

EVERYDAY **NOVEMBER 1990**
ELECTRONICS

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



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The No.1 Magazine for Electronic & Computer Projects



ONE POUND PACKS

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

- BD2 5 13A spurs provide a fused outlet to a ring main where devices such as a clock must not be switched off.
- BD9 2 6V 1A mains transformers 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 unisector, 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 6 1/2 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 DK.
- BD252 1 Panostat, controls output of boiling ring from simmer up boil.
- BD259 50 Leads with push-on 1/4in 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.
- BD654 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 4 1/2". Louvered for ventilation. Price £3.00. Ref. 3P75.
- FLOPPY DISCS 5 1/4" pack of 10 £5.00. Ref 168 3 1/2" pack of 15 £10.00. Ref 10P98.
- 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 8 1/2in wide. Double-sided on fibreglass middle which is quite thick (about 1 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 ET1 and similar circuits. Will refresh your home, office, workshop 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 40hm impedance and consisting of 6 1/2" woofer, 2" mid range and 1" tweeter. Ideal to work with the amplifier described above. Price per pair £30.00. Order ref. 30P7.

VIDEO TAPES These are three VCR 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.

3 1/2in FLOPPY DRIVES We still have two models in stock: Single sided, 80 track, by Chicon. 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 £180.00. 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. 1/2rd 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 snoping 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.

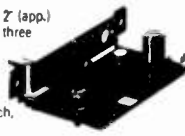
12V TO 220V INVERTER KIT This kit will convert 12v DC to 220v AC. It will supply up to 130 watts by using a larger transformer. As supplied it will handle about 15 watts. Price is £12. Our ref 12P17.

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 (4 1/2in x 4 1/2in x 1 1/4in). 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 TURNABLE 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 gull 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 6 1/2" 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 superb 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 1.35mm and 1.25mm 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. PAPTST fan 80 x 80mm 230V. Our ref 9P7. Price £9.

PAPTST 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, 5KG 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 4 1/2" 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 impedance 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. 3P90.

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 @ 2A, -24V at 0.25A -12V at 0.15A and +90V at 0.4A. £12.00 each. Ref. 12P31.

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 40w. 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 lock tidy. 4 core, suitable for alarms, phones etc. Our price only £5.00 for 50m reel. Ref. 5P153.

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EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

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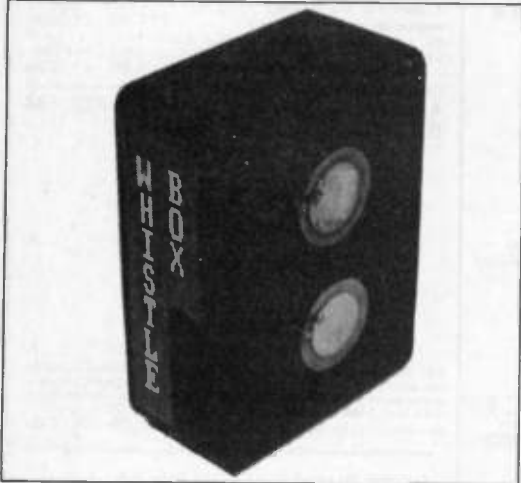
MEMBER OF THE BROADCASTING

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



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

Projects

- EE MUSKETEER** by Chris Walker **708**
Replaces up to four individual audio/TV type remote controls
- CYCLE REAR LIGHT MONITOR** by T. R. de Vaux Balbirnie **716**
Be safe – be seen at night, without failure
- FREQUENCY METER/TACHOMETER – 2**
by Steve Knight **728**
Add-on tachometer sensor for the Frequency Meter
- WHISTLE BOX TIMER** by G. M. Worthington **734**
A whistle operated, bleeping timer for the darkroom
- IN-LINE DIMMER** by T. R. de Vaux Balbirnie **744**
Adds a touch of luxury to table lamps etc.

Series

- BBC MICRO** by Robert Penfold **720**
Morse, PD/Shareware and The End – the last of the line!
- MICRO IN CONTROL – 12** by John Hughes **723**
Software to play tunes, for Morse, and for the lift
- AMATEUR RADIO** by Tony Smith G4FAI **747**
Amateur Radio in Egypt, International Short Wave League
- ROBOT ROUNDUP** by Nigel Clark **748**
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Economic use of Op Amps

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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 amplifiers. 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 Goodman's 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

2½" 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	Description
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
BP029	6	Stereo rotary potentiometers
BP030	2	10k wire wound double precision potentiometers UK made
BP031	6	Single 100k multitem 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" x ¾" 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 TO18 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 4VIA transformer. MC7818CT IC & bridge rectifier. Size 4" x 2¼"
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.

- 30W x 2 (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.

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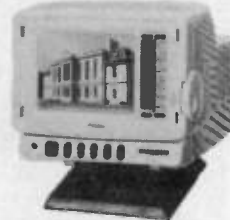
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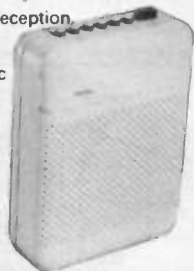
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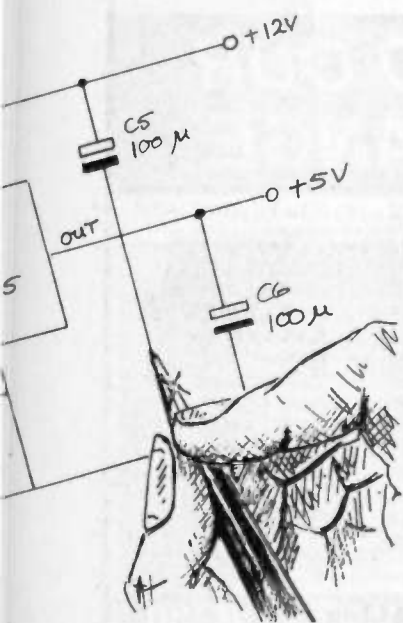
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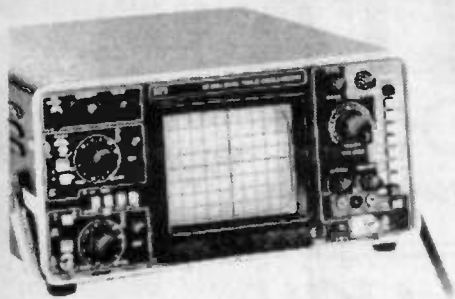
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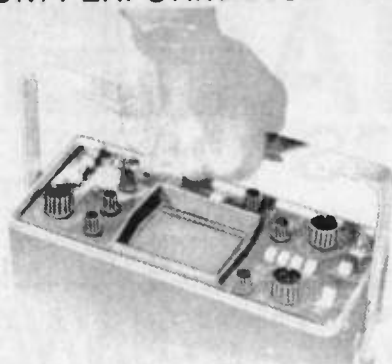


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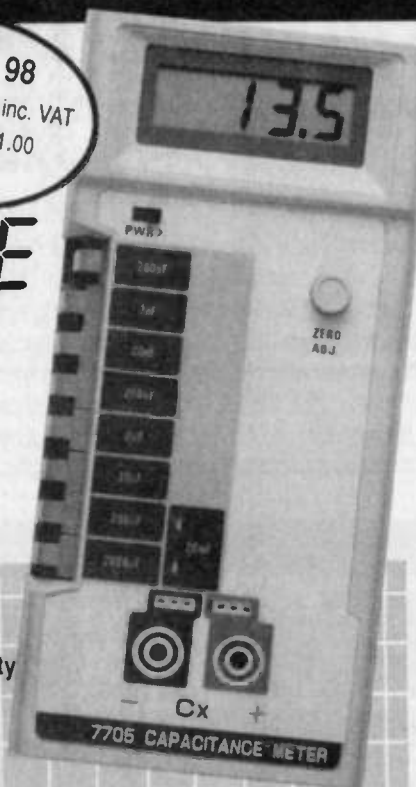
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Specification

ranges	res.	accuracy
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2nF	1.0pF	+ (0.5% + 1 digit)
20nF	10pF	+ (0.5% + 1 digit)
200nF	100pF	+ (0.5% + 1 digit)
2µF	1.0nF	+ (0.5% + 1 digit)
20µF	10nF	+ (0.5% + 1 digit)
200µF	100nF	+ (0.5% + 1 digit)
2000µF	1µF	± (1.0% + 1 digit)
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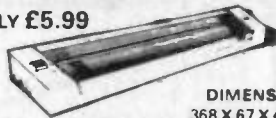
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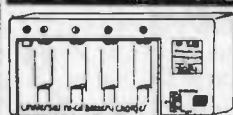
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Contact material.....Silver plated nickel silver
Dims.....243 x 195 x 20mm

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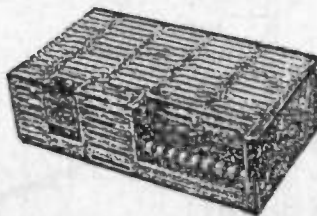
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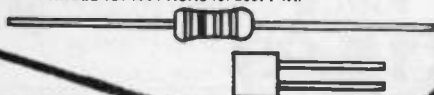
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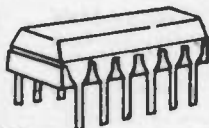
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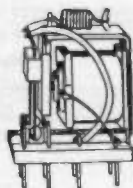
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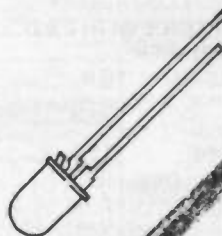
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SUPERHET BROADCAST RECEIVER

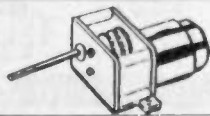
EE MAR '90

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KIT REF 835

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Easy to operate and high performance + **£46.35 VAT**
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EDUCATIONAL BOOKS & BOOK PROJECTS

ADVENTURES WITH ELECTRONICS

The classic Easy to Follow book suitable for all ages. Ideal for beginners — No soldering, uses an S-DEC breadboard. Gives clear instructions with lots of pictures. 16 projects — including three radios, siren, metronome, organ, intercom, timer, etc. Helps you learn about electronic components and how circuits work. Component pack includes an S-DEC breadboard and all the components for the series.

ADVENTURES WITH ELECTRONICS £5.25
COMPONENT PACK (less book) £23.49

FUN WITH ELECTRONICS

From the USBORNE Pocket Scientist series — An enjoyable introduction to electronics. Full of very clear full colour pictures accompanied by easy to follow text. Ideal for all beginners — children and adults. Only basic tools are needed. 64 full colour pages cover all aspects — soldering — fault finding — components (identification & how they work). Also full details of how to build 6 projects — burglar alarm, radio, game, etc. Requires soldering — 4 pages clearly show you how.

The components supplied in our pack allows all the projects to be built and kept. The book is available separately.

FUN WITH ELECTRONICS Book £5.50
COMPONENT PACK (less book) £18.45

30 SOLDERLESS BREADBOARD PROJECTS

A book of projects by R. A. Penfold covering a wide range of interests. All projects are built on a Verobloc breadboard. Full layout drawings and component identification diagrams enable the projects to be built by beginners. Each circuit can be dismantled and rebuilt several times using the same components. The component pack allows all projects in the book to be built one at a time.

Projects covered include amplifiers, light actuated switches, timers, metronome, touch switch, sound activated switch, moisture detector, M.W. Radio, Fuzz unit, etc.

30 SOLDERLESS BREADBOARD PROJECTS Book 1 £2.95
COMPONENT PACK £28.50

ENJOYING ELECTRONICS

A more advanced book which introduces some arithmetic and calculations to electronic circuits. 48 chapters covering elements of electronics such as current, transistor switches, flip-flops, oscillators, charge, pulses, etc. An excellent follow-up to Teach-in or any other of our series. Extremely well explained by Owen Bishop who has written many excellent beginners' articles in numerous electronics magazines.

ENJOYING ELECTRONICS Book £3.60
COMPONENT PACK £15.05

Note — A simple multimeter is needed to fully follow this book. The M102 B2 is ideal. **£13.98**

A FIRST ELECTRONICS COURSE

A copiously illustrated book that explains the principles of electronics by relating them to everyday objects. At the end of each chapter a set of questions and word puzzles allow progress to be checked in an entertaining way. An S-DEC breadboard is used for this series — soldering is not required.

A FIRST ELECTRONIC COURSE BOOK £3.75
PACK £23.47

EVERYDAY ELECTRONICS KIT PROJECTS

ALL KITS HERE HAVE BEEN FEATURED IN EE. IF YOU DO NOT HAVE THE MAGAZINE WITH THE ORIGINAL ARTICLE, YOU WILL NEED TO ORDER THE REPRINT FOR 80p EXTRA. REPRINTS ALSO AVAILABLE SEPARATELY. KITS INCLUDE CASES, PCB'S HARDWARE AND ALL COMPONENTS (UNLESS STATED OTHERWISE) CASES ARE NOT DRILLED, LABELS ARE NOT SUPPLIED.

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	£16.79	528	PA AMPLIFIER May 86
834	QUICK CAP TESTER Feb 90	523	STEREO REVERB Apr 86
	£10.17	513	BBC MIDI INTERFACE Mar 86
833	EE 4 CHANNEL LIGHT CHASER Jan 90	512	MAINS TESTER & FUSE FINDER Mar 86
	£31.45	497	MUSICAL DOOR BELL Jan 86
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790	EPROM ERASER Oct 88		£39.95
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763	AUDIO SIGNAL GENERATOR Dec 87	337	BIOLOGICAL AMPLIFIER Jan 84
	£15.66	263	BUZZ OFF Mar 83
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EE APRIL 85



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

KIT REF 444

£21.89

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

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

EE EQUALISER

EE MAY '87

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

KIT REF 707

£17.37

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

PET SCARER

EE MAY 89

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

KIT REF 812

Mains Adaptor £1.98

£14.49

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

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

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

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

Headphones

£41.95
£1.99

DIGITAL CAPACITANCE METER

EE DEC 85

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

KIT REF 493

£46.46

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

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

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

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

TK FOR KITS

GUARO DOG KIT



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

XK125 £21.95

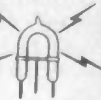
DISCO LIGHTING KITS



DL8000K 8-way sequencer kit with built-in opto-isolated sound to light input. Only requires a box and control knob to complete... **£39.95**
DL1000K 4-way chaser features bi-directional sequence and dimming 1kW per channel... **£23.95**
DLA/1 (for DZ1000K)
 Optional op-to input allowing audio beat/light response... **95p**
DL3000K 3-channel sound to light kit, zero voltage switching, automatic level control and built-in mic. 1kW per channel... **£19.55**
XK139 Uni-directional chaser. Zero switching and built-in audio input... **£12.95**

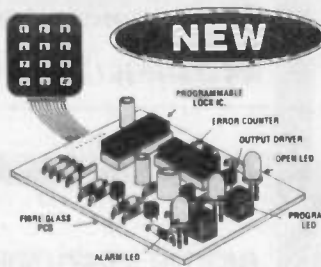
POWER STROBE KIT

Produces an intense light pulse at a variable frequency of 1 to 15Hz. Includes high quality PCB, components, connectors, 5Ws strobe tube and assembly instructions. Supply: 240V ac. Size: 80x50x45.
XK124 STROBOSCOPE KIT. £17.25



PROGRAMMABLE ELECTRONIC LOCK KIT

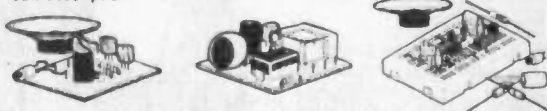
Keys could be a thing of the past with this new high security lock. Secure doors to sheds, garages, even your home or prevent the unauthorised use of computers, burglar alarms or cars. One 4-digit sequence will operate the lock while incorrect entries will sound an alarm. The number of incorrect entries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



XK131 £19.95

SIMPLE KITS FOR BEGINNERS

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



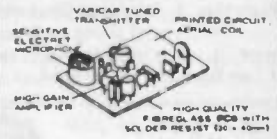
SK1 DOOR CHIME plays a tune when activated by a pushbutton **£4.50**

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

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

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

SUPER-SENSITIVE MICROBUG



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

NEW

REMOTE CONTROL DIMMER KIT

Imagine controlling the brightness of your lights or switching them on or off from the comfort of your armchair! This kit contains all the components from front panel to the last screw to enable you to do just that and fit the shallowest wall boxes. Max power 300W (not fluorescents).
XK132 £19.95

IR TRANSMITTER KIT

Designed for use with the XK132 and comes complete with a pre drilled box. A PP3 9 volt battery is required.
MK6 £4.95



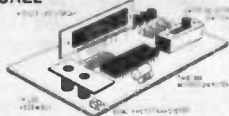
XK136 TOUCH DIMMER KIT £12.95

VERSATILE REMOTE CONTROL SYSTEM

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

MK12 IR Receiver £19.55
MK18 Transmitter £8.95
MK9 4-way Keyboard £2.75
MK10 16-way Keyboard £7.95
601133 Box for transmitter £2.95

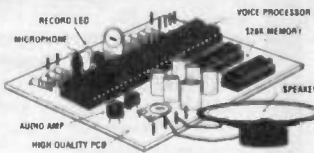
ELECTRONIC WEIGHING SCALE



Kit contains a single chip microprocessor. PCB, displays and all electronics to produce a digital LED readout of weight in Kgs or Sts/Lbs. A PCB link selects the scale-bathroom/two types of kitchen scales. A low cost digital ruler could also be made.
ES1 £8.25

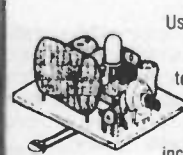
VOICE RECORD/PLAYBACK KIT

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



Size 76 x 60 x 15mm
 Message time 1-5 secs normal speed, 2-10 secs slow speed
XK129 £25.95

PROPORTIONAL TEMPERATURE CONTROLLER KIT



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

TK ELECTRONICS

TK ELECTRONICS

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INCORPORATING ELECTRONICS MONTHLY

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

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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 will be replaced by a new regular feature entitled *Interface* (what else!)

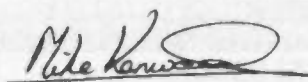
Interface will deal with interfacing ideas and problems, add on circuits and just about any technical computing subject any reader cares to throw at us - provided it is interesting and for a reasonably popular computer. In short we are widening the coverage of computers and readers with Ataris, Amigas, 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

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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

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

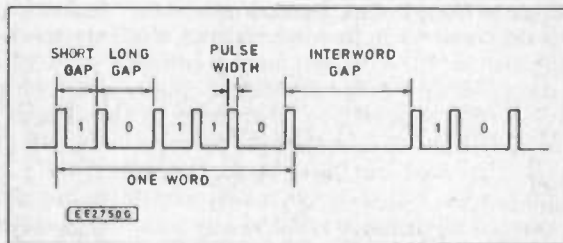
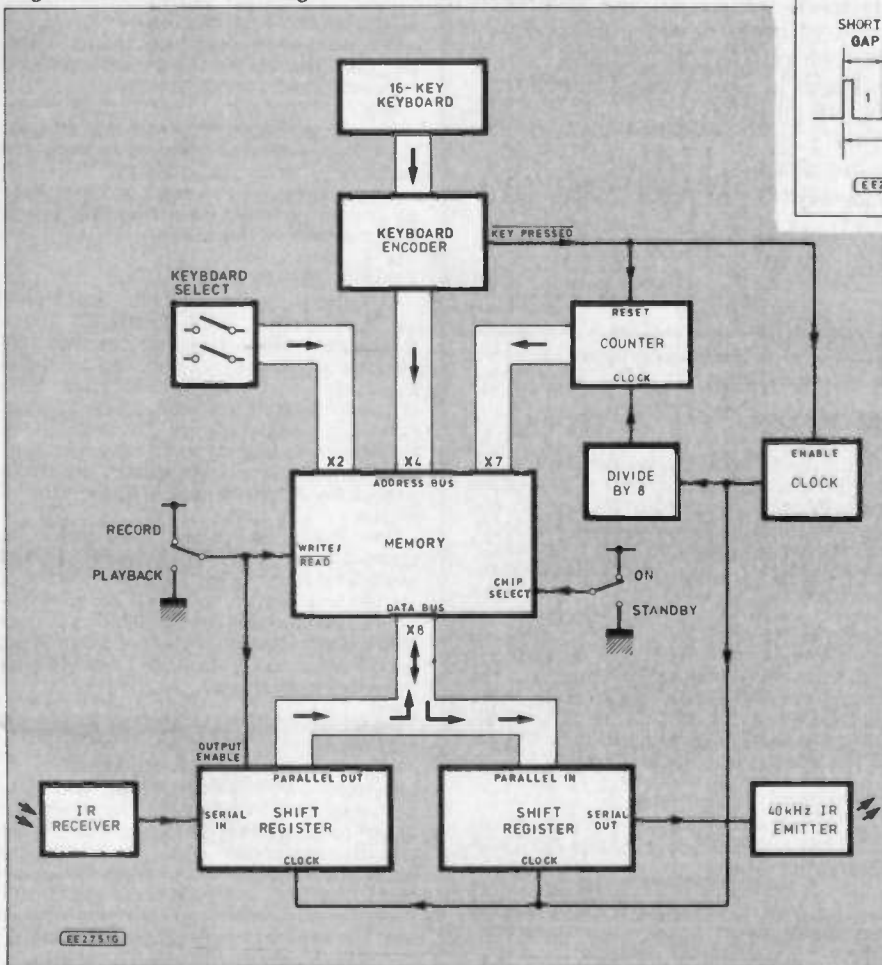


Fig. 1. Pulse position modulation (p.p.m.) word format.

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!

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 $1024 \times 0.12 = 123\text{ms}$. 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 $1024 \times 0.05 = 51\text{ms}$ 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 E²PROM). 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 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.

RECORDING PROCEDURE

Imagine that the Record switch S20 is closed and a keypad button is pressed and held. The 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

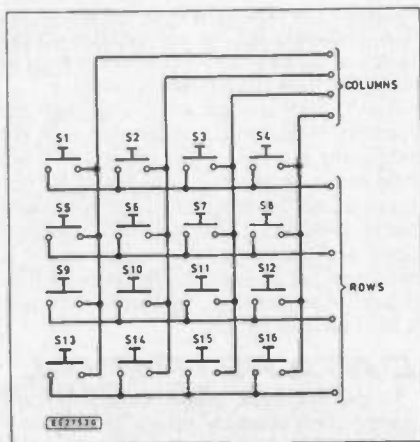
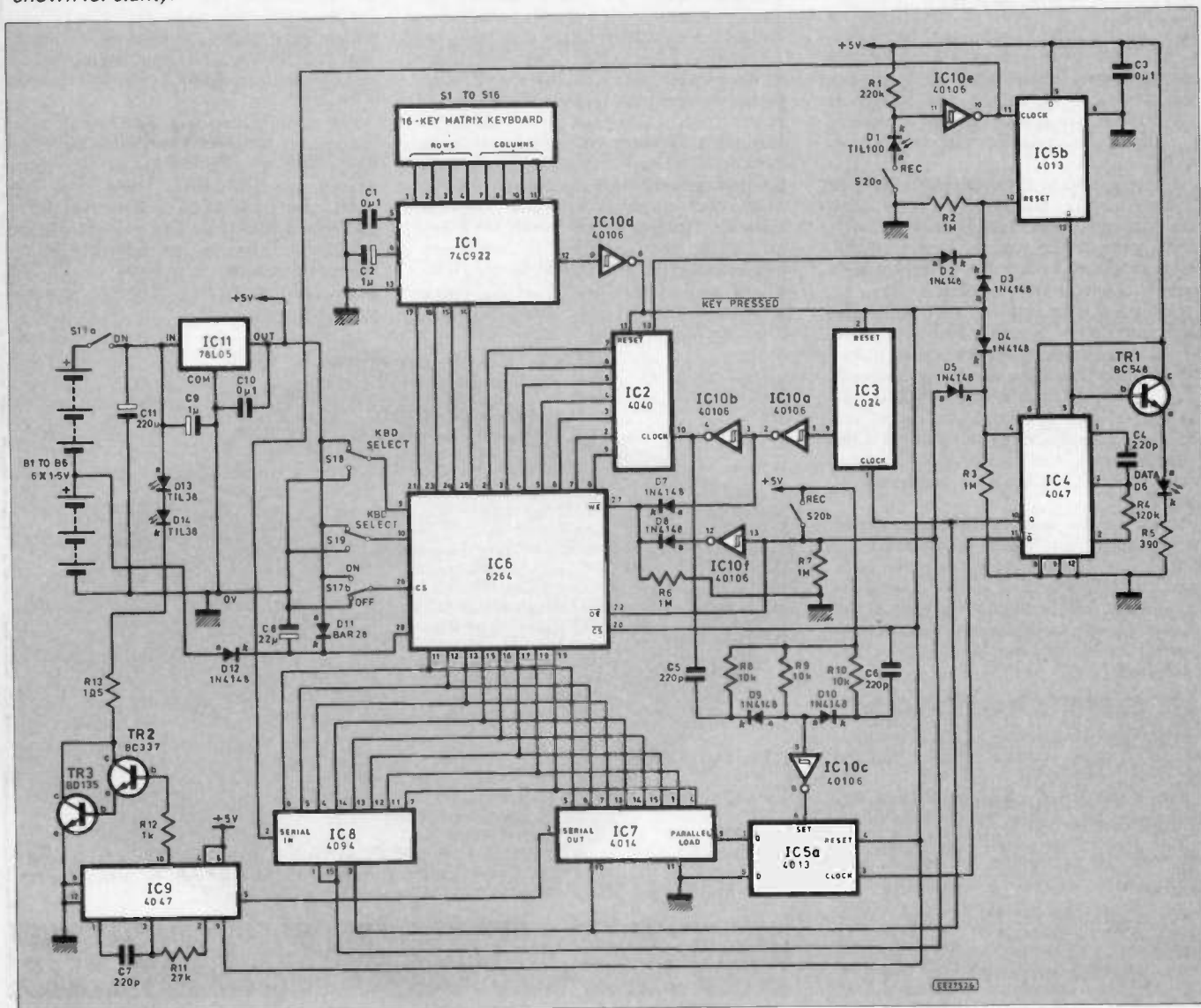


Fig. 4 (left). Circuit representation of the 4 × 4 matrix keyboard wiring.

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.



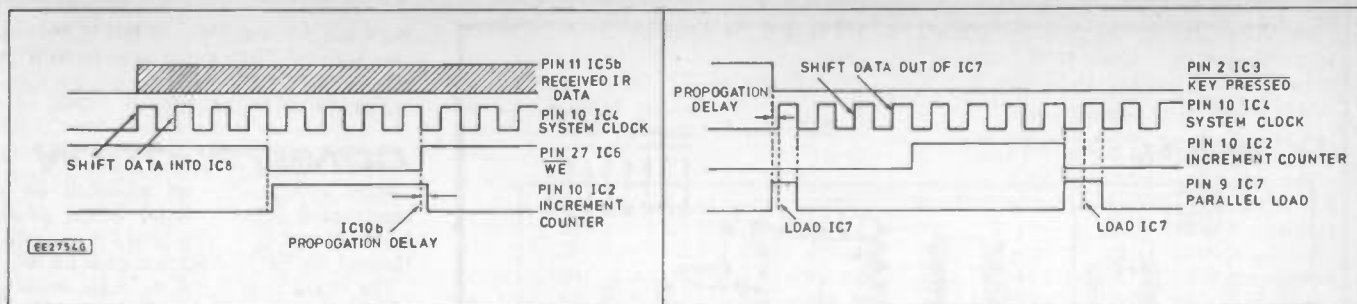


Fig. 5. (a) Timing diagram for the circuit in Record mode. (b) Playback mode timing diagram.

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 propagation 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 i.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 WE pin 27 of IC6 is held high via diode D8 whilst the 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 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

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 similar 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

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TALK
Page

£30

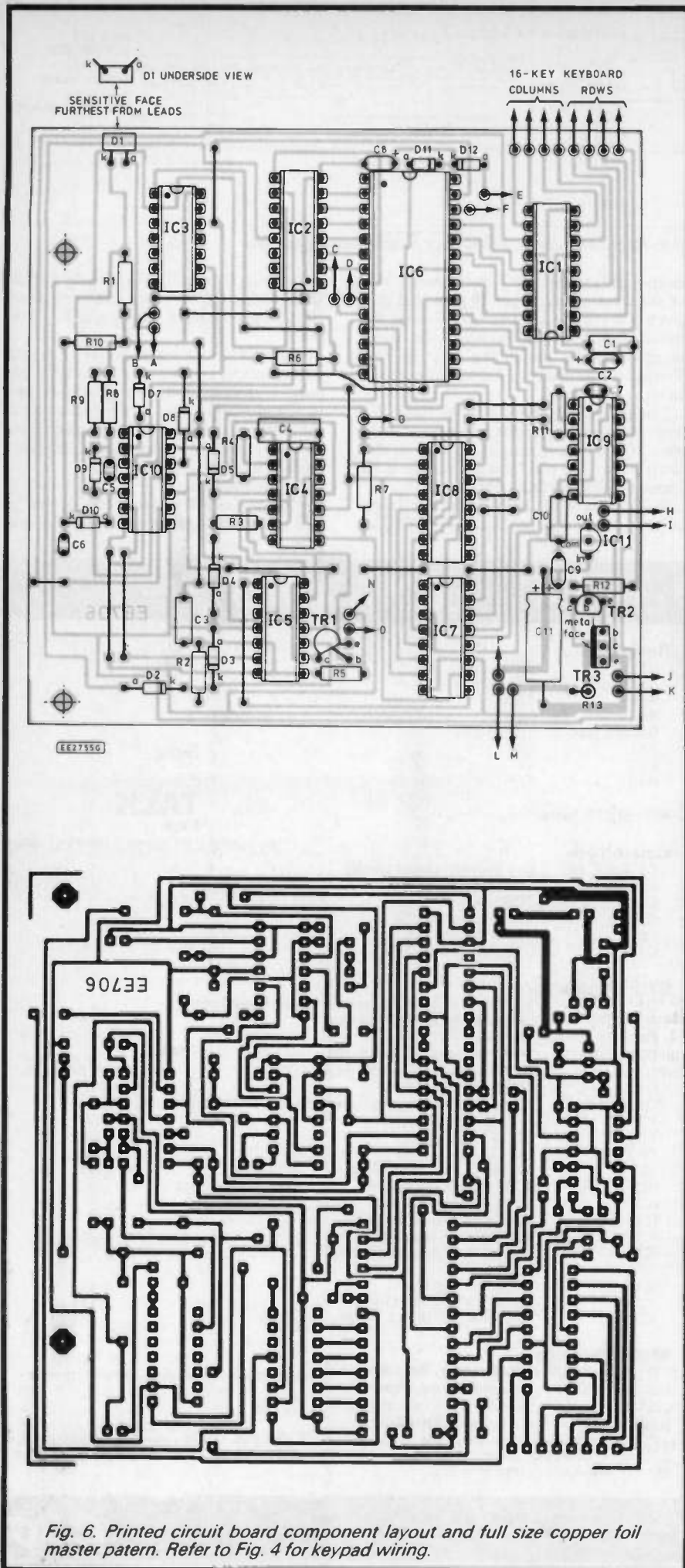


Fig. 6. Printed circuit board component layout and full size copper foil master pattern. Refer to Fig. 4 for keypad wiring.

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

CONSTRUCTION

Most components are 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 x 134mm x 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 i.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.

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ULTRASONIC CAR ALARM

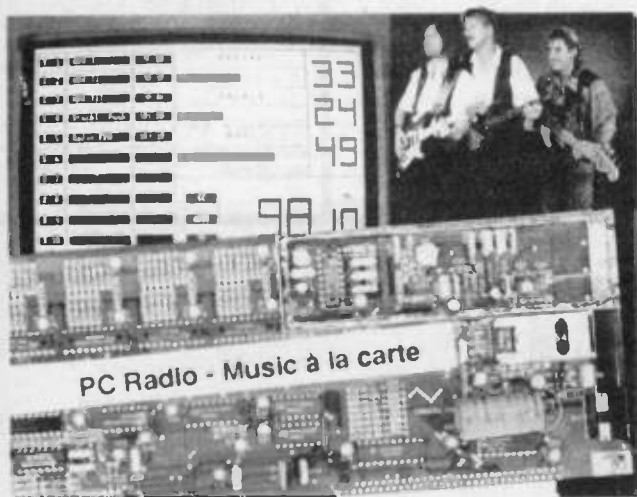


This system is specially designed to protect your car and its contents against potential thieves. Low current consumption and high noise immunity are just two of its distinguishing features.

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).

PC Radio (Elektor Electronics February 1990)



DIGITAL PROFESSIONAL ECHO 1000

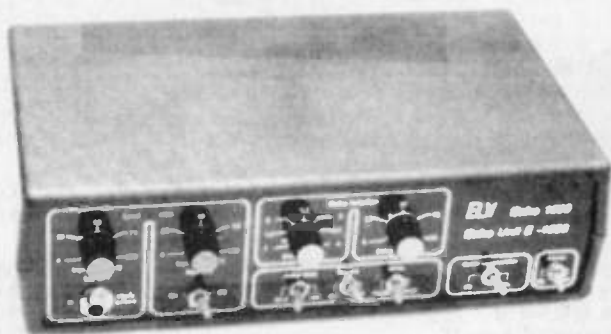
(Elektor Electronics June 89)

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 prin-

ciple 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

Delay 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

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
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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

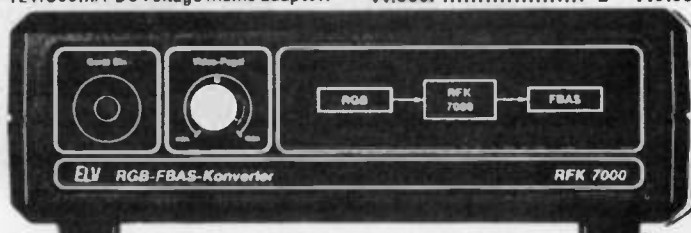
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FRK 7000 CVBS-RGB Converter

With the help of the FRK 7000 e.g. it is possible to use a cheap colour 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

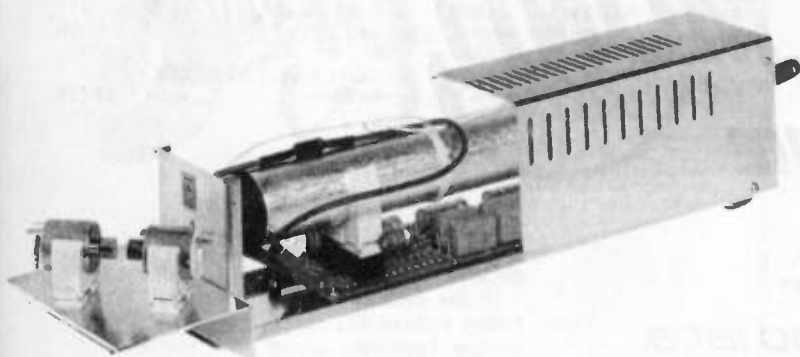
Ready assembled module
44.509F £ 119.50



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LPS 8000 / LC 7000 Low Cost Show Laser

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



An almost infinite number of circular patterns can be projected onto a wall or ceiling with this super laser show equipment.

The complete project includes a laser tube and accompanying power supply, housed in a metal case, and a laser controller, LC 7000. The laser controller drives the accompanying deflection unit, fixed onto the laser power supply case, which produces the numerous configurations.

Naturally the laser tube, together with the power supply, can produce beams without the laser controller and the controller can be used with other, similar lasers.

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

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

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

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

H-N Laser Tube 2 mW
 44.428LR £ 60.80

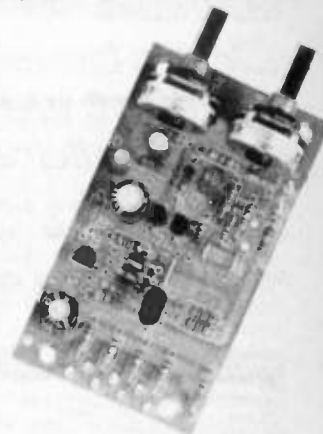
Laser Motor-Mirror Set, complete kit
 44.506M £ 22.95

VIDEO RECORDING AMPLIFIER

(Elektor Electronics April 89)

Losses can easily occur when copying video tapes resulting in a distinct reduction in quality. By using this video recording amplifier, with no less than four (!) outputs, the modulation range is enlarged and the contrast range of the copy increases.

Two level controllers for edge definition (contour) and amplification (contrast range) allow individual and precise adaptation.

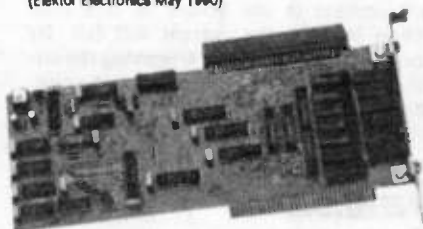


Complete Kit
 (including Box, PCB and all parts)
 44.324BKL £ 14.75

IBM PC Service Card

(Elektor Electronics May 1990)

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



Complete kit
 44.517BKL £ 77.95

Ready assembled module
 44.517F £ 137.95

TA 1000 Telephone Answering Unit

(Elektor Electronics January 1990)

This automatical telephone answering unit uses a 256-kbit voice recording circuit to store and replay your spoken message of up to 15 seconds. Noteworthy features are that it is available as a complete kit, provides 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

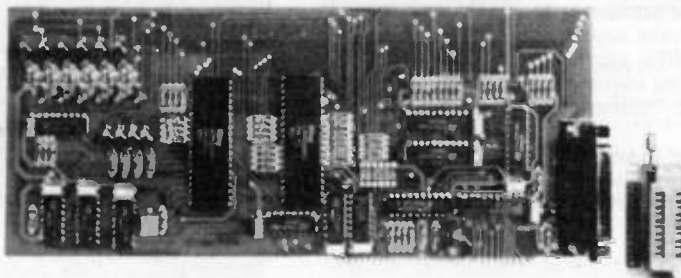


IC TESTER for IBM-PC-XT/AT

(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 socket, connectors, sockets, Flat band cable, PCB, Software
 44.474BKL £ 60.85

Ready Assembled Module
 4.474F £ 113.00

Software, single
 44.474SW £ 17.85

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 lamp. 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.

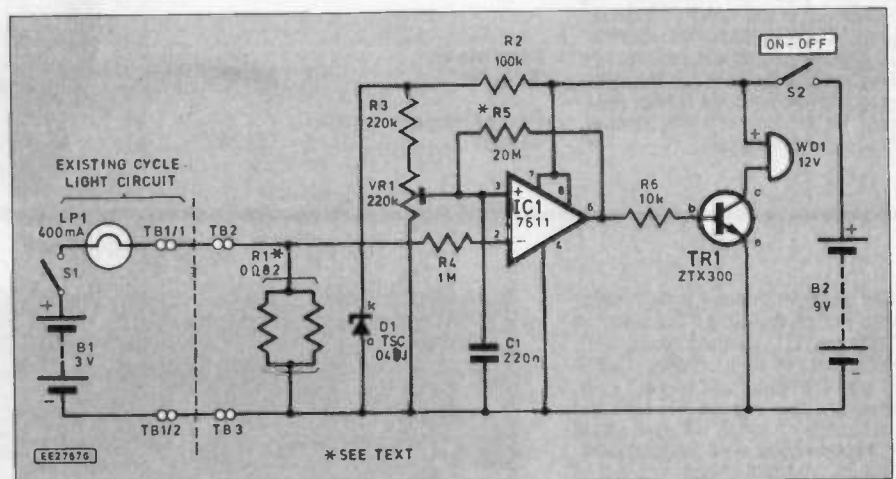
CIRCUIT DESCRIPTION

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 diagram 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.

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

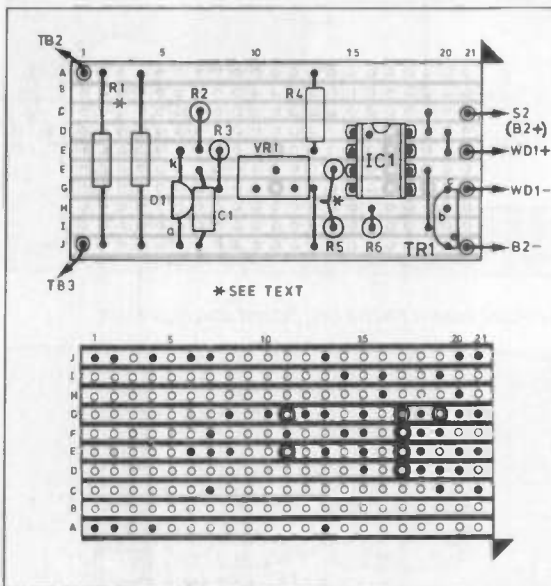


Fig. 2. Stripboard component layout and details of breaks required in the underside copper tracks.

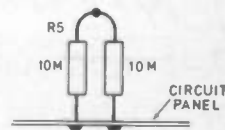


Fig. 3. Using two resistors connected in series to form resistor R5.

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-

COMPONENTS

Resistors

R1	0Ω82 (or 1 off 1 ohm and 1 off 4.7 ohm – see text)	See SHOP TALK Page
R2	100k	
R3	220k	
R4	1M	
R5	20M (or 2 off 10M – see text)	
R6	10k	

All 0.25W 5% carbon

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

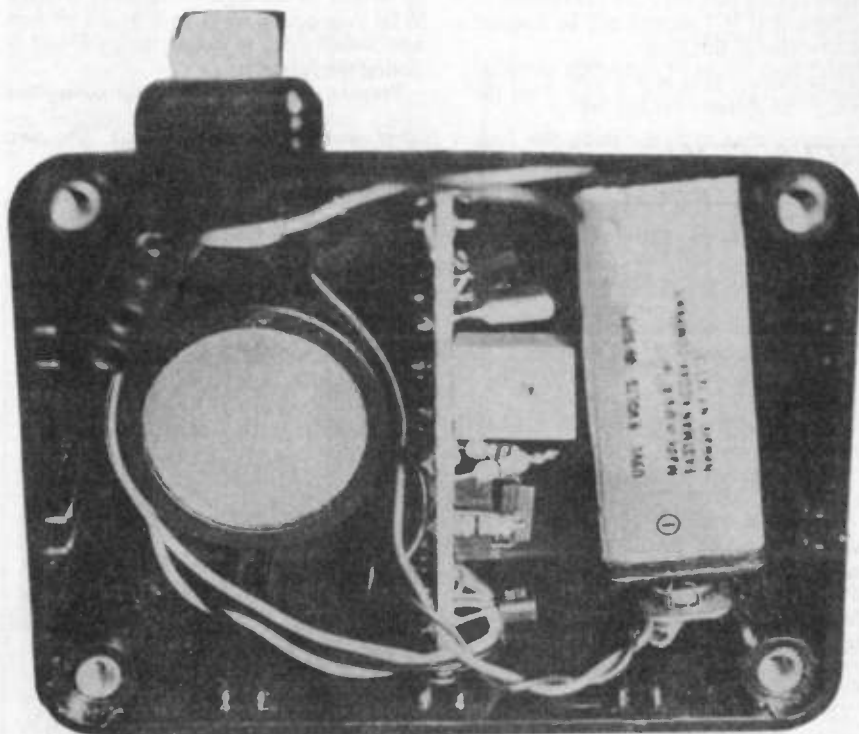
WD1	Pulse tone buzzer (12V operation at 15mA)
B2	9V lithium PP3 battery and connector
S2	Min. s.p.s.t. rocker switch
TB1	Two-way 3A screw terminal block
TB2, TB3	Single-way 3A screw terminal block (2 off)

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)



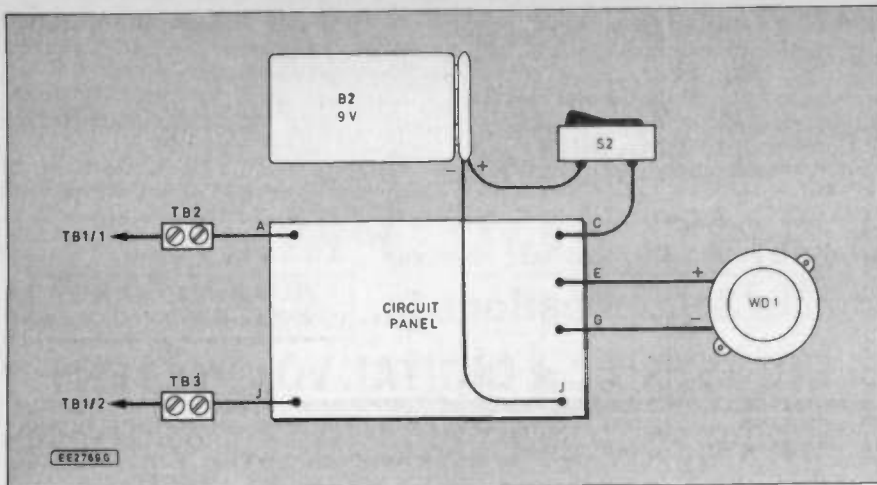


Fig. 4. Wiring from the circuit board to the off-board components.

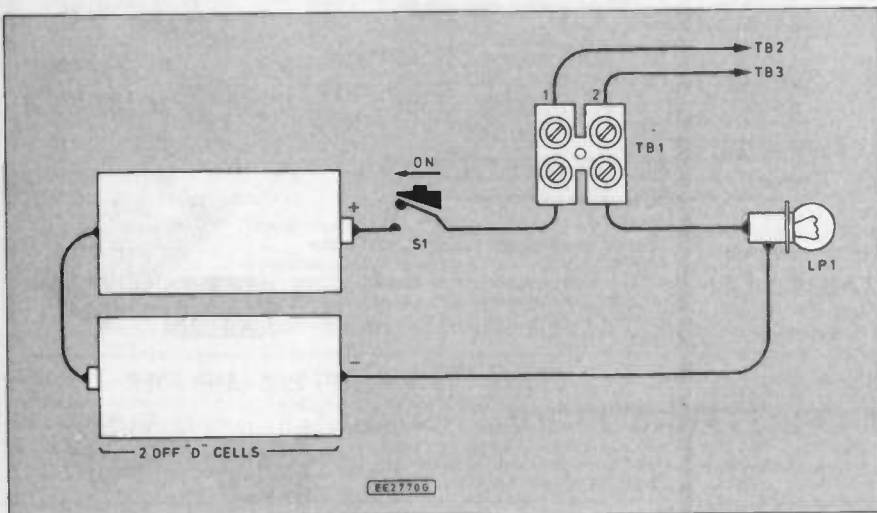


Fig. 5. A typical cycle lamp circuit set-up.

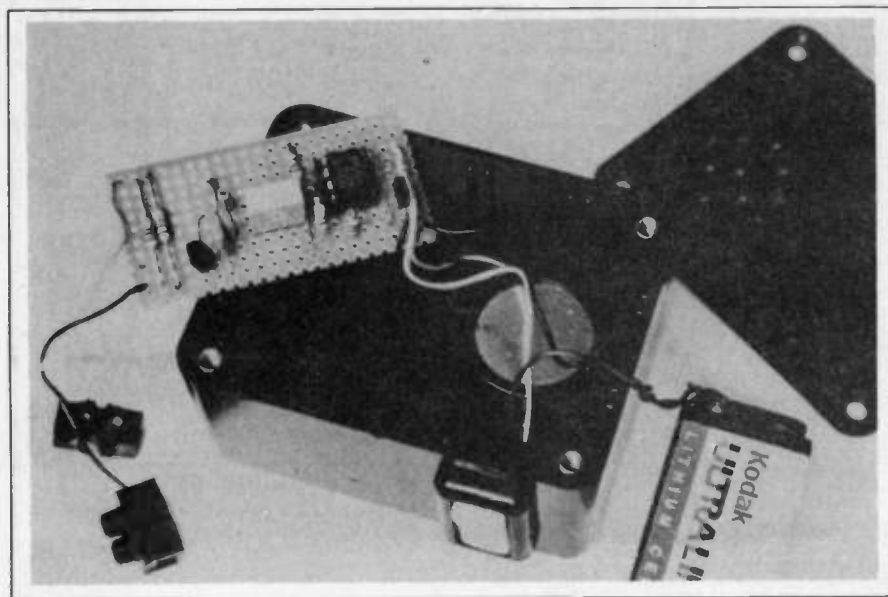
fied plastic box. Make all track breaks and inter-strip links as indicated in Fig. 2 then follow with the soldered on-board components taking care over the orientation of D1. Note that IC1 should not be inserted into its socket at this stage.

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

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



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.

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 anti-clockwise 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! □



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Switchable Dual range, detects intruders up to 6 or 12 metres. This advanced sensor operates by detecting the body heat of an intruder moving within the detection field.

Slow ambient changes such as radiators, etc. are ignored. Easily installed in a room or hallway. Providing reliable operation from a 12V supply, it is ideal for use with the CA 1382 or equivalent high quality control unit.

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Automatic Loop Test & Switch On ★ Automatic Siren Re-Set ★ Audible Entry/Exit Warning Buzzer ★ Two Separate Loop Inputs ★ 24-hr Circuits ★ Easily Installed, Full Instructions Supplied.

This advanced control panel provides effective and reliable control for all security installations, yet its operation is sheer simplicity for all members of the family, and is supplied with two keys. Housed in a steel case with an attractive moulded front panel, it compares with units costing twice the price.



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This tried and tested control unit provides the finest value for money in control systems, with many thousands protecting houses all over the country. A suitable steel enclosure is available separately.

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Accuracy Within 0.1± 1 digit
Input Impedance 100M ohm
Supply Voltage 8V-12V
Dimensions 95.5 x 55 x 11mm

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DVM 356 VERSATILE 3-DIGIT PANEL METER

DT10 TEMPERATURE MEASUREMENT MODULE

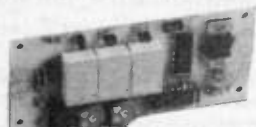
A simple, though effective module which when constructed provides a linear output of 10mV/°C over the temperature range -10 to +100°C.

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Fully built mains power supply providing two 9V outputs of up to 250mA each. Suitable for use with either DVM modules and other equipment.

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★★ AUDIO ★★

AL 12580-125W POWER AMPLIFIER

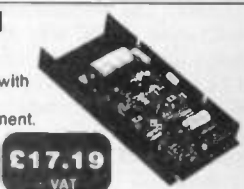
A rugged, high powered module that is ideal for use in discos & P.A. Systems where powers of up to 125W, 4 ohms are required. The heavy duty output transistors ensure stable and reliable performance. It is currently supplied to a large number of equipment manufacturers where reliability and performance are the main considerations, whilst for others its low price is the major factor. Operating from a supply voltage of 40-80V into loads from 4-16 ohms.



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Provides sound reproduction of the highest quality with distortion levels below 0.02%, this module offers superlative performance in all types of audio equipment. Full over-load protection is incorporated ensuring reliability of the highest order. Supplied with its own heat sink, it operates from a 40V-65V supply rail into loads of 8-16 ohms.



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AL 2550-COMPACT LOW-COST 25W AMPLIFIER

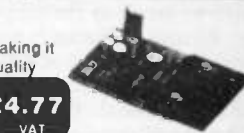
One of our most popular audio modules with tens of thousands installed. Ideal for domestic applications where low distortion and compact size are the prime requirements. Used with supply rails of 20V-50V into loads of 8-15 ohms.



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AL 1030-RUGGED 10W AMPLIFIER

This low cost unit provides a powerful 10W output making it ideal for all medium power applications requiring quality reproduction with rugged performance. Representing excellent value for money it operates from a supply of 18V-30V into loads of 8-16 ohms.



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With a host of features including 3 individual level controls, a master volume and separate bass and treble control, it provides for inputs for microphone, magnetic pick-up and tape, or second pick-up (selectable), and yet costs considerably less than competitive units.

This module is ideal for discos and public address units and operates from 45V-70V.

£17.49
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MG 100G

As MM 100 with two guitar +1 microphone input intended for guitar amplifier applications

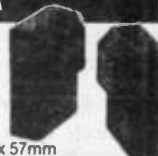
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50FT INFRA-RED BEAM-IR1470

The IR1470 consists of a separate transmitter and receiver providing a beam of up to 50ft which, when interrupted, operates a relay in the receiver which in turn may be used to control external equipment. The system requires only 65mA from a 12V supply. Size: (each unit) 82 x 52 x 57mm

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The DP3570 consists of an adjustable timer switch and 12V stabilised power supply designed to provide switching of loads up to 4A at 240V A.C. for a preset time between 10 secs and 6 mins, the timed period being initiated by the normally open or normally closed inputs.

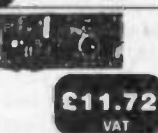
£13.95
VAT



GENERAL PURPOSE ULTRASONIC MOVEMENT DETECTOR US4012

This module uses ultrasonic techniques to detect movement at distances up to 5 metres with an operating range of 60°. Supply voltage 10-14V (12mA). Size: 147 x 52.5 x 15mm.

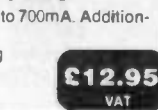
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STABILISED SUPPLY & SWITCHING UNIT-PS1265

The PS1265 provides stabilised 12V output for current levels up to 700mA. Additionally it incorporates a high impedance input for switching loads up to 1kW at 240V without timing.

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BEEB MICRO BEEB

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

IAN 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 TheChars=""
100
110 REM Main Program
120 MODE 7
130 PROCTheScreen_Sav_Program
140 PROCTheCode_Init
150 PROCTheScreen_Init
160 PROCTheSpeaker_Get_Volume
170 PROCTheSpeaker_Get_Speed
180 PROCTheScreen_Sav_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,I,2,2,2
410 DATA J,4,2,6,6,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,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,W,3,2,6,6,X,4,6,2,2,6
460 DATA Y,4,6,2,2,6,Z,4,6,6,2,2
470 DATA 1,5,2,6,6,6,2,5,2,2,6,6,6
480 DATA 3,5,2,2,2,6,6,4,5,2,2,2,6
490 DATA 5,5,2,2,2,2,6,5,6,2,2,2,2
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 " ",6,6,6,2,2,6,6
540 DEF PROCTheCode_Init
550 DIM TheCode_Buffer(38,6)
560 DIM TheCode_Chars(38)
570 ENDPROC
580
590 DEF PROCTheCode_Fill_Buffer
600 FOR ccount = 1 TO 38
610   READ TheCode_Chars(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(ov%)
691 LOCAL place
692 FOR place = 1 TO 38
693   IF ASC(TheCode_Chars(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 TheChars=TheCode_Chars(char)
760 ENDPROC
770
780 REM Screen Methods
790 DEF PROCTheScreen_Init
800 DIM TheScreen_Buffer$(Screenful)
810 TheScreen_Chars=""
820 ENDPROC
830
840 DEF PROCTheScreen_Say_Program
850 CLS
860 PRINTTAB(9,5);"Morse Translation Program"
870 ENDPROC
1110
1120 DEF PROCTheScreen_Say_Start
1125 CLS
1130 PRINT "Enter the lines to translate"
1135 PRINT "at the >> prompt."
1140 ENDPROC
1150
1190
1200 REM Speaker Methods
1210 DEF PROCTheSpeaker_Sound_Char
1220 FOR digit = 1 TO TheChar(0)
1230 SOUND 1,vol,200,TheChar(digit)
1240 SOUND 1,0,200,2 DIV speed%
1250 NEXT digit
1280 SOUND 1,0,200,4 DIV speed%
1270 ENDPROC
1280
1290 DEF PROCTheSpeaker_Word_Pause
1300 SOUND 1,0,200,8 DIV speed%
1310 ENDPROC
1320
1330 DEF PROCTheSpeaker_Get_Volume
1340 PRINTTAB(5,11);"Please select volume"
1350 PRINTTAB(5,12);"(1-quiet,2-normal,3-loud) ";
1360 REPEAT
1370   choices=GET$
1380   choice%=VAL(choices)
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   choices=GET$
1500   choice%=VAL(choices)
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 texts=FNvir
1597 PRINT
1600 ENDPROC
1610
1620 DEF PROCTheText_Scan_Line
1622 LOCAL place
1630 FOR place = 1 TO LEN(texts)
1640   cv%=ASC(MID$(texts,place,1))
1650   PROCTheCode_Get_Char(cv%)
1660   IF ov%=32 PROCTheSpeaker_Word_Pause ELSE PROC
TheSpeaker_Sound_Char
1670 NEXT place
1680 ENDPROC
1685
1690 DEF FNvir
1700 LOCAL in,out$
1710 valids="1234567890 ABCDEFGHIJKLMNOPQRSTUVWXYZ, ."
1720 in=GET:*FX15,1
1730 IF in=13 THEN out$=out$
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(valids,CHR$(in))=0
1780 PRINT CHR$(in):out$=out$+CHR$(in):GOTO 1720
VDU7:GOTO 1720

```

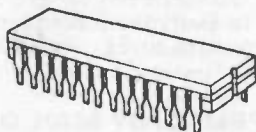
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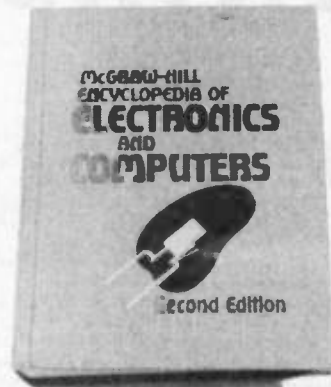
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MICRO IN CONTROL



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)

L 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
032F		2B	28	39	7E

(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.

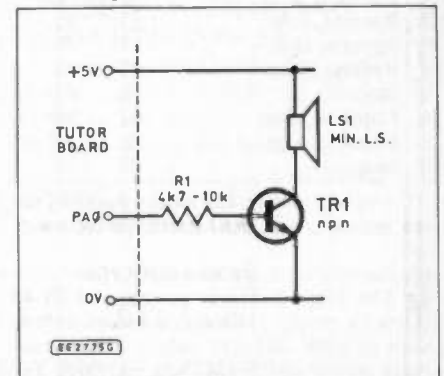
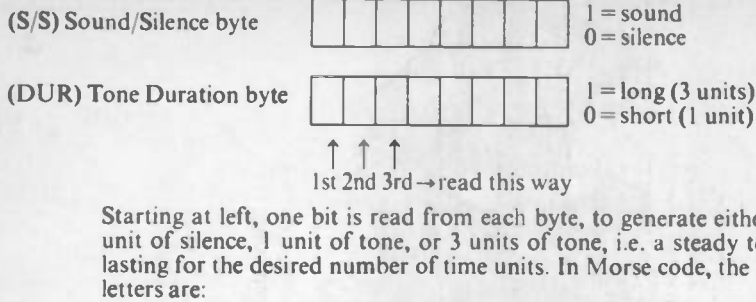


Fig. 12.1. Transistor amplifier circuit. A reasonably high impedance speaker or earphone (say 64 ohms or more) can be connected directly from PA0 to 0V.

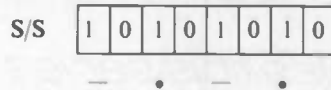
Fig. 12.2 Devising a 2-byte pattern for Morse letters



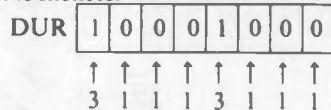
A • — D — ••
B — ••• E •
C — • — • F •• — •

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:



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



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

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

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

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		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

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



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AUDIO DESIGN 80 WATT POWER AMPLIFIER



This fantastic John Linsley Hood designed amplifier is the flagship of our range, and the ideal powerhouse for your ultimate hifi system. This kit is your way to get £K performance for a few tenths of the cost!

Featured on the front cover of "Electronics Today International" this complete stereo power amplifier offers World Class performance allied to the famous HART quality and ease of construction. John Linsley Hood's comments on seeing a complete unit were enthusiastic: -

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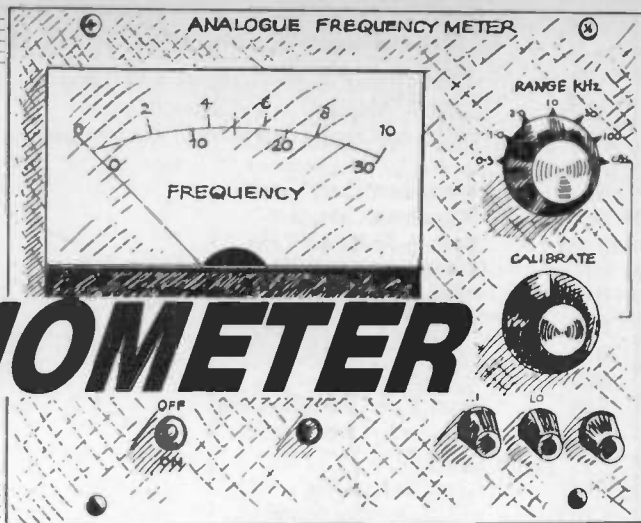
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FREQUENCY METER/TACHOMETER

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 in-

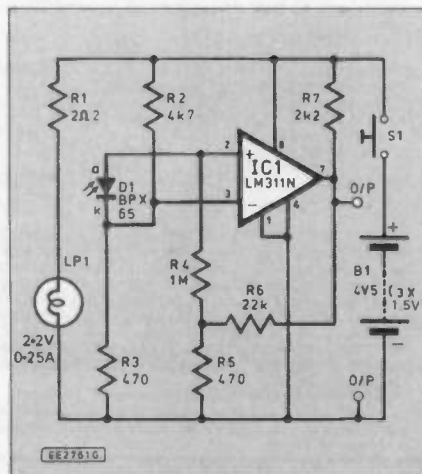


Fig. 1. Complete circuit diagram for the Tachometer Optical Sensor.

COMPONENTS

Resistors

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

All 0.5W 5% carbon

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

See SHOP TALK Page

ternal lamp or received directly from any other source of sufficient intensity. Some practical applications of the sensor will be mentioned later.

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

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.

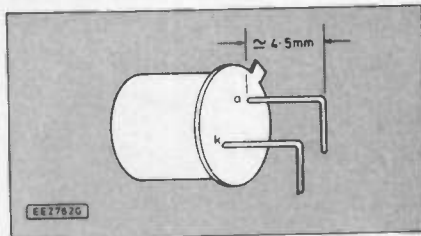


Fig. 3. Carefully bend the photodiode leads through 90 degrees as indicated.

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 LPI 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 direc-

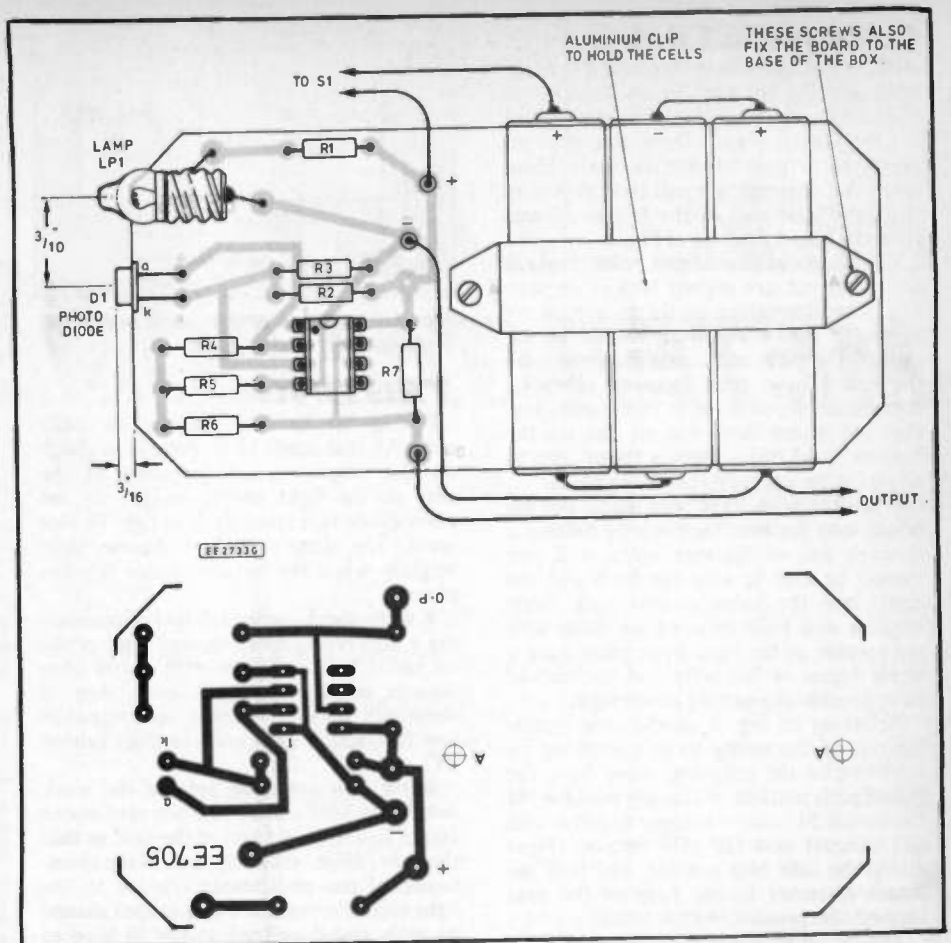


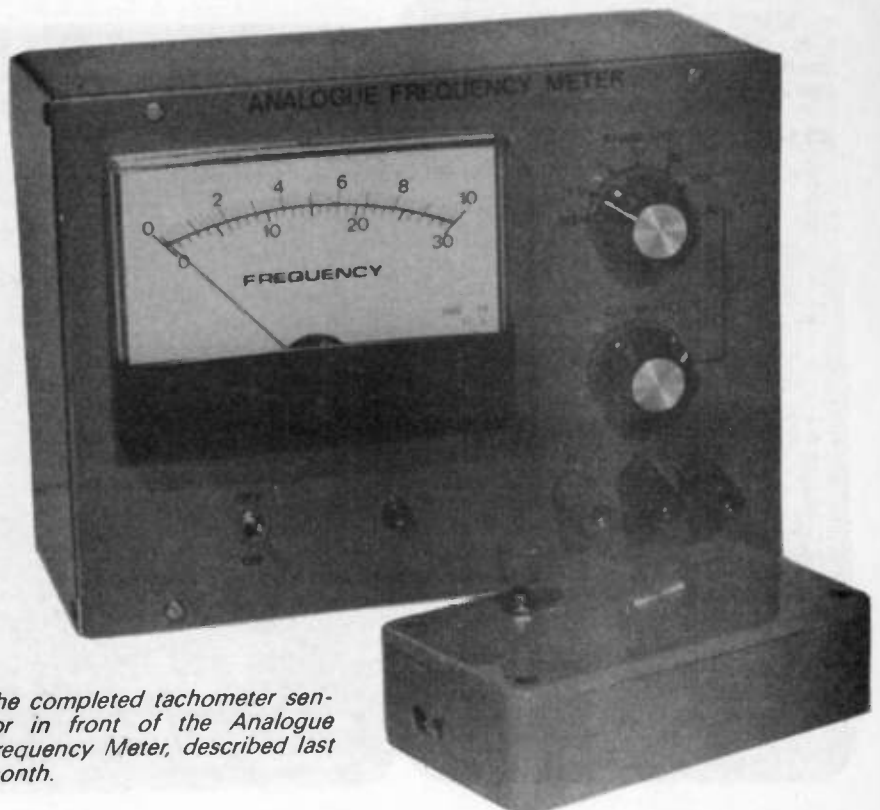
Fig. 2. Printed circuit board component layout and full size copper foil master pattern. The corners of the board have been trimmed to fit the case and the batteries are held in position with a thin metal "strap".

tion of the photodiode. Fig. 2 should make this clear, where the approximate spacings are indicated.

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 all-right 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.

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.

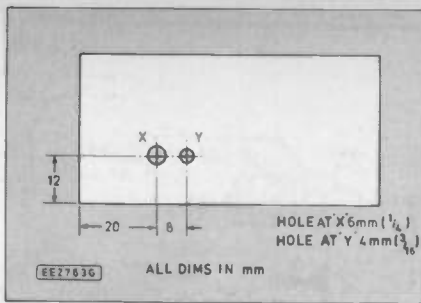


Fig. 4. Lamp and photodiode hole drilling details in end of case.

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

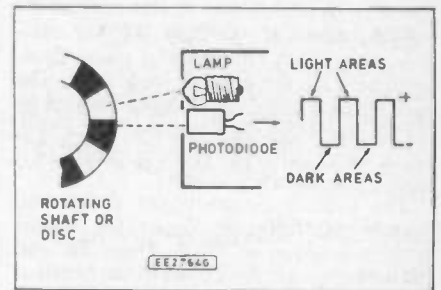
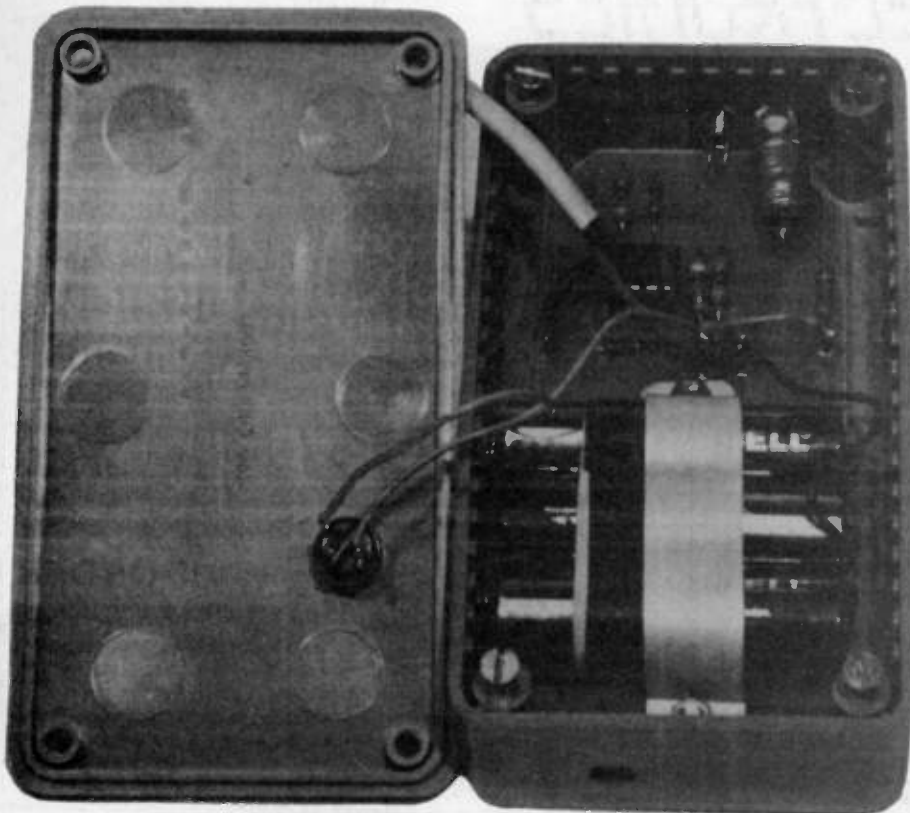


Fig. 5. The principle behind the measurement of rotational speeds.

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



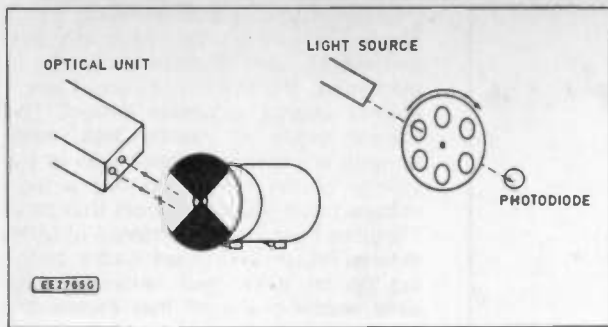


Fig. 6 (left). Two methods of measuring the speed of a motor.

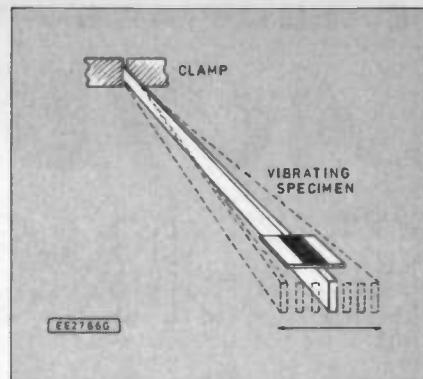


Fig. 7 (right). A method of measuring transverse vibration.

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 fluorescent 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. □

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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 μ A741C 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.

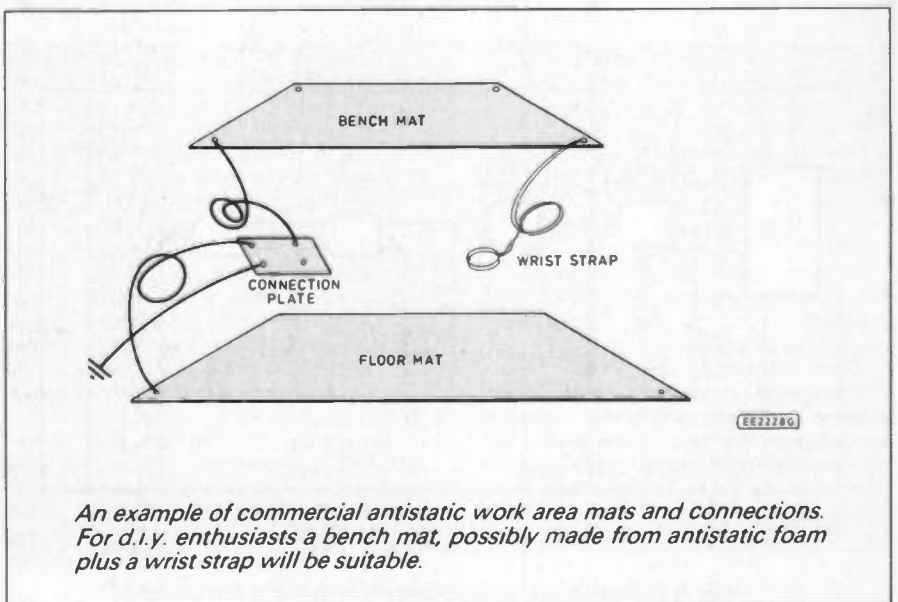
ANTI-STATIC EQUIPMENT

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.

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 $\approx 10\text{mV}$ 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 i.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.

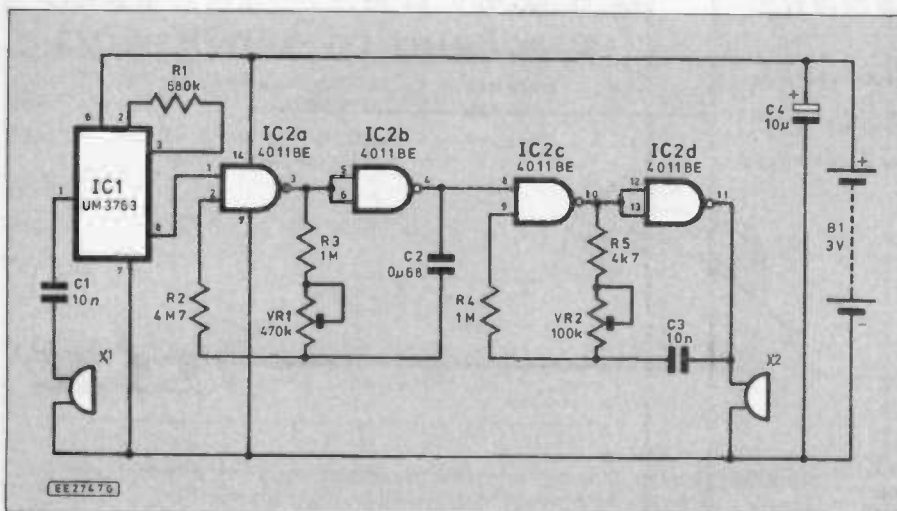


Fig. 1. Complete circuit diagram of the whistle box timer.

COMPONENTS

Resistors

- R1 580k
- 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

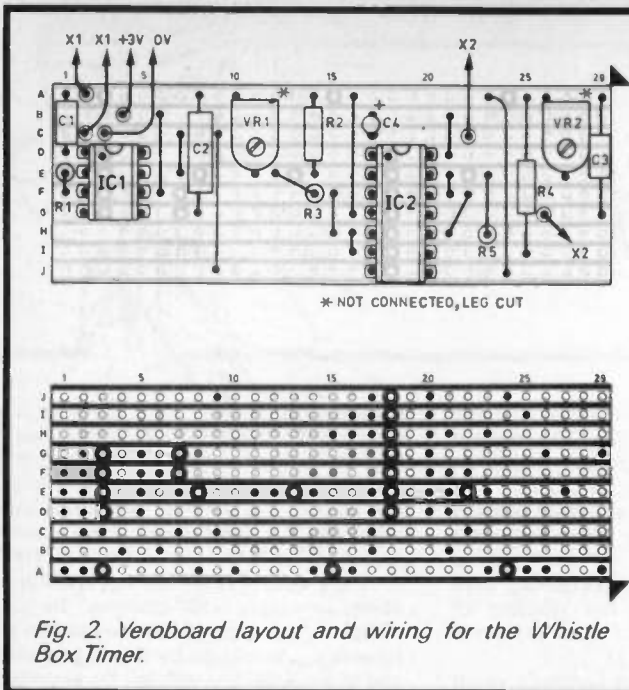
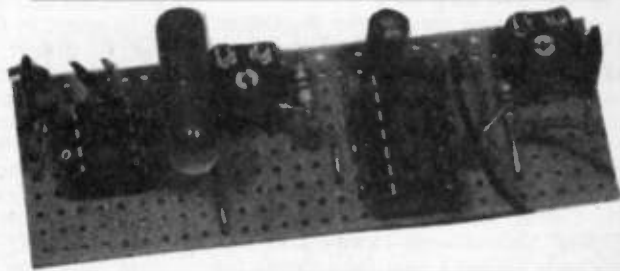
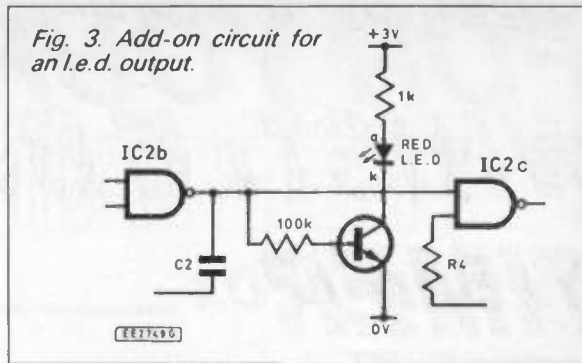


Fig. 2. Veroboard layout and wiring for the Whistle Box Timer.



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.

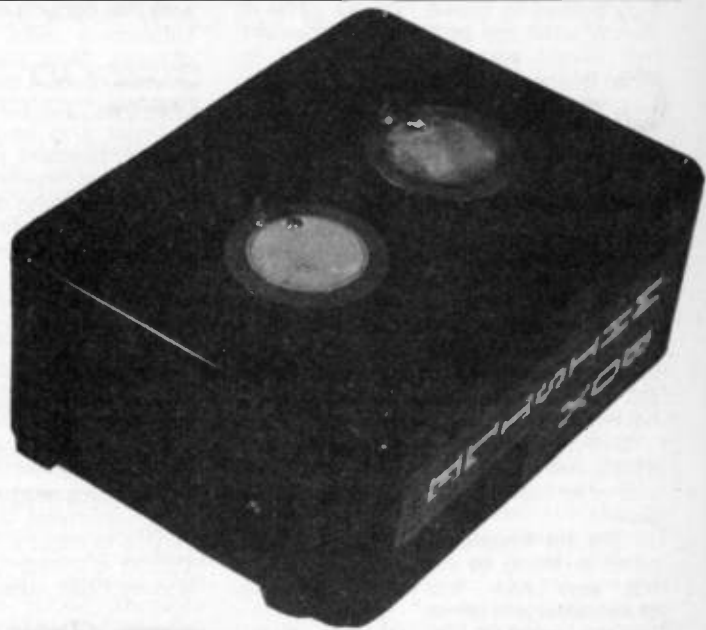
Next the two presets will need to be adjusted. The setting of VR2 depends on personal preference, so long as the chosen pitch allows reliable operation of the circuit. VR1 should be set to give a beeping frequency as close as possible to 0.5Hz. Once this keeps good time for a minute or two, adjustment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



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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 from 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.

HENRY'S

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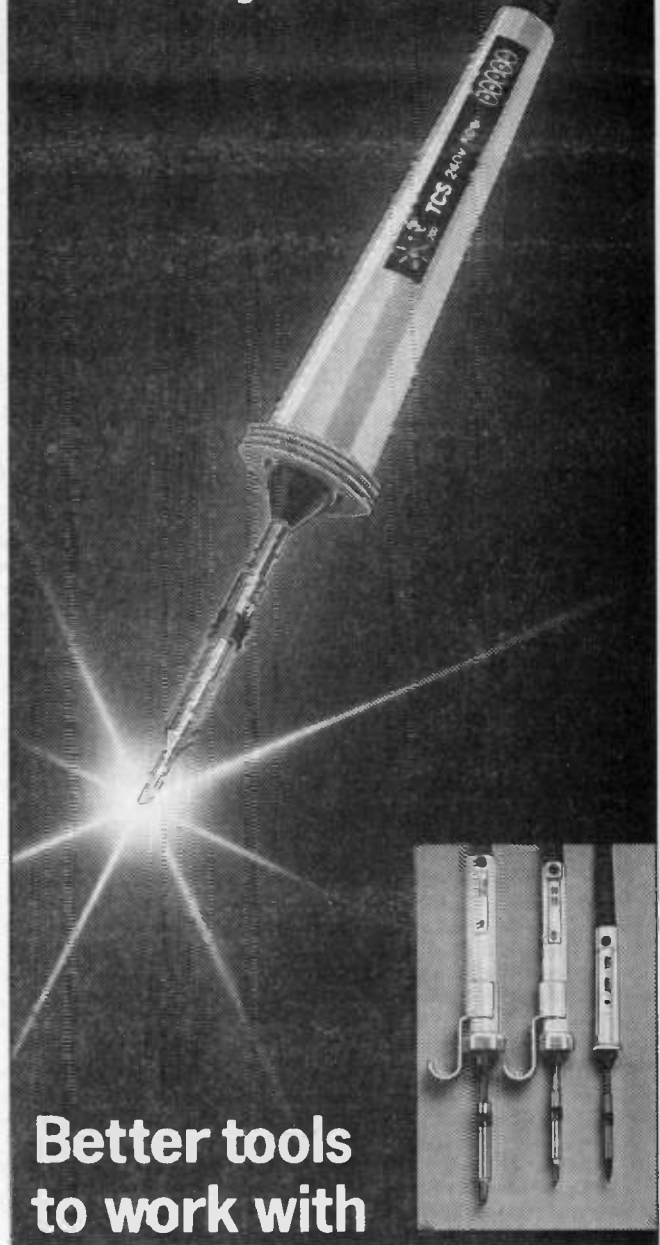
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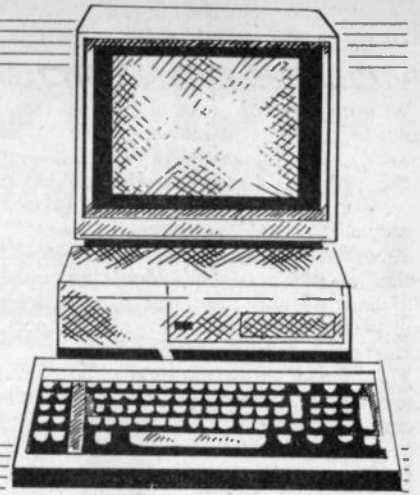


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ELECTRONICS and CAD

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 "stair-case" 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.

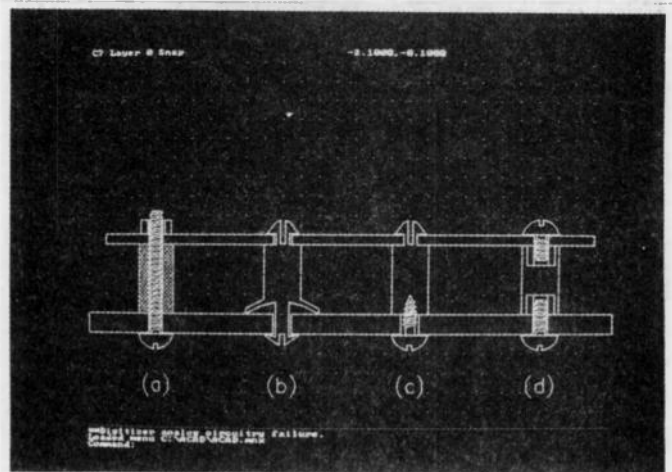
Obviously even a high resolution computer screen can not display a drawing with anything approaching the accuracy with which the program stores the drawing. Most CAD programs actually go well beyond the accuracy of any output device (printer, plotter, etc.).

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 Do 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.

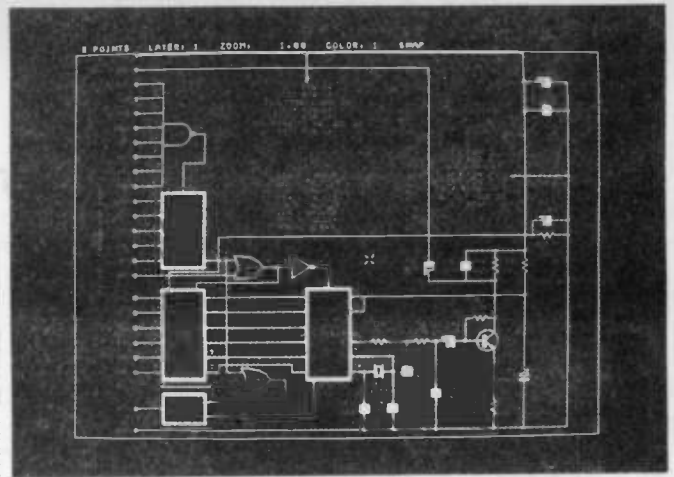
The basic idea is to divide the screen into (say) three windows, with a large one showing the entire drawing, and two smaller ones showing two highly zoomed views. Putting a line from one end of the drawing to the other is then quite easy. The two zoomed views are set to show the start and finish points, 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.

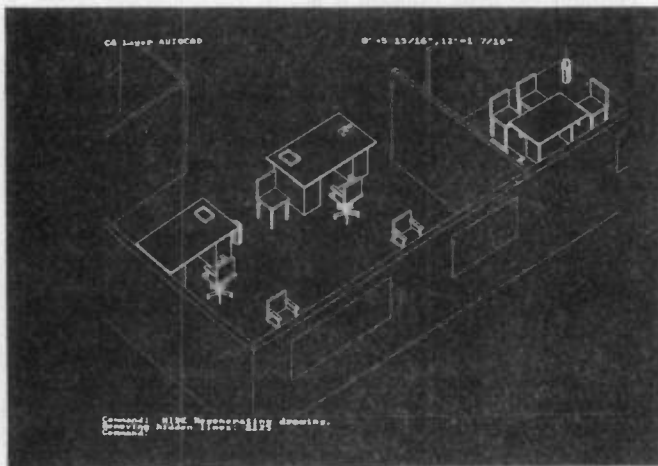
EDITING

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.

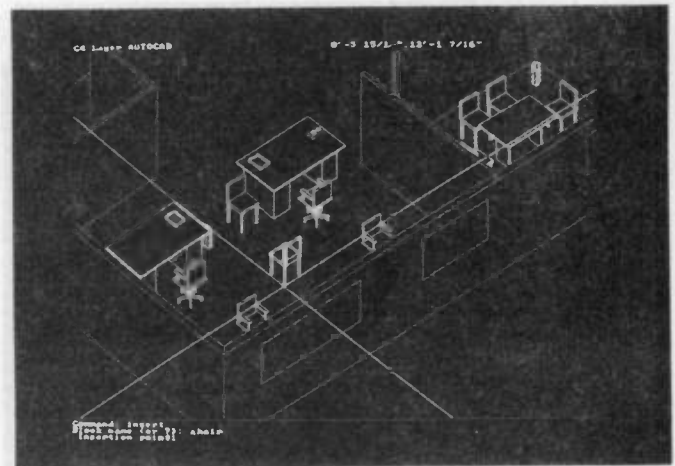
Some systems also include variable width lines. By this I do not simply mean lines that are thick or thin, but that lines can be varied in width along their length. Some very fancy drawings can be produced using a facility of this type.

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 point, 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.

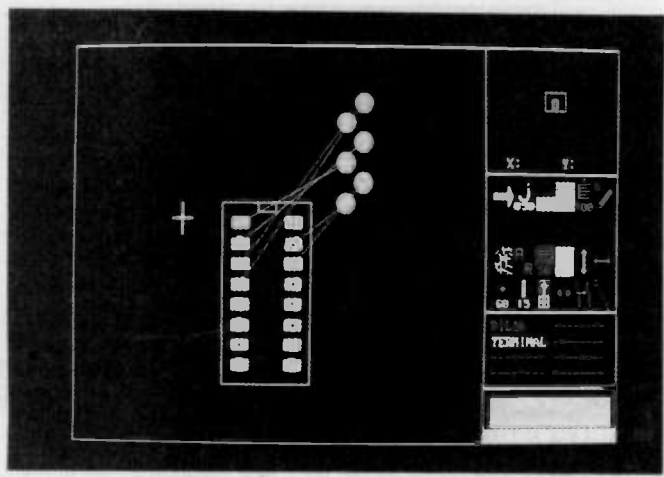
Some quite sophisticated 3D commands are included in some 3D CAD systems. The extrude command might permit changes in scale so that tapered objects can be produced (I once very rapidly drew a reamer using such a facility).

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.

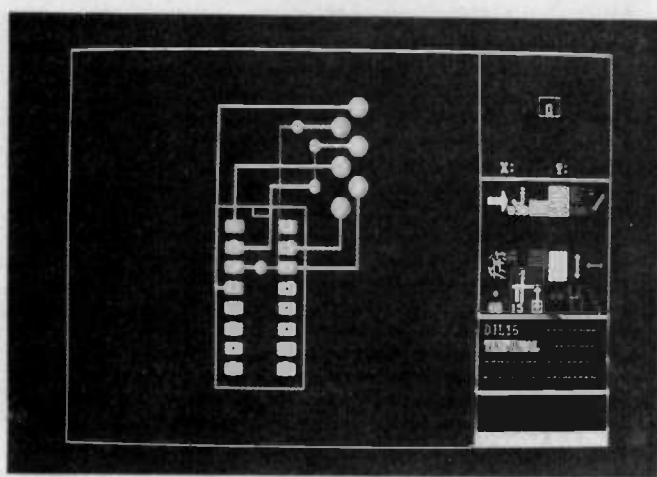
A lot of effort has gone into developing viable 3D micro based CAD systems, but with something less than total success. One problem is that it is difficult for new users to mentally adjust and think in 3D terms.

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.

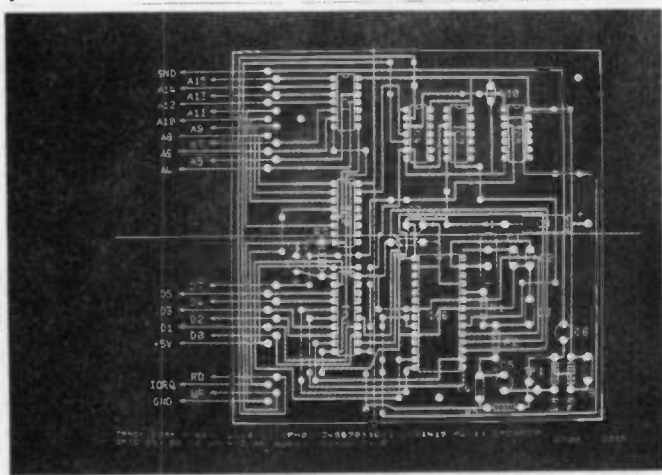
PCB CAD

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 printed 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.



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.

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.

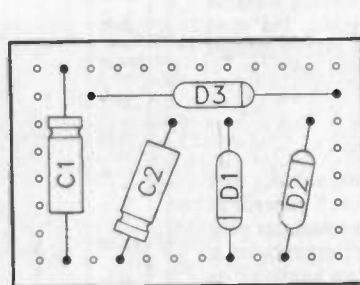
Although the netlist method might seem to be a rather cumbersome way of doing things, it has the advantage of being very reliable. It is easy to check the netlist against the circuit diagram to ensure that the interconnections are all present and correct.

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 system offers automatic component placement, then (in theory anyway) the design process can be fully automated.

AUTO-ROUTING

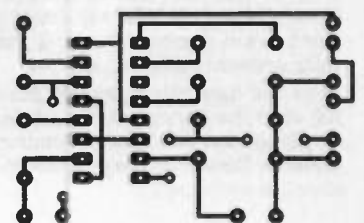
In practice matters are not quite as straightforward as this. Automatic component placement usually requires the user to position the main components (sockets, controls, etc.) to give the automatic placement algorithm a safe starting point.

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)



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.

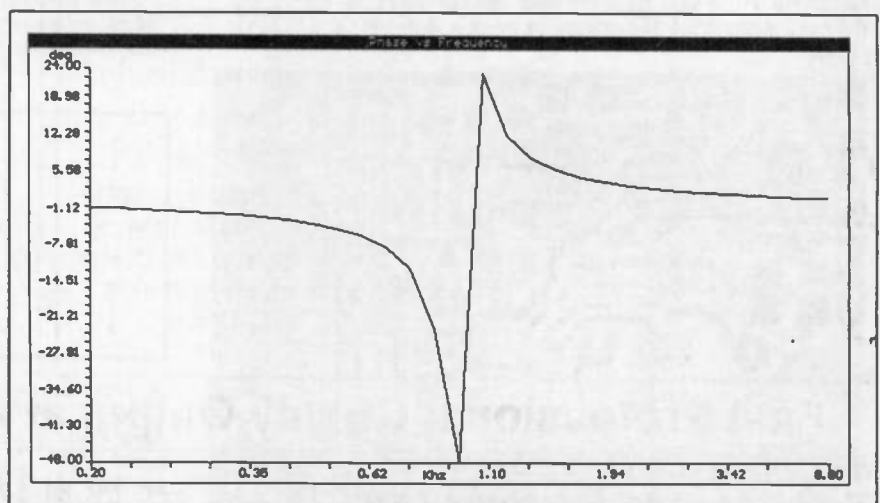
FINALLY

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.

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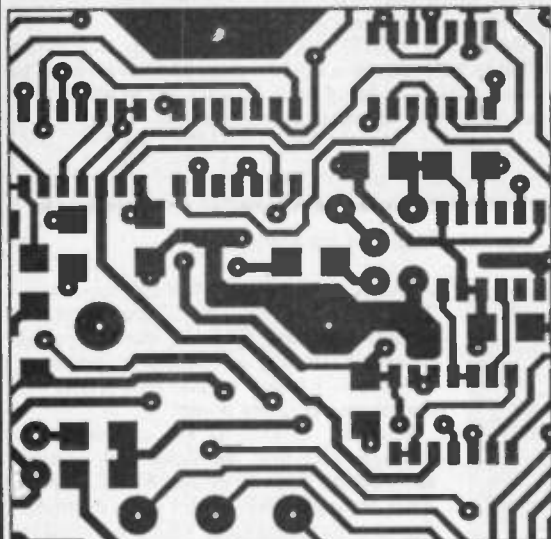
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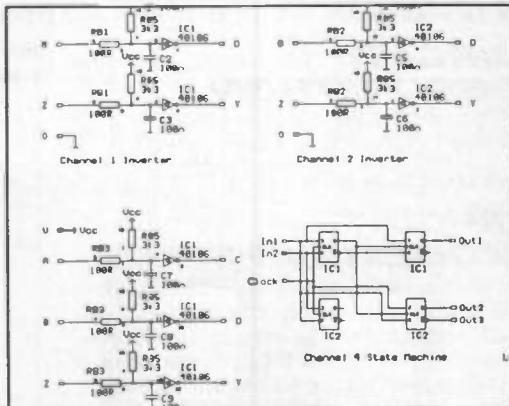
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IN-LINE DIMMER

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 fluorescent 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

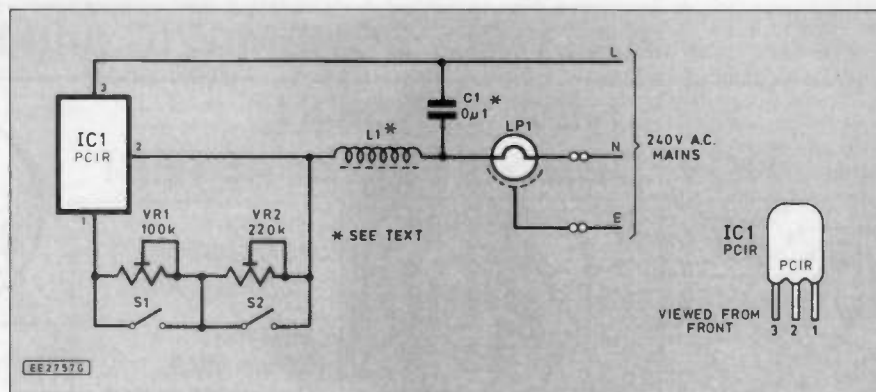
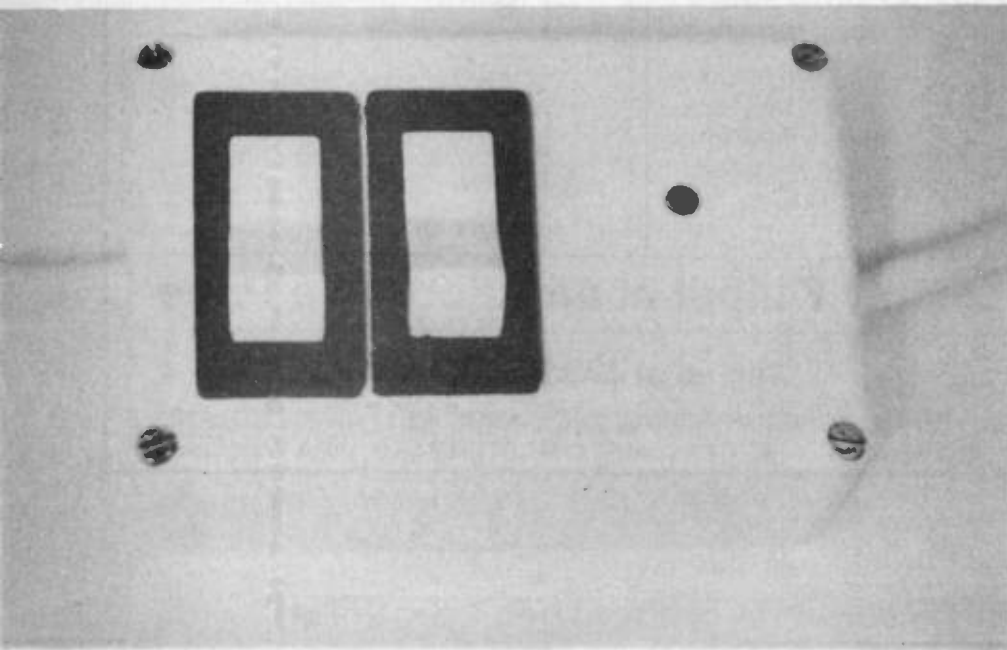


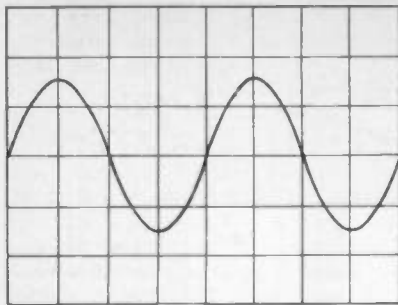
Fig. 1. Circuit diagram of the In-Line Dimmer.

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.

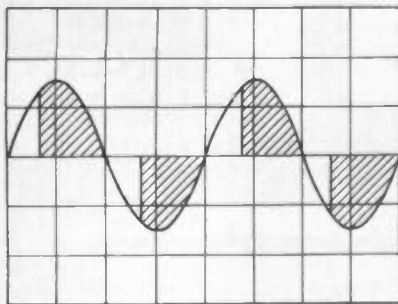
With S1 off and S2 on, current flows through VR1 and the lamp will operate more dimly. With S1 on and S2 off, current flows through VR2 — this gives a greater degree of dimming since VR2 is adjusted to give a higher resistance than VR1. With both switches off, current flows through VR1 and VR2 to give 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

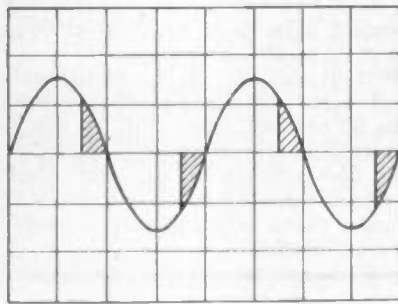




(a)



(b)



(c)

EE2758G

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

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 mains — 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.

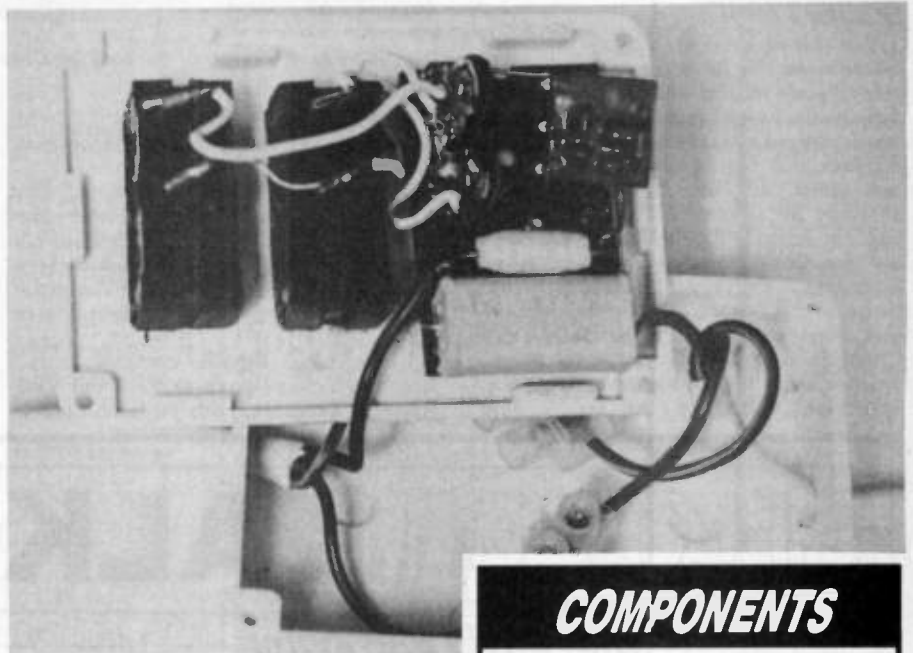
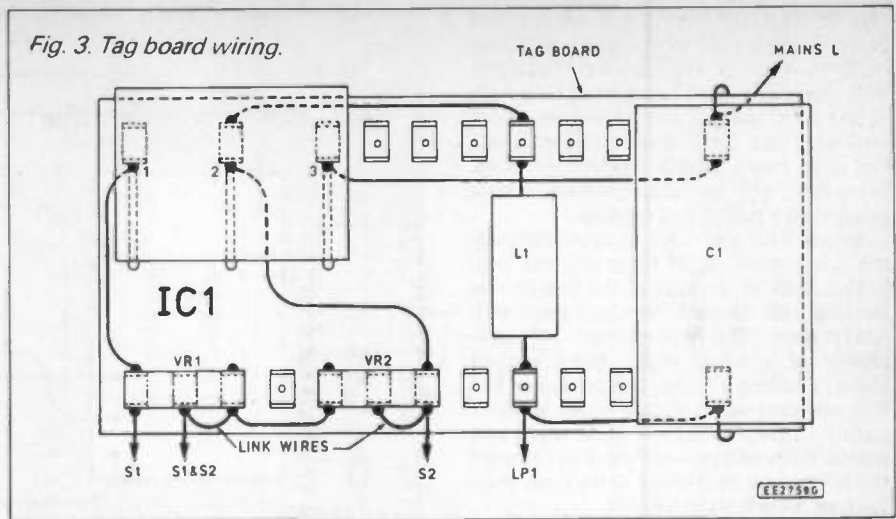
CONSTRUCTION

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 serv-

Fig. 3. Tag board wiring.



ice — 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 100 \times sub-miniature preset
— vertical
- VR2 220 \times sub-miniature preset
— vertical

Capacitor

- C1 0 μ 1 class X
suppressor
capacitor
2 \times 0V a.c.
mains rating (see text)

See
**SHOP
TALK**
Page

Semiconductors

- IC1 PC⁺R 1A integrated circuit
power controller

Inductor

- L1 radio frequency suppressor
choke — 1A rating at
2 \times 0V (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; 3BA 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.

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

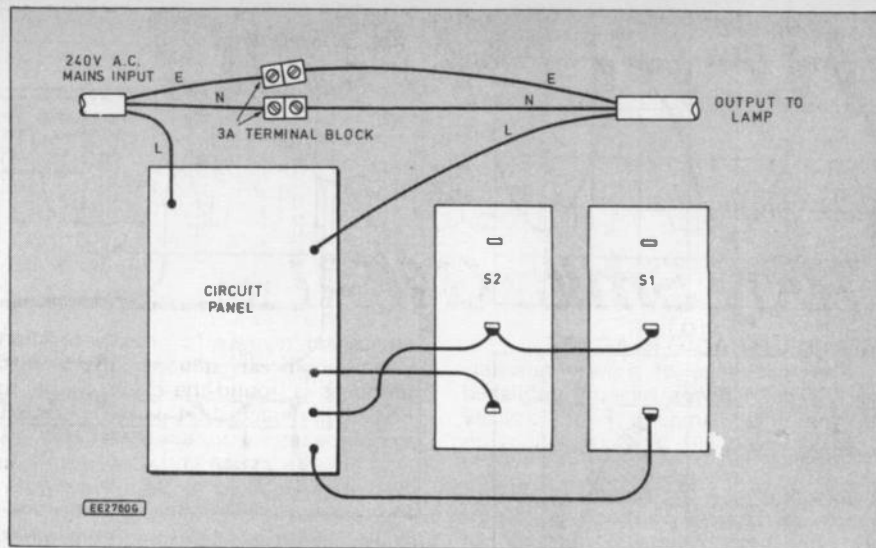


Fig. 4. Wiring of the In-Line Dimmer mains and switch connections.

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.

To date 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 semi-conductors. 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

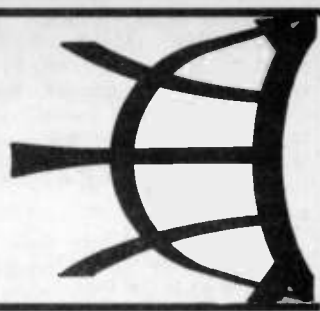
With the construction season now in full swing, just a glance through the advertisement pages at the excellent construction kits now available should inspire anyone who is at all hesitant about taking their soldering iron out of cold storage. If you are still hesitant then the new ten part "Teach In '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.

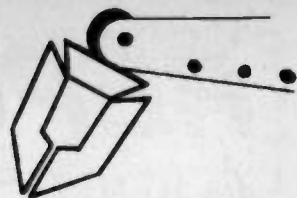
The news bulletins contain up-to-date information about solar and geophysical events which have affected, or may affect, radio propagation, together with forecasts of likely conditions. They also give news of exhibitions, rallies, seminars, courses etc. Information about events on-the-air such as contests, 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 from 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 512x512 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 sub-routines.

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.

ORT 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.

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 be 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.

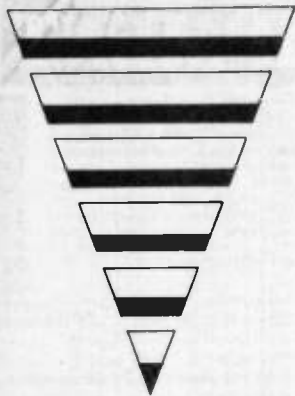


Demonstration setup the RTX robot arm from UMI with its new workcell, together with an "overhead" vision system.

TRANSISTORS		DIODES		RECTANGULAR L.E.D.'S		LINEAR IC'S		74LS SERIES		COMPUTER IC'S	
AA32	9p	8D238	24p	78L08	28p	MC-3302	70p	74LS28	14p	2114 200p	
AC107	40p	8D239	30p	78L12	28p	MC-3401	45p	74LS30	14p	2532 330p	
AC125	25p	8D240	40p	78L15	28p	MC-3403	60p	74LS32	15p	2715 200p	
AC126	25p	8D243A	50p	78L20	28p	MC-3423	15p	74LS31	15p	2732 280p	
AC127	21p	8D244	50p	79L05	40p	NE-531	11p	74LS38	15p	2732A 300p	
AC128	21p	8D245	50p	79L08	40p	NE-544	170p	74LS40	15p	2764 240p	
AC128K	21p	8D246A	50p	79L12	40p	NE-555	20p	74LS42	25p	2764 240p	
AC128K	21p	8D265	45p	79L15	40p	NE-565	110p	74LS47	52p	2764 240p	
AC141K	30p	8D267	46p	7818KC	100p	NE-566	130p	74LS48	48p	2764 240p	
AC142K	30p	8D269	46p	7824KC	100p	NE-567	130p	74LS51	13p	2764 240p	
AC176	22p	8D278	50p	LM309K	100p	NE-570	380p	74LS54	13p	2764 240p	
AC176K	28p	8D311	100p	LM317K	220p	NE-571	290p	74LS55	15p	2764 240p	
AC187	21p	8D312	100p	LM317T	180p	NE-592	85p	74LS73	24p	4164-18 150p	
AC187K	28p	8D313	100p	LM323K	420p	NE-5532P	140p	74LS74	24p	6116 150p	
AC188	21p	8D314	100p	LM723	40p	NE-5534P	110p	74LS75	24p	8264-12 300p	
ACV18	48p	8D315	150p	78HGKC	570p			74LS76	24p	6502 300p	
ACV19	48p	8D316	150p	78M05K	800p			74LS78	24p	6502A 400p	
AD149	60p	8D317	150p	78M12K	700p			74LS83	37p	65C02 930p	
AF124	50p	8D318	150p	78G1UC	190p			74LS85	37p	6503 570p	
AF125	50p	8D331	40p	79G1UC	215p			74LS86	25p	6520 170p	
AF126	50p	8D332	40p	79HGKC	800p			74LS90	26p	6522 330p	
AF127	50p	8D361	60p					74LS91	55p	6532 460p	
AF138	30p	8D362	60p					74LS92	32p	6545 880p	
AF239	30p	8D370	60p					74LS93	32p	6551 530p	
BF379	45p	8D371	30p					74LS95	41p	6800 210p	
BA145	10p	8D410	50p					74LS96	52p	6802 220p	
BA148	10p	8D433	28p					74LS107	28p	6803 800p	
BA154	8p	8D434	30p					74LS109	28p	6808 500p	
BA157	12p	8D435	31p					74LS112	28p	6809 500p	
BB105B	18p	8D436	30p					74LS117	28p	6810 150p	
BB205B	18p	8D437	30p					74LS111	28p	6818 380p	
BC107	8p	8D438	36p					74LS122	35p	6820 140p	
BC108	8p	8D439	40p					74LS123	35p	6821 140p	
BC109	8p	8D440	40p					74LS124	85p	6840 310p	
BC109C	10p	8D441	40p					74LS125	30p	6845 620p	
BC115	10p	8D442	40p					74LS126	30p	6850 110p	
BC118	11p	8D450	50p					74LS133	30p	8080A 400p	
BC140	20p	8D533	50p					74LS136	30p	8085A 300p	
BC141	20p	8D534	38p					74LS138	28p	8086 500p	
BC142	20p	8D535	38p					74LS139	28p	8088 500p	
BC143	20p	8D536	38p					74LS145	65p	8156 300p	
BC147	8p	8D537	40p					74LS147	90p	8159S 120p	
BC148	8p	8D538	40p					74LS148	75p	81596 130p	
BC149	8p	8D539	40p					74LS15*	27p	81LS97 130p	
BC157	8p	8D643	50p					74LS153	31p	81LS98 130p	
BC159	8p	8D645	50p					74LS154	78p	8224 240p	
BC160	30p	8D647	50p					74LS155	36p	8226 240p	
BC171	10p	8D651	50p					74LS156	36p	8243 250p	
BC172	10p	8D675	40p					74LS157	50p	8250 850p	
BC177	14p	8D676	40p					74LS158	27p	8251 270p	
BC178	14p	8D677	40p					74LS160	38p	8253 230p	
BC179	14p	8D678	40p					74LS161	38p	8255 200p	
BC182	7p	8D680	40p					74LS162	38p	8256 1200p	
BC182L	7p	8D679	40p					74LS163	36p	8257 220p	
BC183	7p	8D681	45p					74LS164	36p	8259 280p	
BC183L	7p	8D682	45p					74LS165	50p	8271 3400p	
BC184	7p	8D705	50p					74LS166	55p	8279 270p	
BC184L	7p	8D706	50p					74LS168	60p	8284 440p	
BC212	7p	8D707	50p					74LS169	65p	8288 850p	
BC212L	7p	8D711	50p					74LS170	68p	8748 1100p	
BC213	7p	8D736	50p					74LS174	30p	8755 1400p	
BC213L	7p	8D826	50p					74LS173	32p	AN3-1015 290p	
BC214	7p	8D828	50p					74LS190	40p	SP0256AL2 150p	
BC214L	7p	8D827	50p					74LS191	43p	280ACPU 500p	
BC237	7p	8D897	50p					74LS192	41p	280BCPU 500p	
BC238	7p	8D899	50p					74LS193	41p	280ADMA 400p	
BC239	7p	8D901	50p					74LS194	41p	280AP10 220p	
BC300	20p	8D977	50p					74LS193	44p	280BP10 340p	
BC301	20p	8D932	100p					74LS196	45p	280BCTC 320p	
BC302	20p	8D933	60p					74LS197	42p	280A10 460p	
BC303	20p	8D934	60p					74LS240	45p	280AS10-1 580p	
BC304	20p	8D935	60p					74LS241	42p	280AS10-2 580p	
BC308	10p	8D936	55p					74LS242	43p	280ADART 500p	
BC327	7p	8D937	55p					74LS243	50p		
BC328	7p	8D938	55p					74LS244	50p		
BC337	7p	8D939	50p					74LS245	40p		
BC338	7p	8D940	50p					74LS247	40p		
BC341	28p	8D941	50p					74LS248	40p		
BC446	8p	8D942	35p					74LS249	70p		
BC449	15p	8D943	25p					74LS251	52p		
BC461	28p	8D944	30p					74LS252	36p		
BC477	18p	8D945	40p					74LS257	32p		
BC478	18p	8D946	40p					74LS258	35p		
BC479	18p	8D947	40p					74LS259	50p		
BC489	20p	8D948	18p					74LS260	30p		
BC490	18p	8D949	20p					74LS266	22p		
BC516	22p	8D950	20p					74LS279	33p		
BC528	22p	8D951	20p					74LS280	88p		
BC537	25p	8D952	7p					74LS283	51p		
BC540	25p	8D953	7p					74LS290	26p		
BC543	25p	8D954	7p					74LS293	26p		
BC547	8p	8D955	10p					74LS365	26p		
BC548	8p	8D956	10p					74LS366	31p		
BC549	8p	8D957	10p					74LS367	28p		
BC550	8p	8D958	10p					74LS368	30p		
BC556	8p	8D959	10p					74LS373	45p		
BC557	8p	8D960	10p					74LS374	45p		
BC558	8p	8D961	10p					74LS375	45p		
BC559	8p	8D962	10p					74LS390	42p		
BC560	8p	8D963	10p					74LS393	37p		
BC567	20p	8D964	12p					74LS399	68p		
BC568	20p	8D965	12p					74LS629	95p		
BC569	20p	8D966	12p					74LS641	88p		
BC570	20p	8D967	12p					74LS642	105p		
BC571	16p	8D968	15p					74LS644	105p		
BC572	16p	8D969	15p					74LS645	105p		
BC573	16p	8D970	15p					74LS670	82p		
BD115	30p	8D971	15p					74LS674	310p		
BD124P	50p	8D972	20p					74LS837	250p		
BD124	110p	8D973	20p								
BD131	25p	8D974	20p								
BD132	25p	8D975	20p								
BD133	25p	8D976	20p								
BD135	20p	8D977	17p								
BD136	20p	8D978	17p								
BD137	20p	8D979	17p								
BD138	20p	8D980	17p								
BD139	20p	8D981	17p								
BD140	20p	8D982	17p								
BD142	45p	8D983	17p								
BD150	30p	8D984	14p								
BD157	30p	8D985	14p								
BD158	30p	8D986	14p								
BD166	30p	8D987	14p								
BD175	30p	8D988	14p								
BD177	30p	8D989	14p								

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 extricate 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.

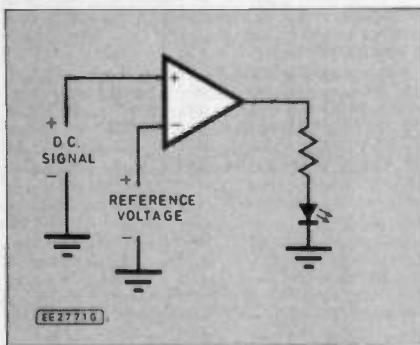


Fig. 1. Comparator plus l.e.d. indicator.

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 impracticable 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.

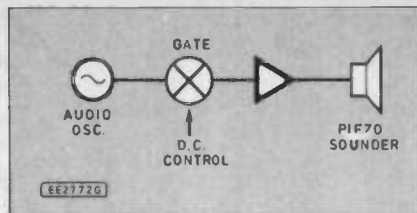


Fig. 2. Conventional audio indicator scheme.

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 impedance, 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.

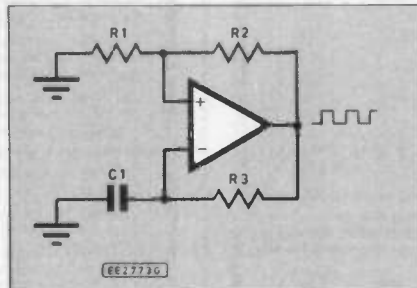


Fig. 3. Astable based on op. amp. (Also called an op. amp. multivibrator.)

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.

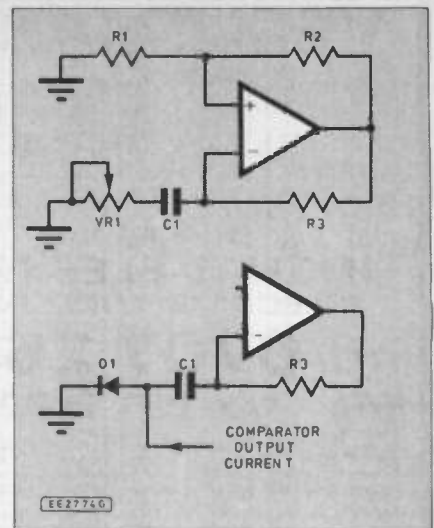


Fig. 4. (a) Adding R4 makes the circuit's stability adjustable. (b) A diode (D1) can be used as a variable resistance to adjust stability.

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.

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By Michael J. Cockcroft
Training Manager, Peterborough ITeC

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4000	23p	4024	41p	4052	41p	4099	67p	4532	53p
4001	23p	4025	23p	4053	41p	40106	37p	4534	354p
4002	23p	4027	36p	4060	48p	4502	67p	4536	239p
4007	23p	4028	41p	4066	34p	4058	142p	4538	44p
4008	48p	4029	44p	4068	23p	4510	53p	4539	62p
4011	23p	4033	126p	4069	23p	4511	53p	4541	53p
4012	23p	4035	28p	4070	23p	4512	53p	4543	80p
4013	28p	4038	106p	4071	23p	4514	115p	4553	221p
4014	42p	4040	55p	4072	23p	4515	115p	4554	354p
4015	41p	4042	40p	4073	23p	4516	62p	4556	60p
4016	28p	4043	54p	4075	23p	4518	41p	4560	195p
4017	44p	4044	54p	4076	50p	4520	44p	4561	221p
4018	41p	4046	50p	4077	23p	4522	80p	4566	283p
4020	48p	4047	41p	4078	28p	4526	64p	4582	203p
4021	48p	4049	32p	4081	23p	4527	71p	4584	37p
4022	49p	4050	32p	4093	28p	4528	67p	4585	53p
4023	23p	4051	41p	4094	50p	4529	71p		

LINEAR

CA3046	71p	LM3352	124p	MC3302	133p	TL072	57p
CA3080	85p	LM339	39p	MC3340	203p	TL074	74p
CA3130	142p	LM348	48p	NE555	28p	TL081	48p
CA3140	67p	LM358	39p	NE556	53p	TL082	62p
CA 3240E	159p	LM380	142p	NE565	159p	TL084	74p
ICM7555	71p	LM381N	300p	NE566	159p	UA709C	62p
LF347	124p	LM382	248p	NE567	53p	UA741	28p
LF351	88p	LM386	124p	NE5532	97p	UA747	78p
LF353	48p	LM387	192p	NE5534	80p	UA748	45p
LF355	62p	LM383	39p	SAA1027	327p	ULN2003	71p
LF356	248p	LM710	80p	SL560C	268p	ULN2004	71p
LM301A	103p	LM723	44p	SP8629	265p	ULN2803	115p
LM308	36p	LM1458	39p	TBA120S	95p	XR2206CP	540p
LM311	88p	LM2917	300p	TBA810	103p	ZN414	142p
LM317T	39p	LM3900	106p	TBA820M	71p	ZN416E	221p
LM324	80p	LM3909	168p	TDA2030H	177p	ZN424E	124p
LM334Z	39p	LM3314	336p	TDA7000	220p	ZN427E	991p
LM334Z	115p	LM3915	336p	TL071	50p	ZN1034E	295p

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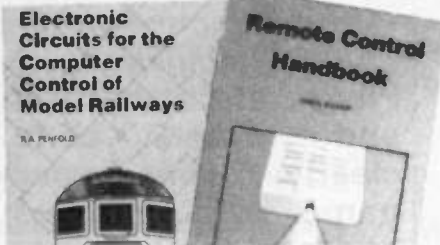
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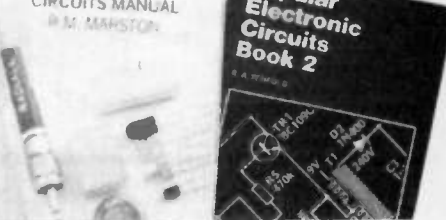
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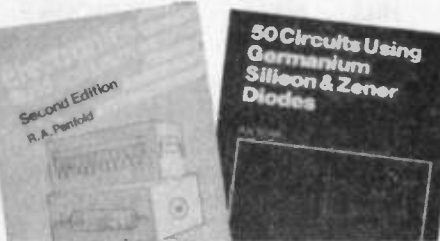
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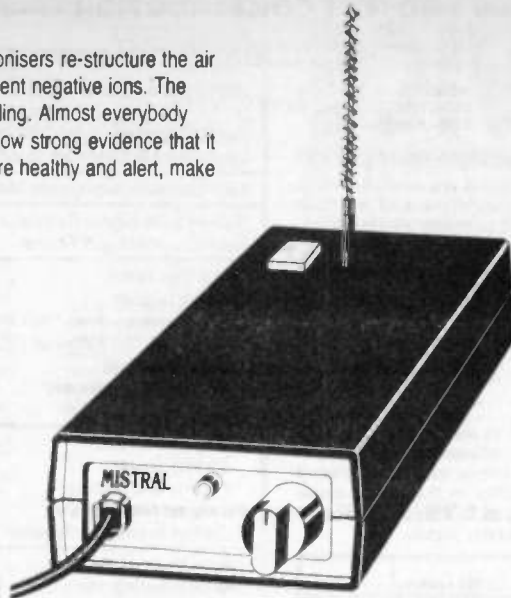
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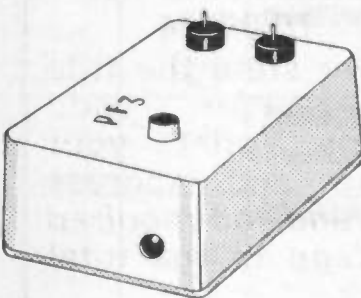
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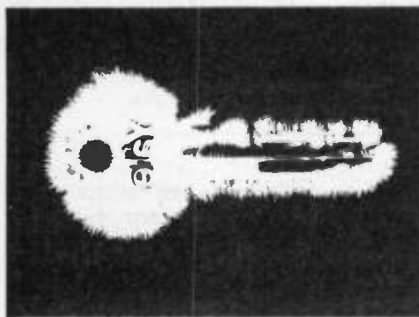
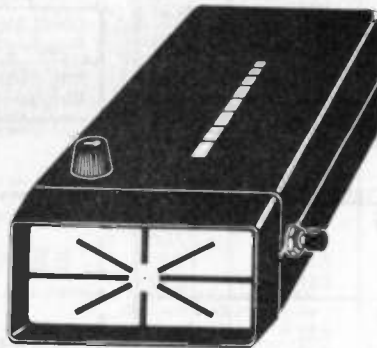
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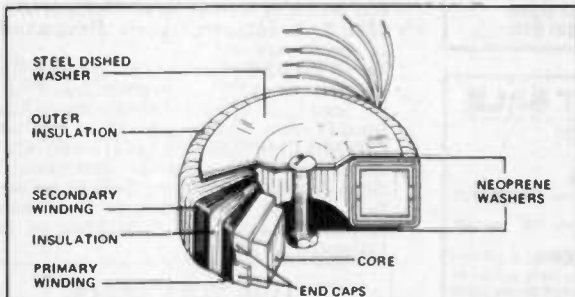


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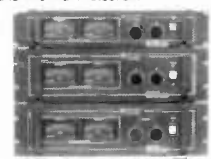
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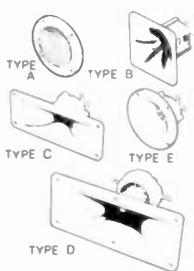
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PIEZO ELECTRIC TWEETERS-MOTOROLA

PIEZO ELECTRIC TWEETERS — MOTOROLA

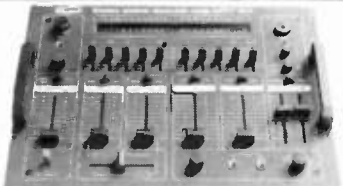
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