59
Electron User Port		638	£6.64
4-Channel Auto-Fade Interface		642	£6.80
Pet Scarer	MAY'89	644	£3.00
Electron A/D Interface		645	£4.84
Spectrum EPROM Programmer	JUN'89	628	£7.87
Bat Detector		647	£4.95
Programmable Pocket Timer	JUL'89	648	£3.82
Electronic Spirit Level	AUG'89	649	£3.85
Distance Recorder		651	£5.23
Treasure Hunter		652	£3.73
Xenon Beacon	SEP'89	650	£4.13
Probe Pocket Treasure Finder		653	£4.12
Power Supplies – Fixed Voltage		654	£4.08
Variable Voltage		655	£4.48
Music on Hold	OCT'89	646	£3.85
Power Supplies – 25V 700mA		656	£4.35
30V 1A		657	£4.55
EE Seismograph – Control		658	£4.08
Detector		659	£4.22
Lego/Logo & Spectrum		660	£6.49

PROJECT TITLE		Order Code	Cost
Wash Pro	NOV'89	643	£3.83
Biofeedback Monitor – Front End		661	£4.52
Processor		662	£4.56
Power Supplies – 1.5V-25V 2A		663	£4.78
Logo/Lego & Spectrum Interface		664	£5.60
EEG Electrode Impedance Meter	DEC'89	665	£3.98
Biofeedback Signal Generator	JAN'90	666	£4.08
Four-Channel Light Chaser		667	£6.70
Quick Cap Tester	FEB'90	668	£3.92
Weather Station			
Anemometer – Freq./Volt Board		670	£3.94
Optional Display		669	£3.73
Wind Direction		673/674	£4.22
System Power Supply		675	£3.59
Prophet In-Car Ioniser		676	£3.18
EE Weather Station	MAR'90		
Display Driver		672 & 678	£4.22
Display and Sensor		671	£4.47
Fermostat Mk2		677	£4.28
Superhet Broadcast Receiver-Tuner/Amp		679/680	£4.22
Stereo Noise Generator	APR'90	681	£4.24
Digital Experimenter's Unit – Pulse Generator		682	£4.46
Power Supply		683	£3.66
Enlarger Timer		684	£4.28
EE Weather Station			
Rainfall/Sunlight Display		685	£4.27
Rainfall Sen and Sunlight Sen		686/687	£4.16
Amstrad Speech Synthesiser	MAY'90	689	£4.68
Quizmaster		690	£4.74
80 Metre Direct Conversion Radio	JUN'90	691	£4.95
Mains Appliance Remote Control			
Infra-Red Transmitter		692/693	£4.75
Mains Appliance Remote Control	JUL'90		
Encoder Board A		694	£6.61
Encoder Board B		695	£4.78
The Tester		696	£4.15
Mains Appliance Remote Control	AUG'90		
Mains ON/OFF Decoder		697	£4.55
(5 or more 697's ordered *together* £3.25 each)			
Simple Metronome		698	£3.94
Hand Tally	SEP'90		
Main Board (double-sided)			
Display		699, 700	£10.95
Alarm Bell Time-Out		701	£4.10
Mains Appliance Remote Control			
Temperature Controller (p.c.b. only)		702	£5.20
Ghost Walker	OCT'90	703	£4.32
Frequency Meter		704	£5.25
Freq. Meter/Tachometer	NOV'90	705	£3.98
EE Musketeer		706	£5.78

BLOCK CAPITALS PLEASE

Please note it is important to give project title as well as order code.

EE PRINTED CIRCUIT BOARD SERVICE

Please send me the following p.c.b.s.

Order Code Project Quantity Price

....

....

I enclose cheque/PO for £..

Name..

Address..

....

Please allow 28 days for delivery (see note above)

EVERYDAY ELECTRONICS CLASSIFIED

Reach effectively and economically today's enthusiasts anxious to know of your products and services through our semi-display and classified pages. The prepaid rate for semi-display spaces is £8.00 (plus VAT) per single column centimetre (minimum 2.5 cm). The prepaid rate for classified advertisements is 30 pence (plus VAT) per word (minimum 12 words).
All cheques, postal orders, etc., to be made payable to Everyday Electronics. **VAT must be added.** Advertisements, together with remittance, should be sent to the Classified Advertisement Dept., Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH. Tel: (0202) 881749.

Kits

PLEASE MENTION EVERYDAY ELECTRONICS WHEN REPLYING TO ADVERTISEMENTS

Miscellaneous

USE THIS SPACE
SELL YOUR PRODUCTS
IT ONLY COSTS (see above for details) **£28**+VAT

NATIONAL
COLLEGE OF
TECHNOLOGY

PACKAGED SHORT COURSES

The National College of Technology (NCT Ltd) offers a range of packaged short courses in analogue electronics, digital electronics, fibres & optoelectronics and programmable logic controllers for study at home or at work. The advantages are that you may,

- –commence at any time
- –work at your own pace
- –have a tutor (optional)

and there is no travelling involved. BTEC certificates are available subject to the conditions of the award. These highly popular packed courses contain workbooks, a cassette tape, circuit board and components necessary to provide both theoretical and practical training.

Whether you are a newcomer to electronics or have some experience and simply need updating, there is probably a packaged short course ready for you. Write or telephone for details, quoting Everyday Electronics, to:

NCT Ltd, Bicester Hall,
5 London Road, Bicester
Oxon OX6 7BU

or telephone (0296) 613067 Ext. 202.

ADVERTISERS INDEX

BTEC ELECTRONICS TECHNICIAN FULL-TIME TRAINING

2 YEAR
BTEC National Diploma (OND)
ELECTRONIC & COMMUNICATIONS ENGINEERING
(Electronics, Computing, Television, Video, Testing & Fault Diagnosis)

1 YEAR
BTEC National Certificate (ONC)
ELECTRONIC ENGINEERING
1—INFORMATION TECHNOLOGY
(Electronics, Satellite TV, Networks, Telecomms)

2—ELECTRONIC EQUIPMENT SERVICING
(Electronics, Television, Video Cassette Recorders, CCTV, Testing and Fault Diagnosis)

3—SOFTWARE ENGINEERING
(Electronics, Assembler, BASIC, Pascal, CADCAM)

4—COMPUTING TECHNOLOGY
(Electronics, Computing Software/Hardware, Microelectronics)

10 MONTHS
BTEC Higher National Certificate (HNC)
COMPUTING TECHNOLOGY & ROBOTICS
(Microprocessor Based Systems, Control, Robotics)

These courses include a high percentage of college based practical work to enhance future employment prospects
No additional fees for overseas students
Shortened courses of from 3 to 6 months can be arranged for applicants with previous electronics knowledge

THOSE ELIGIBLE CAN APPLY FOR E.T. GRANT SUPPORT
AN EQUAL OPPORTUNITIES PROGRAMME

O.N.C. and O.N.D.
Next Course Commences
Monday 7th January 1991
FULL PROSPECTUS FROM

LONDON ELECTRONICS COLLEGE
(Dept. EE) 20 PENYWERN ROAD
EARLS COURT, LONDON SW5 9SU
TEL 071-373 8721

Carbon Film resistors ¼W 5% E24 series 0.51R to 10MO	1p
100 off per value—75p, even hundreds per value totalling 1000	£6.00p
Metal Film resistors ¼W 10R to 1MO 5% E12 series—2p, 1% E24 series	3p
Mixed metal/carbon film resistors ½W E24 series 1RO to 10MO	1½p
1 watt mixed metal/Carbon Film 5% E12 series 4R7 to 10 Megohms	5p
Linear Carbon pre-sets 100mW and ¼W 100R to 4M7 E6 series	7p
Miniature polyester capacitors 250V working for vertical mounting	
.015, .022, .033, .047, .068-4p. 0.1-5p. 0.12, 0.15, 0.22-6p. 0.47-8p. 0.68-8p. 1.0-12p	
Mylar (polyester) capacitors 100V working E12 series vertical mounting	
1000p to 8200p - 3p. .01 to .068 - 4p. 0.1 - 5p. 0.12, 0.15, 0.22-6p. 0.47/50V-8p	
Submin ceramic plate capacitors 100V wkg vertical mountings. E12 series	
2% 1.8pf to 47pf - 3p. 2% 56 pf to 330pf - 4p. 10% 390p - 4700p	4p
Disc/plate ceramics 50V E12 series 1PO to 1000P, E6 Series 1500P to 47000P	2p
Polystyrene capacitors 63V working E12 series long axial wires	
10pf to 820pf - 3p. 1000 pf to 10,000pf - 4p. 12,000 pf	5p
741 Op Amp - 20p. 555 Timer	22p
cmos 4001 - 20p. 4011 - 22p. 4017	40p
ALUMINIUM ELECTROLYTICS (Mfds/Volts)	
1/50, 2.2/50, 4.7/50, 10/25, 10/50	5p
22/16, 22/25, 22/50, 47/16, 47/25, 47/50	6p
100/16, 100/25 7p; 100/50 12p; 100/100	14p
220/16 8p; 220/25, 220/50 10p; 470/16, 470/25	11p
1000/25 25p; 1000/35, 2200/25 35p; 4700/25	70p
Submin, tantalum bead electrolytics (Mfds/Volts)	
0.1/35, 0.22/35, 0.47/35, 1.0/35, 3.3/16, 4.7/16	14p
2.2/35, 4.7/25, 4.7/35, 6.8/16 15p; 10/16, 22/6	20p
33/10, 47/6, 22/16 30p; 47/10 35p; 47/16 60p; 47/35	80p
VOLTAGE REGULATORS	
1A + or – 5V, 8V, 12V, 15V, 18V & 24V	55p
DIODES (piv/amps)	
75/25mA 1N4148 2p. 800/1A 1N4006 6p. 400/3A 1N5404 14p. 115/15mA OA91	6p
100/1A 1N4002 4p. 1000/1A 1N4007 7p. 60/1.5A S1M1 5p. 100/1A bridge	25p
400/1A 1N 4004 5p. 1250/1A BY127 10p. 30/.15A OA47	8p
Zener diodes E24 series 3V3 to 33V 400 mW - 8p. 1 watt	12p
Battery snaps for PP3 - 6p for PP9	12p
L.E.D.'s 3mm. & 5mm. Red, Green, Yellow - 10p. Grommets 3mm - 2p, 5mm	2p
Red flashing L.E.D.'s require 5V supply only	50p
Mains Indicator neons with 220k resistor	10p
20mm fuses 100mA to 5A. Q blow 5p. A/surge 8p. Holders, chassis mounting	5p
High speed pc drill 0.8, 1.0, 1.3, 1.5, 2.0m - 30p. Machines 12V dc	£7.00
HELPING HANDS 6 ball joints and 2 croc clips to hold awkward jobs	£3.50p
AA/HP7 Nicad rechargeable cells 80p each. Universal charger unit	£6.50p
Glass reed switches with single pole make contacts - 8p. Magnets	12p
0.1" Stripboard 2½" x 1" 9 rows 25 holes – 20p. 3¾" x 2½" 24 rows 37 holes	60p

TRANSISTORS

BC107/8/9-12p. BC547/8/9-8p. BC557/8/9-8p, BC182, 182L, BC183, 183L, BC184, 184L, BC212, 212L-10p. BC327, 337, 337L-12p, BC727, 737-12p, BD135/6/7/8/9-25p. BCY70-15p. BFY50/51/52-20p.
BFX88-15p, 2N3055-50p, TIP31,32-30p, TIP41,42-40p, BU208A-£1.20, BF195,197-12p

All prices are inclusive of VAT. Postage 30p (free over £5). Lists Free.

THE CR SUPPLY CO

127 Chesterfield Rd., Sheffield S8 0RN
Tel: 0742 557771 *Return posting*

Page Make-up for £185 plus VAT

IF YOU are looking for a superb, page make-up system complete with over 200 typefaces, that really works and won't cost you an arm and a leg, Typefit is the system for you.

Why? Because for only £185 + VAT you get:

- ☐ Access to over £90k hard/software, and over 200 genuine Monotype and ITC fonts from 1 - 1000 pt.
- ☐ Disc processing through our typesetting bureau from £2.50 for an A4 page.
- ☐ Page make-up, on screen. ☐ Clear, accurate WYSIWYG.
- ☐ A system that's easy to learn and simple to use.
- ☐ Full on-screen help, and telephone back-up.
- ☐ Software that runs on IBM PCs and compatibles.

Send us your discs or modem your files and your typesetting will be returned the same day.

EVERYDAY ELECTRONICS is produced entirely on Typefit

Interested? Please 'phone Terry or Paul for further information or a demonstration disc. Please state disc size and density.

Typefit

THE TYPESETTING BUREAU LTD

6 Church Street, Wimborne, Dorset BH21 1JH. Tel: (0202) 882299.
Fax: 841692. Modem: 882270. DX: 45314 Wimborne. Datalinx: TYPBUR

Published on approximately the first Friday of each month by Wimborne Publishing Ltd., 6 Church Street, Wimborne, Dorset BH21 1JH. Printed in England by Benham & Co. Limited, Colchester, Essex. Distributed by Seymour, Windsor House, 1270 London Road, Norbury, London SW16 4DH. Sole Agents for Australia and New Zealand –Gordon & Gotch (Asia) Ltd., South Africa –Central News Agency Ltd. Subscriptions INLAND £17.00 and OVERSEAS £21 (£39 airmail) payable to "Everyday Electronics" Subscription Department, 6 Church Street, Wimborne, Dorset BH21 1JH. EVERYDAY ELECTRONICS is sold subject to the following conditions, namely that it shall not, without the written consent of the Publishers first having been given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on the cover, and that it shall not be lent, resold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

1991 BUYER'S GUIDE TO ELECTRONIC COMPONENTS
Maplin
FEATURING:
AN ELECTRONICS CAST OF THOUSANDS!
SHOWING NOW!
at your local WHSMITH
POWER-PACKED WITH OVER 600 PAGES!!
STARRING
HUNDREDS OF NEW PRODUCTS AT SUPER LOW PRICES!
ROD BROWN '90
PERFORMANCES DAILY
At your local branch of WHSMITH
ONLY £2.45
Order you copy of the New MAPLIN Catalogue on sale NOW
Pick up a copy from any WHSMITH for just £2.45 or post this coupon now to receive your copy for just £2.45 + 50p p&p. If you live outside the U.K. send £4.85 or 20 International Reply Coupons. I enclose £2.95.
Name
Address
Post Code
Send to Maplin Electronics, P.O. Box 3, Rayleigh, Essex SS6 8LR.
EE91