EVERYDAY ELECTRONICS

JUNE 1991

INCORPORATING ELECTRONICS MONTHLY

£1.50

DIGILOGUE CAR TACHOMETER

DIGITAL AND ANALOGUE DISPLAY OF R.P.M.

S.W. M.W. L.W. RADIO

FISH BITE INFRALARM

AUTOMATIC LIGHT SWITCH

DESIGN YOUR OWN CIRCUITS – 7

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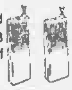
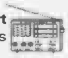
The No.1 Magazine for Electronics & Computer Projects

HIGH POWER AMPLIFIER For your car, it has 150 watts output. Frequency response 20HZ to 20 KHZ and a signal to noise ratio better than 60db. Has builtin short circuit protection and adjustable input level to suit youe 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.
HIGH POWER CAR SPEAKERS. Stereo pair output 100w each. 4ohm 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.
PERSONAL STEREOS Customer returns but complete with a pair of stereo headphones very good value at £3.00 ref 3P83.
2KV 500 WATT TRANSFORMERS Suitable for high voltage experiments or as a spare for a microwave oven etc. 250v AC input £10.00 ref 10P93
MICROWAVE CONTROL PANEL. Mains operated, with touch switches. Complete with 4 digit display, digital clock, and 2 relay outputs one for power and one for pulsed power (programmable). Ideal for all sorts of precision timer applications etc. £6.00 ref 6P18
FIBRE OPTIC CABLE. Stranded optical fibres sheathed in black PVC. Five metre length £7.00 ref 7P29
12V SOLAR CELL. 200mA output ideal for trickle charging etc. 300 mm square. Our price £15.00 ref 15P42
PASSIVE INFRA-RED MOTION SENSOR.

Complete with daylight sensor, adjustable lights on timer (8 secs -15 mins), 50' range with a 90 deg coverage. Manual overide facility. Complete with wall brackets, bulb holders etc. Brand new and guaranteed. £25.00 ref 25P24.

Pack of two PAR38 bulbs for above unit £12.00 ref 12P43
VIDEO SENDER UNIT Transmit both audio and video signals from either a video camera, video recorder or computer to any standard TV set within a 100' range! (tune TV to a spare channel). 12v DC op. £15.00 ref 15P39 Suitable mains adaptor £5.00 ref 5P191
FM TRANSMITTER housed in a standard working 13A adapter (bug is mains driven). £26.00 ref 26P2
MINATURE RADIO TRANSCEIVERS A pair of walkie talkies with a range of up to 2 kilometres. Units measure 22x52x155mm. Complete with cases. £30.00 ref 30P12
FM CORDLESS MICROPHONE. Small hand held unit with a 500' rangel 2 transmit power levels reqs PP3 battery. Tuneable to any FM receiver. Our price £15 ref 15P42A


10 BAND COMMUNICATIONS RECEIVER. 7 short bands, FM, AM and LW DX/local switch, tuning 'eye' mains or battery. Complete with shoulder strap and mains lead **NOW ONLY £19.00!! REF 19P14.**


WHISPER 2000 LISTENING AID. Enables you to hear sounds that would otherwise be inaudible! Complete with headphones. Cased. £5.00 ref 5P179.
CAR STEREO AND FM RADIO. Low cost stereo system giving 5 watts per channel. Signal to noise ratio better than 45db, wow and flutter less than .35%. Neg earth. £25.00 ref 25P21.
LOW COST WALKIE TALKIES. Pair of battery operated units with a range of about 150'. Our price £8.00 a pair ref 8P50

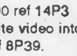
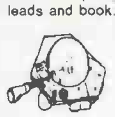
7 CHANNEL GRAPHIC EQUALIZER plus a 60 watt power amp! 20-21KHZ 4-8R 12-14v DC negative earth. Cased. £25 ref 25P14.
NICAD BATTERIES. Brand new top quality. 4 x AA's £4.00 ref 4P44. 2 x C's £4.00 ref 4P73, 4 x D's £9.00 ref 9P12, 1 x PP3 £6.00 ref 6P35
TOWERS INTERNATIONAL TRANSISTOR SELECTOR GUIDE. The ultimate equivalents book. Latest edition £20.00 ref 20P32.
CABLE TIES. 142mm x 3.2mm white nylon pack of 100 £3.00 ref 3P104. Bumper pack of 1,000 ties £14.00

VIDEO AND AUDIO MONITORING SYSTEM

£99.00

Brand new units consisting of a camera, 14cm monitor, 70 metres of cable, AC adapter, mounting bracket and owners manual. 240v AC or 12v DC operation complete with built in 2 way intercom. £99.00 ref 99P2.

1991 CATALOGUE AVAILABLE NOW IF YOU DO NOT HAVE A COPY PLEASE REQUEST ONE WHEN ORDERING OR SEND US A 6"X9" SAE FOR A FREE COPY.

GEIGER COUNTER KIT. Complete with tube, PCB and all components to build a battery operated geiger counter. £39.00 ref 39P1
FM BUG KIT. New design with PCB embedded coil. Transmits to any FM radio. 9v battery req'd. £5.00 ref 5P158
FM BUG Built and tested superior 9v operation £14.00 ref 14P3
COMPOSITE VIDEO KITS. These convert composite video into separate H sync, V sync and video. 12v DC. £8.00 ref 8P39.
SINCLAIR C5 MOTORS 12v 29A (full load) 3300 rpm 6"x4" 1/4" O/P shaft. New. £20.00 ref 20P22.
As above but with fitted 4 to 1 inline reduction box (800rpm) and toothed nylon belt drive cog £40.00 ref 40P8.
SINCLAIR C5 WHEELS 13" or 16" dia including treaded tyre and innertube. Wheels are black, spoked one piece poly carbonate. 13" wheel £6.00 ref 6P20, 16" wheel £6.00 ref 6P21.
ELECTRONIC SPEED CONTROL KIT for c5 motor. PCB and all components to build a speed controller (0-95% of speed). Uses pulse width modulation. £17.00 ref 17P3.

SOLAR POWERED NICAD CHARGER. Charges 4 AA nicads in 8 hours. Brand new and cased £6.00 ref 6P3.
MOSFETS FOR POWER AMPLIFIERS ETC. 100 watt mosfet pair 2SJ99 and 2SK343 £4.00 a pair with pin out info ref 4P51. Also avaliable is a 2SK413 and a 2SJ118 at £4.00 ref 4P42.
10 MEMORY PUSH BUTTON TELEPHONES. These are 'customer returns' so they may need slight attention. BT approved. £6.00 each ref 6P16 or 2 for £10.00 ref 10P77.
12 VOLT BRUSHLESS FAN 4 1/2" square brand new ideal for boat, car, caravan etc. £5.00 ref 5P206.
ACORN DATA RECORDER ALF503 Made for BBC computer, but suitable for others. Includes mains adapter, leads and book. £15.00 ref 15P43
VIDEO TAPES. Three hour superior quality tapes made under licence from the famous JVC company. Pack of 10 tapes £20.00 ref 20P20.

ELECTRONIC SPACESHIP. Sound and impact controlled, responds to claps and shouts and reverses when it hits anything. Kit with complete assembly instructions £10.00 ref 10P81.

PHILIPS LASER. 2MW HELIUM NEON LASER TUBE. BRAND NEW FULL SPEC £40.00 REF 40P10. MAINS POWER SUPPLY KIT £20.00 REF 20P33 READY BUILT AND TESTED LASER IN ONE CASE £75.00 REF 75P4.

SOLDER 22SWG resin cored solder on a 1/2kg reel. Top quality. £4.00 a reel ref 4P70.
600 WATT HEATERS Ideal for air or liquid, will not corrode, lasts for years. coil type construction 3"x2" mounted on a 4" dia metal plate for easy fixing. £3.00 ea ref 3P78 or 4 for £10.00 ref 10P76.
TIME AND TEMPERATURE MODULE A clock, digital thermometer (Celcius and Farenheit (0-160 deg F) programmable too hot and too cold alarms. Runs for at least a year on one AA battery. £9.00 ref 9P5.
Remote temperature probe for above unit £3.00 ref 3P60.
GEARBOX KITS Ideal for models etc. Contains 18 gears (2 of each size) 4x50mm axles and a powerful 9-12v motor. All the gears etc are push fit. £3.00 for complete kit ref 3P93.
ELECTRONIC TICKET MACHINES These units contain a magnetic card reader, two matrix printers, motors, sensors and loads of electronic components etc. (12"x12"x7") Good value at £12.00 ref 12P28.
JOYSTICKS. Brand new with 2 fire buttons and suction feet these units can be modified for most computers by changing the connector etc. Price is 2 for £5.00 ref 5P174.
GAS POWERED SOLDERING IRON AND BLOW TORCH Top quality tool with interchangeable heads and metal body. Fully adjustable, runs on lighter gas £10.00 ref 10P130
SMOKE ALARMS Ionization type 5 year warranty complete with battery only £5.00 ref 5P206
ANSWER MACHINES BT approved remote message playback, intergral push button phone, power supply and tape. Exceptional value at £45.00 ref 45P2
CAR IONIZER KIT Improve the air in your car! clears smoke and helps to reduce fatigue. Case required. £12.00 ref 12P8.
6V 10AH LEAD ACID sealed battery by yuasha ex equipment but in excellent condition now only 2 for £10.00 ref 10P95.
12 TO 220V INVERTER KIT As supplied it will handle up to about 15 w at 220v but with a larger transformer it will handle 80 watts. Basic kit £12.00 ref 12P17. Larger transformer £12.00 ref 12P41.
VERO EASI WIRE PROTOTYPING SYSTEM Ideal for designing projects on etc. Complete with tools, wire and reusable board. Our price £6.00 ref 6P33.
MICROWAVE TURNTABLE MOTORS. Ideal for window displays etc. £5.00 ref 5P165.
STC SWITCHED MODE POWER SUPPLY 220v or 110v input giving 5v at 2A, +24v at 0.25A, +12v at 0.15A and +90v at 0.4A £6.00 ref 6P59
TELEPHONE AUTODIALLERS. These units, when triggered will automatically dial any telephone number. Originally made for alarm panels. BT approved. £12.00 ref 12P23 (please state telephone no req'd).
25 WATT STEREO AMPLIFIER c. STK043. With the addition of a handful of components you can build a 25 watt amplifier. £4.00 ref 4P69 (Circuit dia included).
LINEAR POWER SUPPLY Brand new 220v input +5 at 3A, +12 at 1A, -12 at 1A. Short circuit protected. £12.00 ref 12P21.
MAINS FANS. Snail type construction. Approx 4"x5" mounted on a metal plate for easy fixing. New £5.00 5P166.
POWERFUL IONIZER KIT. Generates 10 times more ions than commercial units! Complete kit including case £18.00 ref 18P2.
MINI RADIO MODULE Only 2" square with ferrite aerial and tuner. Superhet. Req's PP3 battery. £1.00 ref BD716.
HIGH RESOLUTION MONITOR. 9" black and white Phillips tube in chassis made for OPD computer but may be suitable for others. £20.00 ref 20P26.

BARGAIN NICADS AAA SIZE 200MAH 1.2V PACK OF 10 £4.00 REF 4P92, PACK OF 100 £30.00 REF 30P16

CB CONVERTORS. Converts a car radio into an AM CB receiver. Cased with circuit diagram. £4.00 ref 4P48.
FLOPPY DISCS. Pack of 15 31/2" DSDD £10.00 ref 10P88. Pack of 10 51/4" DSDD £5.00 ref 5P168.
SONIC CONTROLLED MOTOR One click to start, two click to reverse direction, 3 click to stop! £3.00 each ref 3P137.
FRESNEL MAGNIFYING LENS 83 x 52mm £1.00 ref BD827.

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LCD DISPLAY. 4 1/2 digits supplied with connection data £3.00 ref 3P77 or 5 for £10.00 ref 10P78.
ALARM TRANSMITTERS. No data avaliable but nicely made complex transmitters 9v operation. £4.00 each ref 4P81.
100M REEL OF WHITE BELL WIRE figure 8 pattern ideal for intercoms, door bells etc £3.00 a reel ref 3P107.
TRANSMITTER RECEIVER SYSTEM originally made for nurse call systems they consist of a pendant style transmitter and a receiver with telescopic aerial 12v. 80 different channels. £12.00 ref 12P26
CLAP LIGHT. This device turns on a lamp at a finger 'snap' etc. nicely cased with built in battery operated light. Ideal bedside light etc £4.00 each ref 4P82.
ELECTRONIC DIPSTICK KIT. Contains all you need to build an electronic device to give a 10 level liquid indicator. £5.00 (ex case) ref 5P194.
UNIVERSAL BATTERY CHARGER. Takes AA's, C's, D's and PP3 nicads. Holds up to 5 batteries at once. New and cased, mains operated. £6.00 ref 6P36.
ONE THOUSAND CABLE TIES! 75mm x 2.4mm white nylon cable ties only £5.00 ref 5P181.
PC MODEMS 1200/75 baud modems designed to plug into a PC complete with manual but no software £18.00 ref 18P12
ASTEC SWITCHED MODE POWER SUPPLY 80mm x 165mm (PCB size) gives +5 at 3.75A, +12 at 1.5A, -12 at 0.4A. Brand new £12.00 ref 12P39.
VENTILATED CASE FOR ABOVE PSU with IEC filtered socket and power switch. £5.00 ref 5P190.
IN CAR POWER SUPPLY. Plugs into cigar socket and gives 3,4,5,6,7.5,9, and 12v outputs at 800mA. Complete with universal spider plug. £5.00 ref 5P167.
CUSTOMER RETURNED switched mode power supplies. Mixed type, good for spares or repair. £2.00 each ref 2P292.
DRILL OPERATED PUMP. Fits any drill and is self priming. £3.00 ref 3P140.
PERSONAL ATTACK ALARM. Complete with built in torch and vanity mirror. Pocket sized, req's 3 AA batteries. £3.00 ref 3P135
POWERFUL SOLAR CELL 1AMP .45 VOLT only £5.00 ref 5P192 (other sizes avaliable in catalogue).
SOLAR PROJECT KIT. Consists of a solar cell, special DC motor, plastic fan and turntables etc plus a 20 page book on solar energy! Price is £8.00 ref 8P51.
RESISTOR PACK. 10 x 50 values (500 resistors) all 1/4 watt 2% metal film. £5.00 ref 5P170.
CAPACITOR PACK 1. 100 assorted non electrolytic capacitors £2.00 ref 2P286.
CAPACITOR PACK 2. 40 assorted electrolytic capacitors £2.00 ref 2P287.
QUICK CUPPA? 12v immersion heater with lead and cigar lighter plug £3.00 ref 3P92.
LED PACK .50 red leds, 50 green leds and 50 yellow leds all 5mm £8.00 ref 8P52
FERRARI TESTAROSSA. A true 2 channel radio controlled car with forward, reverse, 2 gears plus turbo. Working headlights. £22.00 ref 22P6.
ULTRASONIC WIRELESS ALARM SYSTEM. Two units, one a sensor which plugs into a 13A socket in the area you wish to protect. The other, a central alarm unit plugs into any other socket elsewere in the building. When the sensor is triggered (by body movement etc) the alarm sounds. Adjustable sensitivity. Price per pair £20.00 ref 20P34. Additional sensors (max 5 per alarm unit) £11.00 ref 11P6.
TOP QUALITY MICROPHONE. Unidirectional electret condenser mic 600 ohm sensitivity 16-18khz built in chime complete with magnetic microphone stand and mic clip. £12.00 ref 12P42.
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IBM PRINTER LEAD. (D25 to centronics plug) 2 metre parallel. £5.00 ref 5P186.
COPPER CLAD STRIP BOARD 17" x 4" of .1" pitch "vero" board. £4.00 a sheet ref 4P62 or 2 sheets for £7.00 ref 7P22.
STRIP BOARD CUTTING TOOL. £2.00 ref 2P352.
3 1/2" disc drive. 720K capacity made by NEC £60.00 ref 60P2
TV LOUDSPEAKERS. 5 watt magnetically screened 4 ohm 55 x 125mm. £3.00 a pair ref 3P109.
TV LOUDSPEAKERS. 3 watt 8 ohm magnetically screened 70 x 50mm. £3.00 a pair ref 3P108.
BBC TRACKBALLS Once again in stock only £4.00 ref 4P86
CROSS OVER NETWORKS 8 ohm 3 way Japanese made units Excellent units avaliable at only £2.00 for a pair! ref 2P363
SPEAKER GRILLS set of 3 matching grills of different diameters. 2 packs for £2.00 (6 grills) ref 2P364
50 METRES OF MAINS CABLE £3.00 2 core black precut in convenient 2 m lengths. Ideal for repairs and projects. ref 3P91
4 CORE SCREENED AUDIO CABLE 24 METRES £2.00 Precut into convenient 1.2 m lengths. Ref 2P365
TWEETERS 2 1/4" DIA 8 ohm mounted on a smart metal plate for easy fixing £2.00 ref 2P366
COMPUTER MICE Originally made for Future PC's but can be adapted for other machines. Swiss made £8.00 ref 8P57. Atari ST conversion kit £2.00 ref 2P362.
6 1/2" 20 WATT SPEAKER Built in tweeter 4 ohm £5.00 ref 5P205
5" X 3" 16 OHM SPEAKER 3 for £1.00!! ref CD213
ADJUSTABLE SPEAKER BRACKETS Ideal for mounting speakers on internal or external corners, uneven surfaces etc. 2 for £5.00 ref 5P207
PIR LIGHT SWITCH Replaces a standard light switch in seconds light operates when anybody comes within detection range (4m) and stays on for an adjustable time (15 secs to 15 mins). Complete with daylight sensor. Unit also functions as a dimmer switch! 200 watt max. Not suitable for flourescents. £14.00 ref 14P10
2 MEG DISC DRIVES 3 1/2" disc drives made by Sony housed in a 5 1/4" frame 1.2 meg formatted. £66.00 ref 66P1.
360K 3 1/2" DISC DRIVES 1/2 height £25.00 ref 25P26
40 CHANNEL TRANSCEIVER 4 WATT OUTPUT, HANDHELD SQUELCH CONTROL ETC £70.00 EACH REF 70P1
OR AVALIABLE AS A PAIR WITH NICAD BATTERY PACKS FOR £150.00 REF 150P1
Illuminated channel display, 10 section aerial, Hi-Low power switch, external aerial socket, DC charger socket, 12v DC power socket, carrying strap and owners manual.


SOME OF OUR PRODUCTS MAY BE UNLICENSABLE IN THE UK

VOL. 20 No. 6 JUNE 1991

EVERYDAY ELECTRONICS

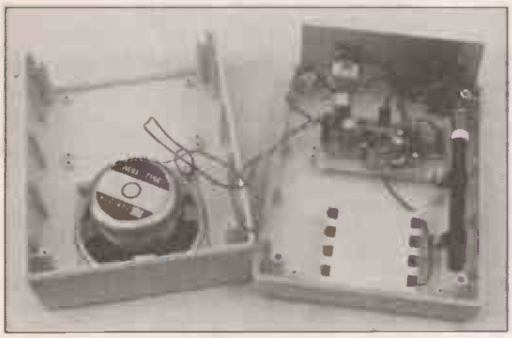
INCORPORATING ELECTRONICS MONTHLY

ABC

The No 1 Magazine for Electronic & Computer Projects

ISSN 0262 3617

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



Projects

Series

Features

Our July '91 Issue will be published on Friday, 7 June 1991. See page 347 for details.

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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

AUSTIN ROVER SHELF SPEAKERS

15 watt speaker. Moulded in black plastic housing for vertical or horizontal use, contains 4½" Goodmans drive unit with a good size magnet

SPECIAL OFFER £4.95 pair + £2 pp

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"RUBBER DUCK AERIAL"

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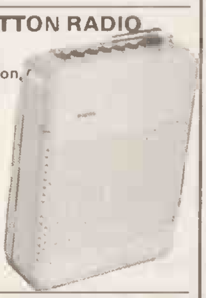
ROSS PUSH BUTTON RADIO



Mains and battery operated.
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Size 230H x 150W x 65D
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Brand new.
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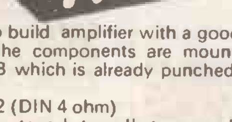
30 + 30 WATT AMPLIFIER KIT



An easy to build amplifier with a good specification. All the components are mounted on the single PCB which is already punched and back-printed.

- 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.) 74 x 400 x 195mm.
Kit enclosed: case. PCB, all components, scale and knobs **£36.80** + £3.50 pp.
(Featured project in *Everyday Electronics*, April 1989 issue). Reprint Free with kit.

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Please state pack(s) required

No.	Qty. per pack	
BP015B	1	30W dome tweeter. Size 90x66mil *JAPAN made*
BP017	3	33000μF 16V d.c. electrolytic high quality computer grade *UK made*
BP019	20	20 ceramic trimmers
BP020	4	Tuning capacitors, 2 gang dielectric a.m. type
BP021	10	3 position, 8 tag slide switch 3 amp rated 125V a.c. *made in USA*
BP022	5	Push-button switches, push on push off, 2 pole changeover. PC mount *JAPAN made*
BP023	6	2 pole 2 way rotary switch
BP024	2	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*
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*
	4	
BP033A	3	6"x⅜" High grade Ferrite rod. *UK made*
BP034	2	AM IF modules with diagram *PHILIPS UK MADE*
BP034A	1	AM-FM tuner head modules. *UK made by Mullard*
BP034B	6	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	20	Fuse holders, panel mounting 20mm type
BP038	6	5 pin din, 180° chassis socket
BP039	3	Double phono sockets, Paxolin mounted
BP041	2	2.8m lenghts of 3 core 5 amp mains flex
BP042	30	Large VU meters *JAPAN made*
BP043	2	4V miniature bulbs, wire ended, new untested
BP044		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
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 TO66 case. *(Ideal replacement for AD161 and 162s)*
BP052A	1	Tape deck pre-amp IC with record/replay switching No LM1818 with diagram
BP053	5	5 watt audio ICs. No TBA800 *(ATEZ)*
BP054	10	Motor speed control ICs, as used with most cassette and record player motors
BP055	1	Digital DVM meter I.C. *made by PLESSEY* as used by *THANDAR* with diagram
BP056	4	7 segment 0.3 LED display (red)
BP057	8	Bridge rectifiers, 1 amp, 24V
BP058	200	Assorted carbon resistors
BP059	1	Power supply PCB with 30V 4V/A transformer. MC7818CT IC & bridge rectifier: Size 4" x 2¾"
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

Postage £3 per order

28.0.28V 4 AMP MAINS TRANSFORMER

With a 5.5V at 0.5A mains input 110-240. Size 90 x 105 x 75 fitted with copper screening band; made for famous HiFi Co. £6.50 each. Postage £2.80. It's weight is 2.7Kgl Brand new and unused condition.

2 for £14 POST PAID

KOSS STEREO HEADPHONES

High quality lightweight stereo headphones fitted 3.5mm jack with adaptor to 6.4mm jack. Ideal use HiFi or personal stereos. Made to sell for nine pounds. Our price for this unit **£4.25** postage 60p.

Hi-Fi stereo cassette deck transport mechanism, complete with 3 digit rev counter and tape heads. 12V d.c. operation. Unused manufacturers surplus *JAPAN made*.

£6.20 + 2.50 P&P 2 for £10.00 + 3.50 P&P

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Manual auto operation, 3 speed (78, 45, 33⅓), 240V operation. Unused but store soiled.

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AMPHONIC 125 + 125 POWER AMPLIFIER

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

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

£142 + £7.00 pp

SPECIAL OFFER

DTMF TONE DIALLER

Suitable for remote control of telephone answering machines, videos, appliances etc. requiring DTMF signals over telephone lines.

£8.95

Please add 75p p&p when ordering

VIDEO SENDER

With this handy unit you can transmit the output of your home video, video camera or satellite equipment over-the-air to a receiving television within a range of 100ft. Simply connect the video and audio output of your equipment into this unit and a 10-13.8V dc power supply extra **£3.75** size 122 x 70 x 21mm

SALE OFFER £11.50 + £2 pp

VHF RADIO TRANSMITTERS

100mW mini bug. Built on a neat little fibre glass pcb with condenser mic. Fully tunable over the FM band. 9V DC **£5.75** + £0.90 pp

2 Watt transmitter kit, supplied with fibre glass pcb, all components, diagrams, ready for you to build. 12-24V DC. **£7.50** + £0.70 pp

25 Watt Transmitter kit. Fully tuneable over the FM band. Kit comprises double sided pcb diagrams and all components, including heat sink. Supply voltage 12-18V DC. **£67** + £1 pp

Transmitters listed on this page are not licensable in the UK.

HIFI WOOFERS

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

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

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

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

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

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

HIFI TWEETER AND MID RANGE

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

4" square 75 watt Audax sealed back mid range ⅜" coil treated paper cone, Ferrofluid cooled coil, chassis size 3⅞" 8Ω imp **£7.95** + £1 pp

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

4¼" x 2¼" 75 watt ⅜" direct drive dome tweeter, Ferrofluid cooled ⅜" voice coil rec crossover, freq 4.5KHz as above but with 3⅜" face plate **£6.90** + £1.30 pp

10½ x 4¼ 120W Jamo horn tweeter 8Ω imp crossover freq 7KHz **£9.95** + £2 pp

MOTOROLA PIZO CERAMIC TWEETERS

Convert electrical energy into sound without the use of voice coils and magnet assemblies. No moving mass, hence excellent transient response and low distortion with high efficiency levels as they cannot reproduce bass sounds. No crossovers are required

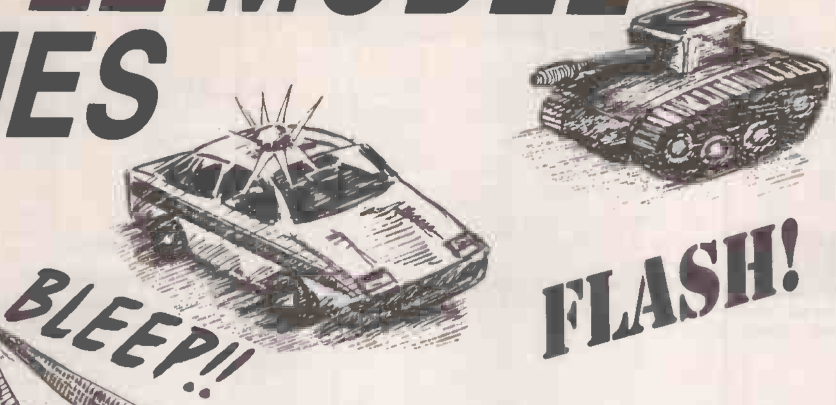
3½" square, 50 watt Pizo super horn tweeter **SALE OFFER £3.95** + 75 pp

3⅜" round, 50 watt Pizo horn tweeter **£5.75** + 75 pp

2" x 6" wide dispersion 400 watt Pizo horn tweeter **£11.95** + £1 pp

NEXT MONTH

SIMPLE MODEL SERIES



Next month we began a novel series which combines two hobbies in one – electronics and model-making. Simple electronics circuits combined with easy-to-assemble models will cover a wide range of interests. There will be whimsical models and realistic scale models. There will be models for the railway enthusiast, miniature furniture for the doll's house, and toys for all ages.

We use integrated circuits as much as possible to keep the wiring simple and cut down on the size of the circuit boards. Assembly by the Vero Easywire wire-wrapping system means that model-makers need not worry about soldering. The first project is a police car with flashing hazard warning lights, blue light and siren.

ULTRASONIC PROXIMITY METER

This project consists of a sensor unit and a display unit linked by a cable which can be several metres long. The display is made up of a row of eight light emitting diodes forming a "dot" bargraph which shows the distance between the sensor unit and any sound-reflecting surface. Applications include fluid level measurement, personnel proximity detector, proximity detector for robotic systems, motorists parking aid, etc.

12V NiCAD CHARGER

This circuit will charge a 12V nickel-cadmium battery pack from a car battery or other nominal 12V d.c. supply. This could have numerous uses where NiCad batteries need to be charged and no mains supply is available. Applications include models, video cameras, audio equipment, lights, boat and caravan back-up supplies, power tools, etc. Note that it is the ability of this circuit to charge 12V batteries from a 12V supply which is the point of the design.

EVERYDAY ELECTRONICS

JULY ISSUE ON SALE FRIDAY JUNE 7, 1991

NEW THIS MONTH

Multiturn Trimpots from 14p
- details in B/L 68.

Grey ribbon cable 100ft reels.

Z30176 14 way £6.00
Z30197 16 way £8.00

Bulk LED's from 2p - See B/L 68.

Stepper Motors

Superb little 12V motor by Airpax. 35mm dia × 21mm deep with a 16 tooth 9.5mm dia gear wheel mounted on the 2mm dia spindle. Fixing centres 42mm. 7½°, 48 step. 100+ price is £9.04.
Order Code Z5045
Prices .... £4.00 100+ 2.50

Mercury Switches

Metal enclosed, in case 7.5mm dia × 9mm long. 10mm flange one end.
Order Code Z2118
Prices .... 2 for £1.00 100+ 0.25; 1k+ 0.18

4 Digit Displays

LCD 4 digit 12.5mm high with low batt and clock symbol. Complete with edge connector. Can you believe the price?!
Order Code Z2119
Prices .... £1.00 each 25+ 0.60; 100+ 0.45; 1k+ 0.35

Driver Chips

For above display. Type ICM 7211 AMIPL, this is a 4 digit LCD decoder driver (µP interface). List £3.69.
Order Code Z2120
Prices .... £2.00 100+ 1.50; 1k+ 1.20

Sealed Lead Acid Batteries

YUASA NP6-12. 12V 6Ah sealed lead acid battery. These have been regularly trickle charged whilst in store. Size 150 × 95 × 65mm. List price £28.00
Order Code Z8918
Prices .... £14.95 10+ 11.20

Motor Panels

PCB 92 × 31mm with mercury tilt switch, 2 VTL 10D2 opto slotted switches, length of 11 core cable with socket and stepper motor as described above.
Z5046
Prices .... £3.50 100+ 2.20

Controller Boards

PCB 175 × 122mm containing a wealth of components - 80C39 CPU, 4 × TL066, TL094, CMOS and 74 series chips, 8 × TO126 transistors, 13 TO92 transistors and lots of R's and C's etc - also a 3V lithium battery. 3 connectors on it go to (a) card reader (b) motor panel & (c) display panel which is identical to our Z027 (P111 of Catalogue).
Order Code Z5047
Prices .... £3.50 100+ 1.75

Opto Slotted Switch

Vactel Type VTL 10D1 - IR emitter and detector can be removed from the plastic housing if required. An extremely cheap version of TIL100/TIL38!
Order Code Z2122
Prices .... Pack of 5 £1.00 100+ 0.10; 1k+ 0.07

AAA Nicads by Sanyo

SUPERDEAL PRICE!! These superb quality batteries are rated 1.2V 200mAh, and may be charged at 20mA or quick-charged at 60mA. Normally costing around £1.50 each, we can offer these at the SUPERDEAL prices below:
Z2117 AAA Nicad .... £1.00 25+ 0.75 100+ 0.60

GLUE GUNS

87-0400 Hot melt glue gun. Electronically controlled heating element which melts the long stick of glue when inserted. Trigger feed. Mains operated. Normally sells for £8.60.
Our price £4.95
Glue sticks - pack of 10 .... £1.00

NI-CAD BATTERIES

Regular stocks: AAA £1.20; AA 99p; C £2.20; D £2.30; PP3 £3.95
Z4150 Ex mobile radio battery. 58 × 63 × 33mm case (sometimes damaged) contains 8 × AA size rechargeable Nicads. These can be removed by breaking the case open. Each cell rated 1.2V 600mA.
Price £3.00
Z4149 As above but 84 × 66 × 33mm. There are again 8 cells but they are longer than AA size, being 73mm long. Each cell rated 1.2V 900mA.
Price £4.50

1991 CATALOGUE + SPRING SUPPLEMENT

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Price to include Catalogue, current bargain list and next 6 lists. All supplied with reply paid envelope **£2.50** (UK & BFPO) **£5.00** Overseas.

SWITCH MODE POWER SUPPLIES

Over the years, we've had many different switch mode power supplies, but this latest unit is without doubt one of the finest we've ever seen! Made by Astec, it is a totally enclosed steel cased unit measuring 175 × 136 × 65mm, which has incorporated in it a switched and fused IEC mains inlet. Inside, the PCB is 160 × 80mm with output pins fitted on one end. A connector to these pins to extend the outputs to the exterior of the case is provided.
Specification:
Model Number: **BM41012**
Input: 115/230V, 50/60Hz
Outputs: +5V 3.75A
+12V 1.5A
−12V 0.4A
Total Wattage: 65W
Prices .... £14.95; 100+ 11.21

We still have good supplies of yet another Astec model. This one is partially cased, the overall size being 160 × 104 × 45mm. The PCB measures 160 × 100mm. Input and Outputs are on flying leads, all colour coded. There is also an additional IEC socket to extend mains to another unit.
Specification:
Model Number **AA12531**
Input 115/230V, 50/60Hz
Outputs +5V 5A
+12V 0.15A
Total Wattage 50W
Price .... £6.95; 100+ 5.21
Have you purchased the above AA12531 PSU?
We now supply a conversion kit to change the outputs to +5V 2.5A; +12V 2A; -12V 0.1A and -5V 0.55A.
K625 Complete kit and instructions.
Price £3.50
K626 Instructions only.
Price £1.00

Z8887 Made by STC, this 160 × 100mm PCB is attached to an aluminium chassis 165 × 102 × 65mm and has a single 5V 6A output. Supplied with connection details, we can offer these at fraction of their normal cost!
Prices .... £5.95; 10+ 4.95; 100+ 3.95
Z8888 As above but 5V 10A output.
Prices .... £8.95; 10+ 6.50; 100+ 5.20

Z8890 DC-DC Converter board Panel 220 × 195 requre 50V I/P for 5V 19.5A O/P.
Prices .... £7.95; 25+ 5.20; 100+ 3.89

VISTEL II VISUAL TELEPHONE

Total communication for deaf people - this brilliant piece of equipment has a full QWERTY keyboard and 40 character screen. Text editor. 9,500 character memory. Auto answer. Auto dial. Calculator. Printer interface. RS232 (V24/28) serial interface. Modem support V21/23/25. These are new and boxed but because the makers are bankrupt, there's no guarantee. Originally sold for over £500. A comprehensive 143 page instruction manual is provided. (Manual only - send £12, £10 refunded on return).
Our special price **£150.00**

PACKS PACKS PACKS

LOTS MORE IN OUR CATALOGUE!

K539 LED Pack. Not only round but many shaped LEDs in this pack in red, yellow, green, orange and clear. Fantastic mix of new full spec devices.
Price .... 100/£5.95; 250/£11.75
K575 Plastic Power Pack. Mainly TO126 and TO220 transistors, SCRs, Triacs etc. All new full spec marked devices offering fantastic value. Lots of TIP and BD types.
Price .... 50/£7.50
INDICATOR PACK
K700 Big variety of neons in this pack! Round, square and oblong, clip and screw fix. Red, Green, Amber and Clear. Tag & wire-ended. All are 110V, but suitable resistors for use on mains are included. Really great value for money!
Price .... 20/£2.50

K805 M2 screws. Good mix, this. Cheesehead, c/s, pan, mostly pozi, few slot. Lengths to 12mm. All steel with various plating
Pack of 100 .... £1.80
K806 M2.5 screws. Various heads - mostly pan and c/s pozi. All plated steel. Lengths to 10mm.
Pack of 100 .... £1.50
K807 M3 screws. Good selection of sizes including a few brass. Most heads. Lengths to 35mm.
Pack of 100 .... £1.50
K808 M4 screws. Huge variety! Pan, c/s, cheese, set, slot, pozi. From 4-50mm long. All steel, plated, black/hi-tensile.
Pack of 100 .... £1.60
K809 M5 screws. As above.
Pack of 100 .... £2.00
MOTOR + GEAR PACK
K579. This pack contains 10 assorted battery powered motors (mostly 3V) + 90 gears etc; 16-60mm dia + worms and shafts. Amazing value.
Price .... Only £7.95

CAMERA BONANZA!

Job lot of returns - famous manufacturer. All are complete and look OK, only minor faults.
Z5028 110mm Manual models include 110LF and 110TF, many have built in flash.
Prices .... £3.50 ea 5 for £14.00
Z5029 110mm Motor driven. Models include 110IF. **Prices** ... £4.00 ea 5 for £16.00
Z5030 35mm Manual. Models include 35HL, 806, 35CT, DL10, DL7. Most have built in flash. **Prices** .... £4.50 ea 5 for £18.00
Z5031 35mm Motor driven. Models include DL15, 35EM, 35EFM, 35ESM, most with built in flash. **Prices** .... £5.50 ea 5 for £22.00
Z5032 Broken cameras. These have parts missing. A parcel of 6 assorted, all 35mm including manual, motor driven, autofocus, twin lens types. **Price** £15.00
Also some brand new cameras and lenses - SAE for details.

GREENWELD
ELECTRONIC COMPONENTS

To avoid confusion over different VAT rates, all our 1 off prices will include VAT @ 15% until further notice. Add 2.17% to total. Quantity prices do not include VAT. P&P £2.00 per order. Min Credit Card £5. No CWO min. Official orders from Education welcome; min invoice charge £10.00. Payment is accepted by cheque, postal order, cash, including foreign currency bank notes, book tokens, Access, Visa, Connect. Our stores have enormous stocks of components and our trade counter is open from 9-5.30 from Mon-Sat. Come and see us!

Tel: (0703) 236363
Fax: (0703) 236307

27D PARK ROAD, SOUTHAMPTON, SO1 3TB

NEW THIS MONTH

½Meg Memory Board

Z8900 Massive panel 460 × 400mm smothered in chips. Could be a complete computer judging by the IC's on the board. Made by Whitechapel Computer Works. Contains at least the following (some panels have extra chips): 64 × 4164-15 RAM's; over 200 74LS, F and other logic chips; 3 × 4016-3, 2 × 8253-5, 8251, 2 × 5516, 6 xtals, 3 × 'D' plugs and sockets. 3 × DIN 64 way socket, + R's, C's etc. Price equivalent to 4164's @ 30p each and rest of chips @ 3p each!
Price £25.00
Z4397 RS232 data cable - 25 'D' plug to 25'D' socket 6 feet long. All pins connected. These are identical to our Cat. No. P2875 @ £4.95 except for some very minor corrosion on socket casing.
Half price .... Just £2.50
K708 Voltage Regulators. This is an excellent pack, made up from a huge variety of the +ve, -ve, fixed and variable regulators from 1.2V to 37V, 100mA to 5A, plastic and metal.
Price .... 20 for £6.95
K709 Bridge Rectifiers. Another superb value pack - could include anything from ½ amp to 35A, 25V to 1000V, plastic and metal.
Price .... 20 for £5.95
K710 SCR's & TRIACS. Big mixture could include all types from TO92 plastic up to DO5 stud mounting with a chance of everything in between! 25V to 1000V, 100mA to tens of amps. Marvellous value.
Price .... 25 for £4.95
K711 74 Logic Pack. All brand new full spec devices from basic gates to complex logic. May include 54 & 64 types as well as 74 in L, LS, S, ALS, H, HC, HCT, etc.
Price per pack of 100 .... £6.00
K712 Crystals. Mostly HC60 and HC18U in a wide variety of frequencies from a few hundred kilohertz to many megahertz and the odd crystal oscillator module or two.
Price .... 20 for £4.95
K713 Fuseholders. Panel and chassis mounting from a basic clip to high current enclosed types for 15, 20 and 32mm fuses.
Price for pack of 50 .... £4.00
K714 Power Supply Capacitors. All cans, mostly computer grade including popular values like 10,000µ 40V etc. Big mix of values and voltages up to 100V or more and 50,000µF.
Price for box of 25 .... £12.50
K536 Bonanza Pack of 74 series chips on panels. 200+ chips, may inlude L, LS, H, HC, HCT etc. (These are actually the Z8900 computer panels with all the memory missing.)
Price £7.00

4.01 MSDOS Packs

A year or so ago we had some Epson MSDOS user packs - and now a new, later version has turned up. These are for the Epson PCe personal computer and the pack consists of the following:
(a) 4 × A5 spiral bound books:
- Setting Up and Getting Started (95 pages)
- Diagnostic users guide (61 pages)
- Everyday with MSDOS (109 pages)
- MSDOS Reference Manual 3.3 (381 pages)

(b) 3 × 3½" 2DD disks:
- MSDOS 4.01 install disk
- MSDOS 4.01 operating disk
- MSDOS 4.01 shell disk.

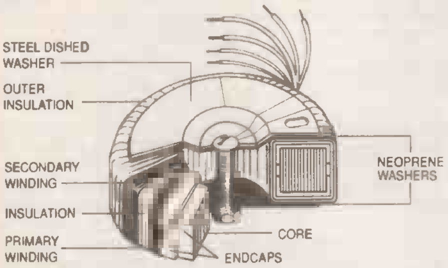
Z8919 All brand new in sealed carton. Incredible value at **£15.00**
Z5048 Panel 275 × 178mm containing some excellent components: 2 × D8243 I/O expander, 8035 CPU, 8253 timer, 2651 USART all in sockets, 2 × 2111A-4 RAM, 25 mostly CMOS chips, 8 × TO126 transistors, 5 × TO92 transistors, R's, C's etc; 26W IDC plug, 2 × 34W IDC plugs, 2 xtals.
Only £3.00

TRANSFORMERS FROM

JAYTEE

The UK Distributor for Standard Toroidal Transformers

•106 types available from stock
•Sizes from 15VA to 625VA
•Dual 120v primaries allowing 110/120v or 220/240v operation



TYPE	SERIES NO.	SEC VOLTS	RMS CURRENT
15VA	03010	6+6	1.25
£10.68	03011	9+9	0.83
	03012	12+12	0.63
	03013	15+15	0.50
	03014	18+18	0.42
	03015	22+22	0.34
	03016	25+25	0.30
	03017	30+30	0.25
30VA	13010	6+6	2.50
£12.21	13011	9+9	1.66
	13012	12+12	1.25
	13013	15+15	1.00
	13014	18+18	0.83
	13015	22+22	0.68
	13016	25+25	0.60
	13017	30+30	0.50
50VA	23010	6+6	4.16
£13.84	23011	9+9	2.77
	23012	12+12	2.08
	23013	15+15	1.66
	23014	18+18	1.38
	23015	22+22	1.13
	23016	25+25	1.00
	23017	30+30	0.83
	23028	110	0.45
	23029	220	0.22
	23030	240	0.20
80VA	33010	6+6	6.66
£15.43	33011	9+9	4.44
	33012	12+12	3.33
	33013	15+15	2.66
	33014	18+18	2.22
	33015	22+22	1.81
	33016	25+25	1.60
	33017	30+30	1.33
	33028	110	0.72
	33029	220	0.36
	33030	240	0.33
120VA	43010	6+6	10.00
£16.45	43011	9+9	6.66
	43012	12+12	5.00
	43013	15+15	4.00
	43014	18+18	3.33
	43015	22+22	2.72
	43016	25+25	2.40
	43017	30+30	2.00
	43018	35+35	1.71
	43028	110	1.09
	43029	220	0.54
	43030	240	0.50

TYPE	SERIES NO.	SEC VOLTS	RMS CURRENT
160VA	53011	9+9	8.89
£19.21	53012	12+12	6.66
	53013	15+15	5.33
	53014	18+18	4.44
	53015	22+22	3.63
	53016	25+25	3.20
	53017	30+30	2.66
	53018	35+35	2.28
	53026	40+40	2.00
	53028	110	1.45
	53029	220	0.72
	53030	240	0.66
225VA	63012	12+12	9.38
£21.04	63013	15+15	7.50
	63014	18+18	6.25
	63015	22+22	5.11
	63016	25+25	4.50
	63017	30+30	3.75
	63018	35+35	3.21
	63026	40+40	2.81
	63025	45+45	2.50
	63033	50+50	2.25
	63028	110	2.04
	63029	220	1.02
	63030	240	0.93
300VA	73013	15+15	10.00
£22.94	73014	18+18	8.33
	73015	22+22	6.82
	73016	25+25	6.00
	73017	30+30	5.00
	73018	35+35	4.28
	73026	40+40	3.75
	73025	45+45	3.33
	73033	50+50	3.00
	73028	110	2.72
	73029	220	1.36
	73030	240	1.25
500VA	83016	25+25	10.00
£29.57	83017	30+30	8.33
	83018	35+35	7.14
	83026	40+40	6.25
	83025	45+45	5.55
	83033	50+50	5.00
	83042	55+55	4.54
	83028	110	4.54
	83029	220	2.27
	83030	240	2.08
625VA	93017	30+30	10.41
£32.64	93018	35+35	8.92
	93026	40+40	7.81
	93025	45+45	6.94
	93033	50+50	6.25
	93042	55+55	5.68
	93028	110	5.68
	93029	220	2.84
	93030	240	2.60

Prices include VAT at new rate of 17.5% and carriage

Quantity prices available on request

Write or phone for free Data Pack

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Cirkit TESTING

TM SERIES MULTIMETERS

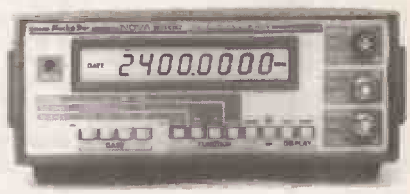
D-MM Good Value!

The TM series of low cost meters, with 3½ digit LCDs, full overload protection, strong ABS case and packed with features. Supplied with test leads, battery and manual.

TM 5315	DC current (10A) continuity and diode test	56-05315	£20.42
TM 5365	Capacitance and frequency (200kHz) ranges	56-05365	£38.73
TM 5375	Frequency range (20MHz) and HFE test	56-05375	£37.55
TM 115	AC & DC current (10A). HFE and continuity test	56-00115	£34.40
TM 135	Capacitance and temp. ranges (inc. probe)	56-00135	£46.95
TM 175	Frequency (15MHz) and capacitance ranges and HFE. diode. continuity and LED test.	56-00175	£58.74
7705	Capacitance meter. 1pF to 20.000uF	56-07705	£39.82

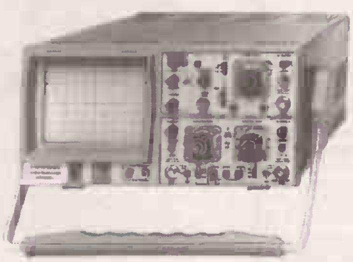
BLACK STAR

Top quality, UK made, frequency counters and generators.



Meteor 100	100MHz counter	56-00100	£128.07
Meteor 600	600MHz counter	56-00600	£158.63
Meteor 1000	1000MHz counter	56-01000	£209.15
Apollo 100	100MHz counter/timer	56-10100	£346.63
Nova 2400	2.4GHz counter	56-02000	£351.33
Jupiter 500	500kHz function generator	56-00500	£129.20
Jupiter 2000	2MHz function generator	56-02001	£175.08

HAMEG 'SCOPES



All Hameg scopes are supplied with two x 10 probes, mains lead, manual and 2 year warranty.

HM203-7	Dual channel. 20MHz	56-52037	£397.15
HM205-3	Digital storage. 20MHz sampling	56-52053	£716.76
HM604	Dual channel. 60MHz	56-56040	£716.76
HM1005	Triple channel. 100MHz	56-01005	£920.60

Full details of all the above are included in our comprehensive catalogue, £1.70 (inc. P&P).

All the above are currently in stock and available for immediate delivery. Standard P&P £1.20, next day delivery £4.60.

All prices include VAT (at 17.5%)

Cirkit

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	PRICE
ETRI FAN – 240V. 14W. – 120mm² 38mm deep	£8.50
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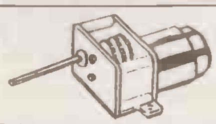

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ADVENTURES WITH ELECTRONICS £5.25
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Note – A simple multimeter is needed to fully follow this book. The M102 BZ is ideal. £13.98

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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.

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EE MAY 89

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KIT REF 812 £14.81

Mains Adaptor £2.02

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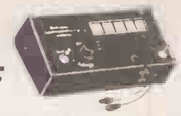

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Simple and accurate (1%) measurement of capacitors from a few pF up to 1,000 μF. Clear 5-digit LED display indicates exact value. Three ranges – pF, nF, and μF. Just connect the capacitor, press the button and read the value.

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KIT REF 840 £19.86

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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 £56.82

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EE NOV 86

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KIT **REF 740** £20.01

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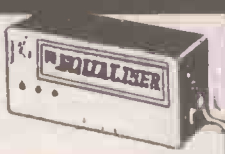
EE Jan '90

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 £32.13



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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 £17.75

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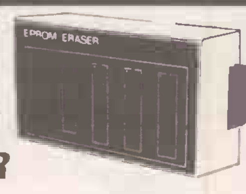
EE DEC '90

A superb kit with pre-drilled painted and silk screen printed case for a really professional finish. This kit uses a microcontroller I.C. to generate 8-channel light sequences.. Sequences are selected by keypad from over 100 stored in memory. Space for 10 user programmed sequences up to 16 steps long also available. 1000 watts per channel, zero volt switching, inductive load capability. Opto-isolated for total safety. Many other features.
Complete kit includes case, PCBs, all components and hardware.

KIT REF 838 £57.17



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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 £28.51

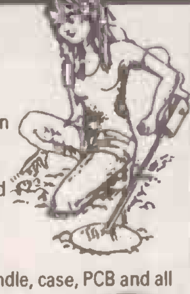
LIGHT RIDERS

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	**£15.58**
KIT REF 560 DISCO LIGHTS	**£22.41**
KIT REF 561 LAPEL BADGE	**£11.65**

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 £42.86

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EE MAR '90

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

KIT REF 835 £17.16

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INCORPORATING ELECTRONICS MONTHLY

The No.1 Magazine for Electronic & Computer Projects

VOL. 21 No. 6 **JUNE '91**

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IN CAR ELECTRONICS

Modern technology has found its way into virtually every area of life – not the least being the motor car. At one time cars were produced without any form of electronics. The charging system consisted of a dynamo with d.c. output and an electromechanical regulator, a system which achieved very high reliability and which is still employed on many "classic" cars without problems. Ignition was simply a mechanical "points" system switching the voltage across a coil and this type of ignition has only comparatively recently been superseded in many cars.

In fact the first sign of electronics in vehicles was "in car entertainment" or more simply the early car radios, which originally used valves. Of course, electronic systems in vehicles have brought their own problems (not the least with servicing, or more correctly service replacement costs) but they have also added vastly to the efficiency and facilities available in modern vehicles. However, electronics for the sake of it can sometimes be a retrograde step.

NOT FOR ME

I, for one, have never been in favour of digital readout for some car instruments. Not because I have anything against digital displays, but simply because it is difficult to read rapidly changing digits and because a digital display is not good at indicating "rate of change" or, put another way, speed of approach to certain limits.

A good example of just what I mean is the digital rev. counter, used with a modern high power, high revving engine – the digital display is changing so rapidly that it is difficult to read quickly and does not give an "instant" appreciation of the approach of over-revving, etc.

An analogue display, with a moving pointer or light can quickly show rate of change and make instrument reading easier on the brain! Of course the analogue display is likely to lack the accuracy of a digital readout and this can cause its own difficulties, particularly when setting up the engine, etc.

OUR ANSWER

The answer to these problems is of course our *Digilogue* (*digi*tal and ana*logue*) rev. counter. An l.e.d. bargraph provides the analogue readout – easy to interpret at a glance, particularly with various colour l.e.ds, and providing that essential rate of change information – and a digital display giving the "modern" accurate information using two digits to indicate 1,000's and 100's of revs per minute e.g. a display of 54 represents 5,400 r.p.m.

Mike Kenward

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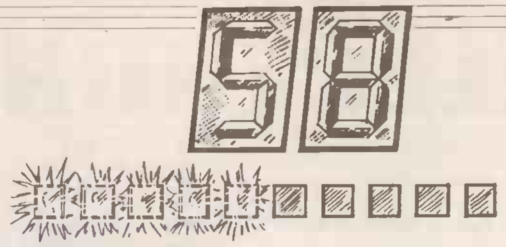


DIGILOGUE CAR TACHOMETER

CHRIS WALKER

Improve your driving performance without "throttling" your engine. Combines the advantages of both digital and analogue readouts.

DRIVING enthusiasts appreciate the need for comprehensive dashboard instrumentation to keep them informed about conditions under the bonnet of their vehicle. The trend that modern car manufacturers seem to be following, however, is to equip the "average" small or family car with the bare minimum of gauges, most having been replaced with simple warning lights.

The argument for this simplification is that many drivers who merely use their car as a convenient means of transportation do not want to be confused by a bank of complicated looking dials and readouts. Whilst this is a valid point, many car-sympathetic drivers do like some form of running commentary about the state of the vehicle they are driving.

PERFORMANCE

The tachometer (not to be confused with the tachograph) is usually omitted from the "basic" or "mid-range" models of car. It is surprisingly useful; one of those instruments which, once you have mastered how to use it constructively, you wonder how you ever managed without.

A tachometer displays engine speed, usually in "revolutions per minute" (r.p.m.). All engines have a characteristic performance which is a function of their r.p.m. For example, most engines will happily "chug" along at 1500-2000r.p.m. and keep the car rolling at 30mph in fourth gear.

But, if a burst of power is required, say to complete an overtaking manoeuvre swiftly and safely, then it is necessary to change down a gear and get the revs up to say 2500-3500 r.p.m. It is in this higher range where the engine can accelerate the car rapidly. A quick glance at the tachometer will show the driver whether or not the engine is prepared for the overtake.

At the top end of the range, the average road car engine will "saturate" at about 5500r.p.m. and running the unit above this speed will result in no further increase in performance. All the above figures are examples only, actually based on the author's car, and will vary between vehicles. The actual set of characteristics for your own vehicle are best found by experimentation *on a quiet road.*

DISPLAY

Constructional articles for tachometers have appeared in the electronics press for some time now, but the Digilogue Car Tachometer is different. It displays the engine speed both as a two-digit number and, simultaneously, on a multi-coloured bargraph display.

The digital readout displays the engine speed in "thousands" and "hundreds", for example "23" means 2300r.p.m. The advantage of a digital display is that it is accurate, has good resolution (that is, it displays to the nearest 100r.p.m. which is more than adequate) and it is easy to interpret the reading because there are no scales to fathom out.

The major disadvantage of digital displays comes when the reading is changing. It is difficult to read a rapidly updated digital display, as constructors will appreciate if they have ever tried to use a digital voltmeter to measure a varying voltage.

In these circumstances the driver glances at the bargraph display which consists of a row of ten rectangular l.e.d.'s. The number of illuminated l.e.d's is proportional to the engine speed and it is easy to see roughly what the current speed is.

In addition, the bargraph l.e.d.'s are grouped into three colours. Below 2500r.p.m. yellow lights illuminate. Between 2500 and 4500r.p.m. the l.e.d.'s are green to indicate that the engine is in its highest performance range. Above 4500r.p.m. are two red l.e.d.'s. These colours make it very easy for the driver to instantly determine what kind of performance he or she can expect from their engine under any condition.

The maximum speed registered on the bargraph is 5000r.p.m. although this is adjustable as described later. The digital readout will display up to 9900r.p.m.

IGNITION CIRCUIT

The basic ignition circuit of a petrol-engined vehicle is shown in Fig.1. Fundamentally, this circuit has not changed much over the years. The most notable update in recent times is to replace the contact breaker points (a switch, mechanically operated by the rotating distributor shaft) with some sort of electronic switch.

The electronic switch is triggered either by a magnetic sensor attached to the distributor shaft or controlled by the "engine management unit" (EMU). The EMU is a dedicated microcomputer which, amongst other tasks, calculates the ideal instant to operate the "points".

Mechanical points are notorious for wearing and pitting over a period of time with a resultant degradation in engine performance. The electronic substitutes do not suffer this problem.

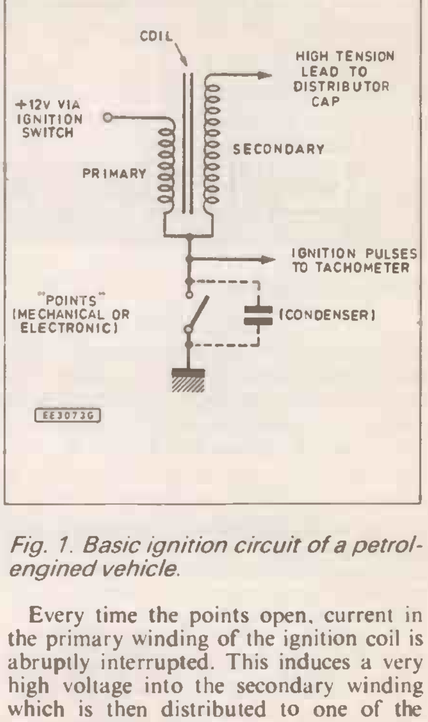


Fig. 1. Basic ignition circuit of a petrol-engined vehicle.

Every time the points open, current in the primary winding of the ignition coil is abruptly interrupted. This induces a very high voltage into the secondary winding which is then distributed to one of the spark plugs to ignite the petrol/air mixture in the appropriate cylinder.

In a four-cylinder engine, two sparks are generated for each revolution of the crankshaft. Therefore, the points will open and close twice per revolution. By counting the rate at which ignition pulses are generated by the points, the tachometer can determine the speed of the engine.

This design has been tested and works with mechanical contact breaker point systems and the semi-electronic magnetic/reluctor systems. It should work with other electronic ignition systems provided the connections to the coil are accessible and not sealed inside the EMU. *It has not been tested with capacitive discharge systems.*

SYSTEMS OPERATION

The block diagram for the Digilogue Car Tachometer is shown in Fig. 2. The ignition pulses are initially filtered by a simple low-pass filter to remove the high frequency "ringing" which occurs every time the points open. This ringing could confuse the tacho if it were not removed. The pulses are also clipped to a maximum amplitude of 5V to prevent damage to the circuit.

A frequency-to-voltage (f-v) converter generates an analogue voltage which is proportional to the pulse frequency and this voltage is fed into a bargraph driver which illuminates a row of l.e.d.'s in proportion to the pulse frequency.

The ignition pulses are also "squared up" by a Schmitt trigger monostable and used to clock a two-stage decimal counter. The counter is controlled so that it counts pulses for 0.3 seconds, after which the output is loaded in the latch and displayed on two 7-segment l.e.d. displays.

The latch holds the output whilst the counter is reset and then allowed to collect another 0.3s worth of ignition pulses, after which the display latch is updated with the latest count. The digital display is updated about 2.5 times per second.

In the 0.3s count period the counter accumulates one two-hundredth of the number of pulses it would receive in one minute. For example, if the engine was rotating at 2700r.p.m. it would make 45 revolutions per second. This corresponds to 90 ignition pulses per second for a 4-cylinder engine. Therefore, in 0.3s the counter would accumulate 27 pulses and "27" would be illuminated on the display, representing 2700r.p.m.

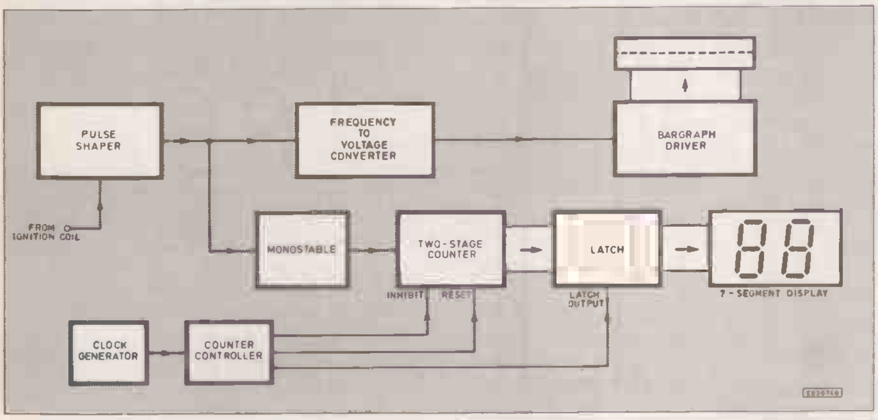


Fig. 2. Block diagram of the Digilogue Car Tachometer system.

CIRCUIT DESCRIPTION

Many sections in the block diagram are replaced by integrated circuits in the circuit diagram for the Digilogue Car Tachometer, shown in Fig.3.

Resistors R1 and R2 and capacitor C1 form a simple low-pass filter to clean-up the ignition pulses as described earlier. Zener diode D1 clips the input signal to 4.7V maximum amplitude.

The frequency-to-voltage converter, IC1, produces a voltage at its output, pin 5, which is given by the formula:

$$V = 5 \times R3 \times C2 \times f$$

where "f" is the pulse frequency on pin 1.

The Zener diode D2 and resistor R5 provide a 2.4V reference for IC1; one cycle

COMPONENTS

Resistors

R1, R2, R4	10k (3 off)
R3*	150k
R5	270
R6	680
R7	47
R8, R11	47k (2 off)
R9	56k
R10	100k
R12	27k
R13	2k2
R14	4k7
R15 to R28	100 (14 off)

All 0.6W metal film

Potentiometer

VR1	47k (or 50k) min. horizontal cermet preset

Capacitors

C1, C5, C6, C7	100n polyester layer (4 off)
C2	10n polyester layer
C3, C4	2μ2 tantalum bead, 35V (2 off)
C8	22μ radial elect. 25V
C9*	4μ7 tantalum bead, 16V
C10	100μ radial elect. 25V
C11	1000μ axial elect. 16V

See SHOP TALK Page

Semiconductors

D1	BZY88C4V7 4.7V Zener diode
D2	BZY88C2V4 2.4V Zener diode
D3 to D6	5mm x 2.5mm rectangular l.e.d. yellow (4 off)
D7 to D10	5mm x 2.5mm rectangular l.e.d. green (4 off)
D11, D12	5mm x 2.5mm rectangular l.e.d. red (2 off)
D13	1N4001 1A 50V rect. diode
TR1	BC548 NPN silicon transistor
IC1	LM2917 frequency-to-voltage converter
IC2	LM3914 bargraph driver
IC3	4093BE quad 2-input NAND Schmitt trigger
IC4, IC5	40110BE decade counter (2 off)
IC6	NE555 timer
IC7	7805 +5V 1A voltage regulator
X1	Dual-digit common cathode 7-segment display

Miscellaneous

FS1	1A 20mm fuse and p.c.b. mounting holder

Printed circuit board available from PCB Service, code EE744; plastic case (with aluminium panels), size 153mm x 84mm x 40mm; d.i.l. sockets: 8-pin (1 off), 14-pin (2 off), 16-pin (2 off), 18-pin (1 off); neutral density display filter 115mm x 33mm; terminal pins (21 off); fixings for IC7; grommet; 3-core cable; 5mm spacers; small piece of stripboard for X1; connecting wire; solder, etc.

*For 6-cylinder engines: R3 = 100k; C9 = 3μ3.

Approx cost guidance only **£30**

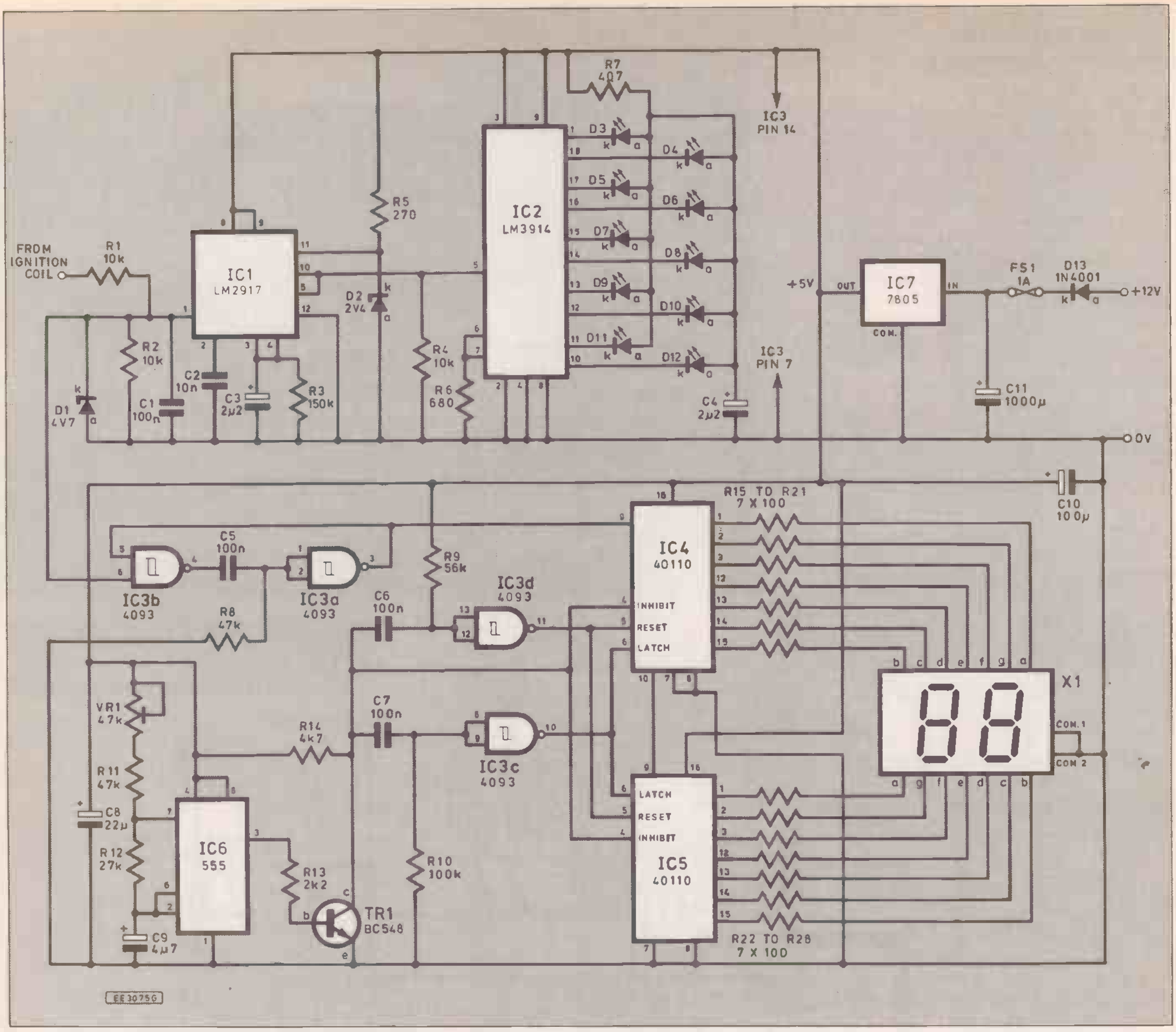


Fig. 3. Complete circuit diagram for the Digilogue Car Tachometer.

is completed every time the voltage on pin 1 rises above 2.4V and then drops back below this level again.

Capacitor C3 acts to reduce the ripple on the output voltage. Increasing C3 reduces the ripple but slows the response time of the converter, therefore, a trade-off has to be made in this respect.

The f-v converter output is fed into pin 5 of the bargraph decoder IC2. An internal reference of 1.25V is generated by this i.c. and all ten bargraph l.e.d.'s (D3 to D12) will light when the pin 5 voltage reaches 1.25V.

By substituting component values into the formula, it will be seen that full-scale occurs at a pulse frequency of about 167Hz, i.e. 5000r.p.m. If you wish to change the range of the bargraph display, experiment with slightly different values for resistor R3.

The bargraph decoder IC2 automatically controls the current through the l.e.d.'s (D3-D12) so that series resistors are not required on each output. The l.e.d. current (controlled by resistor R6) is set at 20mA which gives good daytime illumination without needing dimming at night.

Resistor R7 is present to dissipate some excess power which would otherwise overheat IC2 when several l.e.d.'s were switched on. Capacitor C4 decouples and stabilises the anode rail.

MONOSTABLE

The falling edge of each ignition pulse, generated at the instant the "points" close, triggers the monostable formed from NAND gates IC3b and IC3a to produce a 3ms low (0V) pulse at its output (pin 3 IC3a). Each pulse increments the low-digit counter, IC4, which is a CMOS 40110 decade up/down counter with 7-segment decoded outputs, output latch and output current drivers all in one wonderful package! The down-count facility is not used in this design.

After ten counts, the CARRY output from IC4 (pin 10) pulses low and increments the high-digit counter IC5. Resistors R15 to R28 are current limiters for each segment of the dual 7-segment common cathode display, X1.

A 555 timer, IC6, and associated components form an oscillator whose frequency is adjustable over a small range by preset potentiometer VR1 to allow for component tolerances. It is quite important to use high stability components in the oscillator circuit otherwise factors such as temperature change will affect the accuracy of the digital display.

Preset VR1 is, therefore, a cermet potentiometer, R11 and R12 should be metal film resistors (in fact, all resistors can be metal film types, they are just as cheap as carbon types these days) and capacitor C9 is tantalum bead.

The oscillator output, pin 3 of IC6, is inverted by transistor TR1 and presented to the INHIBIT input of the counters (pins 4 of IC4 and IC5). The counters are only active when this input is low.

On every falling edge of the INHIBIT signal, a short (6ms) positive pulse is created at the output of NAND gate IC3d. This pulse RESETs the counters, after which they begin to accumulate ignition pulses during the period while INHIBIT remains low. See the timing diagram in Fig.4.

Preset VR1 is used to adjust the oscillator frequency so that the count time after the RESET pulse is exactly 0.3s. You do not, however, need elaborate timing equipment for this adjustment, there is an easy method available – see later.

At the end of the count period, when INHIBIT goes high, NAND gate IC3c generates a short negative-going pulse which is presented to the LATCH input of counters IC4 and IC5. Whilst LATCH is low, the counter outputs are loaded into the display latch within the counters. When this input goes high, the display remains fixed irrespective of the state of the counters.

In order to use the unit with 6-cylinder engines (which generate three ignition

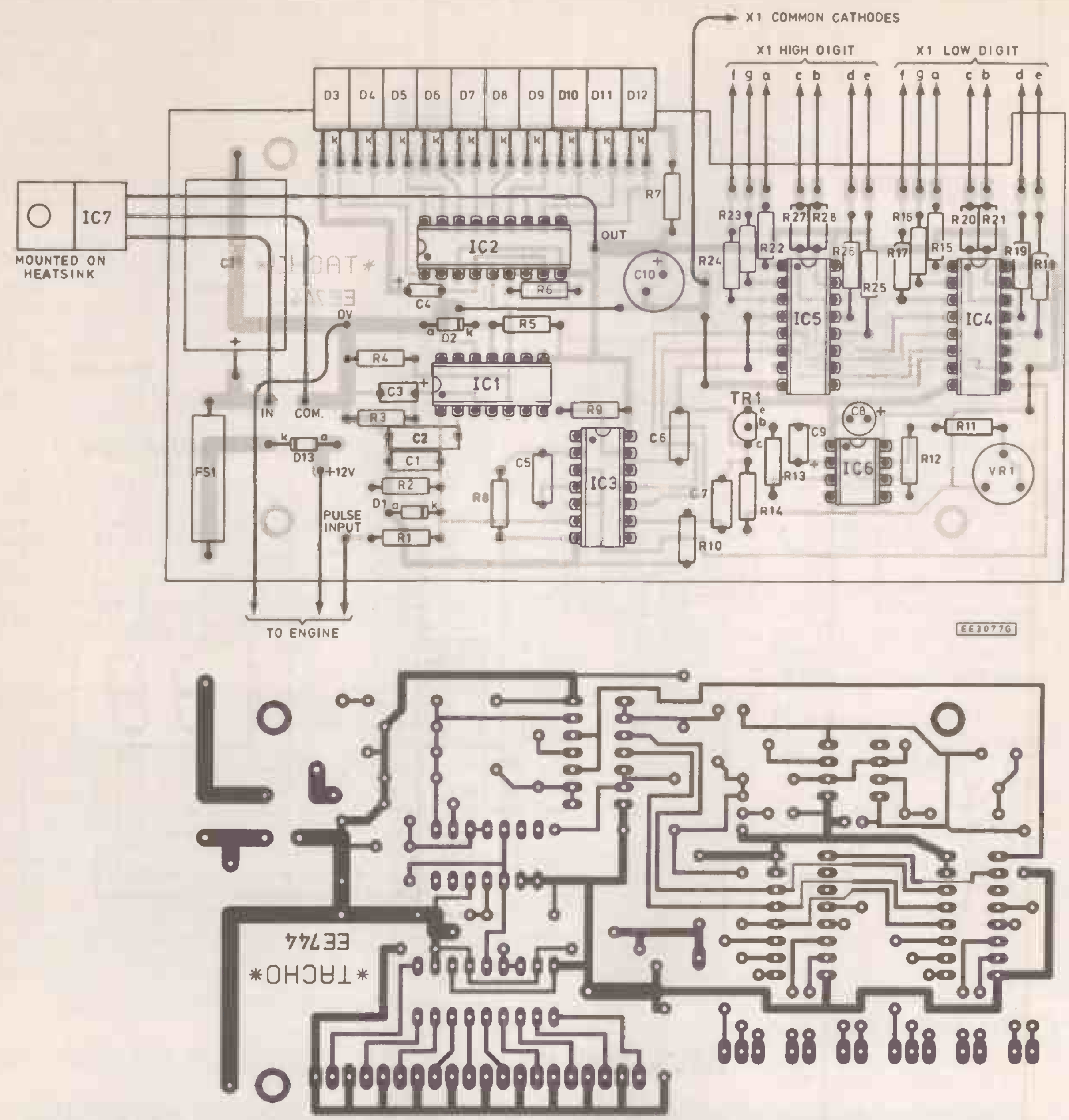


Fig. 5. Printed circuit board component layout and full size copper foil master pattern.

pulses per revolution), just two component values should be changed. Resistor R3 is modified to 100k and capacitor C9 should be 3μ3.

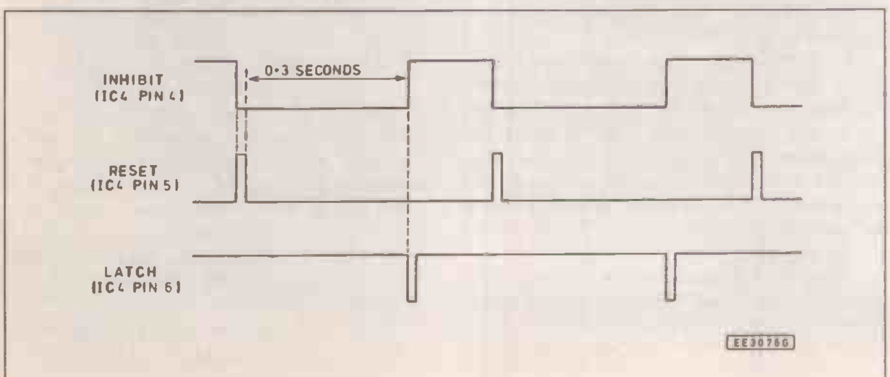
POWER SUPPLY

The first prototype Digilogue Tacho was designed to run off 12V throughout the circuit. It worked fine on the bench, but when installed in the car the noise generated by the ignition circuit, fan blower etc., caused the digital counters to behave very unpredictably.

Smoothing capacitors were not the solution because the circuit requires a relatively large current (about 500mA when fully lit up) and, so, huge capacitors would be required. The easiest answer was to use the 12V to supply a 5V voltage regulator, IC7.

Capacitor C11 goes some way towards eliminating supply noise. Diode D13 prevents accidental reverse-polarity connection and fuse FS1 provides a quick current shut-off in the event of a catastrophic circuit failure.

Fig. 4. Digilogue timing diagram for the counter IC4.

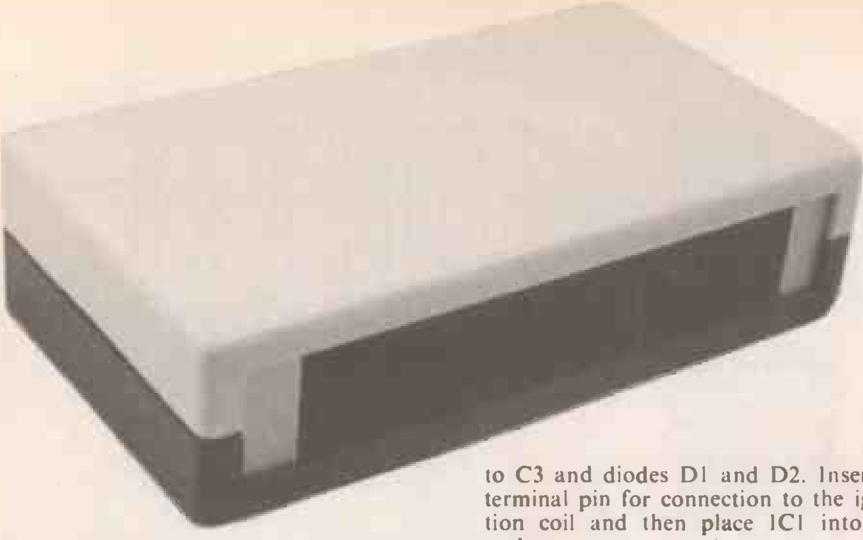


CONSTRUCTION

All components, with the exception of the voltage regulator IC7 and the 7-segment display X1, are mounted on a single-sided printed circuit board. This board is available from the EE PCB Services, code EE744.

Component layout and full size copper track pattern for the printed circuit board is shown in Fig.5. It is suggested that the circuit is constructed in the following stages, as this allows you to test your work after each stage and easily trace faults.

Begin by soldering in the power supply components: the fuse holder for FS1, capacitors C10 and C11 and diode D13. The diode should be mounted slightly



above the board to allow air circulation as it becomes warm in use. During construction, pay careful attention to the polarity of all electrolytic or tantalum capacitors and all semiconductors (diodes, transistor and i.c's); they must all be inserted the correct way around.

Solder in the four wire links and then insert five terminal pins (p.c.b. pins), three for connection to IC7, one for +12V and one for 0V. It is easier to solder the flying leads to terminal pins rather than directly to the p.c.b.

The regulator IC7 needs to be attached to a heatsink to prevent it overheating; if the recommended case is used (see later) it can be fastened to the rear aluminium panel without requiring an insulating washer. Do this now, and then connect it to the p.c.b. with three 15cm lengths of wire.

Attach the 0V and +12V points to a 12V d.c. power supply and connect a voltmeter to the circuit board between the "com" and "out" connections to IC7. The meter should read about 5V. *Do not proceed further until this test is passed.* Disconnect power before continuing with assembly.

F-V CONVERTER

Insert a 14-pin d.i.l. socket for IC1, then solder in resistors R1 to R5, capacitors C1 to C3 and diodes D1 and D2. Insert a terminal pin for connection to the ignition coil and then place IC1 into its socket.

Connect the negative lead of your voltmeter to 0V on the circuit board, apply power to the circuit and use the positive meter probe to check the voltage at pin 11 IC1; it should read about 2.4V. The output voltage at pin 5 should, for the moment, be 0V.

You now need a 100Hz signal source. A signal generator can be used with the amplitude set to about 12V. Alternatively, Fig.6 shows how a mains transformer and bridge rectifier can be used.

The 50Hz mains frequency ends up as 100Hz pulsating d.c. at the rectifier output. The transformer output voltage should be 6V or higher.

Be extremely careful with the mains connections if you use this method. You can use an existing transformer/rectifier from another circuit if you like, but the following stages of this circuit must be disconnected.

Apply power to the tacho circuit and connect the 100Hz signal between 0V and the pulse input. The output voltage from pin 5 IC1 should now be approximately 0.75V, although allow for some variation due to component tolerances. Be careful and patient during the testing phases, it is easy to cause accidental short circuits between all the off-board connections.

BARGRAPH

Remove IC1 from its socket and then solder in an 18-pin d.i.l. socket for IC2. Insert resistors R6 and R7 and tantalum capacitor C4. Identify which lead on the rectangular l.e.d's is the cathode (marked "k" on Fig.5) – if you hold the device up to the light and view the internal structure of the diode, the cathode is connected to the larger electrode.

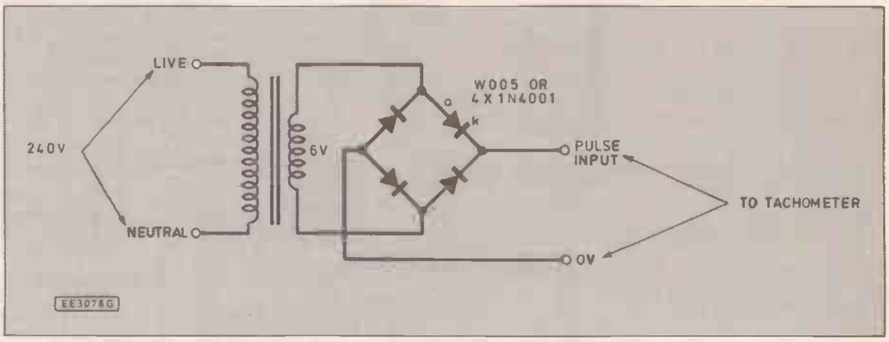
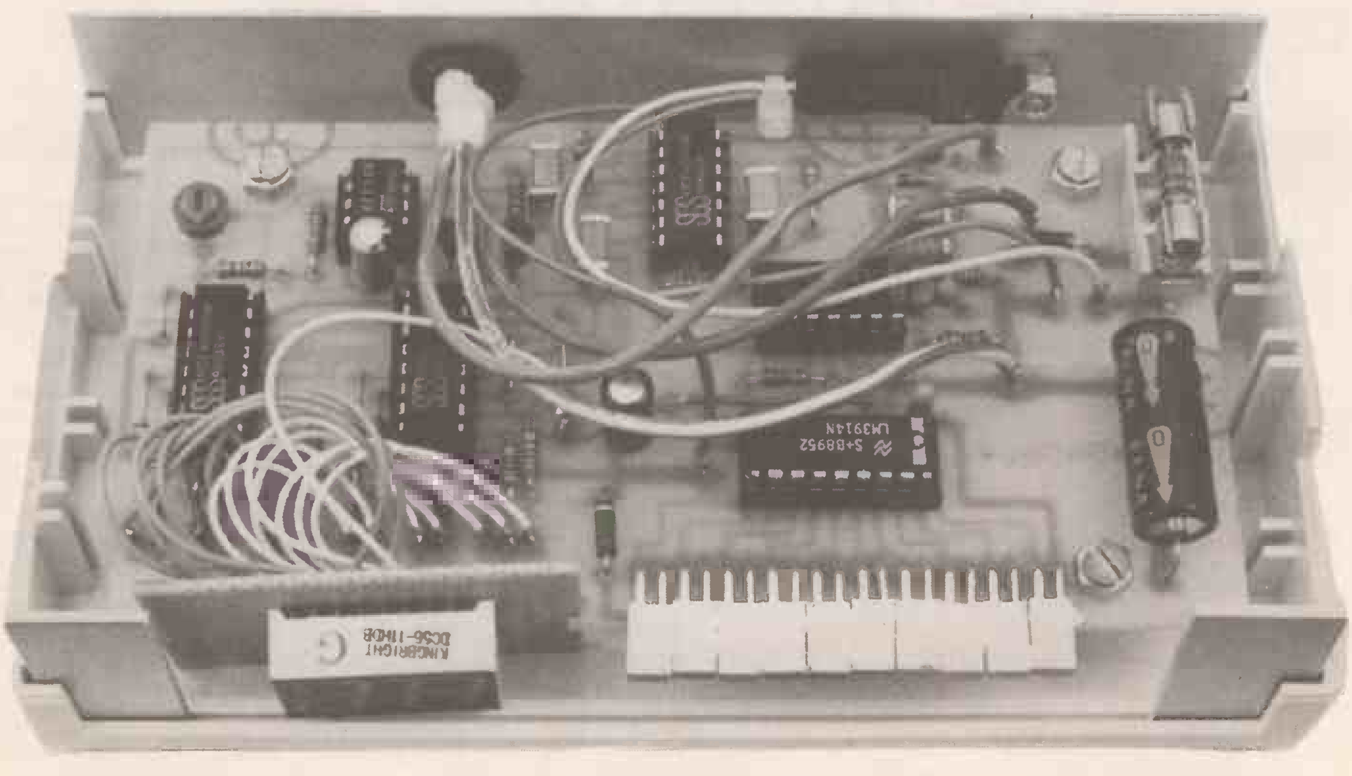


Fig. 6. Circuit diagram for a suitable 100Hz test signal source.

(Below) The completed tacho showing layout of components and the dual-digit display mounted on stripboard and set in a cutout in the main p.c.b.



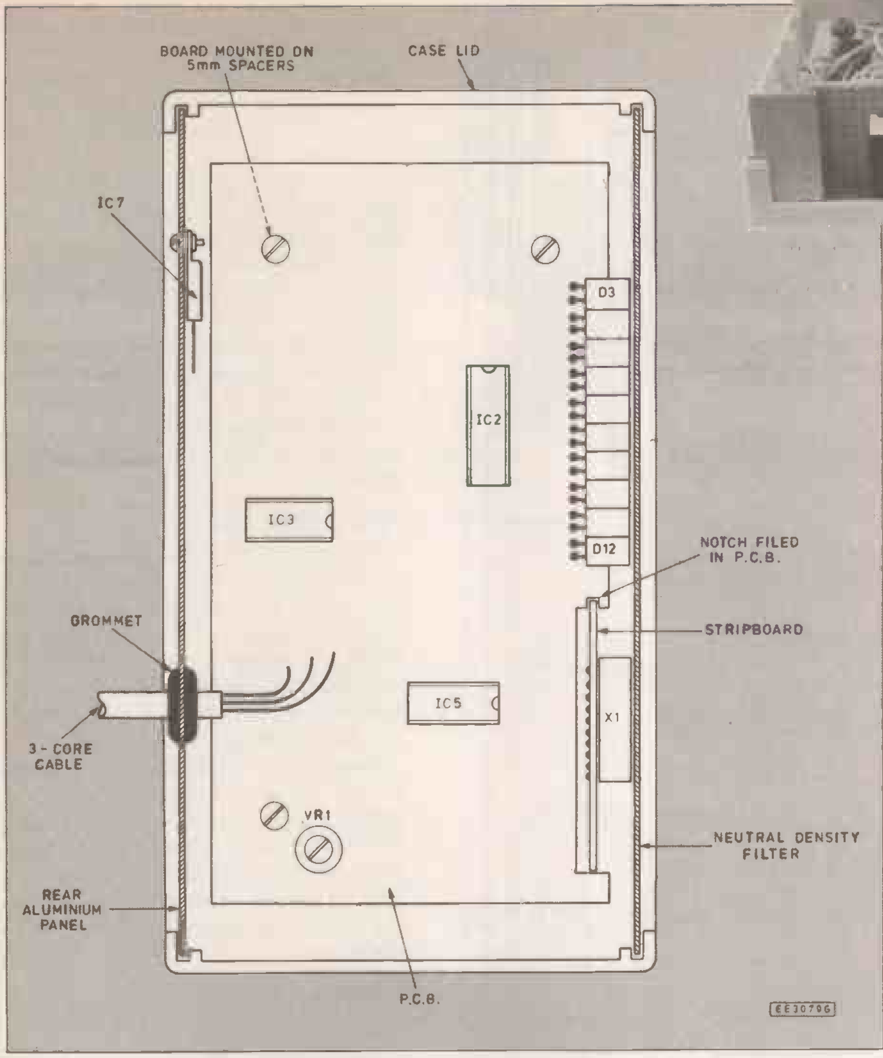
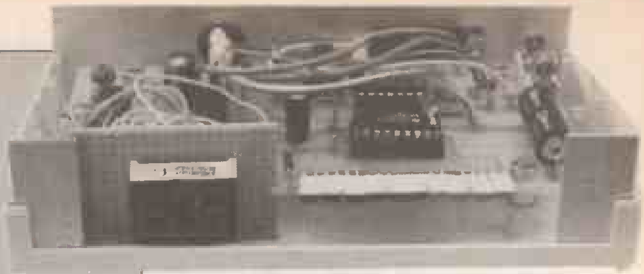


Fig. 7. Layout of components inside the case.



The leads on each l.e.d. should be bent through a right-angle about 5mm from the package so that the l.e.d's lie flat on the board when soldered into place. You may find it beneficial to insert the leads of all ten l.e.d's and glue the body of each one to the board before soldering so you can be sure they are in a neat, level row. It is worth spending some time on this to achieve a professional finish.

Light seepage from one l.e.d. to its un-illuminated neighbour spoilt the bargraph effect in the prototype. This can be eliminated by inserting small slivers of paper or tape between each segment. Painting the top and bottom surfaces of each l.e.d. with "liquid paper" forms an opaque coating which also helps to ensure that the front is the only light-emitting surface.

Place IC1 and IC2 in their sockets and test the bargraph display with the 100Hz signal source. Half of the bargraph (D3 to D7) should illuminate. After playing with your creation so far, switch off and then remove both i.c's before continuing with the digital section.

OSCILLATOR

Add a socket for IC6, insert resistors R11 to R14, preset potentiometer VR1, capacitors C8 and C9 and transistor TR1. After this work, place IC6 in its 8-pin socket and apply 12V to the board.

The easiest way to test the oscillator is as follows: Connect a spare l.e.d. in series with a resistor of about 330 ohms. Now connect this combination across (in parallel with) resistor R14 with the cathode (k) of the l.e.d. adjacent to transistor TR1. The l.e.d. should flash about 2.5 times per second, adjusting VR1 will change this rate slightly.

Providing the circuit has performed satisfactorily so far, the final stage is to solder in all the remaining components. Take care to avoid solder bridges when working around IC4 and IC5 as some thin tracks pass between the i.c. pads. Insert 14 p.c.b. pins for the connections to display X1 and one pin for the 0V common cathode connection.

DISPLAY

In the prototype, the dual-digit 7-segment display is mounted on a small piece of stripboard which is positioned vertically in the space cut out of the p.c.b. No connection details are given for the display as these vary between different manufacturers; refer to your component supplier for details.

If you cannot obtain a dual digit display, you may use two single-digit versions mounted side-by-side. The display is linked to the p.c.b. with 15 short lengths of flexible, insulated wire.

The final adjustment is to apply the 100Hz test signal source and adjust VR1 until "30" is lit up on the display. No further calibration is required. A length of 3-core mains cable can be soldered to the +12V, 0V and ignition pulse terminal pins for later connection to the vehicle.

VIEWING WINDOW

The prototype Digilogue Tacho is housed in a plastic two-section clip-together case, measuring 153mm x 84mm x 40mm externally, and has removable aluminium front and rear panels. Two holes need drilling in the rear panel, one for mounting voltage regulator IC7 and another to take a grommet through which the 3-core cable passes to the engine.

The front panel is removed and replaced with a piece of "neutral density" display filter. This vastly improves contrast and readability to the multi-coloured display and avoids the need to cut awkward-shaped holes in the front aluminium panel.

A piece of filter 147mm x 33mm is required to replace the panel, but the author was unable to obtain a sheet this large so a smaller piece 115mm x 33mm was employed with scrap pieces of aluminium panel used to fill in the end gaps. As the photographs show, this produces an elegant finish – none of the display elements can be seen until they light up.

It is important that the l.e.d's are placed in contact with the back of the display filter, otherwise they will appear blurred when viewed from the front. See Fig.7.

The circuit board is mounted upside-down in the lid of the case, three self-tapping screws are used in conjunction with the mounting pillars inside the lid. It will be necessary to use spacers about 5mm long in order to position the board so that the bargraph l.e.d's sit in the middle of the viewing window.

FITTING IN THE VEHICLE

Find a convenient place to locate the unit, within easy view of the driver but not obscuring the road view in any way. Double-sided sticky pads are probably the easiest way to mount the box, they are somewhat less permanent than screws!

DISCONNECT THE BATTERY BEFORE MAKING ANY MODIFICATIONS TO THE ELECTRICAL SYSTEM OF THE CAR. A car battery can deliver a frighteningly large current and will happily start fires if accidental shorts occur during wiring.

Route the 3-core cable from the tachometer into the engine compartment. Keep the cable well away from moving parts or hot areas of the engine and anchor it in place with tape or nylon cable ties.

The three electrical connections to the unit can probably all be made on the ignition coil. Refer to the maintenance manual for a circuit diagram of your car. One low voltage connector on the coil will be held at +12V when the ignition is switched on, and this can be used as a power source for the tachometer.

The other coil connector goes to the "points" and provides a convenient connection for the pulse input. Do NOT make any connection to the thick, high tension lead from the coil. The 0V (car chassis) connection can be made to a solder tag which is then trapped under one of the coil mounting bolts, making a good connection to the bodywork. Make use of "piggy-back" connectors or "Skotch-bloks" to splice into existing wiring. Twisted and taped connections are dangerous and should be avoided. □

PROJECT DEVELOPMENT FOR GCSE

EMERGENCY! *In this, the last part of the series, a GCSE assessor looks at some last-minute hitches. What you need to do – if anything – will depend on exactly what has gone wrong.*

IF YOUR project has been operating well but in final trials it failed to work, this is nothing much to worry about and is fairly common. Spend a little time looking for obvious things such as poorly-soldered joints, loose wires, broken component leads and cracks in copper tracks.

Providing it is a battery-powered circuit, try gently flexing the circuit panel, poking and wiggling components and wires. Intermittent operation usually signals one of the above faults. Check the supply – it is surprising how many reported problems are simply due to a "flat" battery or one which has been connected the wrong way round! Unfortunately, such reverse polarity could have damaged some semiconductor components.

It may be worth changing i.c's if spares are available but **do not start desoldering and replacing individual transistors at this stage.**

It sometimes happens that the stripboard circuit panel has been placed on the bench and scraps of metal which were there from previous work have lodged between the copper strips causing a short-circuit. If you are lucky, removing the debris will restore proper operation. If you are unlucky, this could also have ruined semiconductor components.

If, after half an hour of checking you cannot find the fault, forget it! Panic usually sets in but *stay calm*! Your teacher had seen the circuit working and the complete account is in your diary. Things like this happen and **it is unlikely to reduce your credit.**

I remember one student who stayed up all night trying to find a fault because his circuit, which had been working well, failed to work the day before it was due to be handed in. Denying himself sleep in this way was totally unnecessary he didn't find the fault anyway!

Diary

If your diary is not complete for whatever reason, this is probably worth spending some time on. However, do check the exam regulations to find out exactly what the requirement is. Remember, if you are entering with the Midlands Examining Group, you need an additional account – an extended piece of prose – but your diary should be supplied also. The diary alone would suffice as the account but your mark would be less.

Make sure you have a good title page – this is your "shop window" and should be of a high standard to impress the reader. It should have the name of the project, your name and candidate number also the name of the school and centre number. Use dry-print lettering for highest quality. Some tasteful decoration would also be in order. Spelling mistakes in the written report should be avoided and good English used throughout.

Photographs

If you have forgotten the photographs needed by some boards, get a friend with a Polaroid camera to take one for you. The actual size of the picture is relatively unimportant but the subject matter should be in close-up and fill most of the frame. A view of the circuit panel and its connections to peripheral components such as switches and potentiometers is particularly useful. A photograph not showing detail will gain little credit.

Any photograph or photographs supplied should be mounted on a piece of thin cardboard, A4 in size. This should be punched with holes and included at the appropriate place in the report. Do not forget to provide captions to state clearly what the photographs show even if this seems obvious. Photographs may, of course, be supplied with written reports which do not actually require them but it is likely to improve your credit only marginally.

A Good Reason

If you have had a long period of illness, or for some other *serious* reason, *not of your own making*, been unable to complete your project or your written report, ask your teacher to submit a plea for special consideration. Death or serious illness of a close relative *(not the cat – Ed)* would also count as a valid reason for applying.

Your application should be substantiated with a doctor's report and any other evidence you can give. Examining boards treat these cases seriously but will only give special consideration if they are satisfied that the reasons are genuine and not merely laziness on the part of the student!

No Box

Your box hasn't arrived? London East Anglian Group need your circuit panel to be build in a box and marks are awarded specifically for this part of the project. With other boards you could get by without one. However, for maximum credit they sometimes insist that if no box is supplied, all controls should be mounted on the circuit panel. Presumably you have not done this because your intended method of construction was based on a box.

In an emergency where a box is needed, you can do several things. Firstly, check with the board's regulations to see what you really must supply – you may find that you need not do anything. If you stand to lose credit because you have not supplied a cased project, you can write in your report a statement of what has happened and draw diagrams with dimensions of the box which would have been used. Make it clear where any holes could be drilled for controls such as switches and potentiometers and show exactly where you would mount them.

Get your teacher to make a written statement to the effect that the box had been ordered in good time but that it failed to arrive because it was out of stock or for whatever reason. Include this in your diary. Another way out is to make and use a cardboard box of the same size. Make it clear in your report that this is for illustration purposes only.

It may be that you can find an alternative case such as a small plastic lunch box. This should be rigid enough for the purpose. You may be able to use a "recycled" box which once contained another project. If this has additional holes drilled in it, make a statement explaining why they are there, cover them over or use them in some way. This should not reduce your credit.

I remember a student who built a project in a margarine container. This was resourceful but the box was not thought to be rigid enough to withstand the rigours of everyday use. I also remember a student who made a beautiful box using hardwood, nicely varnished and complete with dovetail joints and brass hinges on the lid! Good credit was given but no more than would have been awarded for a mass-produced plastic box.

If the circuit is mains-operated, it *always* needs a box and if this has not arrived, the unit **must not be plugged in**. The box would need to be made of metal, earthed, and used in accordance with all current regulations. Further details regarding this were given last month. ***On no account may a mains-operated circuit be used without a suitable housing or on a non-earthed supply.***

Shake the box. If it rattles, find out why and secure whatever is causing it! I always shake the box first – it is surprising what this tells me about the student! It is common for the battery to be left unsecured. At this late stage, it could be held in position using an adhesive fixing pad rather than a proper bracket.

Worst Case

Suppose you have no project at all or just some odd components on a breadboard – due to your own fault. This is probably the worst situation to be in. You will just have to salvage what you can.

Advice can be drawn from NEA who need, as a minimum, one active component capable of being switched to a supply. The written report could consist simply of a title, the purpose of the project, an outline specification and a rough circuit diagram.

MEG state that their minimum requirement is a project specification form duly completed and submitted to the teacher. This will gain hardly any credit but at least a mark – possibly zero – has been obtained. Without this, your examination certificate is likely to be endorsed "A" (Absent) whether you take the written paper(s) or not. It may also mean that you have to pay for your exam entry if this would normally be paid by the centre.

A mark of zero is not the same as obtaining no mark at all. No mark is a result of failing to do the minimum amount of work towards the project. This is recorded by your supervisor as "A" (absent) and your certificate will probably be marked "A" also. A mark of zero at least allows you to proceed with the written papers. Since you are denied a large proportion of the marks, your grade cannot be expected to be very good but at least you will get something

Editorial Note

If you are involved in teaching or assisting students in electronics or technology we would like your views on this series – has it covered everything it was designed for? Can we provide any other information? etc. We are considering reprinting the series in booklet form and making this available (hopefully at a modest price) to students and teachers; would you be interested in such a reprint? Please let us know your thoughts.

Costs

Some boards encourage a costing of the project to be carried out – rather like the exercise which would be done in industry. If you have any time left it would not do any harm to do this even if it is not specifically asked for. The best way is to provide a components list with the cost of each item alongside and the total cost at the end.

That completes the series. I hope that my advice helps you to achieve a mark as high as you deserve for the practical project and a good grade in the examination as a whole. Good luck!

Constructional Project

AUTO LIGHT CONTROL

MUNGO HENNING

No need for youngsters to be afraid of the dark! No more switching on the light with your nose! For the disabled or elderly person, this pressure and light activated mains switch will be invaluable.

EVER WALKED into a dark room carrying something heavy and had to put the article down so that you could turn on the lightswitch? This project will control a mains lamp via a pressure mat, obviating the need to use a separate switch.

Some years ago I built such a device and installed it in my bedroom. My two year old nephew *(Ian Maitland)* had great fun running in and out of the room watching the "magic" lamp! Though not primarily aimed at such a "novelty" use, the device could be of benefit for young children (where they cannot, or should not, reach a light switch) or for the elderly or infirm person.

THE CIRCUIT

Mains voltage is present within this project so the usual precautions must be taken.

The circuit diagram of the Auto Light Control logic stage is shown in Fig. 1. The circuit has two inputs and a single output. The two inputs are the pressure mat (normally open) switch (connected to a 2.5mm jack socket SK1) and a light-dependent resistor (LDR) R2. A relay with mains rated contacts is the single output.

The pressure mat is used to detect people entering or leaving the room. The LDR detects the ambient light level within the room and will prevent the relay from switching when the light level is above a preset value.

Three different coloured light emitting diodes (D4-D6) are used to show the internal state of the circuit. These were added mainly for effect (i.e. further enhanced appeasement!) but prove useful when setting up the device.

The main part of the circuit is the JK flip-flop IC1. There are two independent flip-flops in this package of which only one is used.

If both the J and K inputs of such a flip-flop are taken high (connected to the positive supply rail), then on each pulse applied to the CLOCK input the outputs (Q and Q-bar) change to the opposite state.

The pressure mat input is debounced by resistors R3, R4 and capacitor C2 and inverted and sharpened by IC2a to give a clean clock pulse to the JK flip-flop.

Instead of tying the J and K inputs to the positive rail, the values on both these flip-flop inputs are determined by the current state of the flip-flop and the light level on R2 (LDR). The logic here sets both J and K inputs high if the Q output is high (i.e. the relay is on) or if the Q output is low AND the room is dark enough (IC2c).

This is necessary to prevent the relay from switching on when the room is already bright enough (during daylight), but should the room light fall on the LDR then the circuit will still accept a clock pulse from the pressure mat irrespective of the light level in the room.

The switching point of the LDR is sharpened by the action of the Schmitt NAND gate (connected as an inverter) IC2b. The extra logic removes the requirement to keep the LDR away from the light which is being switched by the relay.

The JK flip flop also has explicit SET and RESET inputs. The SET input is permanently disabled (tied to the 0V ground line) and the RESET pin is connected to an *RC* delay network (R7, C3) to ensure that upon power-up the relay is off.

The l.e.d.s are provided to show the state of the pressure mat input (D5 via IC2d), the LDR switching point (D4) and the relay output (D6). Though having used normal l.e.d.s with CMOS logic outputs satisfactorily for many years, low power l.e.d.s were used in the prototype so as not to overload the CMOS outputs of IC2b and IC2d too much.

A push button switch S1 connected in parallel with the pressure mat allows a separate method of toggling the output. Consider using the device in a bedroom with it situated adjacent to a bedside lamp – as you walk in the room the lamp illuminates and when in bed you simply press the push button to extinguish the lamp.

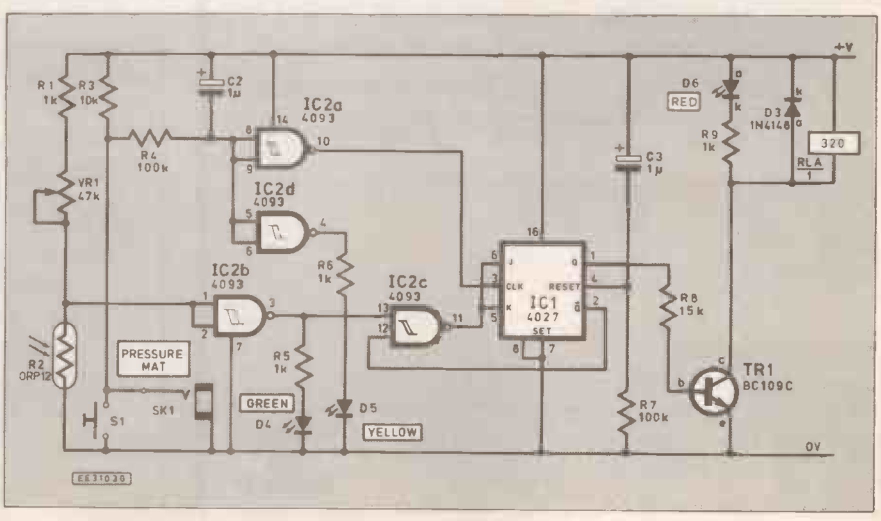
A preset potentiometer (VR1) allows alteration of the LDR switching threshold. This is an internal adjustment on the prototype and ***with mains voltages present should be carried out extremely carefully.*** Concerned readers may like to use a panel-mounting rotary potentiometer. A resistor R1 is connected in series with the preset to limit the overall current flow through the LDR.

The Q output from the flip-flop controls the relay switching transistor TR1 via limiting resistor R8. Signal diode D3 protects TR1 from the back e.m.f of the relay coil.

POWER SUPPLY

The circuit diagram for the power supply to drive the Auto Light Control logic circuit is shown in Fig. 2. The mains is conventionally transformed by T1, rectified by diodes D1 and D2 and smoothed by capacitor C1, giving a supply voltage of 13V to power the circuit.

Fig. 1. Circuit diagram for the sensor and control logic section of the Auto Light Control.



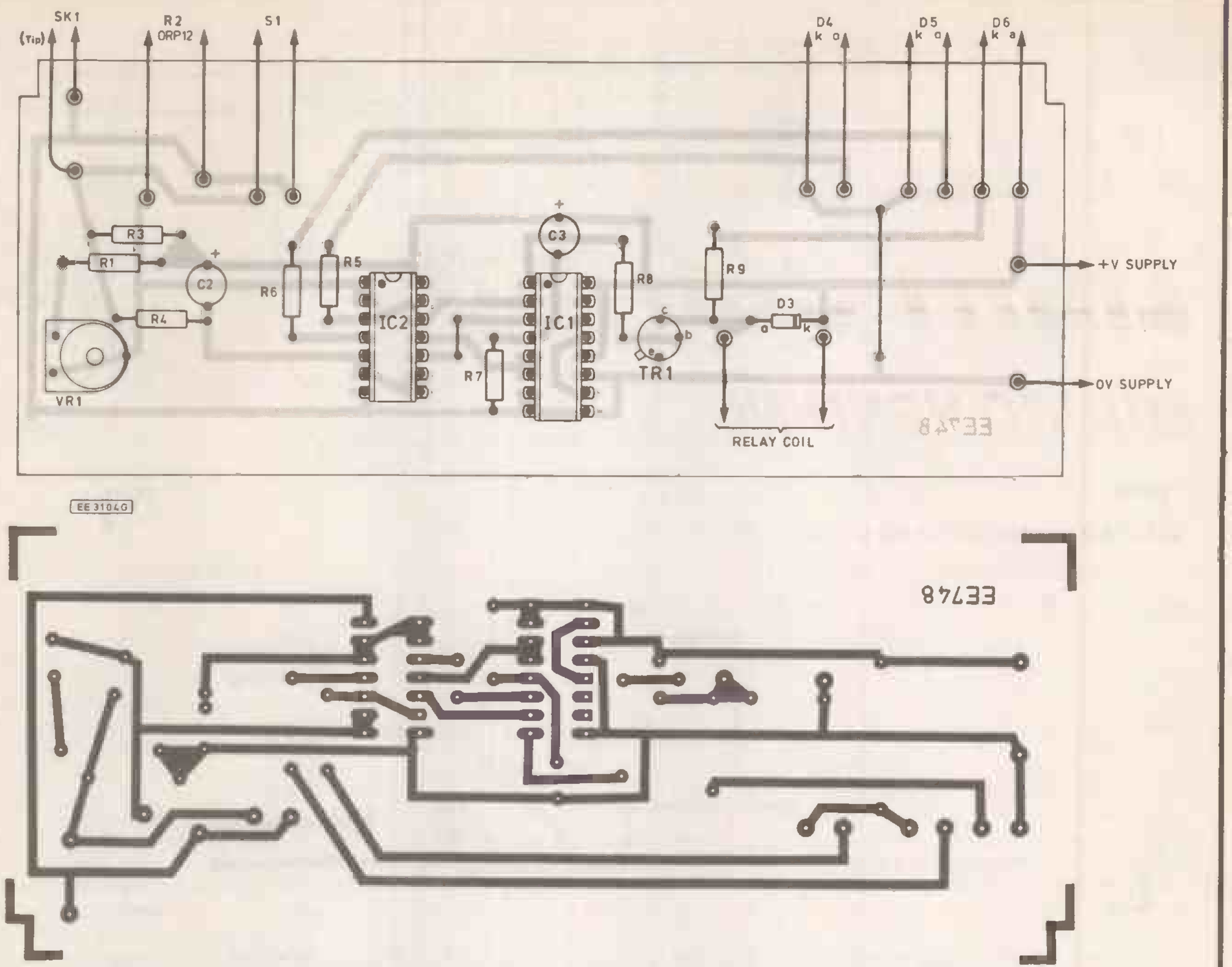


Fig. 3. Printed circuit board component layout and full size copper foil master pattern for the logic board. Only one half of the dual J-K flip-flop IC1 is operational in this circuit.

CONSTRUCTION

The unit was constructed on two printed circuit boards – one for the power supply and output relay, and one for the logic electronics. This proved to be a useful division since the logic electronics can be constructed and tested using a suitable battery without requiring mains electricity.

The printed circuit board component layouts and full size copper foil master patterns are shown in Fig. 3 and Fig. 4. These boards are available from the *EE PCB Service*, codes EE747 and EE748.

Commence construction with the logic board. Fit the wire links, the resistors, diodes, capacitors, transistors and the i.c. sockets – watch the polarity on everything except the resistors (and wire links!). The pressure mat was connected via a 2.5mm jack plug and chassis socket.

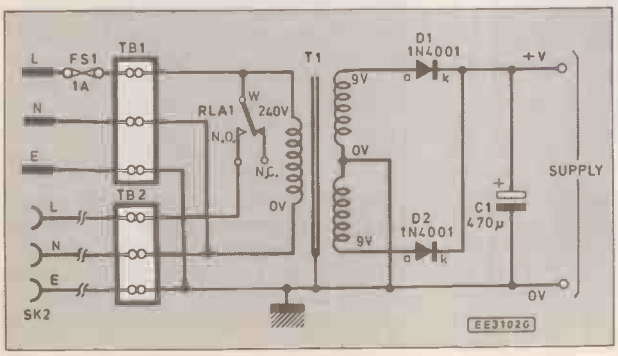
Six appropriate holes should be drilled in the case lid for the three l.e.d.s, the jack socket, the LDR and the push-button switch.

Once assembled, the logic p.c.b. was attached to the case lid by the jack socket and switch S1.

Temporarily use Blu-tack on the inside of the case lid to accurately mark where the hole is required for the jack socket. The hole for the LDR is less critical, and the push switch was mounted on rigid wire stalks proud of the logic p.c.b.

Once assembled and *before* inserting the i.c.s, re-check the p.c.b. for faults and

Fig. 2. Circuit diagram for the power supply and relay switching stage. The mains output socket SK2 is a "wander" type and is shown in the photo opposite.



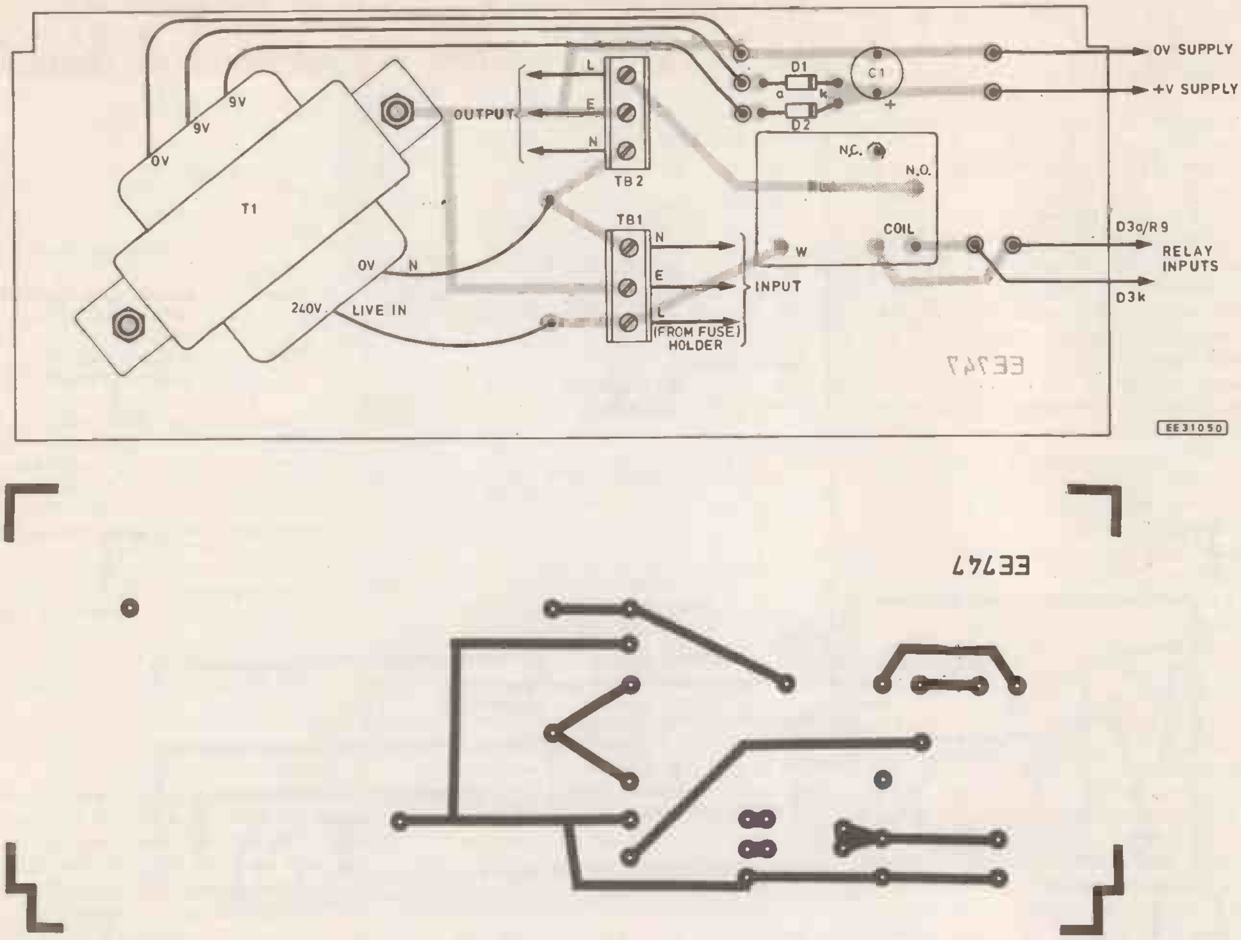


Fig. 4. Printed circuit board component layout and full size copper foil master pattern for the power supply/relay drive board. The mains input lead is connected to one tag of the panel mounting fuseholder and a lead (sleeved) is taken from the other fuseholder tag to the input terminal TB1.

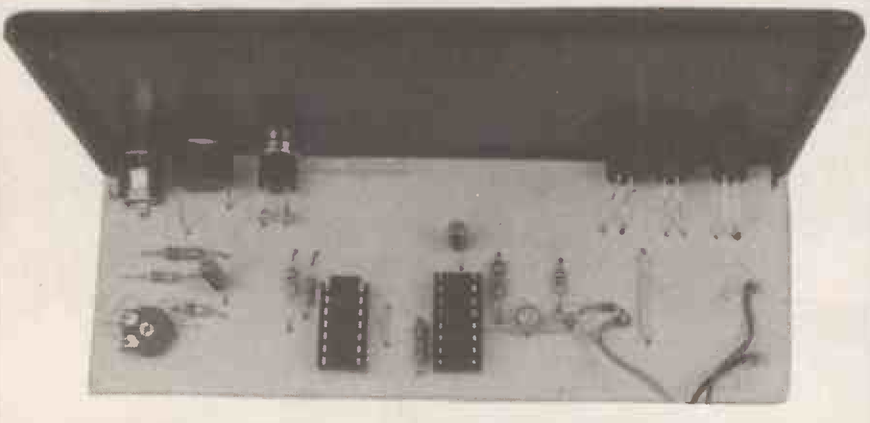
gingerly apply power from a 12V battery – the prototype model drew 0.7mA. Switch off and insert the two i.c.s, taking the usual precautions for CMOS devices and noting the polarity of the i.c.s.

Re-apply power and test the action of the LDR (watching the green l.e.d. D4, it will illuminate when there is sufficient light). Next press the push switch and look for its yellow l.e.d. D5 illuminating when the button is pressed.

With sufficient light on the LDR (the green l.e.d. D4 should be on), repeatedly press the push switch S1; the red l.e.d. D6 should be off. Reduce the light level on the LDR (until the green l.e.d. D4 switches off) then press S1 – on successive depressions the red l.e.d. D6 should change state.

Having proved that the basic logic circuit works, test the special feedback condition as follows:

Get both the red and green l.e.d.s to be lit, then press the pushbutton switch once – the red l.e.d. should extinguish and whilst the green l.e.d. remains on further depressions should cause the red l.e.d. to remain off.



The completed logic board is attached to the case lid by the mounting bush and nuts of the jack socket and pushbutton switch.

POWER SUPPLY BOARD

Though much simpler than the logic p.c.b., the mains p.c.b. requires extra vigilance since it will carry lethal voltages – *bear in mind the safety of the final users of this device.* The component layout and full size copper foil master pattern for the Power Supply Board is shown in Fig. 4.

Three-way p.c.b. mounting screw terminals are used to connect the mains input and trailing socket output cables. The transformer, T1 is bolted to the p.c.b. Strain-relief grommets MUST be used to secure the mains cable to the case – the three-way screw terminals will not endure a sharp tug on the cables (such as when someone trips over a cable).

The mains Live conductor entering the case is connected to the panel-mounting fuseholder and must be sleeved. The output from the fuse is connected (and sleeved) to the input mains terminal TB1.

When construction of the Power Supply board is complete, assemble the mains board into the case ommitting for the moment the four flying leads which will connect the mains and logic board together. Being a mains-coward (and proudly having never touched the mains in my life), please re-check all the connections before switching on. If possible, use a "residual current circuit breaker" device (commonly used with garden power tools) in the circuit whilst testing.

If the circuit is okay, remove power (pull out the plug – never trust a switch more than you have to) then connect a 4-wire loom to the mains p.c.b. for the low voltage power (black and red wires if convenient) and the relay input. If you have a multimeter, start with a 400V range and connect it to the red (positive) and black (ground) wires of the 4-wire loom. (The reason for starting on a 400V range is to protect the meter should there be a serious fault in the mains p.c.b. such that mains voltages are finding a path to the low voltage output. – *Do NOT connect your meter to the mains.)*

Apply mains power again and without touching any metal parts reduce the scale on the multimeter so that you can easily read the output voltage. On the prototype it was 14V (no-load) but remember that the logic circuit can tolerate some variance in the supply voltage as long as the output relay will still work and is not being overrated.

Everything being well, disconnect the main supply (again remove the plug) and temporarily connect one of the relay input wires (of the 4-wire loom) to the ground wire of the same loom. Bare the end of the other relay wire.

Re-apply mains power and without touching any metal parts touch the uninsulated relay input to the positive wire of the 4-wire loom (thereby applying the low-voltage supply to the relay). You should hear a click as the relay switches.

Once again remove mains power, then plug in a working mains table lamp to the trailing socket output of the device (make sure that any local switches on the table lamp are in the ON position, and that the lamp will actually work when mains power is applied). Re-apply power and repeat the relay-testing operation: the table lamp should illuminate when the relay is switched on.

Having succesfully got this far, remove mains power (pull out the plug) and solder the two boards together via the 4-wire loom. Assemble the completed boards in the case and attach a "Mains Warning" notice on the case outside of the finished model. Connect an appropriate length of two-core cable to the pressure mat and connect the other end to a 2.5mm jack plug.

Typical pressure mats have four "identical" wire connections: two are permanently connected within the pressure mat for an alarm system's 24 hour loop (a 24 hour alarm loop protects detection switches from tamper when the main alarm is not armed: even if "Burglar Bill" gets near the pressure mat connections it is not obvious which of the four wires require tampering with), the other two are normally open-circuit and become closed-circuit when sufficient pressure is put on the mat. Use a multimeter on resitance range to determine which two from the four you need.

Re-test the final device then install it in the required location. Irrespective of the age of all the device's users, warn them not to interfere with the device or open its case under any circumstances.

COMPONENTS

Approx cost guidance only **£20** plus case

Resistors

R1, R5, R6, R9	1k (4 off)
R2	ORP12 light dependent resistor
R3	10k
R4, R7	100k (2 off)
R8	15k

See SHOP TALK Page

Potentiometer

VR1	47k enclosed p.c.b. mounting preset, horiz.

Capacitors

C1	470µ radial elect. 16V
C2, C3	1µ radial elect. 16V

Semiconductors

D1, D2	1N4001 1A 50V rec. diode (2 off)
D3	1N4148 signal diode
D4	5mm low current l.e.d., green
D5	5mm low current l.e.d., yellow
D6	5mm low current l.e.d., red
IC1	4027BE CMOS dual J-K flip-flop
IC2	4093BE CMOS Schmitt quad 2-input NAND gate

Miscellaneous

T1	Mains transformer, 9V-0V-9V 250mA secondary.
SK1	2.5mm p.c.b. mounting jack socket
S1	Miniature push-to-make pushbutton switch
PL1	2.5mm jack plug
RLA	12V 320 ohm coil/relay, with 10A 240V a.c. contacts
FS1	1A 20mm fuse and panel mounting fuseholder

Pressure mat; ABS plastic case (MB5), size 150mm x 100mm x 60mm; 3-way p.c.b. screw terminal block (2 off); 14-pin d.i.l. socket; 16-pin d.i.l. socket; 3-core mains cable with trailing socket; strain-relief grommets (2 off); 2-core connecting wire for pressure mat; l.e.d. clips; multi-strand connecting wire; mains warning label; transformer mounting nuts and bolts; solder pins; solder etc.

Printed circuit board available from *EE PCB Service*, code EE747 and EE748.

IN USE

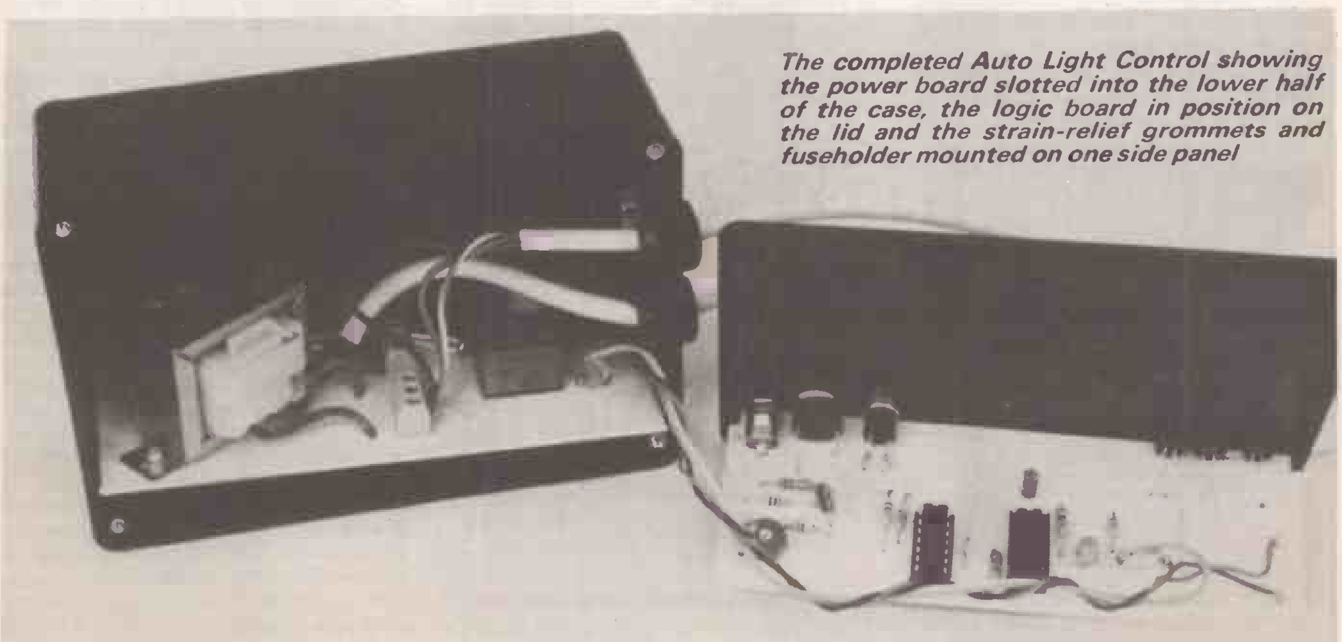
Though the device should perform satisfactorily there are a few points to note:

Large house pets may be heavy enough to operate the pressure mat. On some occasions a pet can walk on to the pressure mat which causes the light to illuminate and this then startles the pet to hastily retreat which leaves the light on!

A single pressure mat cannot detect in which direction a person is moving, they may miss the mat when entering a room but step on it on the way out, leaving a vacated and illuminated room! Also should an even number of people enter the room in orderly fashion the net result is that the light will be off.

The siting of the pressure mat may also need some experimentation. Usually the mat will be placed just inside the room's entrance. On the prototype the room was at the end of a dark corridor and the author proceeded to walk down the corridor and into the room only to find out that the normally open door had been closed – ouch!

Nevertheless, the unit should give hours of entertainment and use. It should also prove to be invaluable to elderly and disabled people. □



The completed Auto Light Control showing the power board slotted into the lower half of the case, the logic board in position on the lid and the strain-relief grommets and fuseholder mounted on one side panel

INTERFACE

Robert Penfold

THIS MONTH we turn our attentions to the Amstrad CPC range of computers. Although these have sold quite well for a number of years, relatively little information on interfacing to these computers, or add-on projects for them, have been published. The CPC computers have not been totally overlooked by *Everyday Electronics* though, and you will find two or three projects for them if you search through some back issues.

Expansion Port

The CPC computers are equipped with a fairly typical range of interfaces, such as disk drive, monitor, parallel printer, and joystick ports. There is no equivalent to the user port of the BBC computers, but there is a general purpose expansion bus.

On the CPC464, which has no built-in disk drive, this port is the one labelled "Floppy Disk", but it is exactly the same as the "Expansion" port of the other CPC computers. This port provides the potential for almost limitless user add-ons, and interfacing to it is reasonably straightforward.

As the CPC range of computers are based on a Z80A microprocessor, they have the usual Z80 style data, address and control buses. Physically the port is a two by 25 way 0.1in. pitch male edge connector with provision for a polarising key so that the female connector cannot be fitted the wrong way up, Fig. 1. Details of the pin numbering, and function is shown in Table 1.

Some of the functions shown in Table 1 are the standard Z80 types, including the address bus (A0 to A15) and the data bus (D0 to D7). The usual control bus lines are there as well, including the ones that will be needed when connecting user add-ons to this port. In particular, there are the separate read and write lines (/RD and /WR), and the input/output request line (/IORQ).

The Z80 has separate memory and input output maps. The /IORQ line goes low when an input/output device is being accessed – /MREQ goes low when a memory circuit is being accessed. The 4MHz system clock is available at pin 50.

Most of the other lines available on the expansion port are ones that will probably not be needed for add-on projects. There are a few potentially useful ones though.

There is a +5V supply line, but this is the only supply line available. It is probably best not to draw very much current from this terminal, and about 100 milliamps or so is a sensible maximum.

The "SOUND" terminal is an audio input, which enables an add-on device to make use of the computer's built-in amplifier and loudspeaker. The audio quality is not particularly good, and there is a high background noise level, but audio performance is adequate for most of the likely applications.

Last, and possibly least, there is a light-pen input at pin 47. Light-pens are good fun, but in my experience they give results which are not stable enough for many practical purposes.

Table 1: CPC Expansion Port Pin Functions

Pin	Function	Pin	Function
1	Sound	26	D0
2	GND	27	+5V
3	A15	28	/MREQ
4	A14	29	/MI
5	A13	30	/RFSH
6	A12	31	/IORQ
7	A11	32	/RD
8	A10	33	/WR
9	A9	34	/HALT
10	A8	35	/INT
11	A7	36	/NMI
12	A6	37	/BUSR2
13	A5	38	/BUSAK
14	A4	39	READY
15	A3	40	/BUS RESET
16	A2	41	/RESET
17	A1	42	/ROMEN
18	A0	43	ROMDIS
19	D7	44	/RAMRD
20	D6	45	RAMDIS
21	D5	46	CURSOR
22	D4	47	L.PEN
23	D3	48	/EXP
24	D2	49	GND
25	D1	50	CLOCK

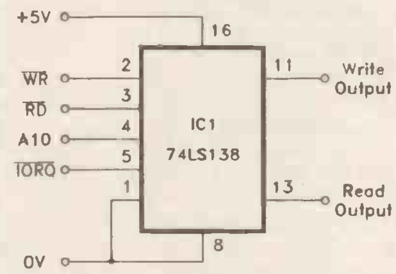


Fig. 2. Minimal address decoding for a CPC computer that is not equipped with a disk drive

Address Decoding

Address decoding for a CPC computer which does not have a disk drive (internal or external) is very simple indeed. It is basically just a matter of activating the add-on device when A10 and /IORQ are low, together with the read or write line (as appropriate). Of course, in practice the add-on circuit may well occupy more than one address, and it will then be necessary to additionally decode some of the lower address lines.

If the add-on circuit is based on a computer chip such as a PIO, then it will probably have register select inputs that will provide the decoding of the lower address lines, avoiding the need for any extra external decoding. Add-ons are effectively at addresses from &F800 to &FBFF with this general scheme of things.

Obviously this very simple method of interfacing enables a minimum of address decoding to be used. In most cases a single 74LS138 3-to-8 line decoder can handle the decoding. Fig.2 shows one way in which the 74LS138 can be used as a CPC address decoder.

For a CPC computer that is fitted with a disk drive, whether it is an integral or external type, address decoding is slightly less straightforward. The simple method described above is likely to cause problems with the add-on and disk drive tending to interfere with each other.

In order to avoid possible conflicts with other hardware, user add-ons must

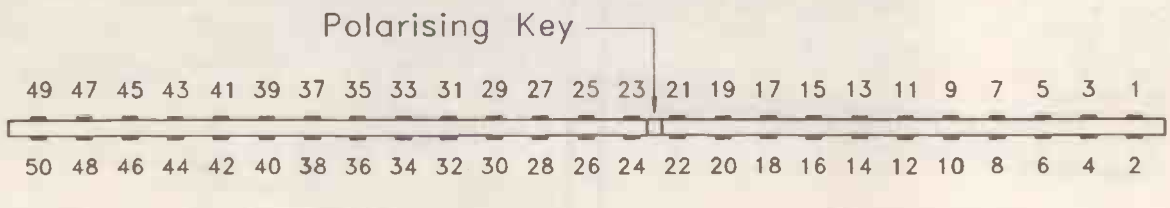


Fig. 1. The pin numbering for the Amstrad CPC Expansion Port, with polarising key.

be mapped into the smaller input/output area specifically reserved for expansion port add-ons. The relevant area of the input/output map is &F8E0 to &F8FF. This means that as a minimum requirement, all the address lines from A5 to A15 must be correctly decoded in order to guarantee that no hardware conflicts occur. Table 2 shows the states of A4 to A15 when an address in the relevant range is accessed.

Table 2: Accessing Address Lines A4-A15

Address Line	State	Address Line	State
A4	High/Low	A10	Low
A5	High	A11	High
A6	High	A12	High
A7	High	A13	High
A8	Low	A14	High
A9	Low	A15	High

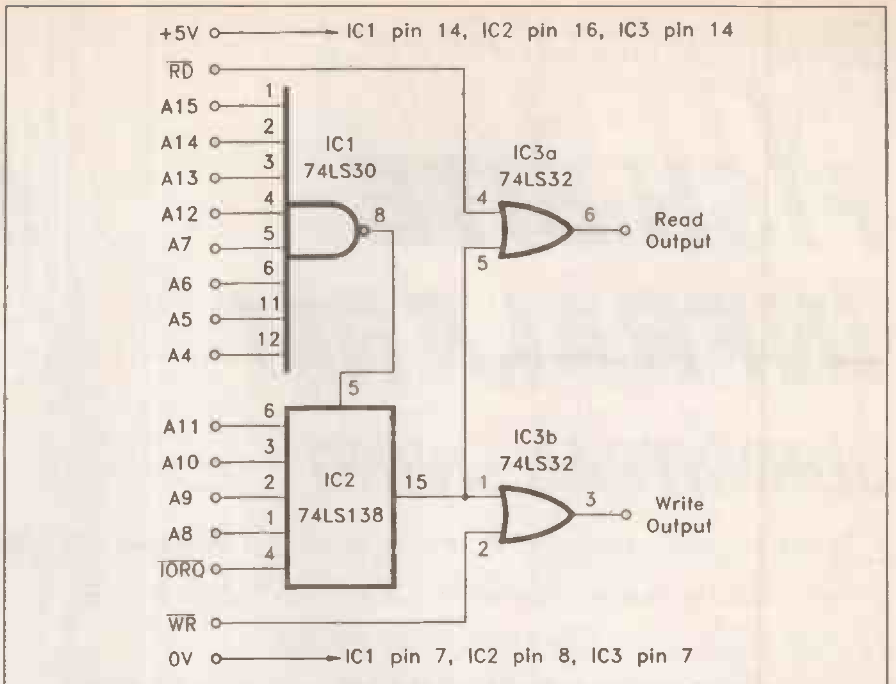


Fig. 3. A circuit to provide address decoding for a CPC computer fitted with a disk drive

The most simple method of CPC full address/control bus decoding I have been able to devise is the one shown in Fig.3. This is actually "borrowed" from my *Amstrad CPC Speech Synthesiser* project, which can be found in the May 1990 issue of *Everyday Electronics*.

The decoder responds to input/output accesses in the range &F8F0 to &F8FF. The circuit basically consists of a 74LS30 8-input NAND gate to decode eight of the "high" address lines, with a 74LS138 3-to-8 line decoder being used to decode /IORQ and the other four address lines.

Two OR gates from a 74LS32 then provide decoding with the /RD and /WR lines so that separate decoded read and write lines are available. In some cases the peripheral chip in use will have inputs for the /RD and /WR lines, rendering this extra decoding unnecessary.

Remember that the four least significant address lines are available if the add-on has more than one register, or if more precise address decoding is needed for any other reason. With four address lines to decode, this means that there are addresses available for up to sixteen read/write registers, which should be adequate for any one add-on unit.

Also keep in mind that adding an inverter in the A4 address line will result in it being decoded to "low" rather than to "high", giving a different block of sixteen input/output addresses (&F8E0 to &F8EF). This permits two add-ons of sixteen registers each (or equivalent) to be used with a CPC computer, and this should be adequate for most users.

Making Contact

From BASIC the input and output ports are contacted using the INP and OUT commands, respectively. The input and output circuits are not memory mapped, and cannot be accessed using PEEK and POKE.

All TTL logic devices should interface with the CPC buses without any difficulty, as will 82** series and Z80 peripheral chips. The 65** and 68** peripherals are not bus compatible with the Z80A microprocessor of the CPCs, although these chips can sometimes be interfaced to the CPCs successfully. Indeed, the CPC computers incorporate a 6845 video controller chip.

One difficulty with the 65** and 68** series devices is that they usually require the system clock signal, but the Z80A clock signal is rather different to that of the 6502 etc. Despite this, the Z80A clock seems to give perfectly good results in most cases.

There is another difficulty in that the Z80A has separate read and write lines, whereas the 6502 etc. have a single read/write line. The write line or an inverted version of the read line will usually provide a suitable substitute for the R/W line. Of course, where a suitable 82** or Z80 peripheral exists, it is better to use this than to risk problems with a 65** or 68** series chip.

It should be pointed out that the CPC computers, particularly the ones which have built-in disk drives, do not seem to like having long cables hanging on the expansion port. It is probably best to keep the cable length down to about 300 millimetres. Longer lengths can cause erratic operation, and can even prevent the computer from completing its initial setting up sequence properly.

There seems to be a lot of interest in PC interfacing at present, and so next month we will return to this subject with some ideas for PC prototyping cards.

FISH BITE INFRALARM

JOHNATHAN LIVING

Don't be caught napping! Reel in the "big one" with the aid of this bite alarm. Detects the movement of the line.

Most amateur fishermen will agree that for at least some of the time, their favourite sport is intended to be relaxing. But when your stories of "the one that got away" are founded on you falling asleep at the rod, drastic action is needed to save your bacon, or rather your perch.

A device designed to do just that is the Fish Bite Infralarm. It is used to replace the traditional rod rests since it too can be attached to a bank stick and will support a fishing rod in much the same way.

The only difference between the two is Infralarm's rather vocal or visual treatment of a moving line. The unit works by emitting a short, high-pitched tone (or briefly lighting a l.e.d.) for approximately every 35mm that the line runs out or in.

HOW IT WORKS

The full circuit diagram for the Fish Bite Infralarm is shown in Fig. 1. Diode D1 is a low-current red l.e.d. which emits radiation around the 650nm part of the spectrum. This proves well matched to infra-red phototransistors (such as TR1 being used in this project) which are predominately sensitive to radiation around the 850-900nm wavelength range.

The fishing line runs on a wheel which has both opaque and transparent sections. When the line moves, the wheel rotates and the optical path between l.e.d. D1 and phototransistor TR1 is successively broken and restored. When the light incident on TR1 decreases, the voltage drop across this device increases correspondingly.

Thus the voltage at the non-inverting input (pin 3) to IC1a depends upon the position of the sensor wheel. It is this change in voltage that the circuit detects and uses to alert the fisherman (or woman!) of line movement.

CIRCUIT DESCRIPTION

Both op-amps contained within IC1 are configured as voltage comparators in the circuit. When the potential of the non-inverting (pin 3) input to IC1a differs to the potential of the inverting (pin 2) input, then this difference is amplified by the open loop gain of the op-amp (approximately 1,000,000 times, or 120dB).

The practical implications of this and the use of a single rail power supply are for all intents and purposes, that when the non-inverting input is at any lower potential than the inverting input, the output is at 0V (low). When the reverse is true, the output is at the supply voltage (9V in this case).

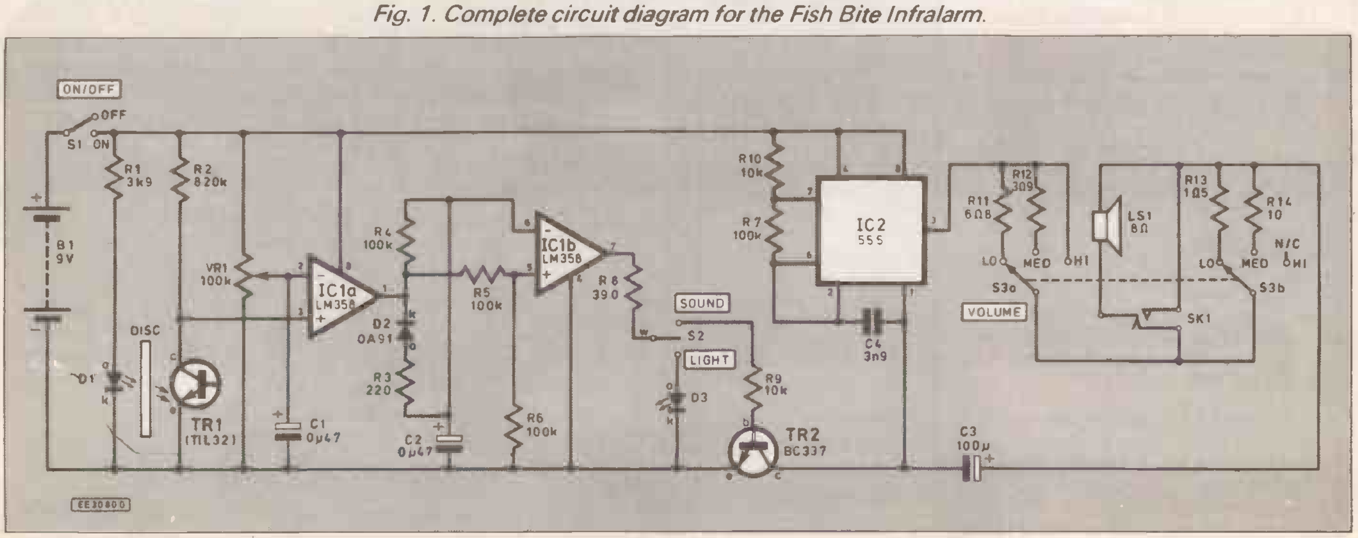
When the wheel rotates to break the optical path from l.e.d. D1 to phototransistor TR1, the voltage at the non-inverting input changes from a value lower than that set by VR1 at the inverting input, to a value higher. The output of IC1a (pin 1) therefore swings from 0V to 9V (high).

The non-inverting input of IC1b (pin 5) immediately attains a potential of 4.5V via the potential divider formed by resistors R5 and R6. Meanwhile, the inverting input of IC1b is held low by the charging action of capacitor C2 via resistor R4. For the time that the voltage across C2 is less than the 4.5V potential at the non-inverting input (calculated by using $t = -RC \times (1 - V_{cap}/V_{supply})$ to be around five hundredths of a second) then the output of IC1b is at 9V. Thereafter, the output of IC1b falls to 0V, completing a 9V pulse.

When the wheel rotates to restore the optical path between TR1 and D1, the output of IC1a swings to 0V which causes diode D2 to be forward biased and C2 discharges rapidly through current limiting resistor R3, ready for the next pulse.

The high (9V) pulse from the output (pin 7) of IC1b, is used to drive, via resistor R8 and switch S2, the warning l.e.d. D3. When switch S2 is moved to its alternate position, the high pulse is used to generate a large base current for (and to saturate) transistor TR2 via resistor R9.

Fig. 1. Complete circuit diagram for the Fish Bite Infralarm.



Transistor TR2 functions to enable a large collector current to flow and operate the oscillator circuit formed around IC2.

The oscillator utilises the ubiquitous 555 timer in astable mode, with the frequency determined by resistors R7, R10 and capacitor C4. A decoupling capacitor C3 is used to remove the d.c. component from the near squarewave output of IC2 in order that a loudspeaker may be driven.

A three-position volume switch is included, which uses a series/parallel technique to reduce the power dissipated in loudspeaker LS1 while maintaining an 8 ohm impedance. This was found to be necessary since varying low resistances on the output of IC2 actually have an effect on the tone produced.

CONSTRUCTION

First sighting of the constructional diagrams for the Fish Bite Infralarm may give the impression that this project is relatively difficult to build. However, provided the following details are followed even the average "fish-person" should soon be hooked on electronics and have no trouble in successfully "landing" this project.

A good starting point to commence construction is the main circuit board, which is built on a piece of stripboard measuring 10 strips by 30 holes. The stripboard component layout and details of the breaks required in the underside copper tracks is shown in Fig. 2.

The board requires all of 20 track breaks on the underside although these are grouped together into four columns, each containing five breaks. The 12 wire links and seven solder pins can then be pushed into position and soldered.

The i.c. sockets, VR1 and the nine resistors can be added next. Capacitors C1 to C4, transistor TR2 and diode D2 should then be soldered into place.

Diode D2 is a germanium type and should be treated carefully. Bend its leads slowly over with light finger pressure. Note its correct orientation (with the cathode (k) band at the top of the board) and solder with the minimum of heating time. The board can now be tested as it stands. See "Preliminary Testing" below.

SENSOR

The next logical step is to construct the sensor. The prototype wheel was made by "Aralditing" two Perspex discs and a discarded cassette tape wheel into a sandwich type construction. The disc material used

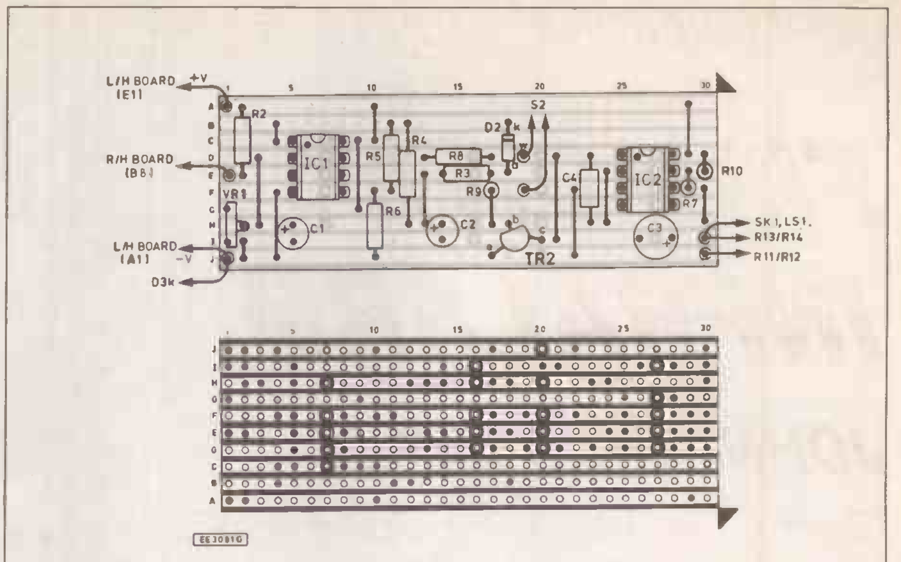


Fig. 2. Main circuit board component layout and details of breaks required in the underside copper tracks.

COMPONENTS

Resistors

R1	3k9
R2	820k
R3	220
R4 to R7	100k (4 off)
R8	390
R9, R10	10k (2 off)
R11	6Ω8
R12	3Ω9
R13	1Ω5
R14	10

All 0.25W 5% carbon

See SHOP TALK Page

Potentiometers

VR1	100k miniature skeleton preset, vertical

Capacitors

C1, C2	0µ47 radial elect. 10V (2 off)
C3	100µ radial elect. 25V
C4	3n9 polystyrene

Semiconductors

D1	5mm low current l.e.d., red
D2	OA91 germanium diode
D3	5mm standard l.e.d., red
IC1	LM358 dual single-rail supply op-amp
IC2	NE555 CMOS timer
TR1	Infra Red phototransistor (TIL32)
TR2	BC337 *npn* medium power transistor

Miscellaneous

S1	SPST miniature toggle switch
S2	SPDT miniature toggle switch
S3	2-pole 6-way rotary switch, with break-before-make action and adjustable end stop
B1	9V PP3 type battery
LS1	8ohm 0.25W miniature loudspeaker
SK1	mono 3.5mm jack socket, with break contact

Stripboard 0.1in matrix, 30 holes by 10 strips (1 off), 8 holes by 7 strips (2 off) and 10 holes by 8 strips (1 off); ABS case, size 120mm x 100mm x 45mm deep; "Foster" type rod rest; solder pins; copper wire 0.8mm diameter or similar; PP3 type battery clip; 8-pin d.i.l. sockets (2 off); knob for S3; M3 by 10mm long panel head bolts (4 off, with nuts); interconnecting wire; solder; spray paint; Araldite etc.

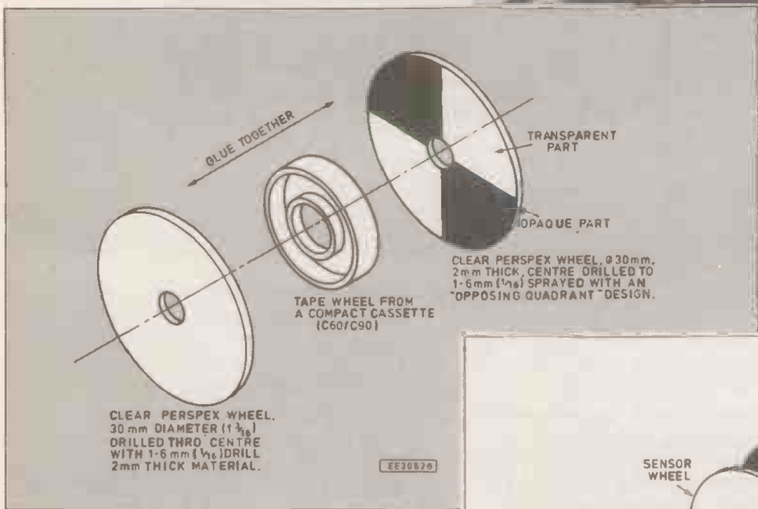
Approx cost guidance only **£10** *plus case and fixings*

is the 2mm thick variety obtainable from most large DIY stores and is usually sold for the purpose of cheap greenhouse cladding.

Mark out two 30mm diameter circles on the protective paper covering the Perspex. Rough hack-saw around the marked outline.

The discs are best reduced to a truly circular shape by filing a number of flats as tangents to the marked out circumference. The corners of the polygon produced can then be removed by further filing to produced a round disc.

Both discs need to be centre drilled through with a 1.6mm or similar size



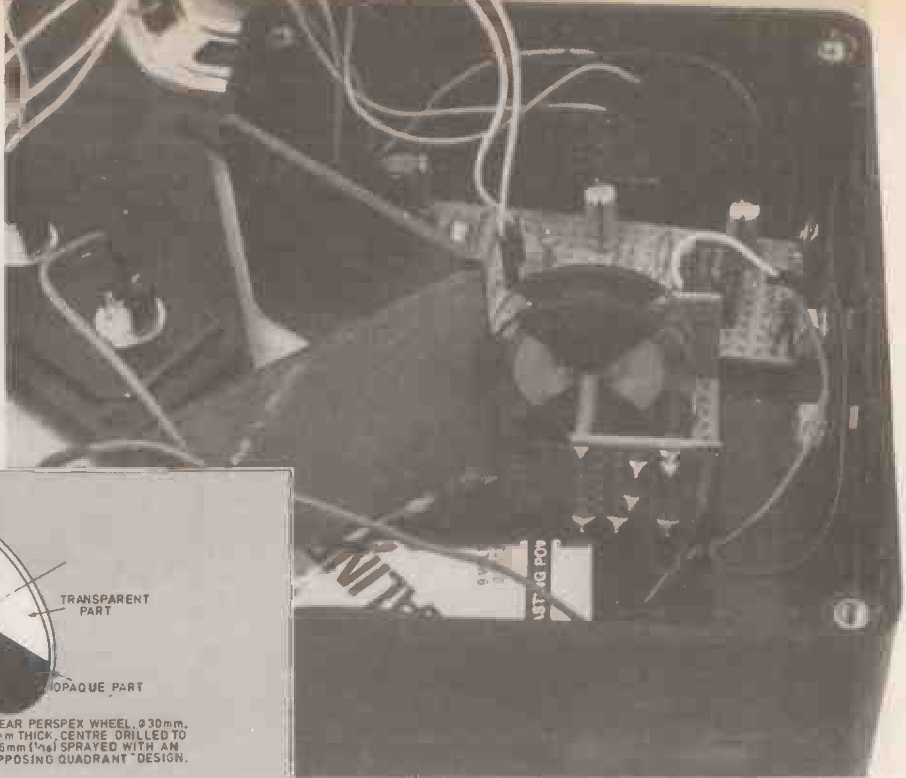


Fig. 3 (above). Sensor wheel construction and (above right) close-up photo of wheel in position.

Fig. 4 (right). Sensor boards and chassis construction.

twist drill, to accept the "axle". One disc should be masked off with insulating tape and sprayed with an "opposing quadrant" design.

The two discs and tape wheel should be glued together as concentrically as possible, as shown in Fig. 3. To prevent the fishing line skidding over the sensor, a few small elastic bands can be stretched onto the centre wheel, or a strip of FINE (grade 480 or higher) wet and dry paper can be glued, abrasive side out, around the centre tape wheel.

SENSOR CHASSIS

The carriage, for the sensor wheel is constructed from three pieces of stripboard; two side pieces (each measuring 7 strips by 8 holes) and a base "plate" (measuring 8 strips by 10 holes). The stripboard panels, component layout and details of sensor assembly are shown in Fig. 4 and Fig. 5.

The side pieces need no track breaks and should be fitted with solder pins (two on the left hand (LH) and one on the right-hand (RH) board) in a reverse fashion (i.e. with the majority of the pin protruding on the copper side) and soldered. Resistor R1 and diode D1 can be fitted to the LH board. Note the orientation of D1, with the flat towards the top of the board.

Phototransistor TR1 can be soldered directly to the RH board, with the flat on the package towards the bottom edge. On the prototype, D1 and TR1 were shrouded with heat shrinkable tubing in order to make both devices more directional.

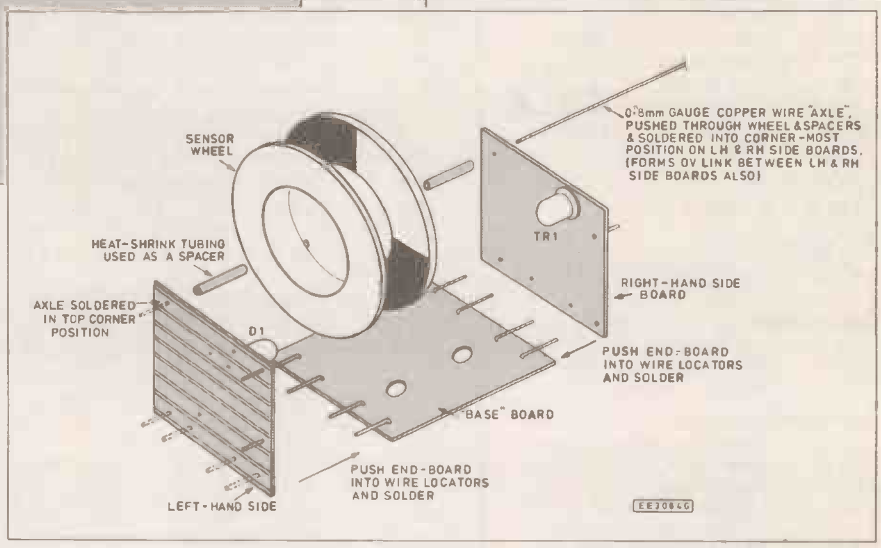
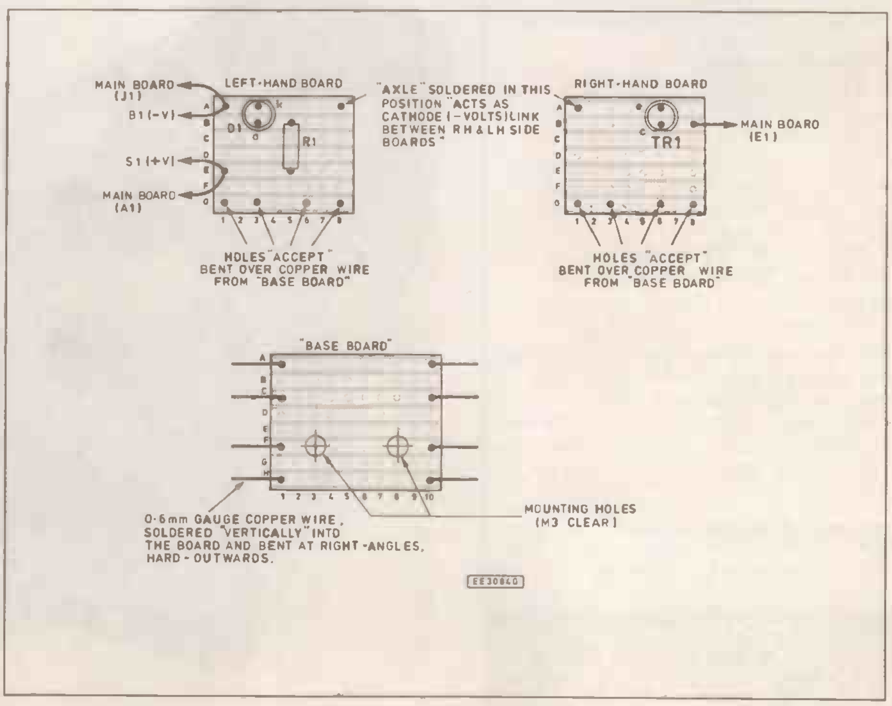


Fig. 5. (below). Component layout for the sensor boards and details of baseboard.



The base plate requires two, 3mm holes to be drilled for mounting the assembly. Four pieces of copper wire, each around 10mm in length, should be soldered vertically into each of the two end columns in the base board. When the wire pieces are bent over and outwards, the LH and RH boards can be pushed onto the wire and then soldered on the reverse to hold the chassis together. The sensor assembly process is shown in Fig. 4.

Heat shrinkable tubing can be used as a spacer on the axle to keep the wheel spinning centrally between D1 and TR1. Note that the axle itself forms the 0V link between the LH and RH boards and must therefore be soldered correctly into the top-corner positions of each board.

PRELIMINARY TESTING

The main circuit board should be tested independently first of all. Set VR1 to approximately half-way. Connect a 9V supply between the solder pins at *A1* (+V) and *J1* (–V). Temporarily link the solder pins in positions *D19* and *F19* on the board and connect loudspeaker LS1 between the solder pins in positions *I30* and *J30*.

Solder a flying lead to *E1*. Touch the opposite end of the flying lead to the negative supply connection (solder pin position *J1*). On removing the lead, a short "beep" should be heard. If this is not the case, then some basic diagnostic tests can be performed:

Remove IC1 from its socket and power up the circuit again. Use a piece of wire to take pin 1 of IC2 to the negative supply connection on the board (*J1*). A sound should be heard. If this is not the case, check components associated with (and including) IC2 (i.e. C4, C3, R7 and R10). Also check the loudspeaker LS1 by VERY BRIEFLY connecting it across the terminals of the 9V supply (a crackle should be heard).

If a sound is heard, connect a wire from the positive supply connection on the board (*A1*) to pin 7 position on the now empty IC1 socket. If a continuous tone is NOT heard, TR2 and perhaps R8 or R9 are at fault.

If a sound is still produced when the link to pin 7 test above is tried, then it is IC1 and all the remaining components which must be suspected as being faulty. IC1 can be tested as follows.

With IC1 replaced in its socket, repeat the initial test of continually touching and removing the end of the flying lead to the negative connection on the board (*J1*). Monitor the voltage between pin 1 on IC1 and the negative board connection (*J1*) using the 10V d.c. range on a multimeter. With the flying lead touching *J1*, the meter should read 0V. When the flying lead is unconnected, the meter should read 9V.

A further test will involve monitoring the voltage between pin 7 on IC1 and the *J1* negative supply connection on the board. As the flying lead is REMOVED from *J1*, the meter reading should very briefly rise from 0V to 9V. The reaction time of your meter will prevent a reading of 9V being obtained, but a pulse should definitely be detected.

SENSOR

The sensor can also be tested independently, in a similar manner. Connect the positive side of a 9V supply to the solder pin in position *E1* on the LH board. The negative connection should also be made to *A1* on the same board.

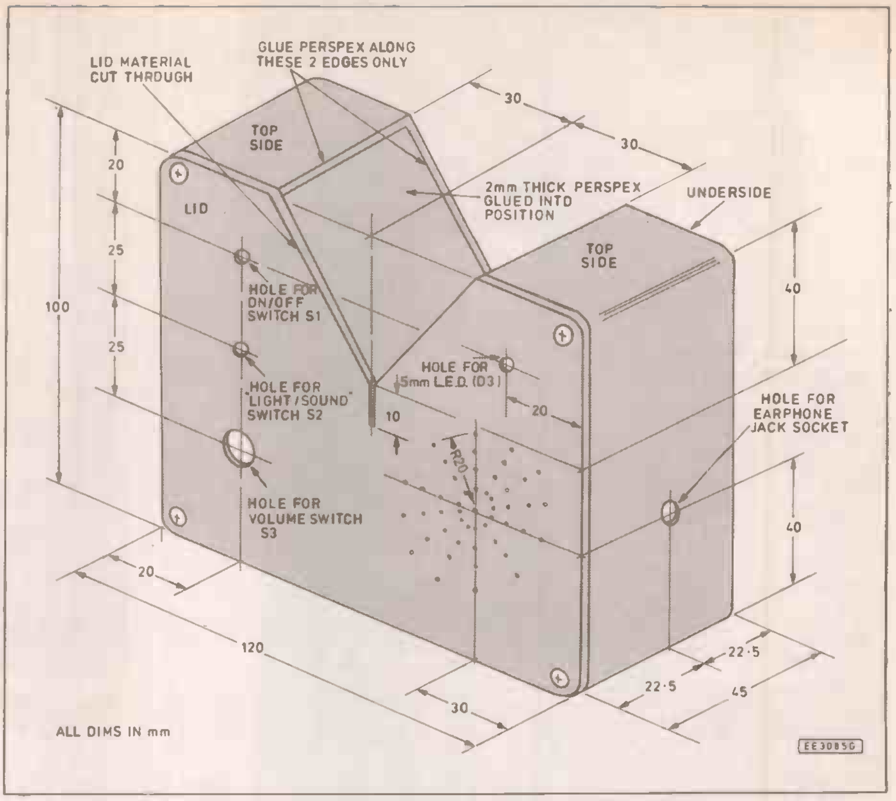


Fig. 6. Case modifications and drilling details.

Connect an 820 kilohm resistor between the solder pin in position *B8* on the RH board and the positive supply connection of the LH board (*E1*). Now measure the voltage between the negative supply connection (*A1* on the LH board) and pin *B8* on the RH board.

With an opaque section breaking the optical path between TR1 and D1, the voltage measured should be over 6V. With the optical path clear, a reading of below 5V should be obtained.

Testing of the sensor should be carried out in a dimly lit room so as to simulate the conditions inside the case. If both the sensor and the main circuit work correctly, you should now proceed with the case work and final interwiring.

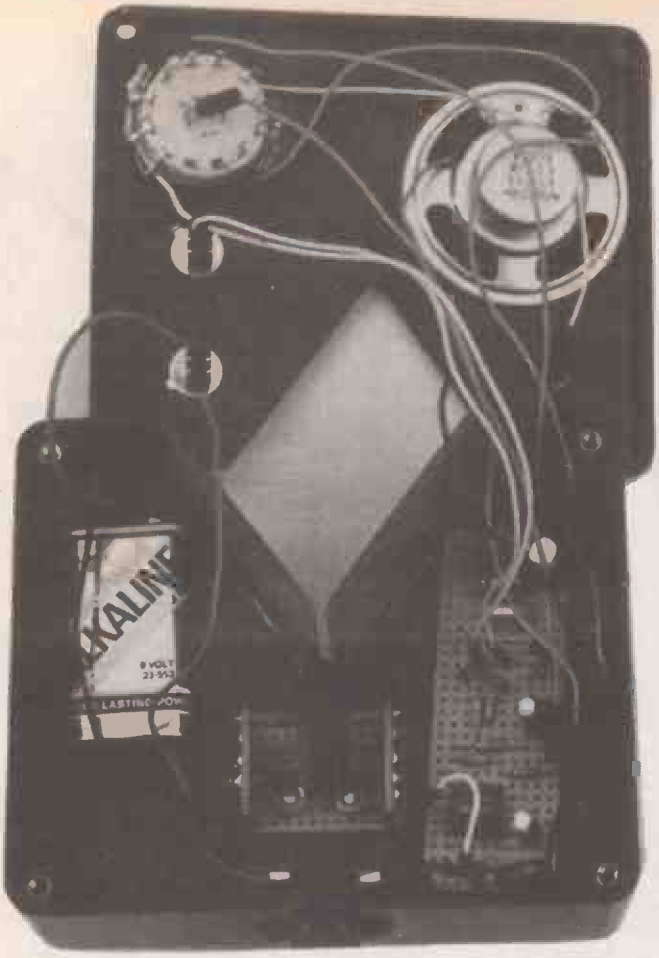
CASE

The prototype case was based around a standard gloss-black finish ABS case of approximate dimensions 120Wx100Dx45H (millimetres). Modification to the case design are shown in Fig. 6.

The lid of the box should only be roughly cut to shape, leaving at least 1mm of waste material around the "V" for finishing. Mark out the 60mm wide by 40mm deep "V" on the under and top sides of the case.

Roughly hacksaw the waste material and finish by filing. Do not attempt to file right into the point of the "V" since a slot, 1mm-2mm wide by 10mm deep is to be filed at that position. The slot is best produced by using a warding or flat file of 1mm-2mm thickness, on its side.

Front panel layout and lettering.



The completed Infralarm showing layout of components inside and on the case lid.

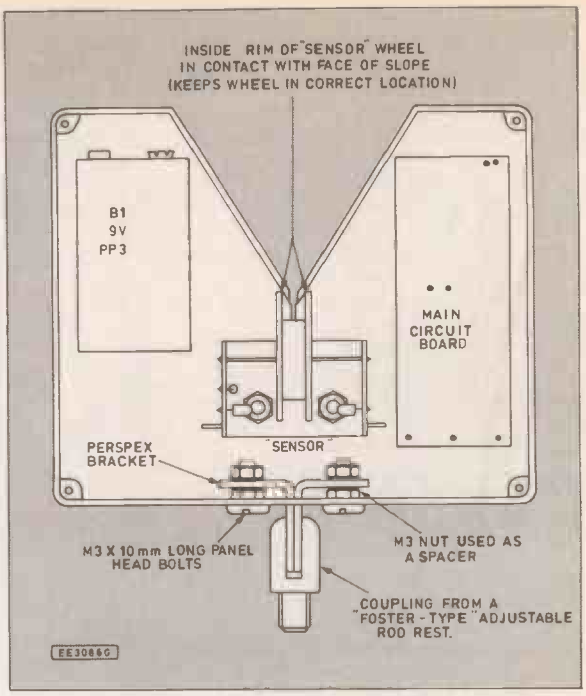


Fig. 7. Sensor mounting and positioning of components inside case.

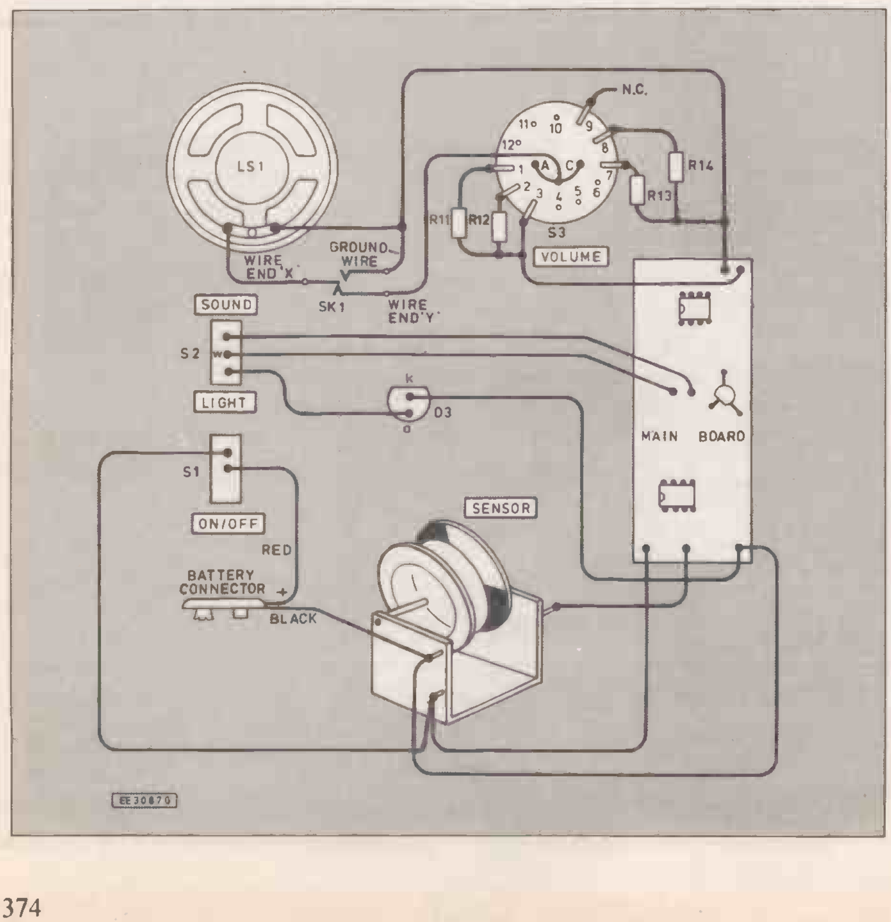
To "fill in" the sides of the "V", the same 2mm clear Perspex as used for the sensor wheel was utilised. Two pieces, each approximately 41mm by 47mm were used. Araldite the two pieces flush to the edges of the "V".

Once the glue is dry, the lid can be fitted and filed to blend in with the Perspex faces.

The "V" can then be masked off and sprayed with a gloss black car spray paint to give a professional finish.

The mounting details for the various controls and panel hardware are also given in Fig. 6. This design is best adhered to since the case can become more than a little cramped when fully "furnished."

Fig. 8. Interwiring between all off-board components.



The mounting of the sensor inside the case is shown in Fig. 7. Notice also the method by which the unit can be attached to a "bank stick" – the coupling from a cheap plastic rod rest is used in conjunction with a bracket bolted to the base of the case. This system enables the unit to be tilted forward such that the rod lies correctly along the faces of the "V".

INTERWIRING

All the point-to-point interwiring necessary for the Infralarm is shown in Fig. 8. Note the orientation of diode D3 relative to its connections.

The wiring of SK1 is particularly difficult if the insertion of a jack plug is to successfully cut out the internal speaker. For testing purposes, it is probably far wiser to omit SK1 by connecting wire end "X" to wire end "Y" and removing the SK1 ground wire, as labelled in the diagram.

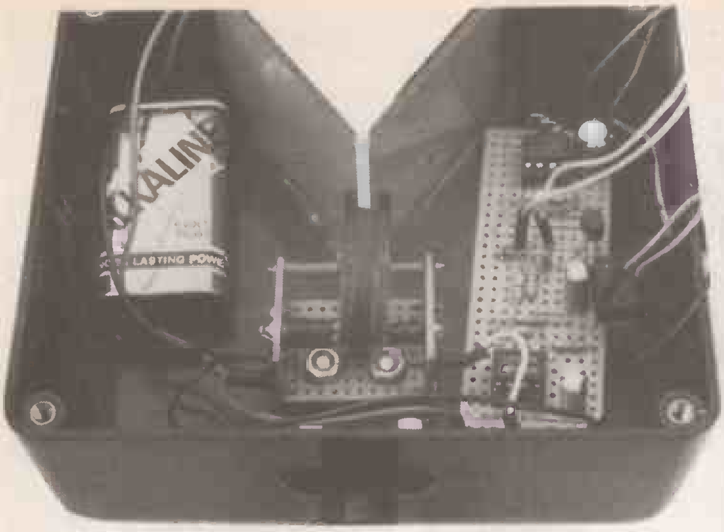
FINAL TESTING

With the project complete, it is an easy task to test its performance. Monitor the voltage between the 0V connection on the main board (*J1*) and pin 2 of IC1. Using VR1, adjust this to something between five and six volts.

Check that the voltage between 0V and pin 3 on IC1 oscillates between a value higher and a value lower than the five or six volts set on pin 2, as the sensor wheel rotates. If this is not the case, choose an intermediate voltage between the extremes on pin 3 of IC1 and use VR1 to set pin 2 on IC1 to this potential.

With the unit switched on, pull some taught string through the slot in the base of the "V". Depending on the position of switch S2, l.e.d. D3 should flash rapidly, or a series of beeps should be heard from the loudspeaker. Adjusting preset VR1, as long as the voltage at pin 2 of IC1 remains within the oscillating limits of pin 3, has subtle effects on the units' operation:

With pin 2 voltage quite low, the circuit functions well at high sensor wheel speeds, but becomes very sensitive to opaque sections on the sensor wheel to the point that



Mounting the sensor chassis so the wheel aligns with the "rod line" V-slot.

The completed Fish Bite Infralarm ready for "casting".

the circuit may respond to fingerprints on the clear sections!

With pin 2 voltage quite high, the circuit will produce a series of "clicks" rather than "beeps" when the wheel rotates at high speed. However, the circuit becomes less sensitive to fingerprints and the like!

IN USE

The Fish Bite Infralarm is very simple to use. Screw a bank stick to the coupling and angle the unit forward so that the front face of the box is perpendicular to the rod. The reel should provide sufficient tension in the line so that when it runs out, the sensor wheel will rotate and the alarm will sound.

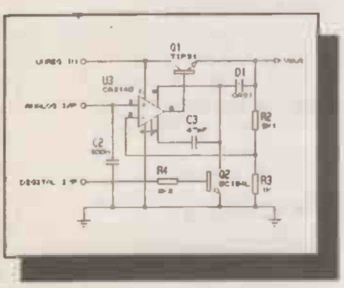
The circuit has a total quiescent current consumption of less than 3mA, making extended running on a PP3 type battery a viable proposition. When active, currents of over 20mA (for the l.e.d. setting on S2) and 50mA (for the alarm) are drawn. This is obviously only an intermittent load and should not drain the battery unduly.

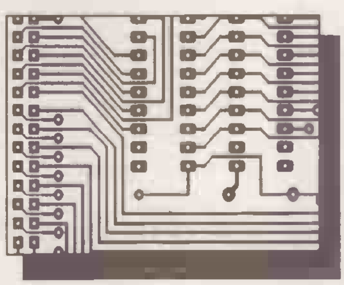
The low-current l.e.d. D1 may prove difficult to obtain and can be substituted for a standard 5mm 20mA type. In this case, resistor R1 should be reduced by a factor of 10 to 390 ohms.

Since the current through D1 constitutes 2mA of the 3mA quiescent supply current, substituting for a standard 20mA type l.e.d.will require the use of a larger battery (something like six "AA" or "HP7" type batteries in series) in order to enable long operating periods as before. A larger case will also be needed in order to make room for the battery pack.

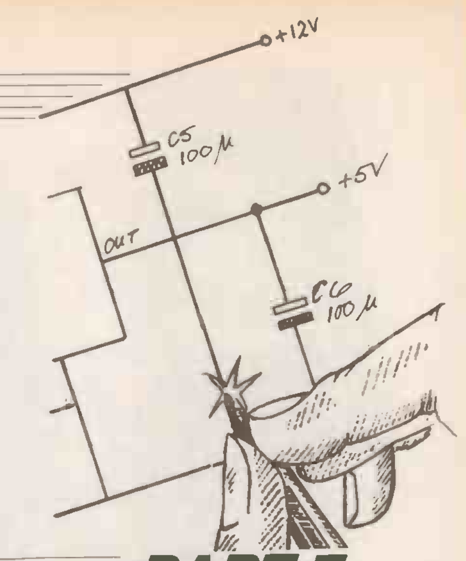
FINALLY

EE hope to combine with this, a project code named "Coax-a-Fish". This is basically an underwater unit with integral 150W PA amplifier and speaker which uses a pre-programmed EPROM to replay constantly the message "Here, fishy, fishy, fishy"!!! □





Teach-In '91



DESIGN YOUR OWN CIRCUITS

Radio

MIKE TOOLEY BA

PART 7

This seventh part deals with radio, one of the most absorbing facets of electronics. Our design problem is based on a medium wave radio tuner for use with the Bench Amplifier/Signal Tracer (described in Part 3) whilst our companion project deals with the construction of a simple portable Radio Receiver.

THE SPACE around us is filled with electromagnetic waves ceaselessly carrying information in every tongue known to mankind. Thus, even though we tend to take modern developments like carphones and satellite TV receivers for granted, "communication without wires" must still be considered something of a marvel. For this reason, radio has a fascination which is not found in any other area of electronics; anyone who has built and operated a radio receiver or transmitter will readily testify to this fact!

THE RADIO FREQUENCY SPECTRUM

Radio signals occupy a very wide frequency range which itself is just part of a much wider electromagnetic spectrum. The lowest radio frequency range which is of practical use (below 30kHz) is only suitable for narrow-band communication. At this frequency, signals propagate as ground waves (following the curvature of the earth) over very long distances.

The highest frequency range which is of practical importance extends beyond 30GHz. At these "microwave" frequencies, considerable bandwidths are available (sufficient to transmit many television channels form point-to-point or to permit very high definition radar systems). Such signals tend to propagate strictly along "line-of-sight" paths. Between these two extremes (and strictly for our own convenience), the radio frequency spectrum is divided into six bands, each spanning a decade of frequency (see Fig. 7.1).

The use to which each frequency range is put depends upon a number of factors, paramount amongst which is the propagation characteristics within the band. Other factors which need to be taken into account include the efficiency of practical aerial systems in the range concerned and the bandwidth available. It is also worth noting that, although it may appear from Fig. 7.1 that a great deal of the r.f. spectrum is not used, it should be stressed that competition for frequency space is fierce. Frequency allocations are, therefore, ratified by international agreement and the various user services very

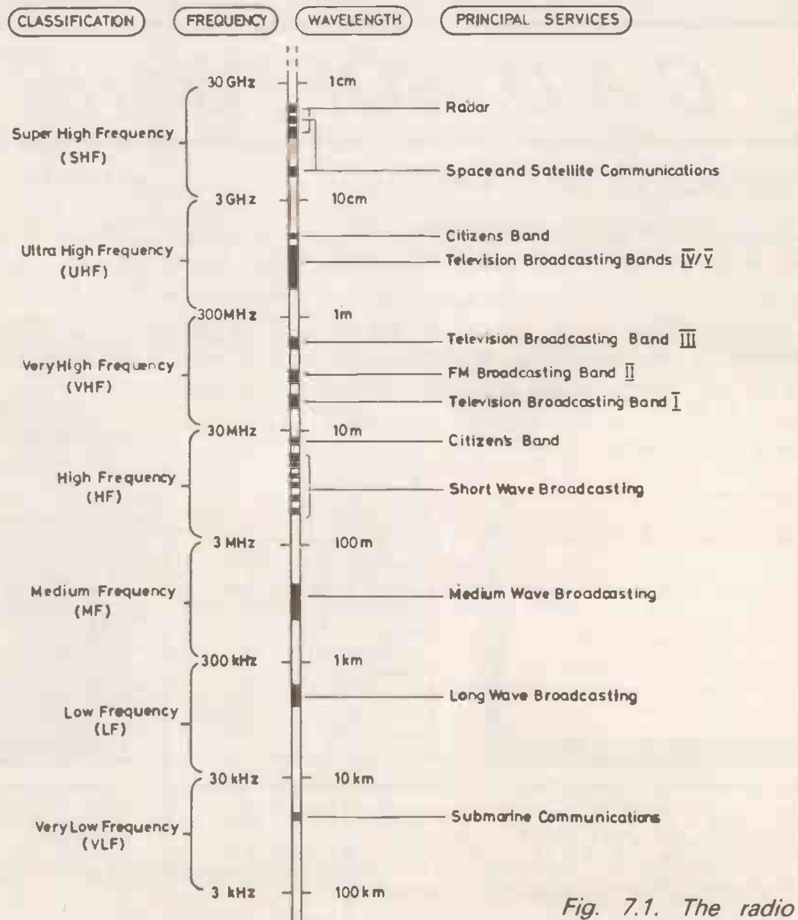


Fig. 7.1. The radio frequency spectrum.

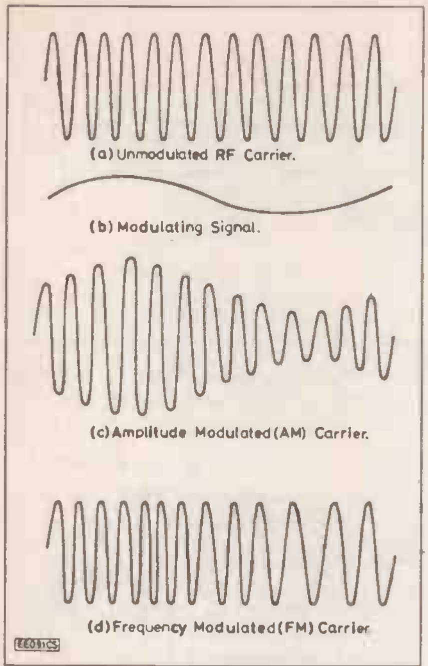


Fig. 7.2. Amplitude and frequency modulation.

carefully safeguard their own areas of the spectrum.

FREQUENCY AND WAVELENGTH

Radio waves propagate in air (or space) at the speed of light (300 million metres per second). The velocity of propagation, v, wavelength, λ, and frequency, f, of a radio wave are related by the equation:

$$v = f\lambda = 3 \times 10^8 \text{ m/s}$$

This equation can be arranged to make f and the subject, as follows:

$$f = 3 \times 10^8/\lambda \text{ Hz} \quad \text{and} \quad \lambda = 3 \times 10^8/f \text{ m}$$

As an example, a signal at a frequency of 1MHz will have a wavelength given by:

$$\lambda = 3 \times 10^8/1 \times 10^6 = 300\text{m}.$$

Question 1: Determine the frequency of an l.f. radio signal having a wavelength of 1500m.

Question 2: Determine the wavelength of a v.h.f. radio signal having a frequency of 150MHz.

MODULATION

In order to convey information from one place to another by means of a radio wave, the signal information must be "modulated" onto a radio frequency carrier. Modulation is simply the name given to the process of changing a particular property of the carrier wave in sympathy with the instantaneous voltage (or current) of the signal to be conveyed.

Methods of modulation with which most readers will be familiar include amplitude modulation (a.m.) and frequency modulation (f.m.). In the former case, the carrier amplitude (its peak voltage) varies according to the voltage, at any instant, of the modulating signal.

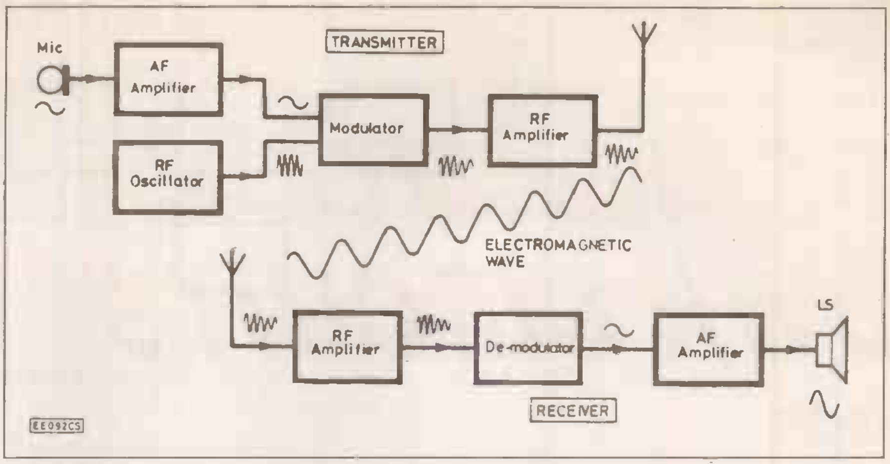


Fig. 7.3. Simplified block schematic of a complete radio communication system.

In the latter case, the carrier frequency is varied in accordance with the instantaneous modulating signal voltage.

The effect of amplitude and frequency modulating a sinusoidal carrier is shown in Fig. 7.2 (note that the modulating signal is, in this case, also sinusoidal). In practice, many more cycles of the r.f. carrier would occur in the timespan of one cycle of the modulating signal.

Question 3: A 1MHz carrier is modulated by a 1kHz signal. How many cycles of the carrier occur within the timespan of one cycle of the modulating signal?

DEMODULATION

Demodulation is the reverse process to modulation and is the means by which the signal information is recovered from the modulated carrier. Demodulation is achieved by means of a demodulator (sometimes called a "detector"). The output of a demodulator consists of a reconstructed version of the original signal information present at the input of the modulator stage within the transmitter.

The simplified block schematic of a complete a.m. radio communication system is shown in Fig. 7.3. The carrier wave (of constant frequency) is generated by means of an r.f. oscillator stage. In order to guarantee the stability of this stage, the frequency of its output is usually governed by means of a quartz crystal.

The output of the modulator (a modulated carrier) is amplified before outputting to the aerial system. The output is usually carefully filtered to remove any spurious signals (harmonics) which may be present and which may otherwise cause interference to other services.

At the receiver, the signal produced by the receiving aerial is a weak copy of the transmitted signal (its level is usually measured in μV!). Also present will be countless other signals at different frequencies (and some with appreciably larger amplitudes than the desired signal). These unwanted signals must be rejected by the receiver's r.f. tuned circuits if they are not to cause problems in later stages.

Besides selectivity, the r.f. amplifier stage also provides voltage and power gain so that a much larger signal is available at the input to the demodulator stage. The signal recovered from the demodulator (usually 100mV, or more) is then applied to an a.f. amplifier in order to bring the signal to a voltage and power level suitable for connection to headphones or a loudspeaker.

SIMPLE RADIO RECEIVER

A simple tuned radio frequency (TRF) radio receiver is shown in Fig. 7.4. This circuit employs a parallel tuned circuit (L2, VC1) input stage which exhibits the impedance/frequency characteristic shown in Fig. 7.5. Maximum gain occurs at the frequency of resonance of the circuit which is approximately given by:

$$f = \frac{159}{\sqrt{LC}} \text{ MHz}$$

where L is the value of L2 (in μH) and C is the value of VC1 (in pF).

In the circuit of Fig. 7.4, TR1 acts as

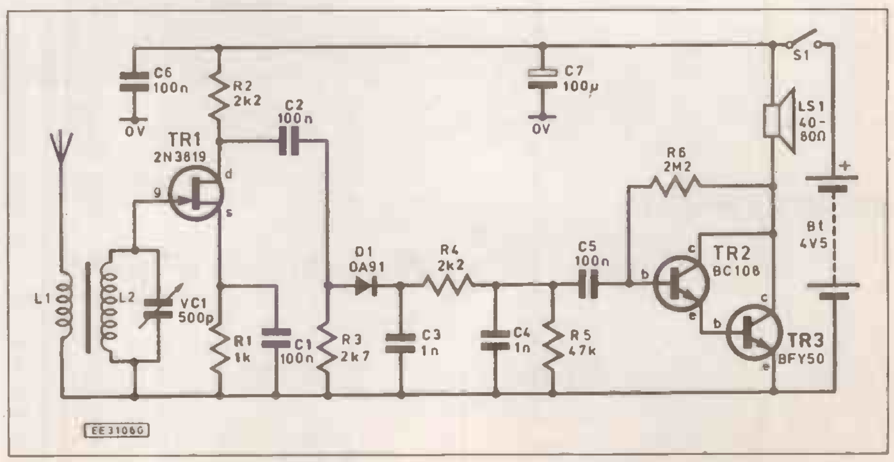


Fig. 7.4. A simple tuned radio frequency (TRF) receiver.

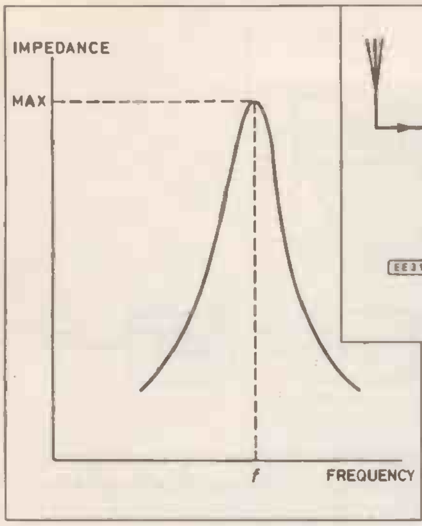


Fig. 7.5. Impedance/frequency characteristic for a parallel tuned circuit.

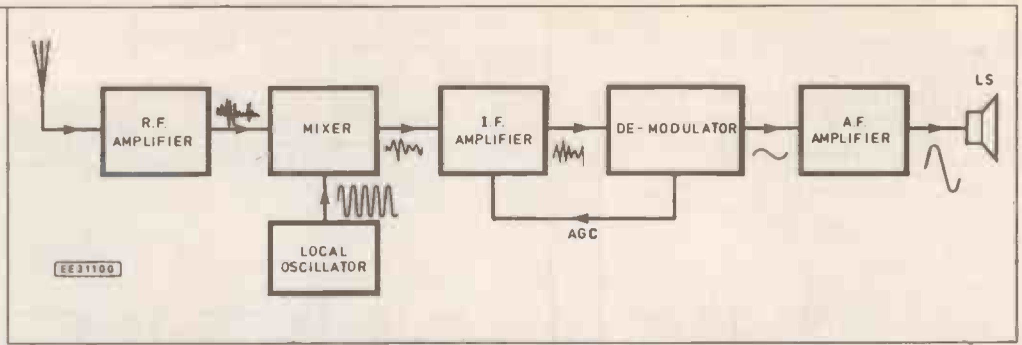
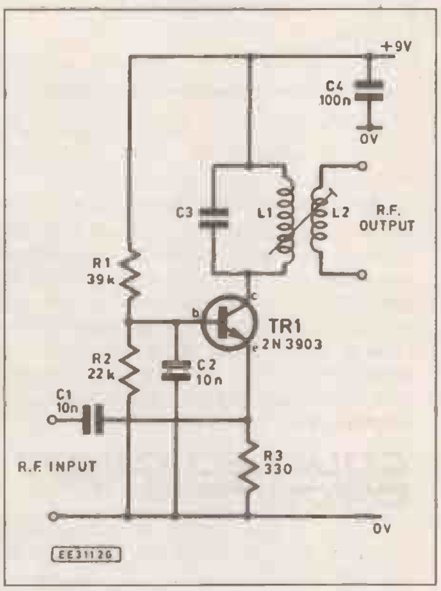


Fig. 7.6. Simplified block schematic for a superhet receiver.



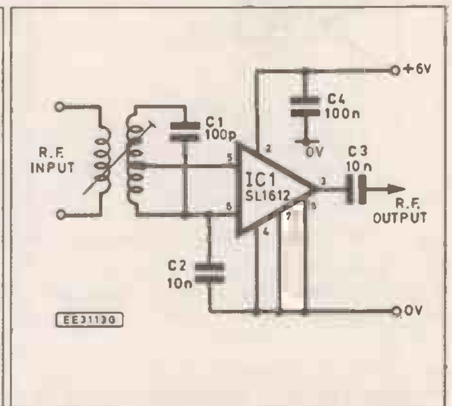


Fig. 7.9 (above). Single-stage r.f. amplifier using an SL1612.

Fig. 7.8 (left). Common base r.f. amplifier stage

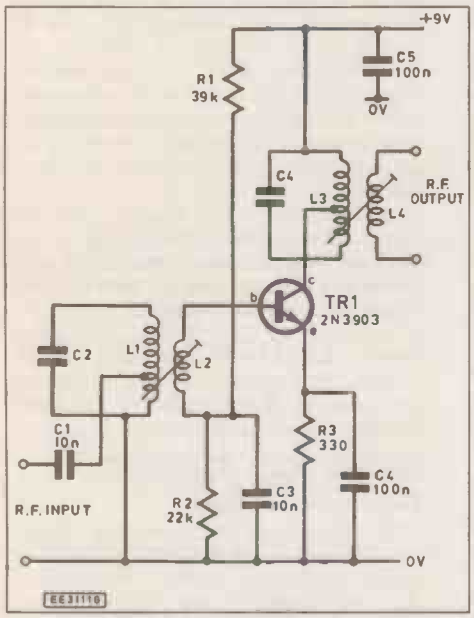


Fig. 7.7. Common emitter r.f. amplifier stage.

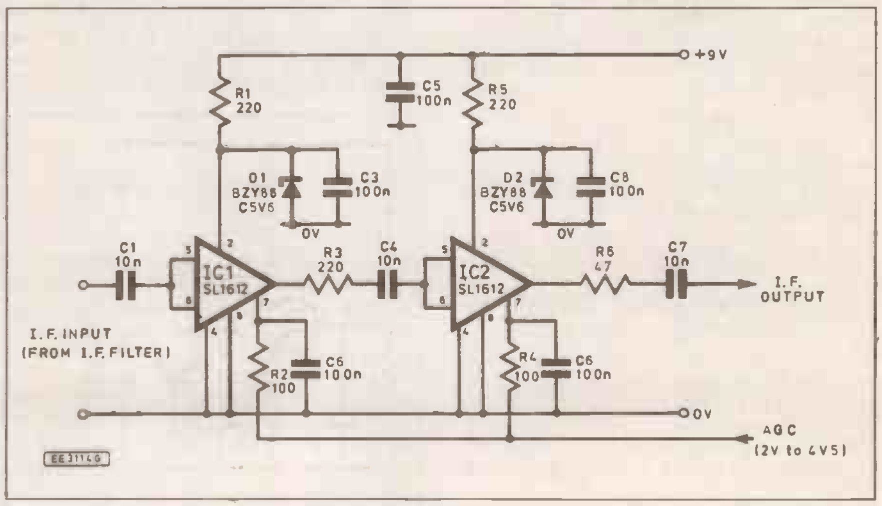


Fig. 7.10. High gain multi-stage i.f. amplifier based on SL1612 devices.

an r.f. amplifier stage. The f.e.t. has a very high input impedance (thus minimising the loading on the parallel tuned circuit to ensure a high value of selectivity). Diode D1 and associated components comprise the a.m. demodulator whilst TR2 and TR3 provide a simple audio frequency amplifier which will provide sufficient output to drive a small loudspeaker.

Question 4: The circuit of Fig. 7.4 is to be built using an inductor of 220µH and a capacitor which has minimum and maximum values of 50p and 500p, respectively. Determine the tuning range for the receiver.

SUPERHET

More complex receivers are based on the supersonic-heterodyne (superhet) principle. In such receivers, the wanted input signal is converted to a fixed intermediate frequency (i.f.) at which the majority of the gain and selectivity is applied. Superhet receivers thus tend to be both more selective and sensitive than their TRF counterparts.

The intermediate frequency chosen is generally 455kHz or 470kHz for a.m. receivers and 10.7MHz for communications and f.m. receivers. Fig. 7.6 shows the simplified block schematic of an a.m. superhet receiver (note that the intermediate frequency is the difference between the signal frequency and the local oscillator frequency).

R.F. AMPLIFIERS

Alternative tuned r.f. amplifier stages are shown in Figs. 7.7 and 7.8. The circuit of Fig. 7.7 is based on a transistor operating in common emitter mode whilst that in Fig. 7.8 uses common base mode.

The circuit of Fig. 7.7 is often used in multi-stage r.f. amplifiers and in the intermediate frequency (i.f.) amplifier stages of superhet receivers. The medium input impedance of the transistor (typically 1.5k) is matched to the input tuned circuit by means of a secondary winding. This step-down impedance matching arrangement helps to avoid over-damping the tuned circuit and ensures that the stage maintains a reasonable degree of selectivity. The medium/high output impedance of the transistor (typically 50k) is tapped into the collector tuned circuit for similar reasons. Provided that appropriate components are used, the circuit is effective at frequencies up to 50MHz, or so.

The circuit of Fig. 7.8 makes an excellent high-gain input matching stage which can be used to match a low-

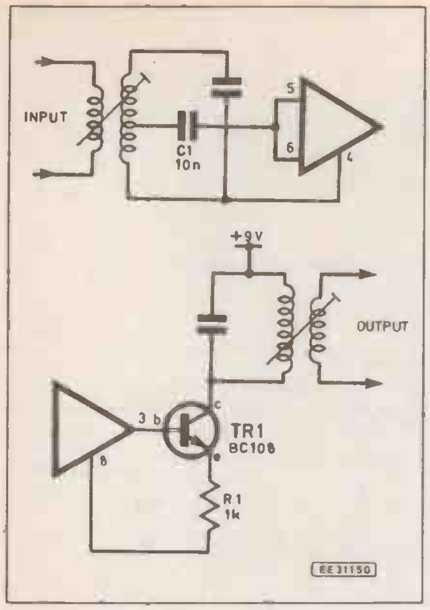


Fig. 7.11. Alternative methods of coupling into and out of an SL1612 amplifier stage. (a) Tapped input coil. (b) Transistor output stage.

impedance aerial system to the very high impedance of an r.f. tuned circuit (without the need for a collector tapping). Provided that appropriate components and constructional techniques are employed, this circuit is effective at frequencies up to 500MHz, or so.

As an alternative to the use of discrete transistors, several integrated circuits are available which can be employed in general purpose r.f. amplifier stages. The Plessey SL1612 is an excellent example of such devices and, whilst the i.c. was developed primarily for use in "professional" r.f. communications equipment, it is ideally suited to "general purpose" and experimental applications. The SL1612 operates from a single +6V (nominal) supply rail and produces voltage gains of up to 34dB with a bandwidth which typically extends from 100kHz to over 15MHz.

The SL1612C can be employed in typical single and high-gain multiple stage r.f. and i.f. amplifiers as shown in Figs. 7.9 and 7.10. In the latter case, automatic gain control (AGC) is incorporated in order to maintain a reasonably constant signal level at the subsequent detector stage. The AGC arrangement makes use of the gain control

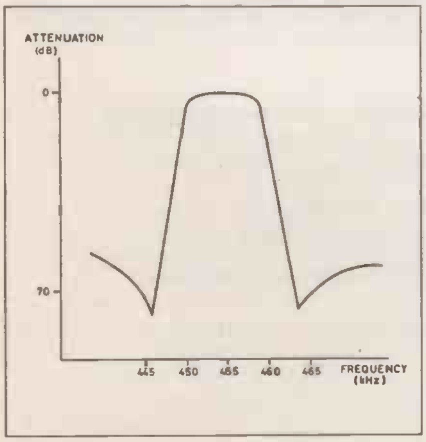


Fig. 7.14. Typical 455kHz ceramic filter response characteristic.

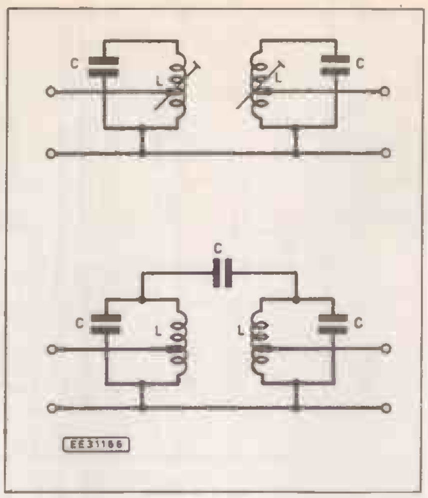


Fig. 7.12. Coupled tuned circuits. (a) Inductive coupling. (b) Capacitive coupling.

input (pin-7) of the SL1612. The d.c. potential applied to this pin determines the value of stage gain. It should be note that maximum gain is realised when the voltage applied to pin-7 is approximately 2V and that the stage gain falls progressively as the voltage is increased to a maximum of about 4.5V. Fig. 7.11 shows alternative methods of coupling into, and out of an r.f. amplifier stage based on an SL1612.

COUPLED TUNED CIRCUITS

Where a high degree of selectivity is required, several tuned circuits may be coupled together, either by means of mutual inductance or by means of mutual capacitance (see Fig. 7.12). With such an arrangement, the degree of coupling between the two tuned circuits is critical in

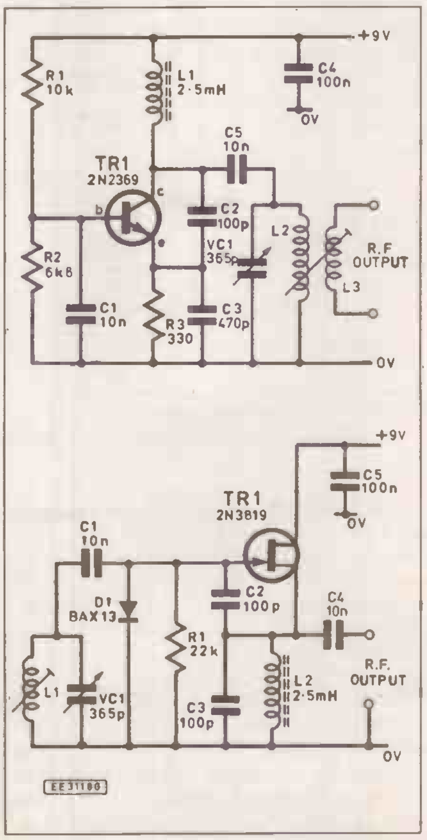


Fig. 7.15. R.F. oscillator circuits. (a) Bipolar transistor oscillator. (b) F.E.T. oscillator stage.

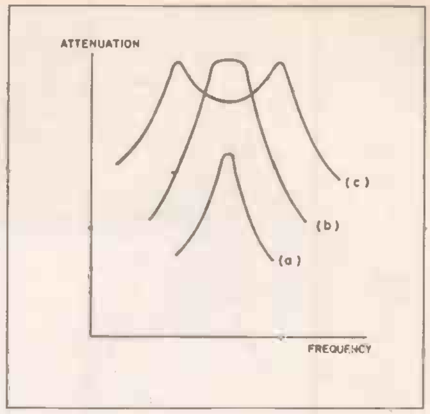


Fig. 7.13. Effect of different degrees of coupling. (a) Under coupling. (b) Optimum coupling. (c) Over coupling.

order to maintain an optimum frequency response characteristic (see Fig. 7.13).

Where a very sharp response characteristic is required, tuned coupling circuits should be abandoned in favour of mechanical or piezoelectric resonators or filters based on quartz crystals. In either event, it may be necessary to couple into and out of such a filter by means of tuned transformers. Compound arrangements of this type permit easy matching to conventional transistor and i.c. amplifier stages and help to minimise unwanted out-of-band responses. Fig. 7.14 shows the typical frequency response characteristic of a 455kHz ceramic filter suitable for the i.f. stages of a superhet receiver.

R.F. OSCILLATORS

R.F. oscillators are used both in the local oscillator stages of superhet receivers and as a signal source in transmitters and signal generators. Fig. 7.15 shows simple transistor oscillator circuits based on bipolar and field-effect transistors. In each case, the stability of the stage (in terms of frequency) will be governed both by the quality of the tuned circuit components and the degree of regulation of the supply voltage.

In order to accurately define the frequency of operation of an r.f. oscillator, a quartz crystal may be used as the frequency determining element. Figs. 7.16 and 7.17 show quartz crystal controlled oscillator circuits suitable for low-frequency (100kHz to 1MHz approx.) and medium/high-frequency (1MHz to 20MHz) crystals.

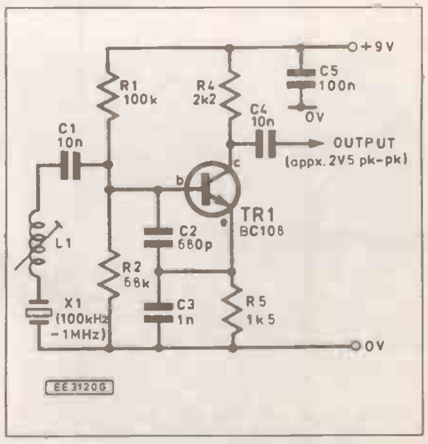


Fig. 7.16. Crystal oscillator for low-frequency crystals.

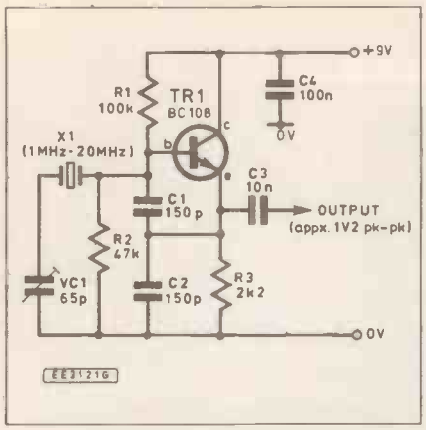


Fig. 7.17. Crystal oscillator for medium/high-frequency crystals.

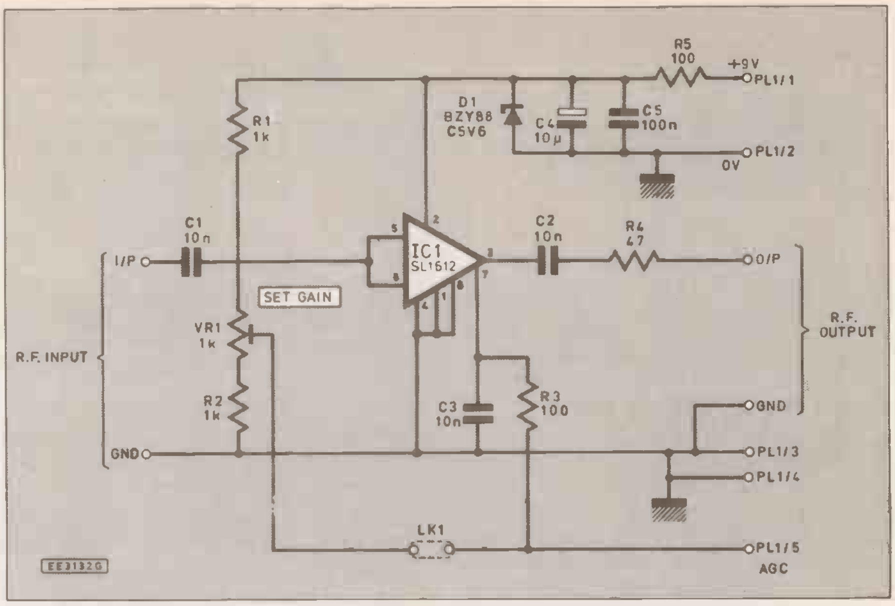


Fig. 7.18. Complete circuit diagram for the R.F. Amplifier module.

R.F. AMPLIFIER MODULE

Our R.F. Amplifier module has been designed to satisfy a variety of requirements and is based on a Plessey SL1612 R.F. Amplifier integrated circuit. Fig. 7.18 shows the complete circuit of the R.F. Amplifier module. The supply and (optional) AGC input are connected by means of a 5-way p.c.b. header (PL1).

Since the input and output signals will usually be connected by means of short length of miniature r.f. coaxial cable, the input and output connections are made by soldering directly to pairs of p.c.b. terminal pins. This arrangement minimises stray coupling between the output and input and helps maintain gain and stability (particularly important at high frequencies). Note that R1, R2 and VR1 are not required in applications in which the AGC input is used.

The connections to PL1 are as follows:

PL1

Pin No.	Function
1	+9V
2	Ground/0V
3	Ground/0V
4	Ground/0V
5	AGC

COMPONENTS

See SHOP TALK Page

Resistors

R1	1k
R2	1k
R3	100
R4	47 (see text)
R5	100

All 0.25W, 5% carbon.

Potentiometer

VR1	1k min. horiz. preset

Capacitors

C1 to C3	10n min. ceramic (3 off)
C4	10µ radial elect. 16V
C5	100n min. ceramic

Semiconductors

D1	BZY88C5V6
IC1	SL1612C

Miscellaneous

PL1	5-way straight p.c.b. header (0.1 inch pitch)
LK1	2-way straight p.c.b. header (0.1 inch pitch) with shorting link

Printed circuit board available from the *EE PCB Service* order code EE750; 0.04 inch terminal pins (4 off).

Approx cost guidance only **£9.50**

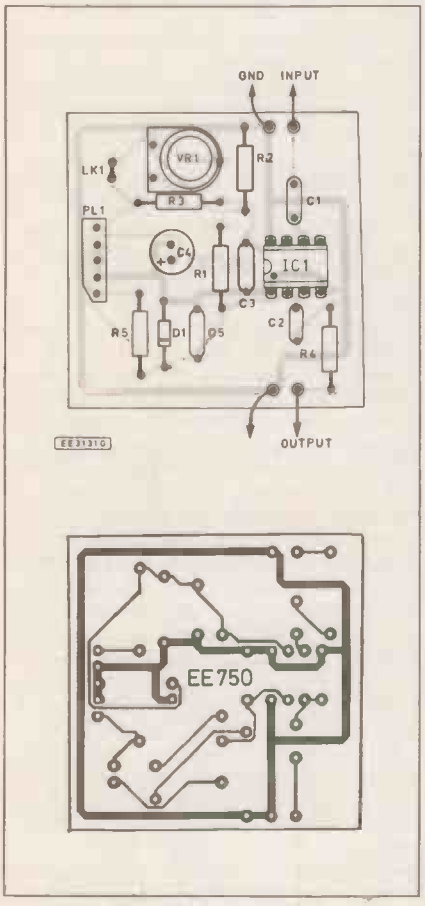


Fig. 7.19. P.C.B. track and component layout for the R.F. Amplifier module.

Photograph of the complete R.F. Amplifier module.

R.F. Amplifier module specifications:

Frequency range	100kHz to 15MHz
Input impedance:	2.5 kilohms (at 1MHz)
Output impedance:	less than 50 ohm (at 1MHz)
Voltage gain:	34dB (R_s = 50 ohm, R_L = 500 ohm)
AGC range:	70dB
AGC current:	150µA (typ. at V_{AGC} = +5V)
Noise figure:	3dB
Maximum output signal:	1V r.m.s. (R_L = 1.2k)
Maximum input signal	250mV r.m.s.
Supply voltage:	9V
Suply current:	40mA (typical)

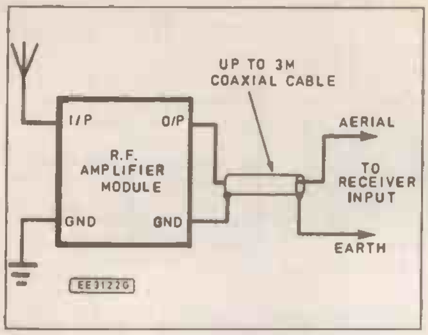


Fig. 7.20. Untuned aerial preamplifier.

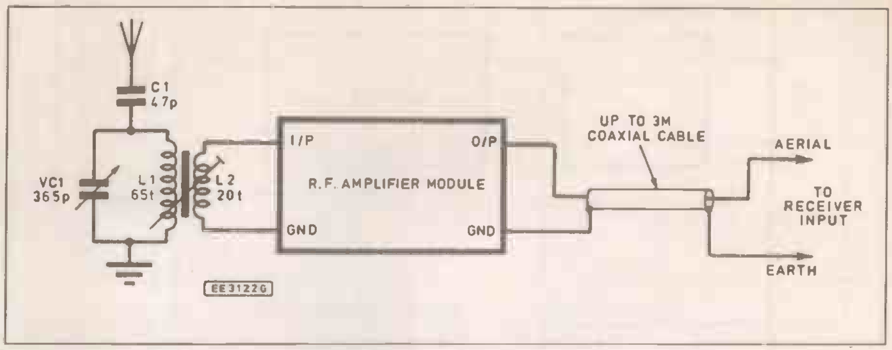


Fig. 7.21. Tuned preselector.

GAIN CONTROL

The gain of the R.F. Amplifier module is determined by the value of d.c. bias applied to pin-7 of IC1. The d.c. bias voltage (V_{AGC}) may be developed internally (from the potential divider chain comprising R1, VR1 and R2) or may be derived externally (in applications where AGC is required).

It is important to note that the stage gain *falls* as the d.c. bias voltage (V_{AGC}) *increases*. Maximum gain occurs for values of V_{AGC} of 2V, or less. Attenuation (rather than gain) occurs as V_{AGC} increases above 3.5V. Maximum attenuation occurs at V_{AGC} = 5V. The relationship between stage gain and V_{AGC} is given in the following table:

V_{AGC}	Stage gain
2.0	34dB
2.5	29dB
3.0	16dB
3.5	3dB
4.0	–26dB
4.5	–36dB
5.0	–40dB

The p.c.b. link (LK1) should be connected in applications in which the AGC facility is not used. In this case, a variable d.c. bias voltage is fed from VR1 to the AGC input to IC1. The voltage is adjustable over the range 2V to 4V approx.

The p.c.b. track and component layout for the R.F. Amplifier module is shown in Fig. 7.19.

APPLICATIONS

The circuit of Fig. 7.20 shows how the R.F. Amplifier can be used as a simple untuned aerial preamplifier stage. It is important to note that, by virtue of the high gain and broadband nature of the unit, this arrangement it not recommended for use with longwire aerials which are likely to produce signals of appreciable amplitude.

A tuned "preselector" arrangement is shown in Fig. 7.21. Long and short aerials (of low and high impedance, respectively) can be connected to this unit. The r.f. tuned circuit should be adjusted (by means of VC1) to maximise the amplitude of the wanted signal and reduce the levels of unwanted signals on other bands (which may otherwise cause blocking and cross-modulation within the R.F. Amplifier or subsequent stages).

A complete TRF receiver arrangement is shown in Fig. 7.22. This circuit is suitable for the reception of strong local signals in the medium and long wave bands. Fig. 7.23 shows how a signal strength meter (S-meter) can be added to the circuit of Fig. 7.22. In conjunction with suitable coils and a calibrated dial, this arrangement makes an excellent field strength meter or wavemeter for use in conjunction with amateur transmitters operating on the l.f. and h.f. amateur bands (160m, 80m, 40m and 20m).

The sensitivity and selectivity of the simple TRF receiver in Fig. 7.22 is somewhat limited but can be greatly improved by means of "reaction". The circuit of Fig. 7.24 shows how this form of feedback can be applied from output to input. In use, VC2 is adjusted to the point at which the circuit just starts to become unstable. The capacitor setting is then reduced a little (to ensure that the receiver remains stable across its desired tuning range).

The coil winding details are for a receiver which covers the medium waveband (from 500kHz to 1.5MHz) where the coils are wound on a ferrite rod. By appropriate changes to the coil, a similar arrangement can be used for frequencies of up to about 15MHz (but using a conventional coil former and external aerial above 2MHz). If you intend to experiment with this arrangement, it is important to note that the number of turns on *each* of the three windings should be reduced in the same proportion as the frequency is increased.

The R.F. Amplifier can also be used as an intermediate frequency (i.f.) amplifier within a superhet receiver arrangement. Figs. 7.25(a) and (b), respectively show i.f. amplifiers for use at 455kHz and 10.7MHz. These circuits are ideal for high-performance a.m. receivers and are based on mechanical resonators and quartz crystal filters, respectively. In both cases, an AGC voltage (derived from the detector stage) is applied in order to maintain a reasonably constant output voltage over a wide range of input signal levels.

Finally Figs. 7.26(a) and (b) show how the R.F. Amplifier module can be used to form the basis of an r.f. oscillator. In Fig. 7.26(a), the frequency of operation is determined by a tuned circuit whilst in Fig. 7.26(b) the frequency is controlled by means of a quartz crystal (this latter circuit is suitable for fundamental mode from 100kHz to over 10MHz, according to the characteristics of the quartz crystal employed). With a suitable crystal (e.g. 100kHz or 1MHz) the circuit of Fig. 7.26(b) makes a simple but very effective receiver calibrator circuit (the harmonics of the fundamental frequency being detectable up to several MHz in the case of a 100kHz crystal and beyond 10MHz for a 1MHz component).

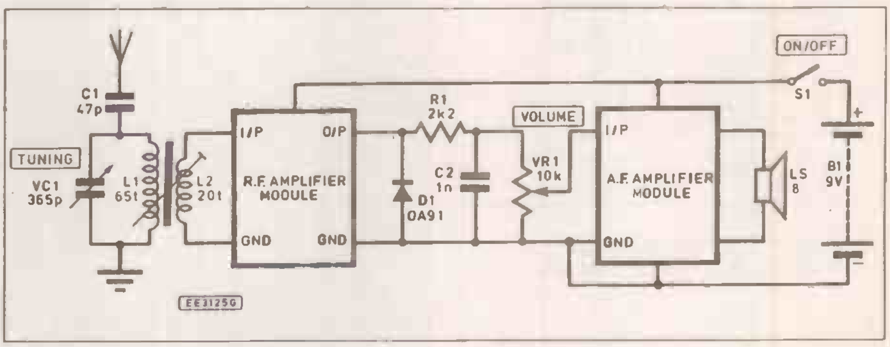


Fig. 7.22. Complete TRF receiver.

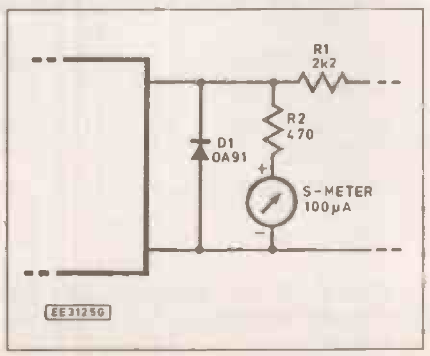


Fig. 7.23. Adding a signal strength meter.

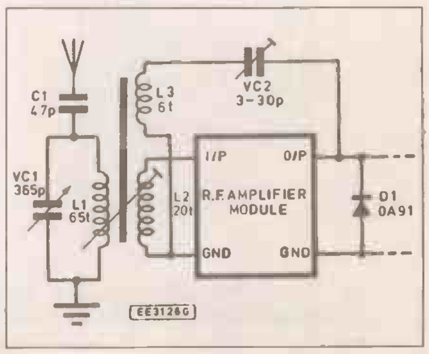


Fig. 7.24. TRF receiver incorporating "reaction".

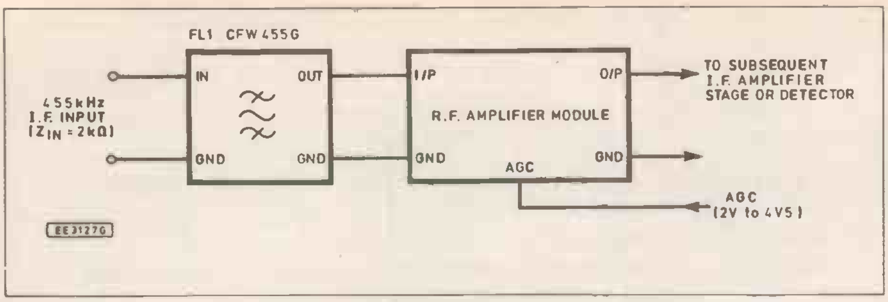


Fig. 7.25(a). I.F. amplifier stage for 455kHz.

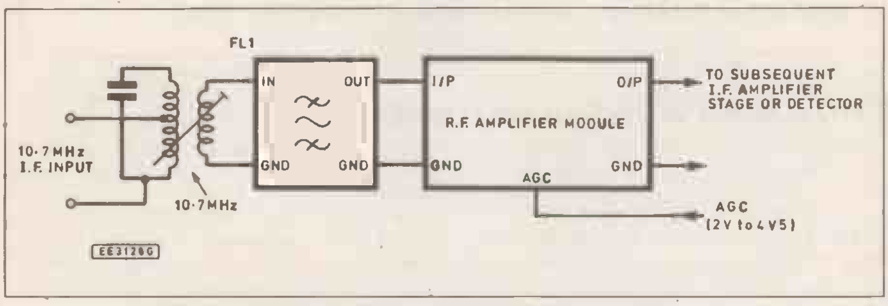


Fig. 7.25(b). I.F. amplifier stage for 10.7MHz.

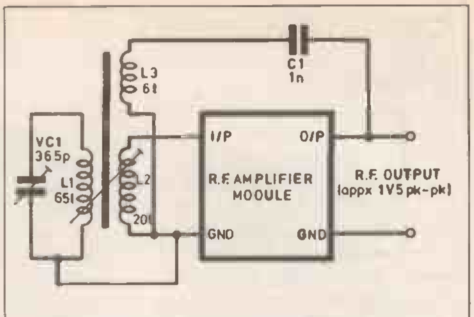
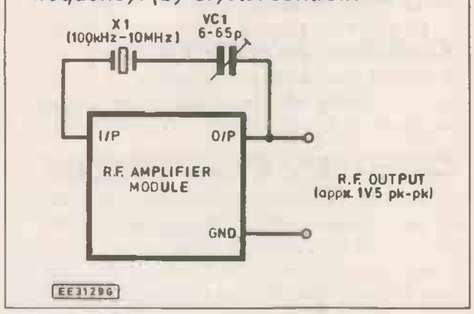


Fig. 7.26. R.F. oscillators. (a) Variable frequency. (b) Crystal controlled.



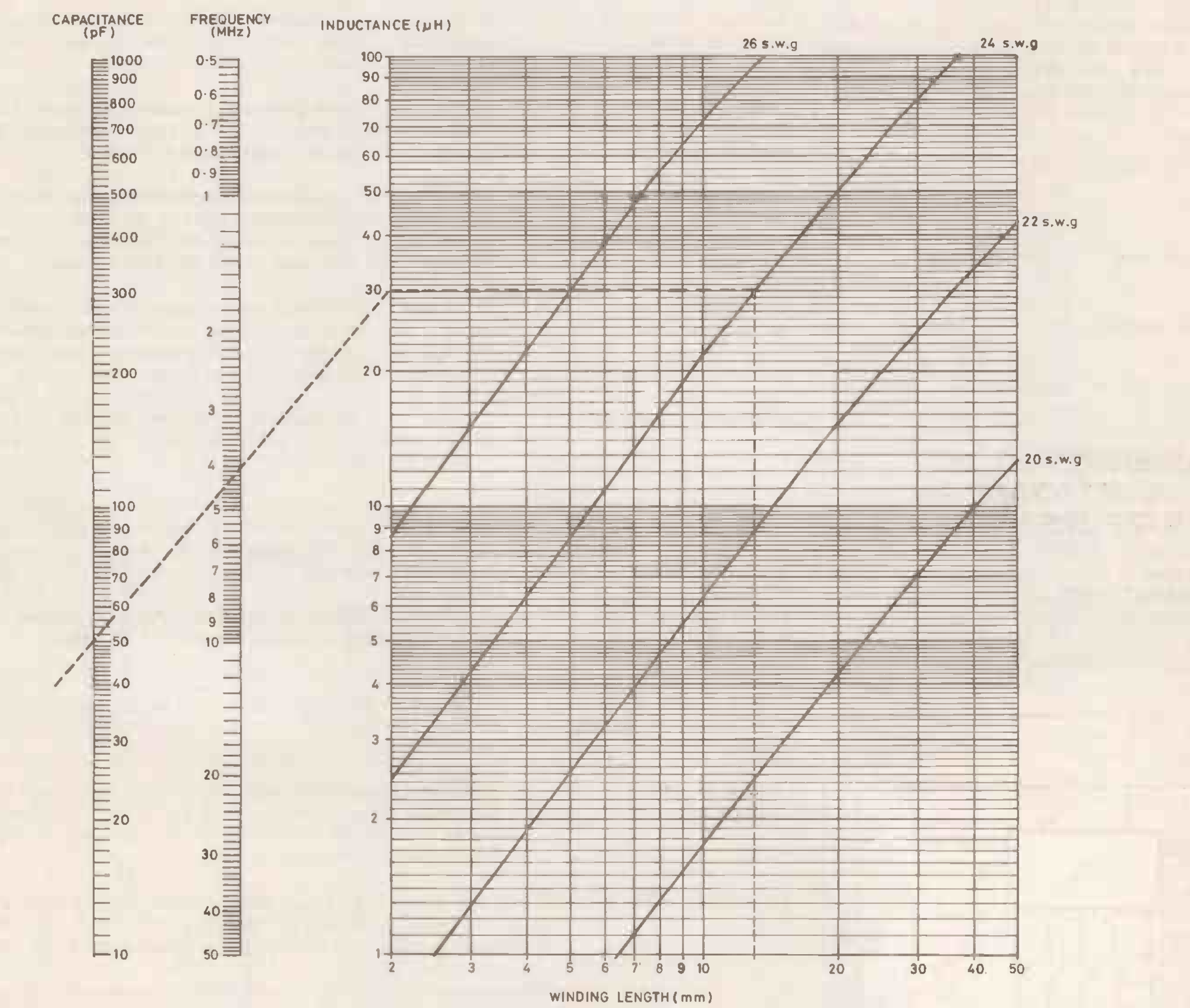


Fig. 7.27. Nomograph for coil winding (based on a 7mm diameter coil former). The example shows how a tuned circuit for operation at 4MHz is realised by a capacitance of 50pF and inductance of 30μH composing a 13mm length winding of 24s.w.g. enamelled copper wire close wound on a 7mm diameter former.

COIL WINDING

One of the major problems which confronts would-be radio experimenters is that of having to wind inductors for use in r.f. tuned circuits and filters. This task is, however, not quite so daunting as it may at first appear. The diagram shown in Fig. 7.27 (which relates to a commonly available type of coil former having a diameter of approx. 7mm) should assist readers in selecting the appropriate components (inductance and capacitance) to obtain a specified resonant frequency as well as indicating the approximate number of turns required.

In order to permit precise adjustment of inductance, the coil former should be fitted with an adjustable ferrite core. In such an event, the *maximum* inductance will increase by a factor of about two.

DESIGN PROBLEM

This month's design problem (as with all of the design problems presented in this series) is designed for readers who would welcome the opportunity of tackling a little "homework". The exercise may be tackled purely "on paper" or may be used as the basis of a complete constructional project.

This month's problem involves designing a simple medium-wave a.m. tuner for use with the Bench Amplifier/Signal Tracer which we described in Part 3. The tuner is to have the following specification:

Tuning range: *700kHz to 2MHz (specify the coil and capacitance required to cover this range)*
Aerial input: *Separate inputs for high and low-impedance aerials*
Audio output: *100mV (typical) into 5kilohm (the unit should incorporate an audio amplifier stage)*
Supply: *single 9V battery (PP3)*

ANSWERS TO QUESTIONS IN PART SEVEN

Question 1: 200kHz
Question 2: 2m
Question 3: 1000
Question 4: Minimum frequency = 479kHz
Maximum frequency = 1.516MHz

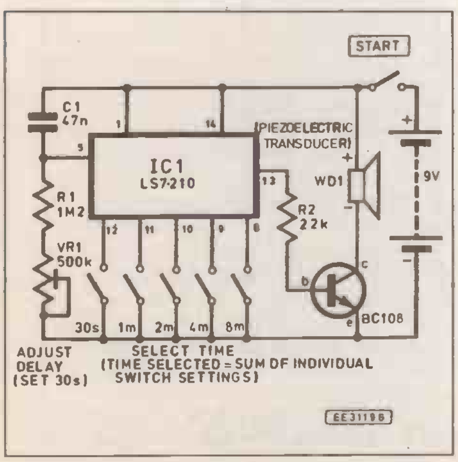


Fig. 7.28. Answer to last month's Design Problem.

Answer to last month's design problem:

A darkroom timer is to be designed according to the following target specification:

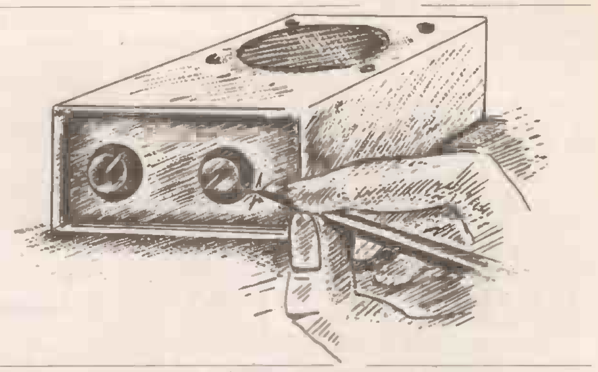
Time intervals: *switch selected from 30 seconds to 7.5 minutes in 30 second increments.*
Visual output: *standard l.e.d.*
Audible output: *piezoelectric transducer (requiring a supply of between 3V and 16V of nominally 5mA).*
Supply: *single 9V batery (PP3)*

One solution to last month's design problem is shown in Fig. 7.28.

Cumulative index to modules

Title	Part	Function/specification
Dual output power supply module	1	Dual ±5V, ±12V or ±15V regulated power supply rated at 1A max. output
723 variable power max. supply module	1	Single variable output of +2V to +37V at up to 5A Output voltage and current limit are set by means of preset controls.
L200 variable power supply module	1	Single variable output of +2.7V to +35V at up to 2A max. Output voltage and current limit are set by means of variable controls.
General purpose transistors amplifier module	2	Pre-defined voltage gain and frequency response. Low/medium input impedance, low output impedance. Requires a single 9V d.c. supply at 2mA nominal.
General purpose operational amplifier module	2	Pre-defined voltage gain and frequency response. Two stages may be used independently (e.g. for stereo operation) or connected in tandem. Requires a dual supply of between ±5V and ±15V at 10mA nominal.
High-quality power amplifier module	3	Fixed gain medium/high power class AB audio amplifier capable of operating with very low distortion. Recommended load impedance 8ohm. Requires a dual supply of between ±12V and ±20V at up to 2A.
TBA820 i.c. amplifier	3	Versatile i.c. low/medium power for general purpose applications. Requires a single supply rail of between +5V and +15V.
Sine wave oscillator	4	Low distortion sine wave oscillator capable of providing outputs over the range 50Hz to 50kHz. Frequency and amplitude adjustable. Requires +12V to +15V supply at 10mA (nominal).
8038 waveform generator	4	Provides sine, square and triangle outputs adjustable the range 0.01Hz to 20kHz. Requires ±9V supply at 10mA.
Digital counter module	5	Single stage decade counter with seven-segment l.e.d. display. Standard TTL input levels. Requires +5V supply at 90mA.
General purpose timer module	6	Astable or monostable mode timer circuit configured by wire links. Extenal trigger (both a.c. and d.c.) and reset inputs. Output up to 12V at 200mA. Requires a single supply rail of between +5V and +15V.
RF amplifier module	7	High gain r.f. amplifier module which can be used in a variety of applications, including receivers (both TRF and superhet) and test equipment. Requires a single supply rail of +9V.

RADIO RECEIVER



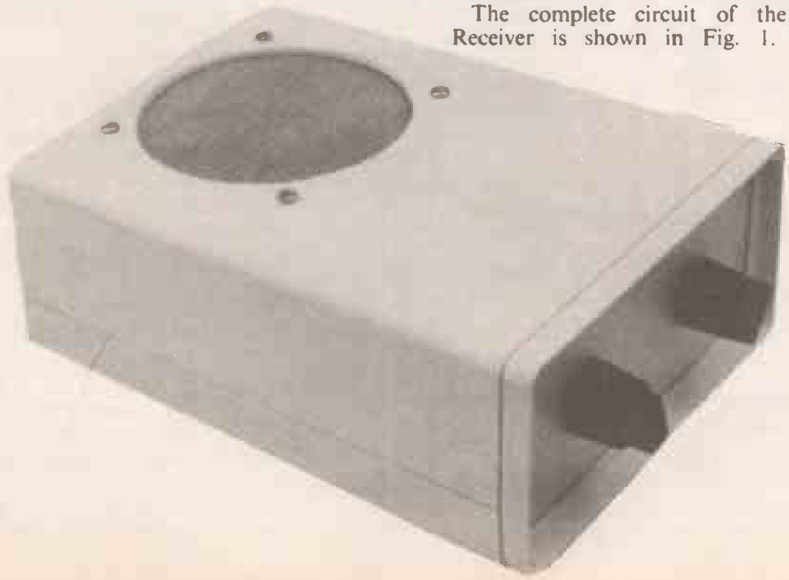
MIKE TOOLEY BA

This companion project to our Design Your Own Circuits series features a simple radio which can be used to receive broadcast signals on the long, medium and short-wave bands. As with all of our practical projects, a number of modifications are suggested so that the more intrepid constructor can customise the unit to his or her own particular requirements.

RADIO receivers can make fascinating constructional projects and, whilst such items are nowadays commonplace and extremely cheap, the pleasure and satisfaction which can be achieved from building your own radio is hard to describe. Projects of this sort can be very satisfying and will never fail to impress friends and family!

Superheterodyne receivers are generally not suitable for the beginner to electronic project construction as they are generally somewhat difficult to adjust and align. Tuned radio frequency (TRF) receivers, on the other hand, often prove to be somewhat disappointing in that they are usually lacking in both sensitivity and selectivity.

Our Radio Receiver adopts the TRF approach and, whilst the design is extremely simple, it is capable of a performance which is comparable with many of the cheaper superhet broadcast receivers which originate from the Far East. Indeed, by incorporating a relatively large ferrite rod and a good quality loudspeaker, the receiver actually out-performs many of the cheaper portable "transistor radios" in terms of sound quality and sensitivity.



CIRCUIT DESCRIPTION

The complete circuit of the Radio Receiver is shown in Fig. 1. IC1, a ZN416E, is an integrated circuit TRF receiver which incorporates the equivalent of 10 transistors in the r.f., detector and a.g.c. stages together with an 18dB low-power audio amplifier/buffer stage.

Coil L1 and VC1 constitute the single r.f. tuned circuit used within the Radio Receiver. In order to obviate the need for an external aerial, L1 is wound on a ferrite rod. The Q-factor of the tuned circuit is crucial in providing an acceptable value of selectivity (usually a problem with TRF receivers). The loading on the tuned circuit is minimised by the exceptionally high value of input impedance at the input (pin-1) of IC1.

The supply to IC1 is adjustable by means of the pre-set resistor, VR1, and series-pass transistor, TR1. This arrangement controls the supply voltage to IC1 which, in turn, determines the r.f. sensitivity of the receiver.

The amplified audio output of IC1 (available at pin-5) is coupled via the volume control (VR2) to a fixed gain audio amplifier stage, IC2. This stage provides a gain of approximately 200 and an output power of up to 300mW (adequate for most portable domestic applications).

The Radio Receiver operates from a nominal 6V d.c. supply rail derived from four AA dry batteries. The receiver will, however, also operate readily from a 9V supply (PP6, PP7 or PP9).

CONSTRUCTION

Construction of the Radio Receiver is very straightforward. With the exception of the two front panel mounted controls, loudspeaker and ferrite rod assembly, all of the components are assembled on a single-sided printed circuit board (available from the *EE PCB Service*) measuring approximately 85 x 47mm. The copper foil and component layout of the printed circuit board is shown in Fig. 2.

Components should be assembled on the printed circuit board in the following sequence; p.c.b. headers, d.i.l. sockets, preset potentiometer, resistors, capacitors, and transistor. As with all of our projects, it is vitally important to ensure that all of the components are correctly located. Furthermore, in the case of the polarised components (such as the electrolytic capacitors, integrated circuits and the transistor) it is absolutely essential to ensure that each component is correctly orientated.

CHECKING

When construction of the printed circuit board has been completed (and before in-

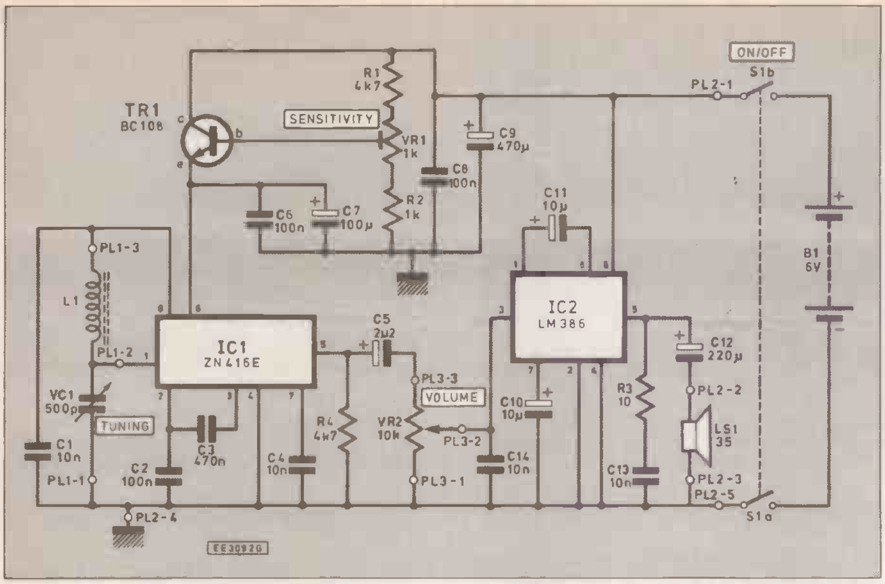


Fig. 1. Complete circuit of the Radio Receiver.

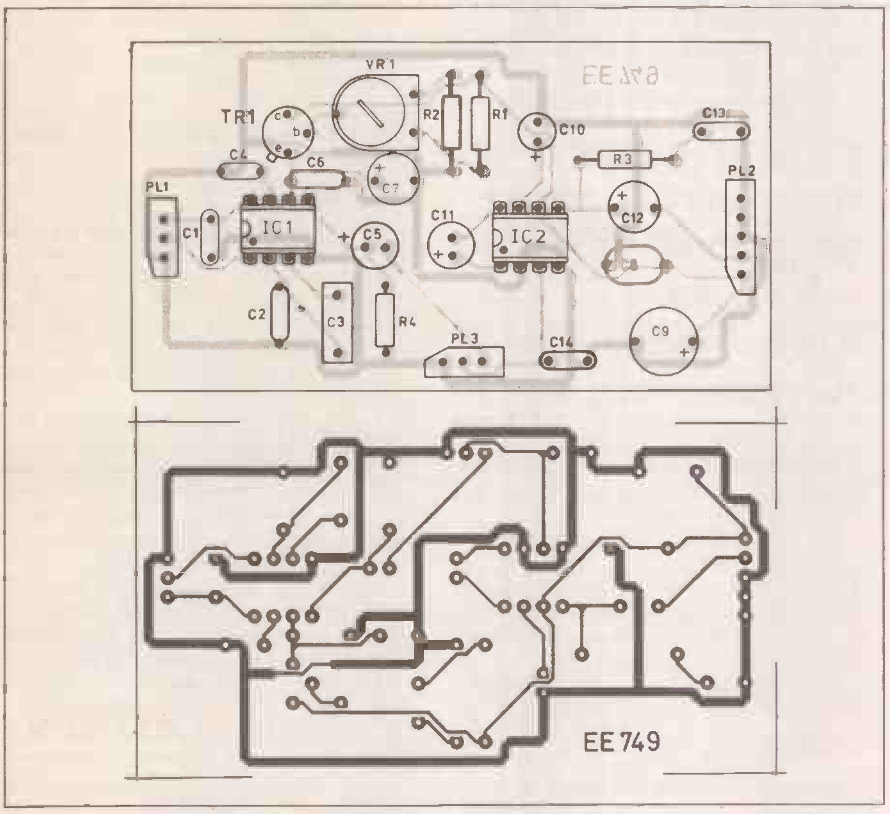


Fig. 2. P.C.B. copper foil and component layout.

serting the two integrated circuits into their respective sockets) it is well worth carrying out a careful visual check of both the upper and lower sides of the board.

The upper (component) side of the printed circuit board should be examined to ensure that the components have been correctly located whilst the lower (copper track) side of the board should be checked to ensure that there are no dry joints or solder bridges between adjacent tracks. This simple precaution will only take a few minutes to carry out but can be instrumental in preventing much heartache at a later stage!

When assembly and checking of the printed circuit board has been completed, the two integrated circuits, IC1 and IC2, should be inserted into their holders (taking care to observe the correct orientation in each case).

CASE

The Radio Receiver should be housed in an ABS enclosure with an aluminium front panel. The enclosure used for the prototype receiver measured approximately 190 x 138 x 68mm and was fitted with an integral bat-

COMPONENTS

See SHOP TALK

Resistors

R1	4k7	
R2	1k	
R3	10	
R4	4k7	

All fixed resistors are 0.25W 5%

Potentiometers

VR1	1k miniature horizontal pre-set
VR2	10k log. (with d.p.s.t. switch)

Capacitors

C1	10n ceramic
C2	100n ceramic
C3	470n miniature layer polyester
C4	10n ceramic
C5	2µ2 radial elect. 63V
C6	100n ceramic
C7	100µ radial elect. 16V
C8	100n ceramic
C9	470µ radial elect. 35V
C10	10µ radial elect. 16V
C11	10µ radial elect. 16V
C12	220µ radial elect. 35V
C13	10n ceramic
C14	10n ceramic

Variable Capacitor

VC1	500p solid dielectric variable capacitor

Inductor

L1	(see text and Fig. 4)

Semiconductors

IC1	ZN416E TRF receiver
IC2	LM386 audio amplifier
TR1	BC108 *npn* transistor

Miscellaneous

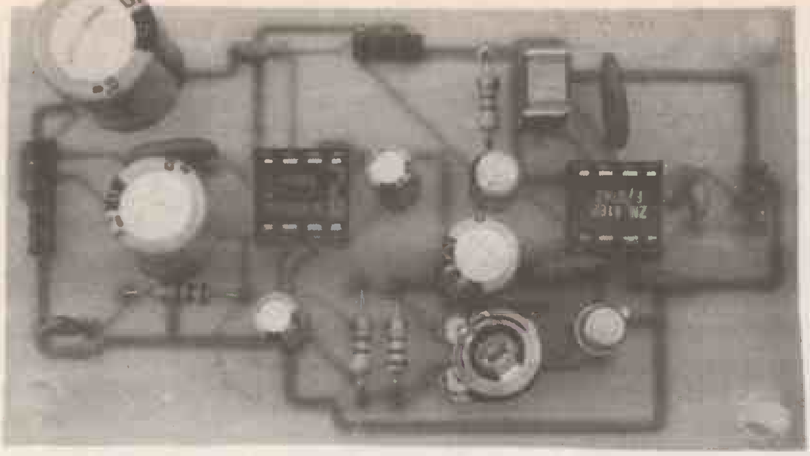
LS1	Speaker 3.5 inch diameter, 35 ohm (or similar)
S2	D.P.S.T. switch (mounted on VR2)
PL1,PL3	3-way straight p.c.b. headers (0.1 inch pitch) and matching "free" connectors, (2 off)
PL2	5-way straight p.c.b. header (0.1 inch pitch) and matching "free" connector

Enclosure ABS enclosure (to suit individual constructor's preference - see text); printed circuit board available from the *EE PCB Service* ,order code EE749; plastic p.c.b. fixing pillars with self-tapping No. 6 fixing screws, (4 off 10mm, 2 off 20mm); snap-fit battery connector (to suit PP6, PP7 or PP9 battery - as appropriate); P-clips (to suit ferrite rod – see text and Fig. 4); 8-pin low-profile d.i.l. sockets (2 off) knobs (2 off); connecting wire etc.

Approx cost guidance only **£27** *plus case*

Specifications

Frequency coverage:	150kHz to 4.5MHz depending on coil (see text)
Sensitivity:	10µV for 100mW output at 900kHz
Selectivity:	±50kHz at –6dB, ±100kHz at –30dB (measured at 900kHz)
A.G.C. range:	+10dB change in audio output over the range 10µV to 1mV
Audio output:	275mW r.m.s. max. (9V supply) 125mW r.m.s. max. (6V supply)
Frequency response:	100Hz to 5kHz (at –3dB)
Supply voltage:	6V to 9V (4 × AA cells for 6V operation, PP6 or PP7 for 9V operation)
Supply current:	65mA (typical)



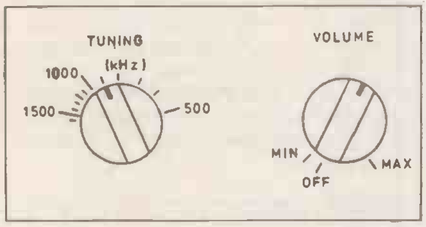


Fig. 3. Recommended front panel layout.

tery compartment which was used to accommodate the four AA batteries.

In practice, the precise dimensions of the enclosure are unimportant provided adequate room is made available on the front panel for the tuning and volume controls, and the enclosure is large enough to accommodate the loudspeaker, ferrite rod assembly, and battery. Where the Radio Receiver is to be fitted with an a.c. mains power supply unit (see Modifications) additional space will be required internally to accommodate the mains transformer and power supply module.

As with the previous projects in this series which have employed loudspeakers, constructors are strongly advised to use a loudspeaker of relatively large size. In the author's experience, the sound quality and efficiency of "miniature" loudspeaker units (of 44mm diameter, or less) leave a great deal to be desired.

The front panel should be carefully marked out before drilling and cutting takes place. As usual, there is nothing particularly critical about the layout of the unit and constructors may wish to experiment with the location of the front panel controls and loudspeaker. Fig. 3 shows the front panel layout and markings used in the prototype.

Once the front panel has been drilled to accommodate the tuning and volume controls, the p.c.b. can be mounted by means of four snap-fit p.c.b. mounting pillars secured to the base of the enclosure.

If the enclosure is not fitted with an integral battery compartment, a battery holder (for a PP6, PP7 or PP9 9V battery) can be manufactured from a simple L-shaped aluminium bracket which can then be secured to the base and/or rear of the case.

COIL

The coil (for recommended medium wave coverage) comprises 65 turns of 30 s.w.g. enamelled copper wire, closewound to occupy a winding length of approximately 23mm. The coil should be wound on an insulated former which can be slid over the ferrite rod so that it can later be adjusted and sealed at the position for which optimum coverage and sensitivity is obtained. In the prototype receiver, the ferrite rod measured 138 x 10mm diameter, and the coil had an inner diameter of approximately 11 mm (see Fig. 4).

The ferrite rod assembly should be supported and retained by means of two P-shaped cable clips (of appropriate diameter) and snap-fit p.c.b. mounting pillars (see Fig. 4).

INTERCONNECTION

Connections to the printed circuit board are made using two three-way 0.1 inch pitch printed circuit board headers (PL1 and PL3) and one five-way 0.1 inch printed circuit board header (PL2). PL1 is used to connect the ferrite rod and tuning capacitor whilst PL2 provides the d.c. power input and loudspeaker output connection. PL3 is used to link the printed circuit board to the volume control.

The recommended method of terminating the female connectors which mate with the headers was described in the first of our constructional projects which appeared in the December 1990 issue of *Everyday Electronics*.

Coloured stranded 0.1 inch pitch ribbon cable is used to make connections to the front panel. The following colour coding is recommended:

PL1

Pin	Colour	Connection to:
1	Brown	Tuning capacitor (ground/shaft)
2	Red	Tuning capacitor
3	Orange	Coil

PL2

Pin	Colour	Connection to:
1	Yellow	S1b (+V)
2	Orange	Loudspeaker
3	Red	Loudspeaker (ground)
4	Brown	Ground (to loudspeaker frame)
5	Black	S1a (0V)

PL3

Pin	Colour	Connection to:
1	Black	VR2
2	Brown	VR2 (wiper)
3	Red	VR2

The internal wiring of the Radio Receiver is shown in Fig. 5.

TESTING

Before testing the Radio Receiver, it is important to carefully check the wiring of the p.c.b., ferrite rod and front panel mounted components. A 6V (or 9V, as appropriate) battery should be connected to the unit and a milliammeter inserted to measure the supply current in the positive supply rail.

If the unit is to be operated from a 9V battery, VR1 should be adjusted for mid-position whereas, if a 6V supply is used VR1 should be set to within 10 per cent of its fully anti-clockwise setting. The tuning control should be adjusted for maximum capacitance (plates fully meshed).

Switch the unit "on" but leave the volume control at minimum setting. The supply current should now be measured and should be in the range 6mA to 20mA. If this is not the case, disconnect the supply and carefully check the wiring and p.c.b.

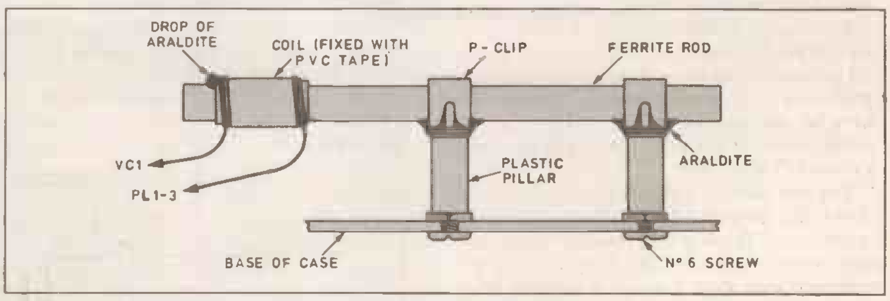


Fig. 4. Ferrite rod coil winding and mounting arrangements.

Coil Details

Wire	Turns	Winding length	Approximate coverage (500pF variable capacitor)
26s.w.g.	20	20 mm (spaced one wire diameter between adjacent turns)	1.4MHz to 4.5MHz
28s.w.g.	45	20 mm (closewound)	850kHz to 2.7MHz
30s.w.g.	65	23 mm (closewound)	500kHz to 1.7MHz
32s.w.g.	100	33 mm (closewound)	350kHz to 1.2MHz
34s.w.g.	150	20 mm (pilewound)	150kHz to 350kHz

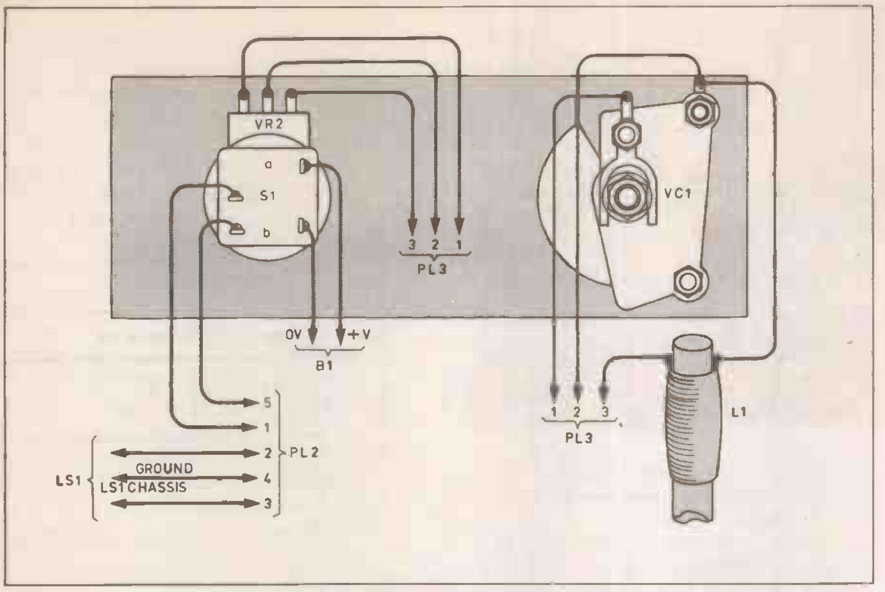
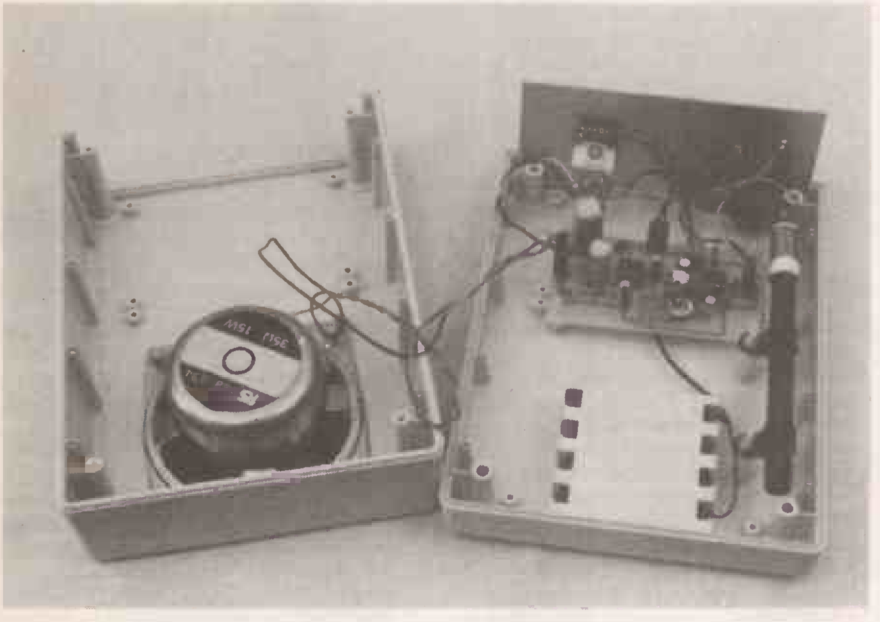


Fig. 5. Internal wiring of the Radio Receiver.



If the supply current is within the correct range, the milliammeter should be disconnected and the volume control advanced to about mid-position. Now adjust the tuning control until a strong signal is heard (this will probably occur at a setting of about 30 per cent from the minimum capacitance position). The position of the coil should now be adjusted in order to optimise the tuning range (frequency coverage) and sensitivity of the receiver.

The coil should simply be moved up and down the ferrite rod until the best setting is obtained. During this process, constructors should note that the ferrite rod is directional and that it may be necessary to rotate the receiver to produce the strongest signal.

Preset VR1 may then be adjusted to set the *overall* sensitivity of the Radio Receiver. The setting of this control may represent something of a compromise between sensitivity and stability. The sensitivity will be increased as the control is adjusted in an anti-clockwise direction. During this process, it is important to ensure that the receiver is unconditionally stable at *all* settings of the tuning control (sensitivity will generally be greater at, or near, the minimum setting of VC1).

IN USE

When the foregoing adjustments have been completed, the Radio Receiver should be capable of receiving a dozen, or more, strong signals across the medium wave band. Reception of distant European signals will improve considerably at night.

Readers should note that the location of the receiver may, in some cases, be critical (particularly when receiving anything other than stronger local stations). For optimum performance, the receiver should be placed in the open and well away from large earthed structures and television receivers (which generate an appreciable amount of radio frequency noise).

When using the receiver, it is well worth experimenting with the optimum position and orientation. Note also that, where several signals are difficult to separate, the receiver should simply be rotated until the unwanted signal is "nulled out".

MODIFICATIONS

A great deal of fun can be had by experimenting with the receiver and several further modifications can be made to enhance the performance of the basic Radio Receiver circuit. As always, the suggestions made here are provided as "food for thought" and should make a starting point for further development. Constructors are invited to report their own modifications to be incorporated in the Readers' Feedback which will appear in the final part of our Design series.

Mains operation

The Radio Receiver can be very easily adapted for mains operation. A suitable mains supply is the Dual Output Power Supply module which appeared in Part One of the series. The module should be fitted with a single 7809 regulator (IC1) and used in conjunction with a transformer having two secondaries rated at 9V, 0.25A (or greater). Fig. 6 shows the necessary circuit modifications.

Mains/battery

The Radio Receiver can also be readily adapted for dual mains/battery operation with automatic changeover to battery operation in the event of supply failure or disconnection of the mains. Fig. 7 shows the necessary changes to the circuit.

L.E.D. indicator

An l.e.d. indicator can be added to the receiver as shown in Fig. 8. The series resistor, R1, should be 390 ohm for a 6V d.c. supply and 680 ohm for a 9V battery.

Alternative coverage

The Radio Receiver can be very easily modified for alternative frequency ranges by simply modifying the coil. Apart from adjustments to VR1, no further changes are necessary in order to ensure operation over the range 150kHz to 4MHz, or so.

The coil winding details opposite (assum-

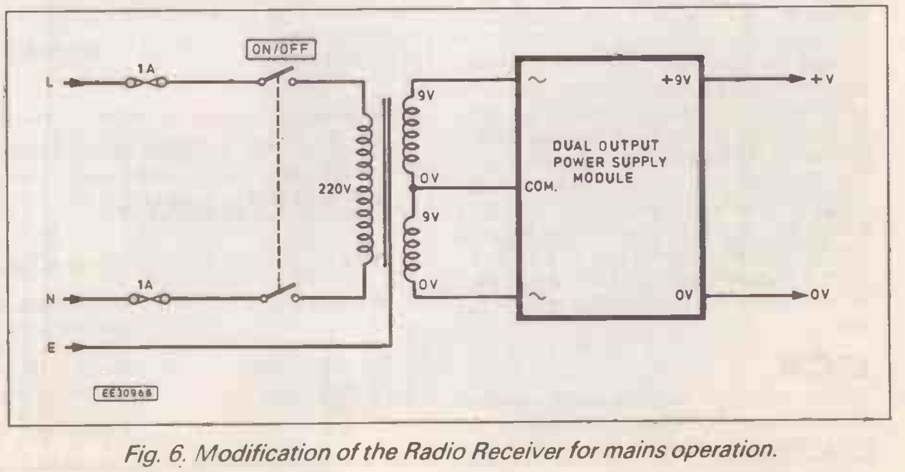


Fig. 6. Modification of the Radio Receiver for mains operation.

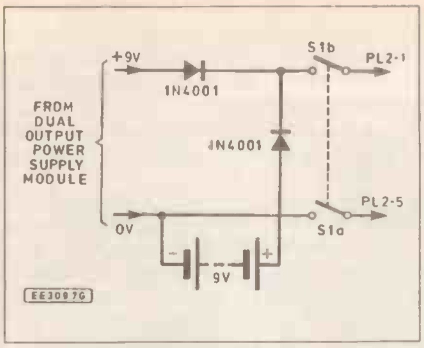


Fig. 7. Modification of the Radio Receiver for mains/battery operation.

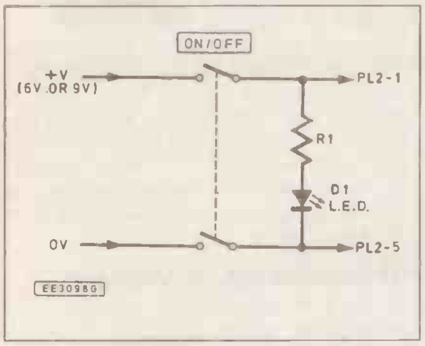


Fig. 8. Fitting an l.e.d. supply indicator.

ing a 10mm-12mm diameter former on an adjustable ferrite rod) are provided as a starting point for further experimentation:

External aerial and/or earth

The performance of the receiver can be considerably improved by connecting an external wire aerial and/or earth. This modification will help to overcome some of the limitations of the ferrite rod but it is important to couple the aerial correctly to the circuit in order to preserve a high Q-factor within the tuned circuit and thus maintain adequate selectivity.

A "long-wire" aerial (typically more than 10 metres of wire) should be coupled inductively to the ferrite rod. A suitable coupling coil should consist of no more

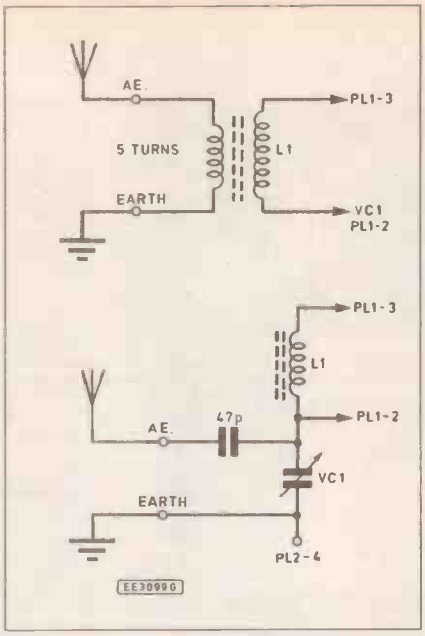


Fig. 9. External aerial and earth connections (a) using inductive coupling ("long-wire" aerials) (b) using capacitive coupling (short aerials).

than about 5 turns of 26 to 30s.w.g. wire wound on the centre of the ferrite rod. One end of this winding should be taken to the aerial connector (e.g. 2mm socket) whilst the other should be taken to the earth connector (see Fig. 9(a)).

Short aerials (comprising no more than a few metres of insulated wire) do not require a separate coupling inductor and can simply be coupled to the "top end" of the tuned circuit by means of a small value polystyrene capacitor (see Fig. 9(b)).

Pre-set tuning

As an alternative to continuous tuning, constructors may wish to experiment with switch selection of several pre-set stations. Such an arrangement is ideal for an elderly or blind person who may find the continuous tuning control somewhat difficult. Fig. 10 shows an arrangement which provides rotary switch selection of four stations.

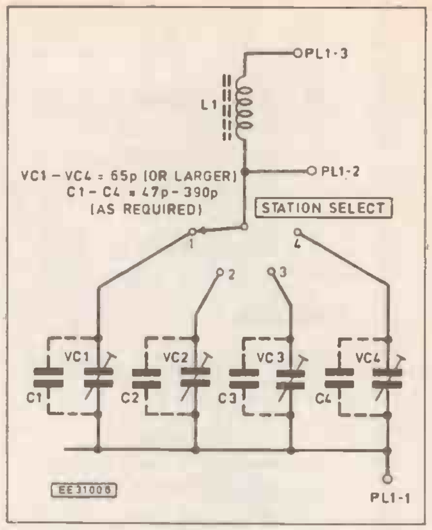


Fig. 10. Pre-set tuning arrangements.

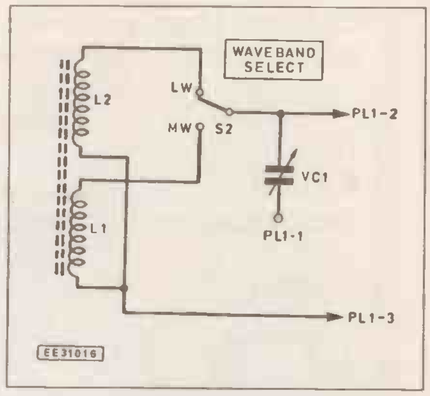


Fig. 11. Modifications for dual-band (e.g. LW and MW) operation.

Dual-band operation

The receiver may be easily modified for dual-band (long wave and medium wave, or medium wave and short wave) operation by simply fitting two coils to the ferrite rod (one at each end) and switching between them. Fig. 11 shows the necessary modifications to the circuit. □

Constructional Project

MODULAR DISCO LIGHTING SYSTEM

Part Two: SIMPLE CHASER AND SWEEPER MODULES

CHRIS BOWES

Light up your party or disco road show with these two easy-build light chaser effects modules.

LAST month's article dealt with the Switched Power Output Module which provides the power supply to run the *Modular Disco Lighting System* and also will turn on, and off, four output circuits under the control of an effects module. This includes mains driven coloured light boxes.

This months article deals with two simple chasers which provide either a simple (1, 2, 3, 4, 1, 2 . . .) chase or a sweeping (1, 2, 3, 4, 3, 2, 1 . . .) chase, both with variable speed controls. These are the first two of a number of effects modules which are used to drive the output module (and other outputs) to produce the patterns required.

Although the effects described are relatively simple they do, however, serve two functions in that they both provide an introduction to how the system for generating effects works. Also, because of their relatively low cost, they will enable you to get your system working fairly painlessly.

EFFECTS FEATURES

There are two slightly unusual features present in all of the effects modules in this system and these need to be understood when following through the circuit descriptions for this series. Firstly, all of the effects modules are designed with *two* outputs, and can thus be connected directly to up to two separate output modules.

Each of these output modules contains it's own power supply, the current from which is available to power the effects module. The common zero volt (0V) line is connected to pin 8 and the positive supply from each connected input is made to pin 7. In order to combine the two power supplies, without problems, all 0V connections are commoned and all positive input supplies are routed through a 1N4001 diode before being used to operate any part of the circuit.

The other unusual feature is that the circuitry for the effects modules has been designed so that all modules may directly drive any commercial dimmer pack, which is controlled by a positive going voltage. Some of these dimmer packs are intolerant of voltages in excess of 10 volts and, for this reason, the circuits, and their associated printed circuit boards, have been designed to accommodate voltage dropping networks containing a Zener diode and appropriate series resistor in each signal output circuit. For applications where the output of the effects modules is routed solely into other modules covered by this series they can be omitted.

CHASER CIRCUIT

The complete circuit diagram for the Simple Chaser Module is shown in Fig.1. The common 0V connections from pin 8 of each of the chassis mounted output "plugs" PL1/PL2 is commoned on the (p.c.b.) whilst the incoming positive volts from pins PL1/7 and PL2/7 of the two output plugs is first passed through either of the 1N4001 diodes D1 or D2 before these supplies are combined on the p.c.b.

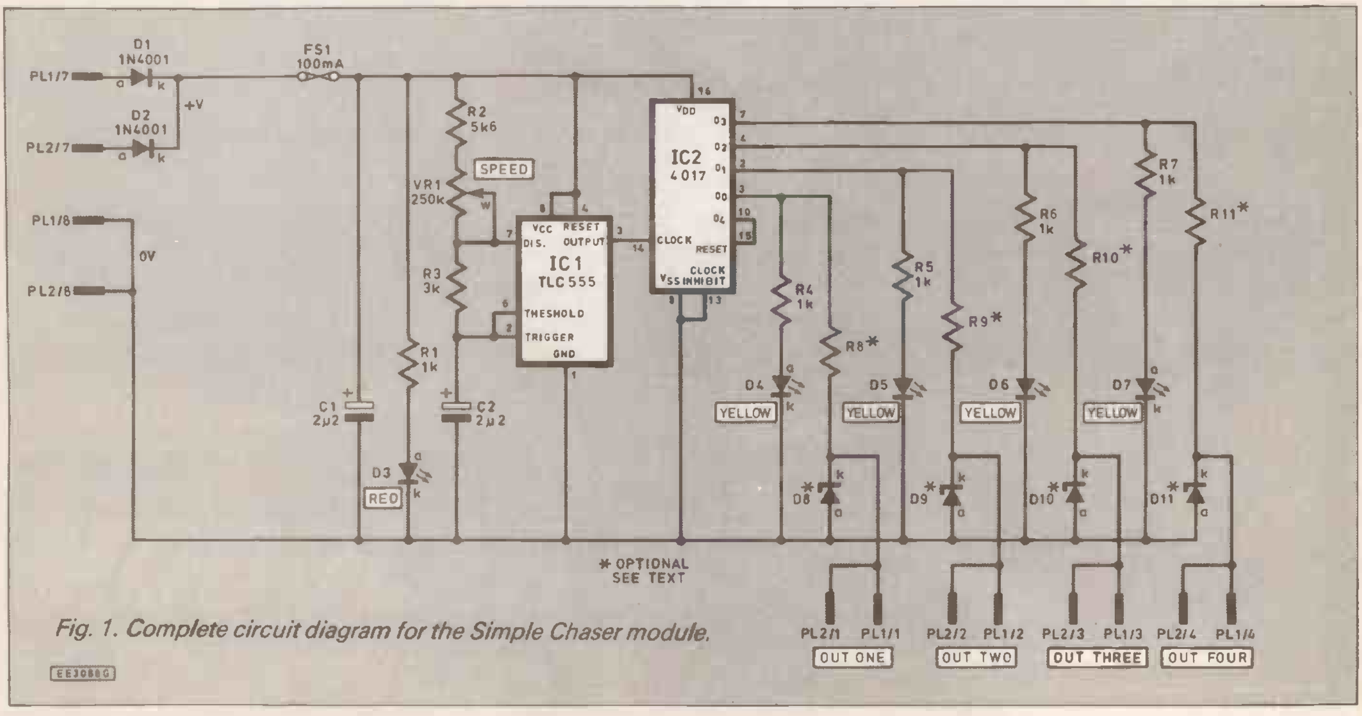


Fig. 1. Complete circuit diagram for the Simple Chaser module.

These diodes have been included to avoid problems which might occur should any of the power supply connections be inadvertently reversed. Fuse FS1 is a 100mA anti-surge type which is mounted on the printed circuit board in order to protect the circuit in the event of fault conditions arising.

Capacitor C1 is a standard 2µ2 tantalum which is used to decouple the integrated circuits in the unit. The presence of power to the module is indicated by l.e.d. D3 which has resistor R1 in series with it to reduce the current flowing through the l.e.d. to a safe level.

A clock pulse, which steps the Chaser through its sequence, is generated by IC1 and its associated components. This is a standard 555 timer connected in the astable mode and in this configuration an output clock pulse, the frequency of which is dependent upon R2, VR1, R3 and C2, is produced at pin 3. The component values given have been chosen to give a wide range of clock pulse frequencies depending upon the setting of the Speed potentiometer VR1.

The output pulse from pin 3 of IC1 is fed to the clock (CP_1) input (pin 14) of IC2, which is a 4017 Johnson counter. The clock inhibit (CP_0) input of this i.c. (pin 13) is held at 0V and in this configuration the outputs O_0-O_4 are made to go to the Logic 1 (high) state in sequence.

Output O_4 (pin 10) is connected to the Master Reset input (pin 15) of IC2. When output O_4 goes to the "high" state the counter is reset taking output O_0 once more to the Logic 1 state.

This arrangement causes each of the four outputs connected to pins PL1/1-4 and PL2/1-4 of the module's chassis mounted output plugs to be energised in turn. The state of each of these outputs are indicated by the l.e.d.s D4 to D7, each of which is connected in series with their respective series resistors (R4-R7).

Resistors R8-R11 and Zener diodes D8 to D11 are included to prevent the output voltage rising above 10 volts and causing problems if the outputs are connected to theatrical dimmer racks, which shut down if the input voltage exceeds 10 volts. If the module is only going to be connected to other modules within the *Modular Disco Lighting System* they may be omitted and the connections to the output chassis plugs taken from the connection where the resistors R8 to R11 would be made to the outputs of IC2.

SWEEPER MODULE

The circuit of the Sweeper Module is very similar to the Chaser Module but this module has the added dimension that the output sequence is 1, 2, 3, 4, 3, 2, 1, 2 . . . etc. Although this effect is relatively simple it has proved to be very effective particularly if it is used to provide an overall background cover or to control a number of small lamps round a feature such as the disco deck etc.

The full circuit diagram for this module is given in Fig.2. The early part of the circuit is identical to that of the Chaser Module and so does not require repetition.

In this configuration the outputs O_0 to O_6 of the 4017 (IC2) are made to go to the Logic 1 state in sequence by connecting the reset (MR) input (pin 15) to the O_6 output (pin 5) instead of the O_4 output as happens in the Chaser Module.

IC3a and IC3b, which are each one quarter of a 4072 quad two input OR gate, have been added to the basic sweeper circuit so as to provide a summing function to make output 2 of the module go to the Logic 1 state when the i.c. outputs O_1 and O_5 are at Logic 1, and output 3 of the module go to the Logic 1 state when the outputs O_2 and O_4 of IC2 are at Logic 1. This arrangement energises each of the four outputs connected to the output plug pins PL1/1-4 and PL2/1-4 in the required sequence.

CONSTRUCTION

Construction of these modules is relatively simple with the greater majority of the components being mounted on the printed circuit boards. The component layout and full size copper foil master pattern for the Simple Chaser Module is shown in Fig.3, and for the Sweeper Module in Fig.4.

The foil pattern should be transferred to a suitable piece of board which is then etched and drilled in the usual way. Alternatively, the boards are available from the *EE PCB Service*, codes EE745 and EE746.

The connection of the printed circuit board to the case mounted components is eased if all of the terminations on the printed circuit board are fitted with terminal pins. These are simply driven through the appropriate holes and soldered into position as the first stage of the construction.

After locating the solder pins in position, the components can be inserted into the board and soldered in place. Although this process can be carried out in any con-

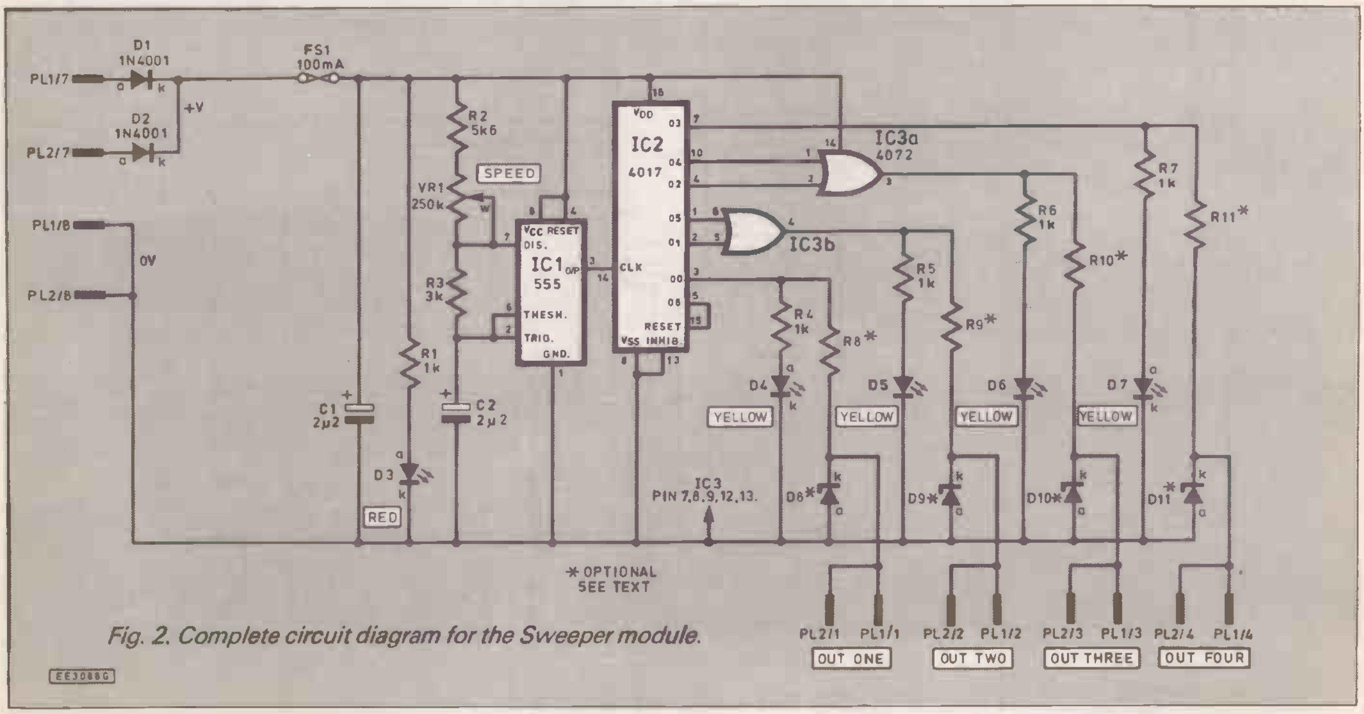


Fig. 2. Complete circuit diagram for the Sweeper module.

COMPONENTS

See SHOP TALK Page

Resistors

R1	1k
R2	5k6
R3	3k
R4-R7	1k (4 off)
*R8 to R11	(4 off) see text

All 0.25W 5% carbon

Potentiometer

VR1	250k rotary, lin.

Capacitors

C1, C2	2μ2 Tantalum, 25V (2 off)

Semiconductors

D1 to D2	1N4001 1A 50V rec. diode (2 off)
D3	Red standard l.e.d.
D4 to D7	Yellow standard l.e.d. (4 off)
*D8 to D11	9V Zener diode (4 off)
IC1	TLC 555 CMOS timer
IC2	4017 Johnson decade counter
†IC3	4072 dual four-input OR gate (Sweeper only)

†The components lists for BOTH modules are identical with the exception that the 4072 (IC3) is only required for the Sweeper Module. * Optional components.

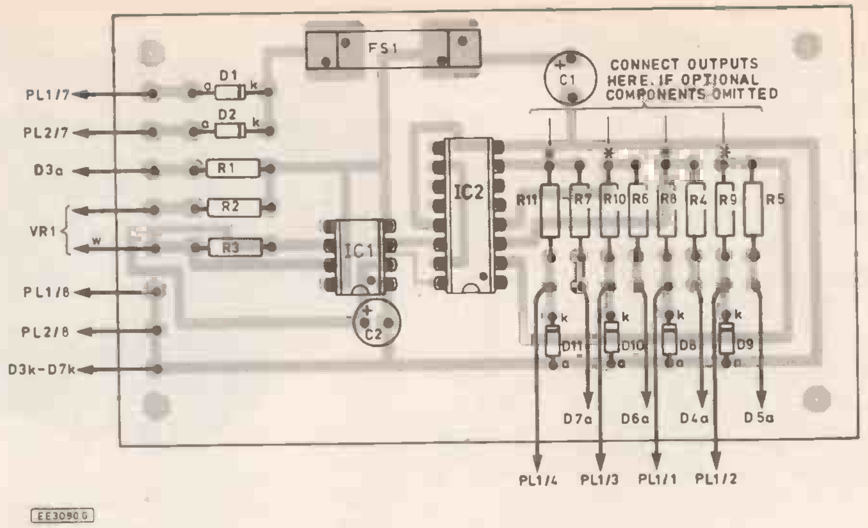
Miscellaneous

PL1, PL2	10-pin circular video chassis mounting plug, with matching cable socket (2 off).
FS1	100mA 20mm fuse and p.c.b. fuse clips.

Aluminium instrument case (Maplin "Blue case 233"), size 250mm x 150mm x 75mm; 8-pin d.i.l. socket; †14-pin d.i.l. socket; 16-pin d.i.l. socket; connecting wire; stand-off pillars (4 off); plastic control knob, solder etc.

Printed circuit boards available from the *EE PCB Service*, codes EE745 (Chaser) and EE746 (Sweeper).

Approx cost guidance only **£15** *plus case*



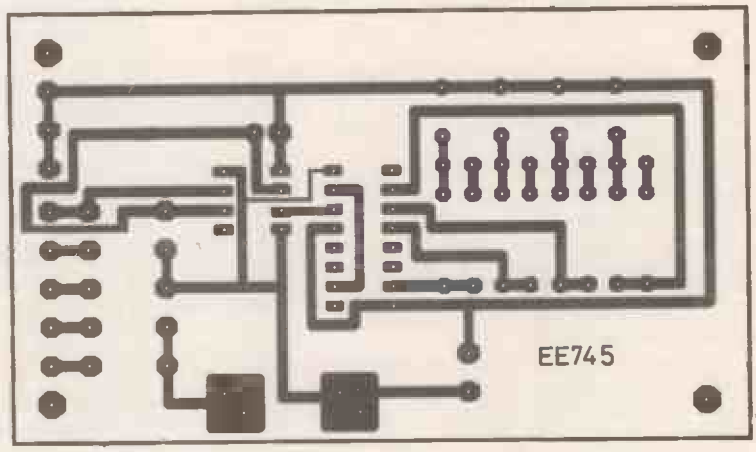
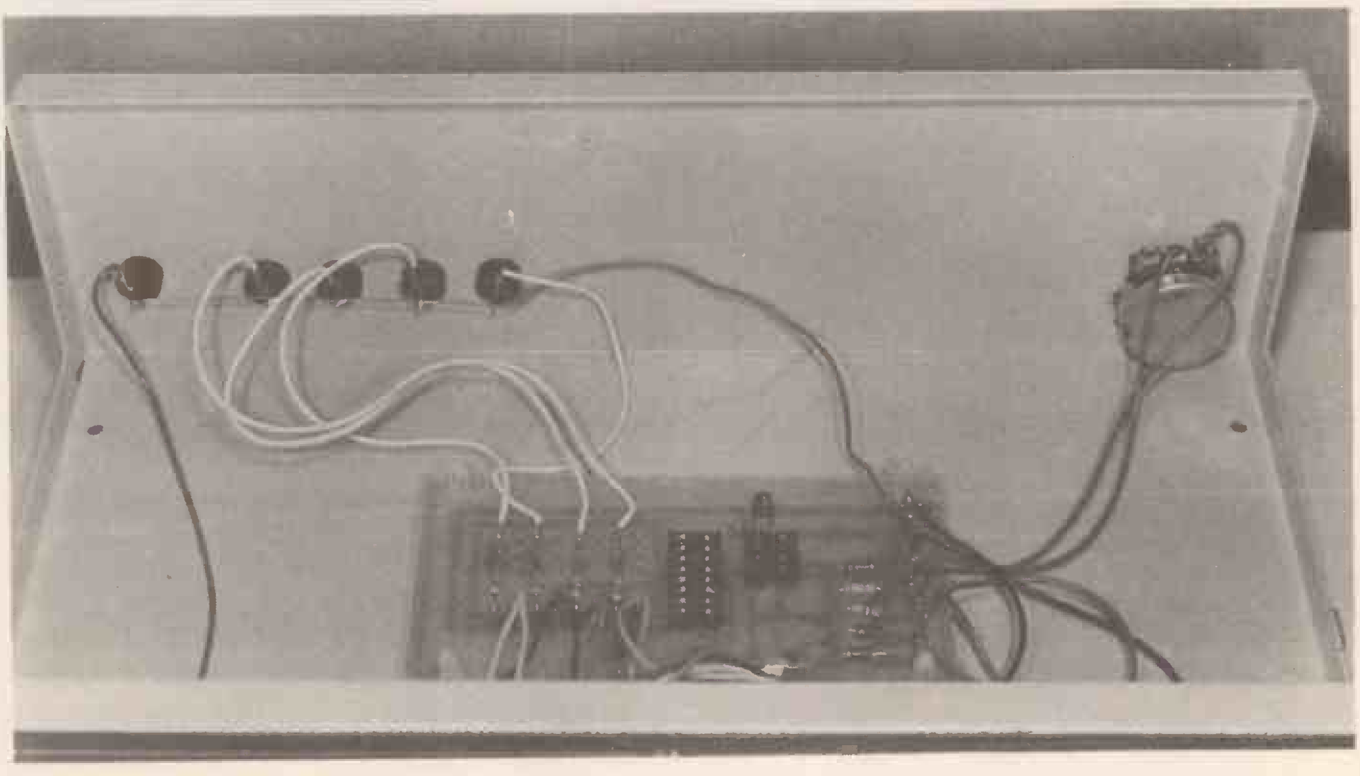
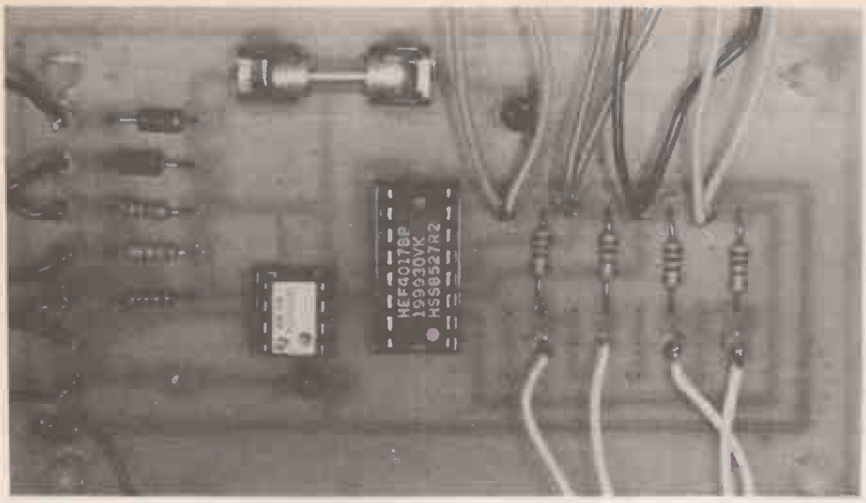


Fig. 3. Printed circuit board component layout and full size copper foil master pattern for the Simple Chaser. The Zener diodes (D8-D11) and limit resistors (R8-R11) are optional components only required if the unit is to be used with theatrical dimmers, see text.

Wiring to the front panel l.e.d.s and Speed control potentiometer. The two 10-pin circuit chassis mounting plugs are located on the rear panel. They should be wired in parallel and then connected to the board as shown above.





The completed Simple Chaser board, without the Zener diodes and limiting resistors.

venient order. You will find that it is easier to perform this task if the components are inserted in ascending order of size.

All the components of a particular size should be soldered into position before going onto a larger size of components. Care should be taken to ensure that all of the polarity sensitive components (such as diodes, i.c.s, and capacitors) are connected to the circuit board with the correct polarity.

The i.c.s are best accommodated in sockets which are soldered in place along with the other components. The i.c.s should be inserted as the last task before testing out the unit. Care should also be taken with these components to ensure correct polarity.

CASE

Great care has been taken in the design of this modular system with the positioning of case mounted components. It is therefore important that the front and rear panel layouts, shown in the photographs should be adhered to when making up the modules.

The case should first be drilled to accommodate the stand-offs for the printed circuit board and the case mounted components. The panel markings should also be applied and secured at this stage before any components are installed.

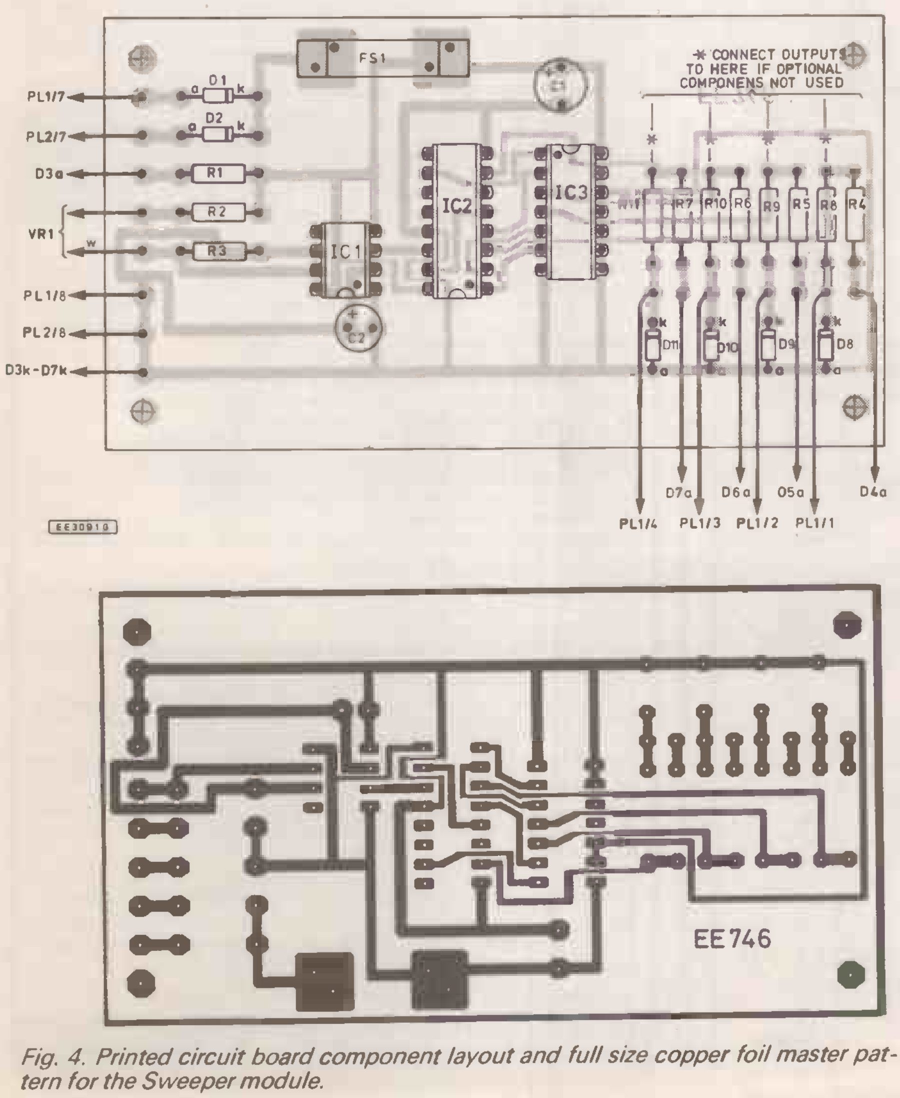


Fig. 4. Printed circuit board component layout and full size copper foil master pattern for the Sweeper module.

The case mounted components should now be installed and connections made from them to the appropriate points of the printed circuit board. Construction of these two modules is not difficult but will be eased if the cathodes (k) of l.e.d.s D3-D7 are connected to a common negative (0V) buzz bar which is taken to the common "earthing" point on the p.c.b.

All of the modules in this series have been designed to fit into the case detailed in the components list and you are strongly advised to ensure that the case specified, or one with at least the *minimum* of *internal* space, is used since some of the other modules are very tightly packed into the specified case. Although these modules are not tightly packed the use of the same style of case for all of the modules will give a pleasing sense of wholeness of design to the units.

WIRING UP

The connections between the printed circuit board and the case mounted components are best made with flexible wires, cut to a size which allows the board to remain connected to the control panel when removed for fault finding etc. There are a number of connections to be made and the use of as many colours of wire as are available will reduce the risk of confusion at this stage. The ends must be prepared by tinning before the cable is inserted into the appropriate holes on the board and then soldered into place.

All of the effects modules are designed to be connected to the output modules which they control or to any other effects. The routing of controllers is by means of a simple eight-way cable which is terminated at one end in a cable mounting 10-pin socket and at the other end in a matching 10-pin cable mounting socket.

These connectors are connected pin-to-pin for pins 1 to 8. In order to operate the automatic input and output sensing circuits in certain other modules it is necessary to also connect pins 9 and 10 together with wire links in both the cable mounting plug and the cable mounting socket of all of the interlinking cables.

TESTING

Once all the connections have been made the boards should be carefully checked for broken tracks, solder blobs and incorrectly placed components. The i.c.s should then be carefully inserted into the correct sockets, taking care to ensure that they are the correct way round.

Testing the unit is very simple. All that is required is to connect one of the two output sockets to an input socket on a Switched Power Output Module (last month) or other output module.

Once connected the module should operate with D4 to D7 lighting in the appropriate sequence. Operation of VR1 should change the frequency of the clock pulse, and hence the speed at which the "chase" occurs; from a very fast sequence (which is almost indistinguishable from all the modules l.e.d.s being on) to a very slow pulse.

Next month: The Masterlink module.

SHOP TALK

with David Barrington

Digilogue Car Tachometer

The dual or double-digit 7-segment display called for in the *Digilogue Car Tachometer* should be available from most components advertisers. When ordering be sure to ask for the "common cathode" type.

The pinout connections for dual-digit devices seem to vary quite considerably with different manufacturers so the display stripboard will have to be "tailored" to suit the display purchased. If you cannot obtain a double-digit display, you may use two single-digit version mounted side-by-side.

The coloured rectangular l.e.d.s, which make up the bargraph or "analogue" display are readily available and should not cause any sourcing problems. However, the "neutral density" display filter material may prove difficult to locate locally. A suitable piece is listed by **Maplin**, code JE16S, but is slightly smaller than specified so the aluminium side-cheeks will have to be larger to take up any resulting gap.

The case used in the prototype model is a Verobox, part no. 202-21040F. The printed circuit board for the Digilogue Tacho is available from the *EE PCB Service*, code EE744 (see page 404).

Automatic Light Control

Looking at the circuit for the *Automatic Light Control* the only component likely to cause concern when shopping for parts is the mains relay.

The 10A p.c.b. mounting mains relay used in the model was purchased from Maplin, code YX97F (10A Mains Relay). Other relays can, of course, be used provided they have similar ratings. Substitute relays may not fit the board or more importantly their connecting tags may be different and the p.c.b. may need to be altered accordingly.

If readers should experience any problems locating the pressure mat they can contact security or alarm specialists such as **Suma Design** (☎ *0827 714476*) or **TK Electronics** (☎ *081 567 8910*) who may be able to help.

The two printed circuit boards for this project are available from the *EE PCB Service*, codes EE747 (PSU) and EE748 (Logic board).

Fish Bite Infralarm

The infra red phototransistor used in the prototype model of the *Fish Bite Infralarm* was purchased from Maplin (YY66W). This device is claimed to be similar to the TIL32 which many of our advertisers stock.

The rest of the components for this project are standard lines and should be fairly easy to obtain. When ordering parts make sure you specify the low current(2mA) l.e.d.

The standard coupling used on the base of the case, for attachment to a bank stick, was "acquired" from a cheap Foster type rod rest which usually retails for around £1 in most fishing tackle shops.

Teach-In '91

This month, a couple of items look as though they will cause followers of the Teach-In '91 series, *Design Your Own Circuits*, certain supply difficulties.

The ZN416E t.r.f. receiver chip for the *Radio Receiver* back-up project appears to be only available from **Cirkit** (☎ *0992 444111*), stock no. 61-00416.

Suitable miniature loudspeakers should be generally available, but the designer has been impressed with the performance of the one used in the prototype model and recommends its use. This was purchased from Electromail, code 248-274 (35 ohm).

The ferrite rod for the aerial should be easily obtainable and is currently listed by **Cirkit, Omni, Greenweld and Maplin**. The rod is listed from about 8mm to 10mm diameter of varying lengths and any of these should be OK; the only criterion seems to be, will it fit inside the case!

Tuning to the *R.F. Amplifier Module*, the SL1612 r.f. amplifier only appears to be listed by Cirkit, code 61-016112, and **Electromail** (☎ *0536 20455*), code 303-208.

The printed circuit boards for both projects can be obtained from the *EE PCB Service*, codes EE749 (Radio) and EE750 (R.F. Amp).

Modular Disco Lighting System

We do not expect any component buying problems to be encountered when ordering parts for the *Simple Chaser* and *Sweeper Modules*, this month's *Modular Disco Lighting System* projects.

The metal instrument case for both models is the **Maplin** Blue case 233, code XY48C. Other cases can be used but they must be METAL and be earthed.

The two printed circuit boards are available from the *EE PCB Service*, codes EE745 (Chaser) and EE746 (Sweeper).

Just to illustrate how it pays to check advertisers special "bargain offers". Last month the *Switched Power Output Module* called for several solid-state relays and quite a considerable saving could (and still can) have been made if news of the ones on offer from **Greenweld** at £3 (Z1718) had arrived in the office a week earlier.

Design Feature

A.C. CAPACITOR POWER REGULATORS

BRIAN CORDINGLEY

Transformers and solid-state lamp dimmers can be replaced by a.c. rated capacitors with advantage in many mains powered circuits.

MOST readers will be familiar with the use of resistors to limit current or reduce voltage in circuits. They will also be aware that their use is restricted by the power dissipation which accompanies their operation. In contrast, in a.c. circuits capacitors may be used to regulate current and voltage with virtually no loss of power. Some circuits which exploit this property are described in this article.

MAINS RATED

Capacitors connected to the mains require an a.c. voltage rating of 250V or greater and **should be designated for class X or class Y at 250V a.c. mains.**

For cost and reliability the author has found that capacitors employing a metallised polypropylene film are most suitable. Some commercial applications of mains rated capacitors include interference suppressors, motor start and run circuits and fluorescent light ballast equipment.

The plates of metallised film capacitors consist of a very thin layer of aluminium or zinc evaporated onto a synthetic or paper dielectric under vacuum. A transient over-voltage or a defect in the dielectric may cause an arc to be established between plates of opposite polarity. The arc evaporates the plating at the site of the defect and forms an insulating oxide of the metal and the capacitor is effectively repaired. This property is known as "self healing" and is a characteristic of many capacitors intended for use across the mains.

SAFETY

Mains circuits of this type must be housed in fully insulated cases or in earthed metal cases. Do not build these circuits if you are not sure about the safety aspects.

If projects based on this article are to be housed in metal cases then **no part of the case should be in electrical contact with the circuit and all accessible metal parts must be earthed.** Clearly ***this also applies to any equipment to which these projects are connected.***

The neutral wire from the mains is at near-earth potential and it is good practice to have the major part of the circuit at or near this potential. It is for this reason that the regulating capacitor is connected as near as possible to the mains line. This laudable aim is easily defeated by incorrect wiring of the mains plug!

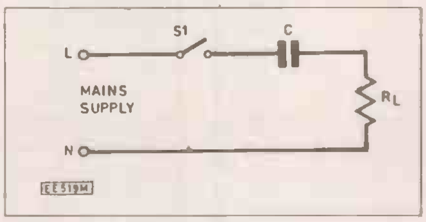


Fig. 1. Equivalent circuit for the analysis of a.c. capacitor regulator circuits.

These projects on a.c. capacitors invite design work and experimentation. The author, after some less than pleasant experiences, wears rubber gloves when substituting components and making voltage and current measurements. It is all too easy to forget that mains circuits have some nasty potential differences when absorbed in a series of trials. ***Beware we cannot afford to loose any readers.***

PROTECTION OF CIRCUITS

The power circuits for the projects described below can be reduced to the equivalent circuit shown in Fig. 1 for the purpose of analysis.

At switch on, a high surge current can flow. The magnitude of the surge depends at what point of the mains cycle contact is made and the state of charge of the capacitor at that instant. This high current has the capacity to destroy any semiconductors in its path. If the load does not have sufficient resistance to limit the surge current to a safe value an additional series resistor is included in the circuit. The power rating and value of this resistor will depend on the application but *it should be rated at 250V.*

Experience teaches that capacitors rated for mains usage are very reliable though the consequences of capacitor failure to short circuit should be considered. If a surge limiting resistor is employed in the power supply it will almost invariably fail to open circuit after a capacitor short and thus interrupt the fault current. (It's a good idea not to use a resistor of too high a wattage in this position!)

Nevertheless, there is a likelihood that any resistors or semiconductors (diodes and l.e.d's) in the path of the fault current will be destroyed on capacitor failure. **The mains plug should be fitted with a 2A fuse or a fuse added to the line input on the circuit board.**

Capacitor failure in lamp dimmer or heater circuits will result in full power being applied to the load. The consequences depend on the application but they should be borne in mind.

A.C. CAPACITORS IN RC MAINS CIRCUITS

It is anticipated that the reader will wish to build regulator circuits for specific applications but based broadly on the designs described. To facilitate the selection of components it is desirable to introduce a few formulae.

The reactance, X, of a capacitor, C, at frequency, f, is given by:

$$X = \frac{1}{2\pi fC} \qquad 1$$

The impedance, Z, of a series circuit containing a capacitor and a resistive load R_L, may be determined from,

$$Z = \sqrt{(R_L{}^2 + X^2)} \qquad 2$$

Where R_L is the sum of all the series resistance in the circuit.

In many circuits R_L is much smaller than X, or the voltage across the load is significantly less than mains voltage, (say below 50V). Under these circumstances the approximation:

$$Z \approx X \qquad 3$$

may be applied.

The current flowing in the circuit with mains voltage, V, is

$$I = \frac{V}{Z} \qquad 4$$

The voltage across a resistive load is given by

$$V = IR_L \qquad 5$$

In 4 and 5 if V is the r.m.s. voltage then I is the r.m.s. current. Similarly, if V is the mean voltage then I is the mean current.

The value of mean current is useful in battery charging circuits. In heating circuits, it is the r.m.s. current and voltage that are of principal interest. When the mains is rectified:

$$I_{mean} = \frac{I_{r.m.s.}}{1.11}$$

Throughout this article mains voltage is taken to be 240V r.m.s. and mains frequency to be 50Hz. The effect of a bridge rectifier on the calculation of current can be ignored for the purposes of the projects.

The following sample calculation may be of assistance. If in Fig. 1, C is 2μ2 and R_L is 150 ohms, then

$$X = \frac{1}{(2 \times \pi \times 50 \times 2.2 \times 10^{-6})} = 1447 \text{ ohm}$$

$$Z = \sqrt{(150^2 + 1447^2)} = 1455 \text{ ohms}$$

(alternatively, the approximation in **3** may be used).

$$I_{rms} = \frac{240}{1455} = 0.1649\text{A}$$

$$I_{mean} = \frac{0.165}{1.11} = 0.1486\text{A}$$

R.M.S. load voltage = 0.1649 × 150 = 24.7V

CHARGE RETENTION

Plastic film capacitors can retain a charge *for several weeks* and any residual voltage **will appear across the mains plug.** A resistor is therefore placed across a.c. capacitors to discharge them within a reasonable period of time. Some manufacturers actually include this resistor within the capacitor case. A value between 470k and 2M2 should prove satisfactory and the resistor *should be designed to withstand 250V.*

POWER SUPPLY CIRCUITS

Capacitors can be used in power supplies if either space, cost or energy savings can be exploited. A.C. capacitors dissipate very little power (often much less than 100mW) and run cool. Small transformers often run warm and if equipment is left on permanently then for every watt of dissipation about 50p each year is going to be added to the electricity bill.

Capacitors are silent when connected across the mains whereas almost invariably transformers emit an audible hum which can be a disadvantage in some circumstances. The principal disadvantage of capacitors is that they do not isolate the circuit electrically from the mains supply.

Transformers should be used if the circuit demands either isolation from the mains, the provision of continuous current greater than about 1A at low voltage or the stepping up of a voltage. Consider using capacitors elsewhere.

A CONSTANT CURRENT CHARGER

The circuit displayed in Fig. 2 will charge from 1 to 20 NiCads at a current of around 100mA mean, the current reducing only slowly as the number of cells on charge is increased. The circuit is particularly useful as an on-board charger for rechargeable equipment and will charge at a constant rate almost irrespective of the state of charge of the cells. If the load current demand is somewhat less than 100mA then the circuit can be used with its rechargeable cells as an uninterruptable power supply.

When C1 is 1μ5, the impedance of the circuit is 2122 ohms from equation **3**, and C1 will carry an r.m.s. current of 0.113A (113mA) or 0.102A mean with a short circuit at the output.

Resistor R1 limits the surge current at switch on and R2 discharges C1. 1000V diodes are used for the bridge. It is useful to have an indication that charge current is flowing and R3 and R4 are selected to provide about 7mA for the l.e.d. to serve this purpose. These values will need attention if C1 is changed to provide a different current output.

If you have a meter, check the charging current by placing the meter across the output sockets with the batteries removed – this circuit is inherently short circuit protected. The reading should be about 100mA.

The output voltage is governed by the number of cells on charge and, on open circuit, the output **will be approaching mains voltage**. If this is likely to be a problem (for example when the circuit is used as an uninterruptable power supply) then any circuit supplied should be provided with over-voltage protection.

A COMPACT TRICKLE CHARGER

The simplicity and low energy consumption of capacitor regulated power supplies can prove advantageous where trickle charging is required for stand-by circuits. Mass plate NiCads and certain lead acid cells have a very low rate of self discharge and can be maintained at full charge by a current of less than 1/100 of their amp-hour capacity. Precise trickle charge instructions may be obtained from the manufacturers of cells.

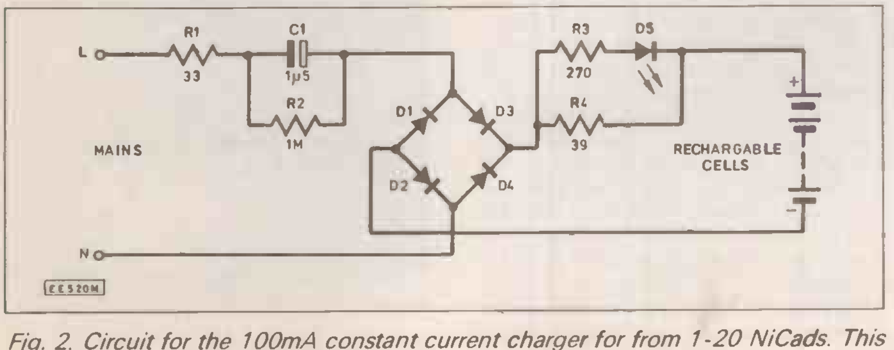


Fig. 2. Circuit for the 100mA constant current charger for from 1-20 NiCads. This circuit may also form the basis of an uninterruptable power supply.

COMPONENTS

CONSTANT-CURRENT CHARGER

Resistors

R1	33 1W
R2	1M 0.5W
R3	270 0.5W
R4	39 1W

All 250V

Capacitors

C1	1μ5, 250V a.c. rated (class X or Y)

Semiconductors

D1 to D4	1N4007 or other 1000V diodes (4 off)
D5	l.e.d.

Miscellaneous

Group board; battery connector; mains wire and plug with 2A fuse; insulated or earthed case.

COMPACT TRICKLE CHAGER

Resistors

R1	33
R2	1M

All 0.5W, 250V

Capacitors

C1	100n, 250V a.c. rated (class X or Y)

Semiconductors

D1 to D4	1N4007 or other 1000V diode (4 off)
D5	l.e.d.

Miscellaneous

S1	SPST switch

Group board; battery connector; mains wire and plug with 2A fuse; insulated or earthed case.

5V, 70mA POWER SUPPLY

Resistors

R1	33
R2	1M

All 1W, 500V

Capacitors

C1	1μ2, 250V a.c. rated (class X or Y)
C2	470μ, elect. 10V

Semiconductors

D1 to D4, D6	1N4007 or other 1000V diode (5 off)
D5	5V6 1W Zener diode

Miscellaneous

Group board; mains wire and plug with 2A fuse; insulated or earthed case.

LAMP DIMMER

Resistors

R1	1M, 0.5W 250V

Capacitors

C1	2μ, 250V a.c. rated (class X or Y)

Miscellaneous

S1	see text
S2	SPDT 2A, 250V a.c. switch

Mains terminal block; 40W bulb; table lamp; 2A mains fuse; insulated or earthed housing.

Cost: Components for each project should cost less than **£5**. (Excluding table lamp and rechargeable batteries.)

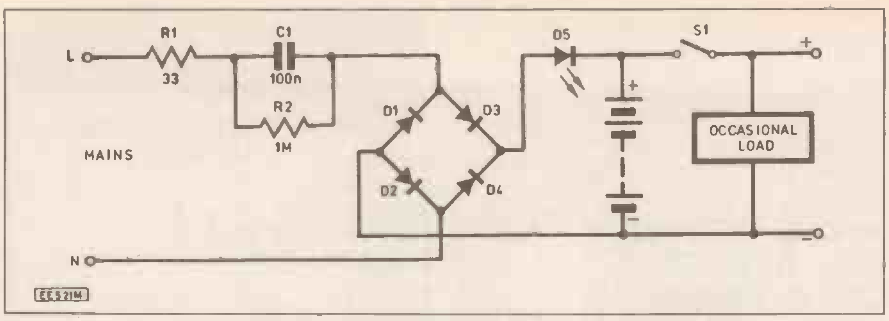


Fig. 3. Trickle charger for lead-acid or mass-plate nickel-cadmium rechargeable cells. The circuit consumes very little space and can be used to power stand-by equipment.

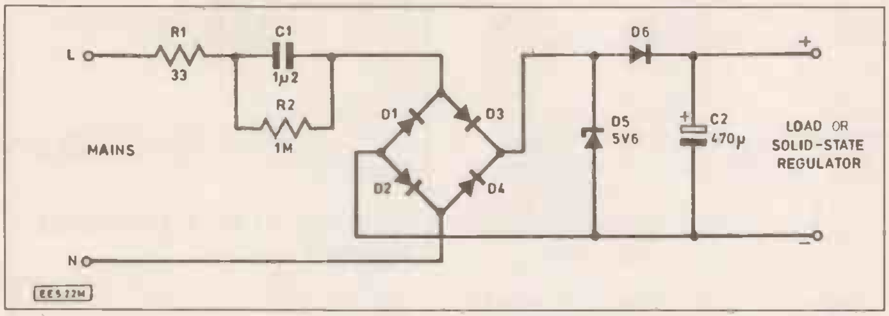


Fig. 4. 5V 70mA d.c. power supply. This circuit may be adapted to provide a wide range of output currents and voltages and may be connected to a voltage regulator for increased voltage stability.

The circuit depicted in Fig. 3 displays a basic trickle charge circuit to provide a charging current of about 6.8mA mean (or 7.5mA r.m.s.) this current will not be a strong function of the number of cells charged. The general notes for the circuit in Fig. 2 apply to this circuit also. The low value of mean current enables the l.e.d. to be supplied directly.

Note: If NiCads become totally discharged it may be necessary to place them in a circuit capable of supplying a high current for a short period to get them to accept charge again.

A 5V, 70mA POWER SUPPLY

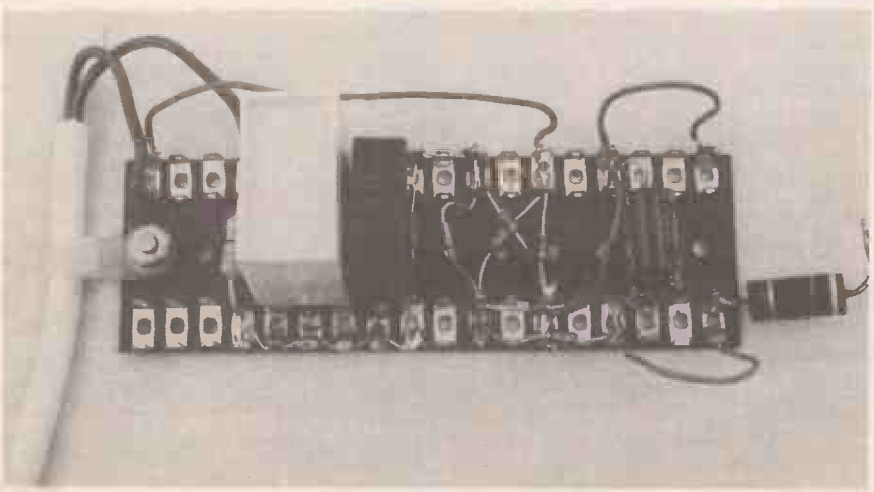
A circuit design for a 5V, 70mA supply is shown in Fig. 4. This is also intended to be treated as an example of a general technique. It is relatively easy to adapt this circuit to provide a wide range of output voltages and currents by appropriate selection of D5 and C1 respectively.

Capacitor C1 at 1µ2 provides an r.m.s. current of 90mA. Current that does not go through the load heats the Zener diode and consequently it is desirable to choose C1 such that it provides not much more current than the maximum required by the circuit.

The output voltage of the supply is equal to the Zener voltage less the voltage dropped across D6 (say 0.7V). Maximum power is dissipated in the Zener when the load is open circuit. This is approximately equal to the product of the mean current and the Zener voltage:

$$\frac{5.6 \times 0.09}{1.11} = 0.45\text{W}$$

Diode D6 reduces hum by preventing charge stored on capacitor C2 from partially discharging through the Zener diode during the interval of near-zero voltage in the supply cycle. A value for C2 of about 470µ should provide adequate smoothing.



*The circuit of Fig. 4. built on tagboard. The unit **must** be enclosed in an earthed metal case or a fully insulated case – see text.*

If a high degree of stability is required then it is a relatively simple matter to connect an i.c. voltage regulator to the output, **but remember all the circuitry must be isolated for safety.**

LAMP DIMMING CIRCUITS

Electronic lamp dimmers based on triac controllers are fairly common. They do however suffer from a number of disadvantages: they produce electrical noise (switch a radio to long wave near a dimmer and turn the tuning dial) and often audible noise; most solid-state dimmers are incapable of giving control over a full range of output and they can cause perceptible flickering at some settings.

The circuit shown in Fig. 5 shows how a capacitor may be employed to control the brightness of a lamp. The circuit provides two brightness levels – full and dimmed. Noiseless and flicker free operation will be obtained and output can be controlled to any level of brightness by appropriate selection of capacitor value.

In most potential applications it will not be economically attractive to fit a rotary switch to provide multiple settings. This is because a relatively high-current switch would be required to accommodate the surge currents occurring on the charge and discharge of the capacitors.

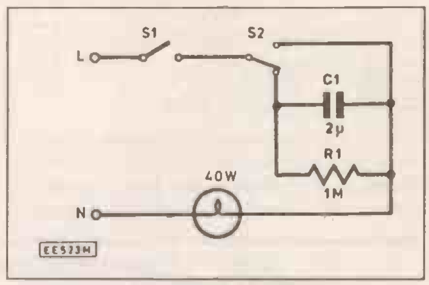


Fig. 5. Lamp dimmer circuit offering flicker-free operation at two levels of brightness.

It is fortunate that in many applications a simple choice between bright and dimmed or even a single level of light output will prove adequate. Applications such as night lights or bedside reading lights come into this category.

The circuit shown in Fig. 5 illustrates how a dimmer circuit may be wired into an existing table lamp or light fitting. The capacitor and its discharge resistor should be connected at a point between the line and the live of the lamp socket. The exist-

Concerted "dimming" lamp.

ing switch can be used for on-off control and a S.P.D.T. switch used to provide two levels of output.

There are no semiconductors to protect and the resistance of the bulb restricts surge current adequately. The capacitance value of 2µ provides a comfortable light for bedside reading when used in conjunction with a 40W bulb. A value of 1µ5 provides an illumination level acceptable as a night light.

CAPACITOR SELECTION

The resistance of incandescent lamps and perceived light output vary in a complex manner with filament temperature. It is for this reason that a subjective approach to the selection of the value of the a.c. capacitor is adopted and the table below indicates the range of values of C1 from which to choose.

The characteristics of filament lamps and the selection of C in lamp dimmer circuits.

Bulb Rating W	Approx. Bulb Resistance Cold Ohm	Hot Ohm	Capacitor Values of Interest Min. µF	Max. µF
15	303	3840	0.22	0.82
25	170	2300	0.47	1.2
40	110	1440	1.0	2.2
60	68	960	1.5	3.0
100	40	576	2.0	5.0

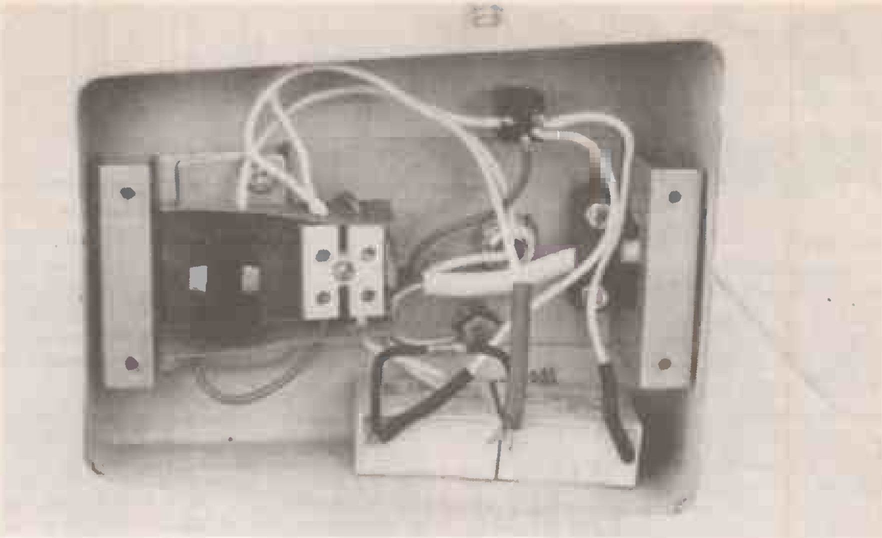
The smallest value of capacitance for a specific bulb rating provides a level of filament flow that is just perceptible; the larger value provides a soft light for bed-time reading. The actual value selected is to be determinded by experiment.

The characteristics of flourescent lamps and their inductive ballasts makes them *unsuitable for control by both simple triac controllers and series capacitors.*

OTHER APPLICATIONS

It is possible to reduce the power output of heating elements which do not contain thermostats by applying the same technique as that used for lamp dimming. This will be useful for the control of loads of up to about 200W and values of C1 may be found by trial and error using the filament-lamp table as a guide.

The projects discussed in this article have been concerned solely with resistive loads. Capacitors may also be used to control the power delivered to inductive loads. for example, the speed of some motors may be controlled and output voltages of transformers may be altered. However when capacitors are used with inductive loads it is possible to arrive at circuit conditions which cause **voltages significantly in excess of mains voltage to appear across the series capacitor or the load.** The use of capacitors with inductive loads is a topic in its own right and is outside the scope of the present article. □



The switch, capacitors and resistor "dimming" components housed in the lamp base. Note the earth connection to the metal case.

ROBOT ROUNDUP

Nigel Clark

MONEY

No specific money has been set aside by the Government to help with the further funding of design and technology subjects in the next school year, 1991-2. This is despite the fact that the first testing in the subjects will be taking place in 1992.

In the present year £17m was provided for meeting the costs following a grant of £10m the year before. The money was intended for new equipment and the cost of assessing pupils performance.

Some money will be available under the Department of Education and Science's GEST scheme, Grants for Education Support and Training. However, it is not a straightforward grant which is given to local education authorities (LEA) to be split among the schools in their area. It has to be applied for by the school's first putting forward a proposal to the LEA which then passes them on to the DES. If the proposal is approved 60 per cent of the cost will be met, the balance to be found by the school or LEA, but increasingly by the school.

There is a total of £170m for next year, up from the present £120m. In addition £30.4m is being made available for information technology (IT). However this is being targeted at increasing the number of micros for the younger age range, primary and middle schools, as well as special schools.

This will be of some help in the teaching of design and technology subjects, however the DES also wants to encourage the use of computers in more areas, to reflect the growing use of computers in industry and commerce, thus increasing the demand for time on the computers in schools.

FALLING NEED?

It could be argued that the need for extra money is falling. As has often been pointed out the design and technology subjects are not totally new subjects but more a reorganisation of existing ones.

In addition a survey by the DES has shown that the average number of micros per primary school has risen from 2.5 in 1988 to 4.3 and from 23 to 41 in secondary schools. Almost all primary schoolchildren and 90 per cent of secondary children up to 16 have worked on micros.

Spending on information technology has also increased from an average £500 in primary schools in 1988 to £950 in 1990 and from £4,900 to £15,100 in secondary schools.

COMPLAINTS

However, many teachers still seem to complain about the lack of resources to enable them to do a proper job. Their complaints can be dismissed with the comment that teachers always complain of shortages. And if design and technology is about problem solving then finding a solution within the extra resource constraint should make the project more challenging and realistic.

It is possible to agree with that view, but only up to a point. An average of 41 computers per secondary school can hide a wide variation, and even a school on the average does not have a great number considering that many secondary schools have more than 1,000 pupils.

Another interesting fact revealed by the DES survey was that the total spent last year on hardware and software was £78m of which only £13.5m was grant supported spending from the government. Of that spending 40 per cent came from parent teacher associations and other private sources.

That may have been acceptable some years ago when such equipment was considered to be extra to the normal requirements of a school. But now that it has been brought more and more into the mainstream of a school's activities it should be met from mainstream finances not extra fund raising. Relying on fund raising for essential equipment will mean a growing divide between schools serving rich neighbourhoods and those serving poor.

LOCAL MANAGEMENT

Another concern about the resources for design and technology relates to the local management of schools. Under the government's plans by 1 April 1993, 85 per cent of a schools potential budget must be decided by the school's governors and headteacher, with 80 per cent of the budget directly linked to pupil numbers.

With all their other increased responsibilities there is a concern that governors and headteachers will not be able to judge what equipment is best for their school from the increasing amount which is becoming available, and whether they will be able to get the best price by buying individually rather than in bulk if the decision was taken, as in the past, by the LEA.

RESOURCE

Remaining on the National Curriculum theme the amount of equipment and resources continues to grow. Resource, the LEA-funded supplier based in Doncaster, is working on a package to help explain control technology. In common with other similar products Resource says it is aiming to explain the subject by putting it into real everyday situations. The package is based around a small book and costs about £4.

It follows the recent release of Resource's Honeypot creation. Intended for primary schools it features an imaginary village in which a variety of problems arise for the pupils to solve. The pack contains a drawing of the village, books and a teacher's pack for about £45.

DEVELOPMENTS

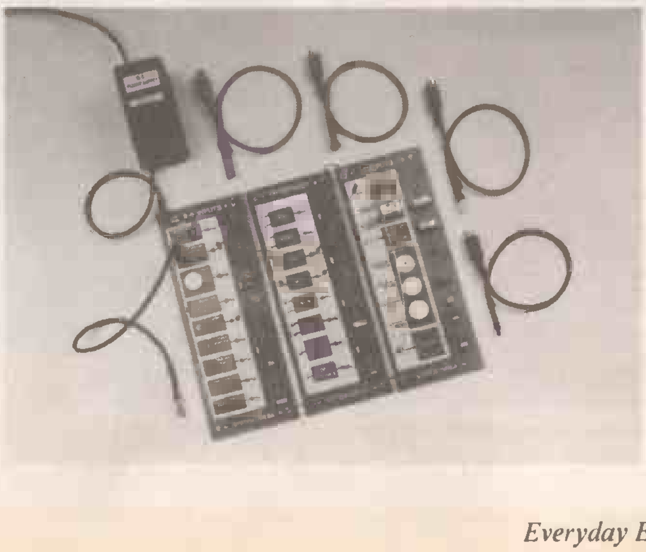
Swallow Systems is boosting the user-friendliness of its PIP Mobile by supplying a range of soft covers. The idea is that although for most purposes PIP can be customised by using junk materials teachers might want to make the machine more appealing to younger children. At £16 each, dog and rabbit covers are available in three colours as well as a panda in black and white.

The number of computer links for PIP have been extended. They are now available for BBC's B and Master PC compatibles. The older prototype Nimbus software has been withdrawn and replaced by PIPNIM from Pink Elephant Software. The prices of the leads and software range from £30 for the PC compatibles to £15 for the BBCs.

Economatics has been extending its electronics teaching range by introducing System Omega, which is said to be a self-contained kit for introducing pupils to electronics systems and giving them an understanding of input-process-output.

Developed by Omega Electronics it is aimed at children in key stages 2 and 3 of the Curriculum, that is for ages 7 to 14. The kit contains a power supply, three boards, plug leads for making connections and teacher's materials for a total of about £130, or £115 without the power supply.

System Omega boards, power supply and sensor leads



System Omega is intended to be simple and easy to use. The boards have eight inputs including a pulser and an external sensor socket. Outputs for a variety of sounds, a counter and a relay are available.

For further information contact: Economatics (Education) Ltd, Epic House, Orgreave Road, Handsworth, Sheffield S13 9LQ. ☎0742 690801.

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The books listed have been selected as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full details are given on the last book page.

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Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.
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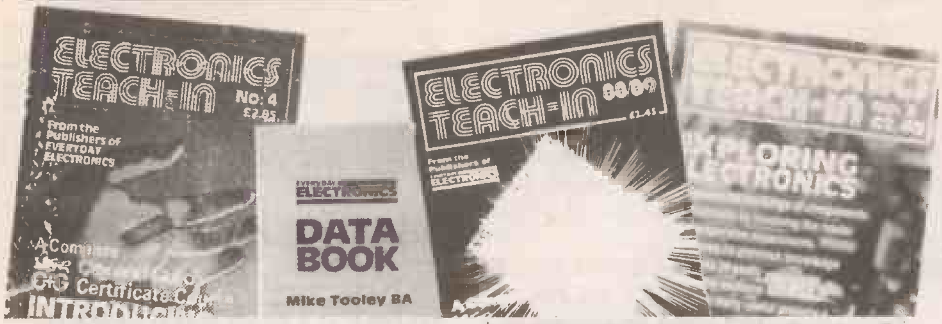
TEACH-IN, THEORY, AND REFERENCE



ELECTRONICS TEACH-IN No.4
INTRODUCING DIGITAL ELECTRONICS (published by *Everyday Electronics*)
Michael J. Cockcroft

Although this book is primarily a City & Guilds Introductory level course (726/301), approximately 80% of the information forms a very basic introduction to electronics in general, it therefore provides an excellent introductory text for beginners and a course and reference book for GCSE students.

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If you are more used to the black and white keys of a synth keyboard than the QWERTY keyboard of a computer, you may be understandably confused by the jargon and terminology bandied about by computer buffs. But fear not, setting up and using a computer-based music making system is not as difficult as you might think.

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The guide covers versions 3.0, 3.1 and 3.2 of both PC-DOS and MS-DOS as implemented by IBM and other manufacturers of "compatible" microcomputers, including the AMSTRAD PC's. It covers both floppy disc-based systems and hard disc-based systems.

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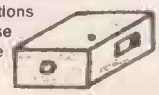

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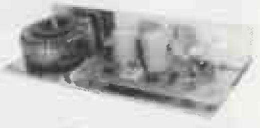

OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 1Hz – 100KHz −3dB, Damping Factor, >300, Slew Rate 45V/uS, T.H.D. Typical 0.002%, Input Sensitivity 500mV, S.N.R. −125dB. Size 300 × 123 × 60mm.
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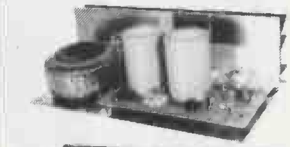
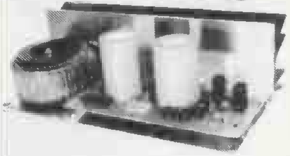


OMP/MF200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, Frequency Response 1Hz – 100KHz −3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. Typical 0.001%, Input Sensitivity 500mV, S.N.R. −130dB. Size 300 × 155 × 100mm.
PRICE £62.99 + £3.50 P&P.



OMP/MF300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, Frequency Response 1Hz – 100KHz −3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. Typical 0.0008%, Input Sensitivity 500mV, S.N.R. −130dB. Size 330 × 175 × 100mm.
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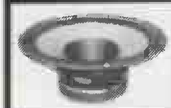

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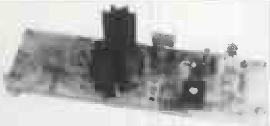

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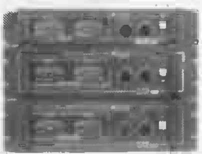

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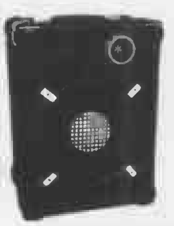

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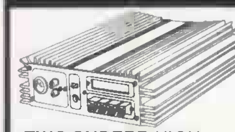

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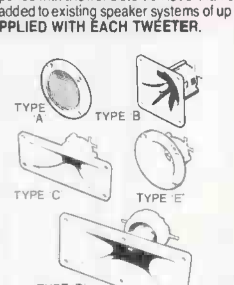

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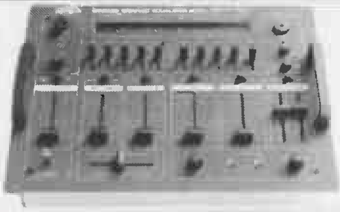

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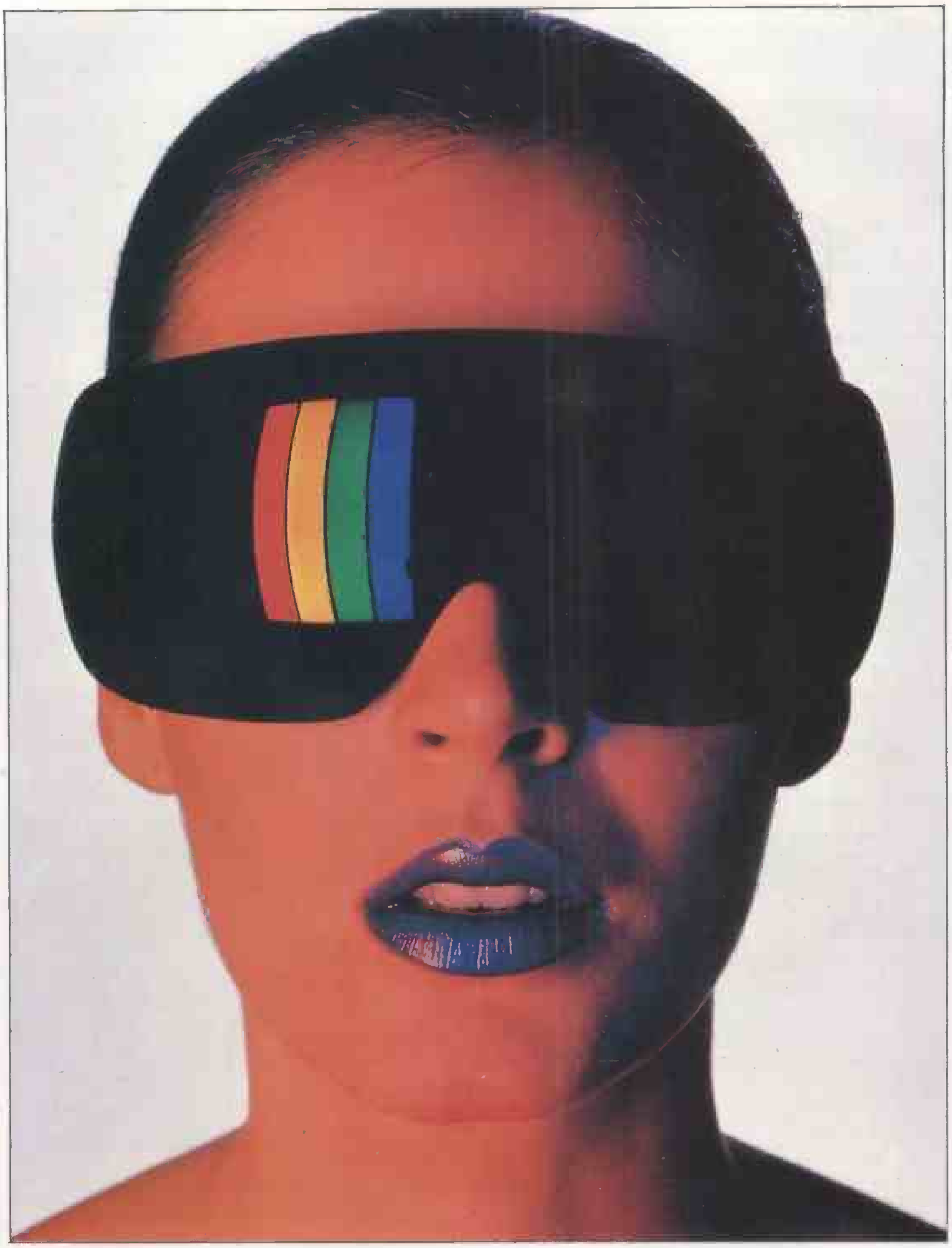

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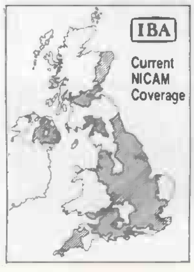

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