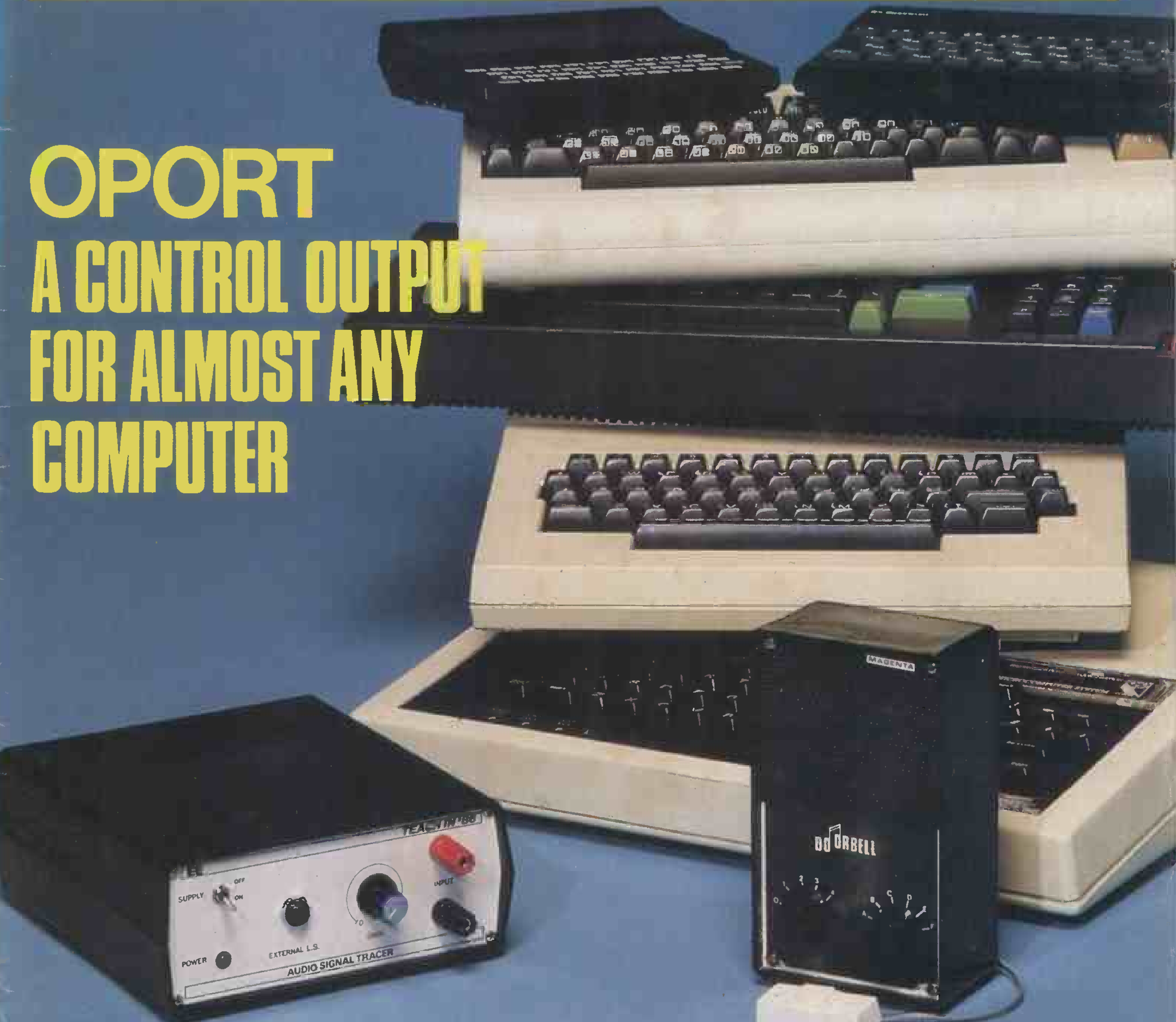
EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY

JANUARY 1986 £1·10

OPORT
A CONTROL OUTPUT FOR ALMOST ANY COMPUTER



TEACH IN '86 PROJECT... AUDIO SIGNAL TRACER

MUSICAL DOORBELL

Newcomers Magazine for Electronic & Computer Projects

Australia $2 New Zealand $2.25 Malaysia $5.25

£1 BAKERS DOZEN PARCELS

Price per parcel is £1.00, but if you order 12 you get one extra free. Unless marked s.h.
All the parcels listed below are brand new components.

1 – 5 13 amp ring main junction boxes
2 – 5 13 amp ring main spur boxes
3 – 25 13 amp fuses for ring mains
4 – 5 surface mounting switches suitable insulated for mains voltage
5 – 3 flush electrical switches intermediate type, will also replace 1 or 2 way switches
6 – 5 in flex line switches
7 – 4 in flex line switches with neons
8 – 2 80 watt brass cased elements
9 – 2 mains transformers with 6v 1a secondaries
10 – 2 mains transformers with 12v ½a secondaries
11 – 1 extension speaker cabinet for 6½" speaker
12 – 5 octal bases for relays or valves
13 – 12 glass reed switches
14 – 4 OCP 70 photo transistors
15 – 25 assorted gemanium transistors OC45 etc
16 – 4 tape heads, 2 record, 2 erase
17 – 2 ultra sonic transmitters and 2 ditto receivers (with circuit of invisible beam switch)
18 – 2 15000 mfd computer grade electrollics
19 – 2 light dependent resistors similar ORP12
20 – 5 diff micro switches
21 – 2 mains interference suppressors
22 – 2 25 watt crossover units
23 – 1 40 watt 3 way crossover unit
24 – 250 various screws and self tappers
25 – 1 of each wafer switches – 6p 2 way; 4p 3 way; 2p 6 way; 1p 12 way
26 – 2 tape deck counters
27 – 1 6 digit counter 12v
28 – 1 6 digit counter mains voltage
29 – 1 BOAC in flight stereo unit (second hand)
30 – 2 Nicad battery chargers
31 – 1 key switch with key
32 – 2 humidity switches
33 – 2 aerosol cans of ICI Dry Lubricant
34 – 96 × 1 metre lengths colour-coded connecting wires
35 – 4 battery operated model motors
36 – 2 air spaced 2 gang tuning condensors
37 – 2 solid dielectric 2 gang tuning condensors
38 – 10 compression trimmers
39 – Long and Medium wave tuner kit
40 – 4 × 465 KC IF transformers
41 – 8 Rocker Switches 10 amp Mains SPST
42 – 6 Rocker Switches 10 amp Mains SPDT
43 – 5 Rocker Switches 10 amp SPDT Centre Off
44 – 4 Rocker Switches 10 amp DPDT
45 – 1 24 hour time switch mains operated (s.h.)
46 – 1 6 hour clock timeswitch
47 – 2 lever switches 4 pole changeover up and ditto down
48 – 2 6v operated reed switch relays
49 – 10 neon valves – make good night lights
50 – 2 × 12v DC or 24V AC 4CO relays
51 – 1 × 12v 2C 0 very sensitive relay
52 – 1 × 12v 4C 0 relay
53 – 2 mains operated relays 3 × 8 amp changeovers (secondhand)
54 – 10 rows of 32 gold plated IC sockets (total 320 sockets)
55 – 1 locking mechanism with 2 keys)
56 – Miniature Uniselector with circuit for electric jigsaw puzzle
57 – 5 Dolls' Hous switches
58 – 2 telephone hand sets incorporating ear piece and mike (s.h.)
59 – 2 flat solenoids – ideal to make current transformer etc.
60 – 5 ferrite rods 4" × 5/16" diameter aerials
61 – 4 ferrite slab aerials with L & M wave coils
62 – 4 200 ohm earpieces
63 – 1 Mullard Thyristor trigger and modules
64 – 10 assorted knobs ¼ spindles
65 – 5 different thermostats, mainly bi-metal
66 – Magnetic brake – stops rotation instantly
67 – Low pressure 3 level switch
68 – Heavy duty 4 pole contactor – 24v coil
69 – 2 25 watt pots 8 ohm
70 – 2 25 watt pots 1000 ohm
71 – 4 wire wound pots – 18, 33, 50 and 100 ohm
72 – 1 1250 watt dimmer Ultra ref SE20
73 – 4 3 watt wire wound pots 50 ohm
74 – 50 1/3 watt carbon film resistors good spread 10 values
75 – 20 2 watt carbon resistors 10 values
76 – 30 1 watt carbon resistors 15 diff values
77 – 1 time reminder adjustable 1-60 mins
78 – 5.5 amp stud rectifiers 400v
80 – 2 10a bridge rectifiers 30v
81 – 2 30a panel mounting slydlok fuses
82 – 4 porcelain fuse holders and fuses
83 – 1 fluorescent choke – your choice – 15, 20, 30, 40 or 65 watt
84 – 10 ·1 uf mains voltage suppressor condensors
85 – 1 mains shaded ple motor ¾" stack – ¼ shaft
86 – 2 5" ali fan blades fit ¼" shaft
87 – 2 3" plastic fan blades fit ¼" shaft
88 – Mains motor suitable for above blades
89 – 1 mains motor with gear box 1 rev per 24 hours
90 – 1 mains motor with gear box 1 rev per 12 hours
91 – 2 mains motor with gear box 16rpm
92 – 4 fluorescent starters suit 4-80w tubes
93 – 4 11 pin moulded bases for relays
94 – 5 B7G valve bases
95 – 4 skirted B9A valve bases
96 – 1 thermostat for fridge
97 – 1 infra red fire element 1000 watts
98 – 1 motorised stud switch (s.h.)
99 – 5 assorted ferrite shapes
100 – 3 ferrite magnets
101 – 1 2½ hours delay switch
102 – 1 mains power supply unit – 9v dc
103 – 1 mains power supply unit – 6v dc
104 – 1 mains power supply unit – 4½v dc
105 – 1 5 pin flex plug and panel socket
106 – 1 12v vibrating reed buzzer
107 – 5" speaker size radio cabinet with handle
108 – 5 different multi way push switches
109 – 10 ¼" spindle type volume controls
110 – 10 slider type volume controls
111 – 2 musical boxes (less keys)
112 – 1 heating pad 200 watts mains
113 – 1 Fm front end with tuning condensor and data
114 – 1 1w amplifier Mullard 1172
115 – Wall mounting thermostat 24v
116 – 3 pairs small 2prs. medium croc clips
117 – 4 pairs large (car size) crocodile clips
118 – Teak effect extension 5" speaker cabinet
119 – 1 log & 1 coal fibreglass fire fronts
120 – p.c.b. with 2 amp full wave and 17 other recs.
121 – 2 13 amp flush switched sockets
122 – 10 mtrs twin screened flex white p.v.c. outer
123 – 100 plastic with hardened pin flex staples
124 – 10 slide switches

MULLARD UNILEX AMPLIFIERS

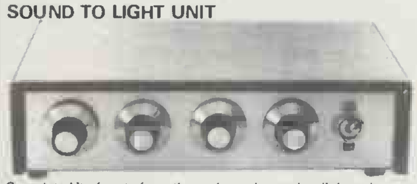
We are probably the only firm in the country with these now in stock. Although only four watts per channel, these give superb reproduction. We now offer the 4 Mullard modules – i.e. Mains power unit (EP9002) Pre amp module (EP9001) and two amplifier modules (EP9000) all for £6.00 plus £2 postage. For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

Ex-Electricity Board.
Guaranteed 12 months.

VENNER TIME SWITCH

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

SOUND TO LIGHT UNIT



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

THIS MONTH'S SNIP

TOP OF THE POPS LIGHTING
if you use our disco switch ONLY £6.90

These have 12" × 10 amp changeover swtiches each rated at 10 amps so a whole street could easily be lit with one. Switches adjustable and could be set to give a running light, random flashes, etc. 230 volts main operation. Brand new, made by Honeywell. Offered at approximately on third of cost.

TANGENTIAL BLOW HEATER

by British Solartron, as used in best blow heaters. 3Kw £6.95 complete with 'cold' 'half' and 'full' heat switch, safety cut out and connection diagram.

Please add post £1.50 for 1 or 3 for £20 post paid
2.5 Kw KIT Still available: £4.95 + £1.50 post
or have 3 for £16 post paid.

FROZEN PIPES

Can be avoided by winding our heating cable around them – 15 mtrs connected to mains costs only about 10p per week to run. Hundreds of other uses as it is waterproof and very flexible. Resistance 60 ohms/metre. Price 28p/metre or 15m for £3.95.

CORDLESS TELEPHONES

"IT'S FOR YOU-OU" even if you are in the bath, its an infinite extension any room and even in the garden – have one on approval or come and try one here. BT approved £120 not yet approved £59. Both have 10 memory.
SOCKETS PLUGS ETC for BT phones

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

25A ELECTRICAL PROGRAMMER

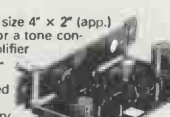
Learn in your sleep. Have radio playing and kettle boiling as you wake – switch on lights to ward off intruders – have a warm house to come home to. You can do all these and more. By a famous maker with 25 amp on/off switch. Independent 60 minute memory jogger. A beautiful unit at £2.50

THE AMSTRAD STEREO TUNER

This ready assembled unit is the ideal tuner for a music centre or an amplifier, it can also be quickly made into a personal stereo radio – easy to carry about and which will give you superb reception.
Other uses are a "get you to sleep radio", you could even take it with you to use in the lounge when the rest of the family want to view programmes in which you are not interested. You can listen to some music instead.
Some of the features are: long wave band 115 – 170KHz, medium wave band 525 – 1650KHz, FM band 87 – 108 MHz, mono, stereo & AFC switchable, fully assembled and fully aligned. Full wiring up data showing you how to connect to amplifier or headphones and details of suitable FM aerial (note ferrite rod aerial is included for medium and long wave bands). All made up on very compact board.
Offered at a fraction of its cost — only £4.95

MINI MONO AMP on p.c.b. size 4" × 2" (app.)

Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amp. Brand new. perfect condition, offered at the very low price of £1.15 each, or 13 for £12.00.



J. BULL (Electrical) Ltd.
(Dept. EE), 34 - 36 AMERICA LANE, HAYWARDS HEATH, SUSSEX RH16 3QU. Established 30 YEARS

MAIL ORDER TERMS: Cash, P.O. or cheque with order. Orders under £20 add £1 service charge. Monthly account orders accepted from schools and public companies. Access & B/card orders accepted day or night. Haywards Heath (0444) 454563. Bulk orders: phone for quote. Shop open 9.00 – 5.30, Mon to Fri, not Saturday.

TWO POUNDERS

Following the popularity of our BAKERS DOZEN £1 PARCELS, we are now introducing some BAKERS DOZEN £2 PARCELS. We feel that you will agree that most are exceptional bargains but you can still get a bit extra, as with the £1 parcel, if you buy 12 you get another free!

2P1 – 24 hour time switch with 2 on/offs, an ideal heating programmer
2P2 – Wall mounting thermostat, high precision with mercury switch and thermostat
2P3 – Variable and reversible 8-12v power supply, ideal for model control
2P4 – 24 volt psu with separate channels for stereo made for Mullard UNILEX Amplifiers.
2P5 – 12 volt psu 750 ma output – plastic cased
2P6 – 100 watt mains to 115 volts auto-transformer with voltage tappings
2P7 – Mini key, 16 button membrane keyboard, list price over £12, as used on PRESTEL
2P8 – Mains motor with gear box and variable speed selector. Series wound so suitable for further speed control
2P9 – Time and set switch. Boxed, glass fronted and with knobs. Controls up to 15 amps. Ideal to program electric heaters, battery chargers etc
2P10 – 12 volt 5 amp mains transformer – low volt winding on separate bobbin and easy to remove to convert to lower voltages for higher currents
2P11 – Power amp module Mullard Unilex EP9000 (note stereo pre-amp module Unilex 9001 is BD216
2P12 – Disk or Tape precision motor – has balanced rotor and is reversible 230v mains operated 1500 rpm
2P13 – Sun Lamp switch stays on for ½ hr or 1 hr depending on setting of grub screw
2P14 – Mug Stop kit – when thrown emit piercing squawk
2P15 – Interupted Beam kit for burglar alarms, counters, etc
2P16 – Lockable metal box with 2 keys, ideal for your tools
2P17 – 1 rev per minute mains driven motor with gear box, ideal to operate mirror ball
2P18 – Liquid/gas shut off valve mains solenoid operated
2P19 – Disco switch-motor drives 6 or more 10 amp change over micro switches supplied ready for mains operation
2P20 – 20 metres extension lead, 2 core – ideal most Black and Decker garden tools
2P21 – 10 watt amplifier, Mullard module reference 1173
2P22 – Motor driven switch 20 secs on or off after push
2P24 – Clockwork operated 12 hour switch 15A 250V with clutch
2P25 – 1000 watt flasher mains motor driven
2P26 – Counter resettable mains operated 3 digit
2P27 – Goodmans Speaker 6 inch round 8ohm 12 watt
2P28 – Drill Pump – always useful couples to any make portable drill
2P29 – 24 position Yaxley switch contacts rated 5A – ¼ spindle
2P30 – 15 metres 6 way telephone or interconnecting wire
2P31 – 4 metres 98 way interconnecting wire easy to strip to use the cores separately
2P32 – Hot Wire amp meter – 4½ round surface mounting – old but working and definitely a bit of history
2P33 – 0-30 amp meter 2" round panel mounting with shunt ex ministry equipment
2P34 – Solenoid Air Valve mains operated
2P35 – Battery charger kit comprising mains transformer, full wave rectifier and meter, suitable for charging 6v or 12v
2P36 – 20 Amp meter, with shunt unused but ex-equipment
2P37 – 0-100 micro amp meter, 2" square flush mounting good make
2P38 – 200 R.P.M. Geared Mains Motor 1" stack quite powerful, definitely large enough to drive a rotating aerial or a tumbler for polishing stones etc.
2P41 – Liquid crystal display, 8 digit 13mm black on silver.
2P42 – Tubular heater, 60 watts per ft, unused but slightly storage soiled, made by G.E.C. Perfect order (must be collected by appointment).
2P43 – Small type blower or extractor fan, motor inset so very compact, unused.
2P44 – Inverter to operate 21" 13 watt fluorescent tube off 12 volts.
2P46 – Our famous drill control kit complete and with prepared case.
2P47 – Joy switch kit complete as previously sold.
2P48 – Telephone ringing unit reduces mains to 50 volts and changes frequency from 50 hz to 25 hz to give right ringing tone.
2P49 – Fire Alarm break glass switch in heavy cast case.
2P51 – Stereo Headphone amplifier, with pre-amp and normal controls.
2P54 – 2½kw. blow heater section of coal or log effect fire, this is a sheet metal assembly which holds the elements, the motor with fan, and the lamp holders and bits which give the flickering flame effect. Please collect or add £3 to cover packing and postage.
2P55 – Mains motor, extra powerful has 1½" stack and good length of spindle both ends.

IONISER KIT

Refresh your home, office, shop, work room, etc. with a negative ION generator. Makes you feel better and work harder – a complete mains operated kit, case included.
£11.95 plus £2.00 post.

CAR STARTER/CHARGER KIT

Flat Battery! Don't worry you will start your car in a few minutes with this unit – 250 watt transformer 20 amp rectifiers, case and all parts with data £16.50 or without case £15.00 post paid.

4/5A BATTERY CHARGER

Transformer and rectifier £3.95 & £1 post. 3 Kits £12.

SUPER H.F. SPEAKER CABINET

Made for an expensive Hi-Fi outfit. Will suit any decor, is resonance free, cut outs for 8" woofer, 2¾" mid range and 2½" tweeter. Front is black and the completed unit most pleasing. Price per pair £6.90 carriage £3.50.

OTHER POPULAR PROJECTS

Big Ear, listen through walls	£9.50
Silent Sentinel Ultra Sonic Transmitter and Receiver	£9.50
Car Light 'left on' Alarm	£3.50
3 – 30v Variable Power Supply	£13.80
2 Short & Medium Wave Crystal Radio	£3.99
Radio Stethoscope – fault finding aid	£4.80
Morse Trainer – complete with key	£2.99
Drill Control Kit	£2.00
Transmitter Surveillance Kit	£2.30
Radio Mike	£6.90
FM Receiver Kit – for surveillance or normal FM	£3.50
Insulation Tester – electronic megger	£7.95
Matchbox Radio – receives Medium Wave	£2.95
40 watt amp – Hi-Fi 20hz–20kHz	£9.50
115 Watt Amplifier 5Hz 25kHz	£13.50
Power Supply for 115 watt amp	£8.50

VOL15 Nº1 JANUARY '86

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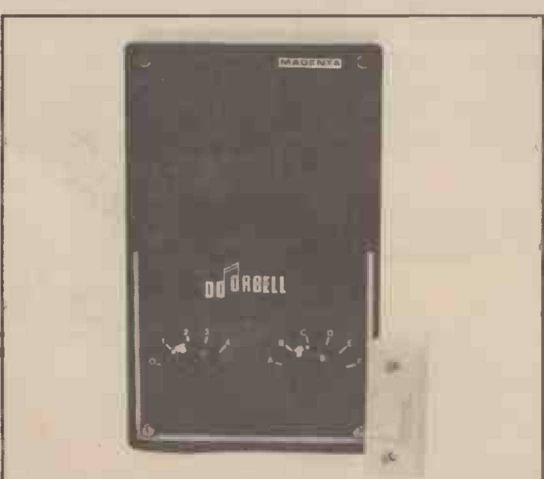
ISSN 0262–3617

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



Projects

Series

Features

Our February 1986 issue will be published on Friday, January 17. See page 24 for details.

E.E. PROJECT KITS

MAGENTA

Full Kits inc. PCBs, or veroboard, hardware, electronics, cases (unless stated). Less batteries.
If you do not have the issue of E.E. which includes the project – you will need to order the instruction reprint as an extra – 70p each. Reprints available separately 70p each + p&p 60p.

THIS MONTH'S KITS
SAE or 'phone for prices

MUSICAL DOORBELL Jan 85	£16.98
TTL LOGIC PROBE Dec 85	£8.59
OPTICAL INTENSITY TRANSDUCER Dec 85	£16.34
DIGITAL CAPACITANCE METER Dec 85	£35.98
DIODE/TRANSISTOR TESTER Dec 85	£15.98
UNIVERSAL LCR BRIDGE Nov 85	£23.49
FLUX DENSITY TRANSDUCER Nov 85	£26.15
FLASHING PUMPKIN less case Nov 85	£3.82
SQUEAKING BAT less case Nov 85	£8.63
SCREAMING MASK less case Nov 85	£9.98
STRAIN GAUGE AMPLIFIER Oct 85	£25.46
SIMPLE AUDIO GENERATOR Oct 85	£2.59
SOLDERING IRON POWER CONTROLLER Oct 85	£4.72
VOLTAGE REGULATOR Sept 85	£6.78
PERSONAL STEREO P.S.U. Sept 85	£8.99
R.I.A.A. PRE-AMP Sept 85	£14.49
CARAVAN ALARM Sept 85	£9.37
FRIDGE ALARM Sept 85	£6.82
SEMI-CONDUCTOR TEMP. SENSOR Sept 85	£18.93
RESISTANCE THERMOMETER Sept 85 Less Probe	£18.83
PLATINUM PROBE Extra	£22.00
LOW COST POWER SUPPLY UNIT Aug 85	£16.72
TRI-STATE THERMOMETER (Batt) Aug 85	£6.05
TREMOLO/VIBRATO Aug 85	£34.48
STEPPER MOTOR INTERFACE FOR THE BBC COMPUTER less case Aug 85	£13.99
1D35 STEPPER MOTOR EXTRA	£14.50
OPTIONAL POWER SUPPLY PARTS	£4.67
EMERGENCY LIGHTS FLASHER less lamps July 85	£6.39
CONTINUITY TESTER July 85	£5.37
TRAIN SIGNAL CONTROLLER July 85	£8.78
AMSTRAD USER PORT July 85	£15.33
ACROSS THE RIVER June 85	£17.97
ELECTRONIC DOORBELL June 85	£6.55
COMPUTERISED SHUTTER TIMER June 85	£10.61
GRAPHIC EQUALISER June 85	£23.33
AMSTRAD CPC 464 May 85	£15.34
MAINS VERSION	£22.48
AUTO PHASE May 85	£16.39
INSULATION TESTER Apr. 85	£16.96
LOAD SIMPLIFIER Feb. 85	£16.98
SOLID STATE REVERB Feb. 85	£39.98
GAMES TIMER Jan. 85	£7.63
SPECTRUM AMPLIFIER Jan. 85	£5.98
TV AERIAL PRE-AMP Dec. 84	£12.36
Optional PSU 12V £2.03. 240V	£9.86
MINI WORKSHOP POWER SUPPLY Dec. 84	£34.98
DOOR CHIME Dec. 84	£14.91
BBC MICRO AUDIO STORAGE SCOPE INTERFACE Nov. 84	£28.77
PROXIMITY ALARM Nov. 84	£17.98
MAINS CABLE DETECTOR Oct. 84	£4.39
MICRO MEMORY SYNTHESISER Oct. 84	£47.98
DRILL SPEED CONTROLLER Oct. 84	£6.89
GUITAR HEAD PHONE AMPLIFIER Sept. 84	£6.38
SOUND OPERATED FLASH less lead Sept. 84	£5.91
TEMPERATURE INTERFACE FOR BBC MICRO Aug. 84	£19.70
CAR RADIO BOOSTER Aug. 84	£13.87
CAR LIGHTS WARNING July 84	£7.99
VARICAP AM RADIO May 84	£10.43
EXPERIMENTAL POWER SUPPLY May 84	£18.72
SIMPLE LOOP BURGLAR ALARM May 84	£13.62
MASTERMIND TIMER May 84	£5.44
FUSE/DIODE CHECKER Apr. 84	£3.45
QUASI STEREO ADAPTOR Apr. 84	£10.90
DIGITAL MULTIMETER add on for BBC Micro Mar. 84	£24.98
NI-CAD BATTERY CHARGER Mar. 84	£9.85
REVERSING BLEEPER Mar. 84	£6.78
PIPE FINDER Mar. 84	£3.60
IONISER Feb 84	£23.98
ZX81 EPROM PROGRAMMER Feb 84	£14.48
SIGNAL TRACER Feb 84	£14.89
CAR LIGHT WARNING Feb 84	£3.76
GUITAR TUNER Jan 84	£17.73
BIOLOGICAL AMPLIFIER Jan 84	£19.16
CONTINUITY TESTER Dec 83	£9.99
CHILDREN'S DISCO LIGHTS Dec 83	£8.42
NOVEL EGG TIMER Dec 83 inc. case	£10.24
SPEECH SYNTHESIZER FOR THE BBC MICRO Nov. 83 less cable + sockets	£21.98
MULTIMOD Nov. 83	£16.98
LONG RANGE CAMERA/FLASHGUN TRIGGER Nov. 83	£13.50
HOME INTERCOM less link wire Oct. 83	£14.38
DIGITAL TO ANALOGUE BOARD Oct. 83 less cable, case & connector	£19.98
HIGH POWER DAC DRIVER BOARD Oct. 83 less case	£12.52
HIGH SPEED A TO D CONVERTER Sept 83 less cable & connector	£27.98
SIGNAL CONDITIONING AMP Sept 83 no case	£8.98
STORAGE 'SCOPE INTERFACE FOR BBC MICRO Aug 83 less software	£15.38
PEDESTRIAN CROSSING SIMULATION BOARD Aug 83 no case	£10.29
HIGH POWER INTERFACE BOARD Aug 83 no case	£10.38
USER PORT I/O BOARD less cable + plug	£10.49
USER PORT CONTROL BOARD July 83 less cable + plug + case	£25.14
GUITAR HEADPHONE AMPLIFIER May 83	£7.92
MW PERSONAL RADIO less case, May 83	£7.62
MOISTURE DETECTOR May 83	£5.46
CAR RADIO POWER BOOSTER April 83	£11.99
FUNCTION GENERATOR April 83	£45.98
FLANGER SOUND EFFECTS April 83	£24.17
NOVELTY EGG TIMER April 83 less case	£5.48
DUAL POWER SUPPLY March 83	£59.38
BUZZ OFF March 83	£4.51
PUSH BIKE ALARM Feb. 83	£11.73
ZX TAPE CONTROL Nov. 82	£7.13
CONTINUITY CHECKER Sept. 82	£5.47
2-WAY INTERCOM July 82 no case	£4.52
ELECTRONIC PITCH PIPE July 82	£5.40
REFLEX TESTER July 82	£7.77
SEAT BELT REMINDER Jun 82	£4.10
EGG TIMER June 82	£5.44
CAR LED VOLTMETER less case. May 82	£3.18
V.C.O. SOUND EFFECTS UNIT Apr. 82	£12.71
CAMERA OR FLASH GUN TRIGGER Mar. 82 £13.65 less tripod bushes	
POCKET TIMER Mar. 82	£4.10
GUITAR TUNER Mar. 82	£17.19
SIMPLE STABILISED POWER SUPPLY Jan. 82	£26.98
MINI EGG TIMER. Jan. 82.	£4.40
SIMPLE INFRA RED REMOTE CONTROL Nov. 81	£18.70
CAPACITANCE METER Oct. 81	£25.81
SUSTAIN UNIT Oct. 81	£13.99
TAPE NOISE LIMITER Oct. 81	£4.98
HEADS AND TAILS GAME Oct. 81	£2.75
CONTINUITY TESTER Oct. 81	£4.48
PHOTO FLASH SLAVE Oct. 81	£3.80
FUZZ BOX Oct. 81	£7.98
SOIL MOISTURE UNIT Oct 81	£6.39
0-12V POWER SUPPLY Sept. 81	£19.48
COMBINATION LOCK July 81 less case	£21.58
SOIL MOISTURE INDICATOR E.E. May 81	£4.49
GUITAR HEADPHONE AMP E.E. May 81	£4.66
PHONE BELL REPEATER/BABY ALARM May 81	£6.15
INTERCOM April 81	£24.43
MODULATED TONE DOORBELL Mar. 81	£7.35
2 NOTE DOOR CHIME Dec. 80	£11.35
LIVE WIRE GAME Dec. 80	£12.87
GUITAR PRACTICE AMPLIFIER Nov. 80 £14.10 less case. Standard case extra	£4.99
SOUND TO LIGHT Nov. 80 3 channel	£23.40
TRANSISTOR TESTER Nov. 80	£12.80
AUDIO EFFECTS UNIT FOR WEIRD SOUNDS Oct. 80	£14.40
IRON HEAT CONTROL Oct. 80	£6.30
MICRO MUSIC BOX Feb. 80	£17.86
Case extra	£3.60
SPRING LINE REVERB UNIT Jan. 80	£27.20
UNIBOARD BURGLAR ALARM Dec. 79	£6.70
DARKROOM TIMER July 79	£3.20
MICROCHIME DOORBELL Feb. 79	£17.48
SOUND TO LIGHT Sept. 78	£9.20
CAR BATTERY STATE INDICATOR less case Sept. 78	£2.29
R.F. SIGNAL GENERATOR Sept. 78	£31.20
IN SITU TRANSISTOR TESTER Jun. 78	£7.50
WEIRD SOUND EFFECTS GENERATOR Mar. 78	£6.20
ELECTRONIC DICE Mar. 77	£4.96

TOOLS

ANTEX MODEL C IRON	£6.98
ANTEX X5 SOLDERING IRON 25W	£7.25
ST4 STAND FOR IRONS	£2.85
HEAT SINK TWEEZERS	45p
SOLDER HANDY SIZE 5	£1.39
SOLDER CARTON	£2.50
SOLDER REEL SIZE 10	£4.67
LOW COST PLIERS	£1.98
LOST COST CUTTERS	£1.99
BENT NOSE PLIERS	£1.89

MINI DRILL 12V (MD1)	£8.38
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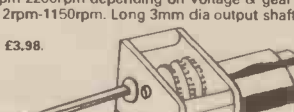

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EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY

VOL15 Nº1 **JANUARY '86**

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ELECTRONICS AND EDUCATION

This month's leader is dedicated to another magazine. That may seem a little odd, but our sister publication, *Practical Electronics,* has become involved with an in-depth look at electronics in schools and in particular with the Microelectronics Education Programme. In the January issue of PE (now on sale) there is an article by the National Coordinator of MEP describing the what, why and how of MEP. The issue also carries a reply by Chris Patten, of the Department of Education and Science, to items and comments previously published in PE.

Some months ago I became worried about the lack of teaching of technology in many schools and said so in my PE editorial. Things went from there and the result has been contact with MEP and the DES and two articles describing MEP and what is now available to schools for teaching (covered in PE February issue on sale Jan. 3rd, 1986).

Why am I mentioning all this here? Well EE is aimed at the student and gets into many schools. It is therefore often read by teachers, some of whom may not be aware of what is available to assist with electronics—or even what Government and Local Education Authority policy is on the subject. If you teach electronics, if you are an interested parent, or if you are keen to learn electronics at school the two articles on the MEP will certainly be of interest to you.

FUTURE

In future issues of EE we hope to publish designs connected with MEP. We wish to encourage all schools to put some form of electronics on the curriculum—yes even primary schools. Where the Microelectronics For All (part of MEP) course is being taught, teachers have noticed the significant effect on the pupils' development, vocabulary and use of language. Because the course requires pupils to work in groups, solving problems which they find interesting, challenging and meaningful, many students that have previously not been motivated by traditional teaching suddenly show an interest and ability which surprises their teachers.

Everyday Electronics has always been dedicated to teaching electronics; we will go on doing this, hopefully, to more students getting a grounding in the subject at school.

Mike Kenward

BACK ISSUES & BINDERS

Certain back issues of EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY are available world-wide price £1.25 inclusive of postage and packing per copy. Enquiries with remittance should be sent to Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF. In the event of non-availability remittances will be returned.

Binders to hold one volume (12 issues) are available from the above address for £5.50 inclusive of p&p world-wide.

READERS' ENQUIRIES

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

COMPONENT SUPPLIES

Readers should note that we do not supply electronic components for building the projects featured in EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY, but these can be supplied by advertisers.

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

OLD PROJECTS

We advise readers to check that all parts are still available before commencing any project in a back-dated issue, as we cannot guarantee indefinite availability.

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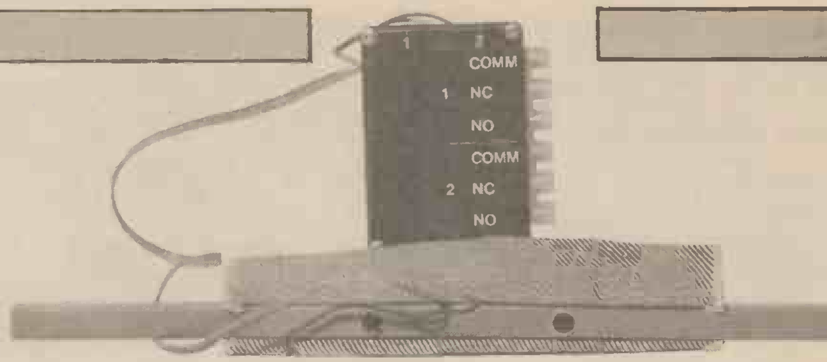
OPORT



GIDEON TEARLE

Control the world at the speed of light! This clever light-activated interface allows computer control via your TV.

IT IS OFTEN necessary for a computer to control other electrical equipment; but because a computer is a delicate piece of electronic circuitry it is often unwise for amateur constructors to make their own interfaces.

Another problem which crops up time and time again is the lack of documentation by computer manufacturers for the output port of the computer. It is often the case, also, that the programs required to control the output port are beyond the scope of the user.

OPTICAL CONNECTION

The majority of home computers are connected safely to one peripheral which is used as an interface between the computer and the user. The peripheral is the television. Due to the relative ease with which a computer can be programmed to display characters at a certain position on the screen and at a certain time, all that an interface between the television and the output has to do is to read what is on the screen and convert it into an electrical signal suitable for driving a relay.

SMOOTHING

The basic circuit shown in Fig. 1 would work perfectly if the television behaved in the way a light bulb behaves. Unfortunately, the television behaves in a totally different way. The screen can be said to consist of 520625 elements (in a similar way to the way that a computer's images are built up out of pels or pixels) and only one of these is ever lit at one time.

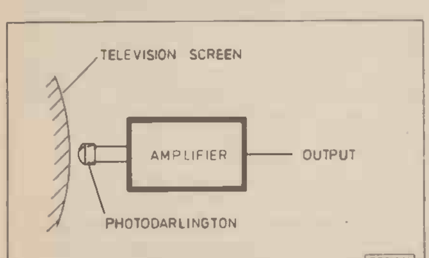


Fig. 1. The idea behind the Oport. The TV acts as the interface.

The time between an element lighting for the first time and the same element lighting for the second time is one twentyfifth of a second. From these two figures it can be worked out that one element is lit for a very small time, in fact $7{\cdot}683 \times 10^{-8}$ seconds. By assuming that a photodarlington will pick up light from elements in a $1cm^2$ area and by working out the amount of elements in an area of this size, it is possible to work out that the photodarlington will be on for approximately 0·235 per cent of the time when triggered.

This figure is correct for a 12″ set, but it would be less for a bigger television as there would be fewer elements in a $1cm^2$ area. As it is not feasible for an output to be active for only a very small time, a capacitor is placed across the output. It should be realised that the value specified was found to be adequate for a 12″ set and that an increase in screen size may need an increase in capacitance.

CIRCUIT DESCRIPTION

The full circuit diagram is shown in Fig. 2. It should be pointed out at this stage that any number of channels can be constructed, though the PP3 battery specified may need to be replaced by a more substantial power supply.

The circuit diagram shows a two channel unit, but only one channel will be described. Components used in the second channel are identified separately, but essentially the two channels are identical. TR1 is a photodarlington placed next to the screen. When light falls on TR1 it turns on, and takes the base of TR2 high. TR2 turns on and this causes TR3's base to be grounded, turning this transistor on as well.

When TR3 is on, relay RLA1 is energised and the capacitor, C1, is charged. When TR1 is no longer illuminated, C1 holds the relay on for a short time. If TR1 is not relit before C1 discharges totally, the relay will switch off. If TR1 is relit before C1 discharges, the relay will stay on.

Thus if a character is displayed on the screen in front of TR1, TR1 will turn on and off very fast, at about 25Hz. This will be too quick for C1 to discharge between pulses and thus the relay will stay energised. Putting a blank in front of TR1 will cause no pulse to arrive at C1 to recharge it so it will discharge, de-energising RLA1. VR1 has been incorporated into the circuit to allow the sensitivity of the device to be adjusted so that the unit is not triggered by daylight.

CONSTRUCTION

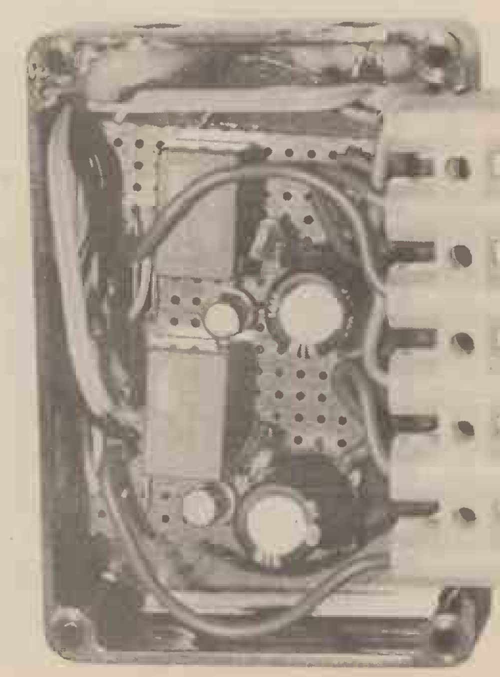
The unit is constructed on stripboard as shown in Fig. 4. As the unit is capable of switching currents of up to 1A at 250V it is advisable to break the strip between the normally-closed contact and the normally-open contact of each relay twice, as shown.

Each photodarlington should be mounted as shown in Fig. 3 inside a small tube to prevent light from anywhere but the screen getting in. The way in which the constructor fixes the tubes so that they will stay put in front of the screen is up to the individual. The mounting should be easily removable and should be arranged in such a way that the ends of the tubes (if they are made from metal) do not scratch the screen.

When constructing the mounting for the tubes it is wise to remember that the tubes should be positioned so that the end nearest to the screen is *directly* over a character position, as shown in Fig. 5. This is so that the program used to control the Oport is of the simplest possible nature. If the unit is going to be used in very bright conditions it is wise to cover the whole of the mounting and a small section of the screen with a flap of opaque material.

Connections between the circuit board and the photodarlingtons should be made by using ribbon cable or some other lightweight cable. Connections between the terminal block and the circuit board should be made using insulated cable rated 1A at 250V at least. The battery was external to the prototype unit and was connected using a PP3 clip. If more channels are made, a mains-based power supply should be used.

In the prototype, holes were drilled in the side of the box to allow adjustment of VR1 and VR2. These potentiometers may be miniature presets, glued in position, or alternatively standard rotary potentiometers, mounted externally.



TESTING

When the unit is completed, check to see that the transistors are inserted the right way round and check that all the tracks are broken where they should be. Adjust the presets so that the resistance of each one is at its maximum. Put an ohmeter across the common and normally-closed connections on the terminal block. The reading should be 0Ω; the normally-open terminal should give no reading to the common terminal.

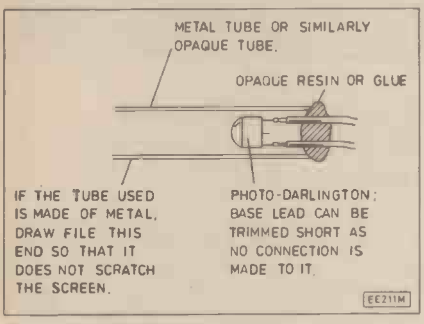


Fig. 3. Suggested method for mounting TR1 and TR4 in tubes.

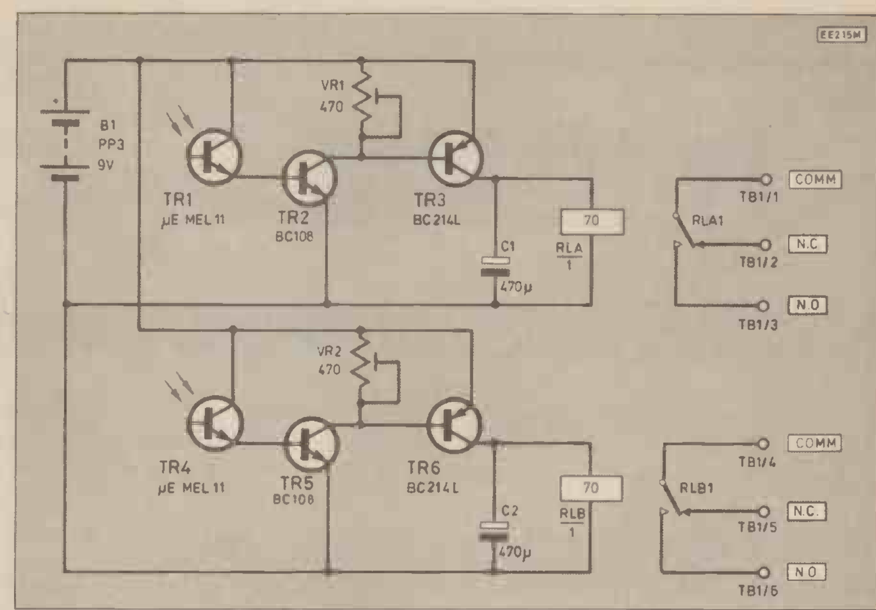


Fig. 2. Circuit diagram for a two-channel Oport.

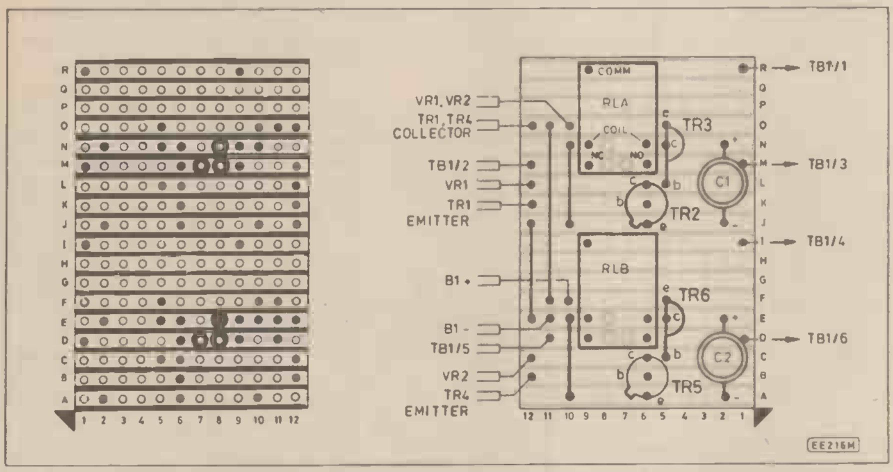


Fig. 4. Stripboard layout—soldering points, track breaks, and component overlay.

Connect B1 to the circuit and put the probe back into the normally-closed terminal. There should now be no reading. Placing the probe back into the normally-open terminal should give a reading of 0Ω. Repeat this with any other channels. If the readings are not correct check the whole circuit carefully.

TEST PROGRAM

When the unit is working properly, some form of test program is necessary. Position the photodarlingtons' mounting in the correct place on the television and adjust the presets so that the relays just go off. The program used to test the prototype with an Electron is given in Listing 1.

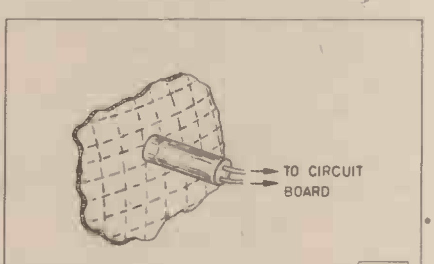


Fig. 5. TV screen divided into imaginary squares indicating character positions.

Listing 1: Test program. This will also run on the BBC machine.

```
10 MODE 2
20 COLOUR 143
30 PRINT TAB(7,30);" "
40 COLOUR 136
50 PRINT TAB(12,30);" "
60 COLOUR 128
70 PRINT TAB(0,0);"Ready:"
80 END
```

The program places a flashing square in front of the first tube (which was at 7,30) and another flashing square flashing in a complementary way to the first in front of the second tube (12,30). The covers were taken off the two relays and the unit was adjusted using the presets until the arms of the two relays were moving directly out of phase with each other, just as the squares flash exactly out of phase with each other. The program may differ from computer to computer but it should not be beyond anyone to create flashing squares where they are wanted.

IN USE

If the relays click on and off happily when they are supposed to, the unit is ready for use. There is no one way of using the Oport, the only restrictions are the rating of the unit's outputs (1A at 250V); the programming skills and the imagination of the user.

If it is necessary for the ratings of the outputs to be increased, heavier duty relays should be used, though the properties of the coils should, if possible, be exactly the same (70Ω and 5V). Different relays should also be used if more outputs per channel are required.

ADJUSTING THE TV

Different sets vary in brightness, but best results are likely to be obtained with the "Contrast" control full on and the "Brightness" control adjusted so that a blank screen gives out no light at all. □

COMPONENTS

See Shop Talk page 25

Potentiometers
VR1,VR2 470 (2 off)

Capacitors
C1,C2 470µ (2 off)

Semiconductors
TR1,TR4 µE MEL 11 (2 off)
TR2,TR5 BC108 (2 off)
TR3,TR6 BC214L (2 off)

Miscellaneous
B1 PP3 9V battery
RLA,RLB coil—70Ω, 5V. Contacts—1A at 250V a.c. n.o. and n.c.

0·1 inch matrix stripboard, size 18 strips × 12 holes; 3A mains wire; 3-way ribbon cable; PP3 battery clip; 1A terminal block, 6-way; case to fit circuit board—e.g. Verobox type 301.

Approx. cost Guidance only **£6.50**

MUSICAL DOORBELL

MARK STUART

The electronic doorbell is one of the most useful and popular projects in the field of hobby electronics. This circuit uses the AY-3-1350 integrated circuit which provides a total of 25 tunes and three chimes.

THE selection of a particular tune for the doorbell is made by the setting of two rotary switches connected to IC1, the AY-3-1350. The tunes are divided into five banks of five as shown in Table 1. Chimes are selected in a different manner depending upon the connection of the doorbell push switch. Up to three separate bell pushes may be connected, each producing a different tune or chime. Power is supplied by a used by the internal oscillator on IC1 to determined the pitch of the notes. Adjustment of VR1 allows the pitch of the tunes to be varied to suit the user.

Power is applied to the i.c. via TR1. Normally when the "bell" is silent and none of the pushes pressed TR1 is turned off. Closing any of the bell pushes will turn on TR1 via R5 and D1 or D2 depending on which "push" is pressed.

When TR1 is turned on power is applied to IC1 via the shunt regulator circuit R4 and Zener diode D4. Feedback from IC1 via R6 maintains base current in TR1 so that it remains turned on even though the bell pushes are released. This feedback stops when the i.c. has completed the tune. At the point TR1 is turned off the power is removed from IC1 and the circuit assumes the quiescent state.

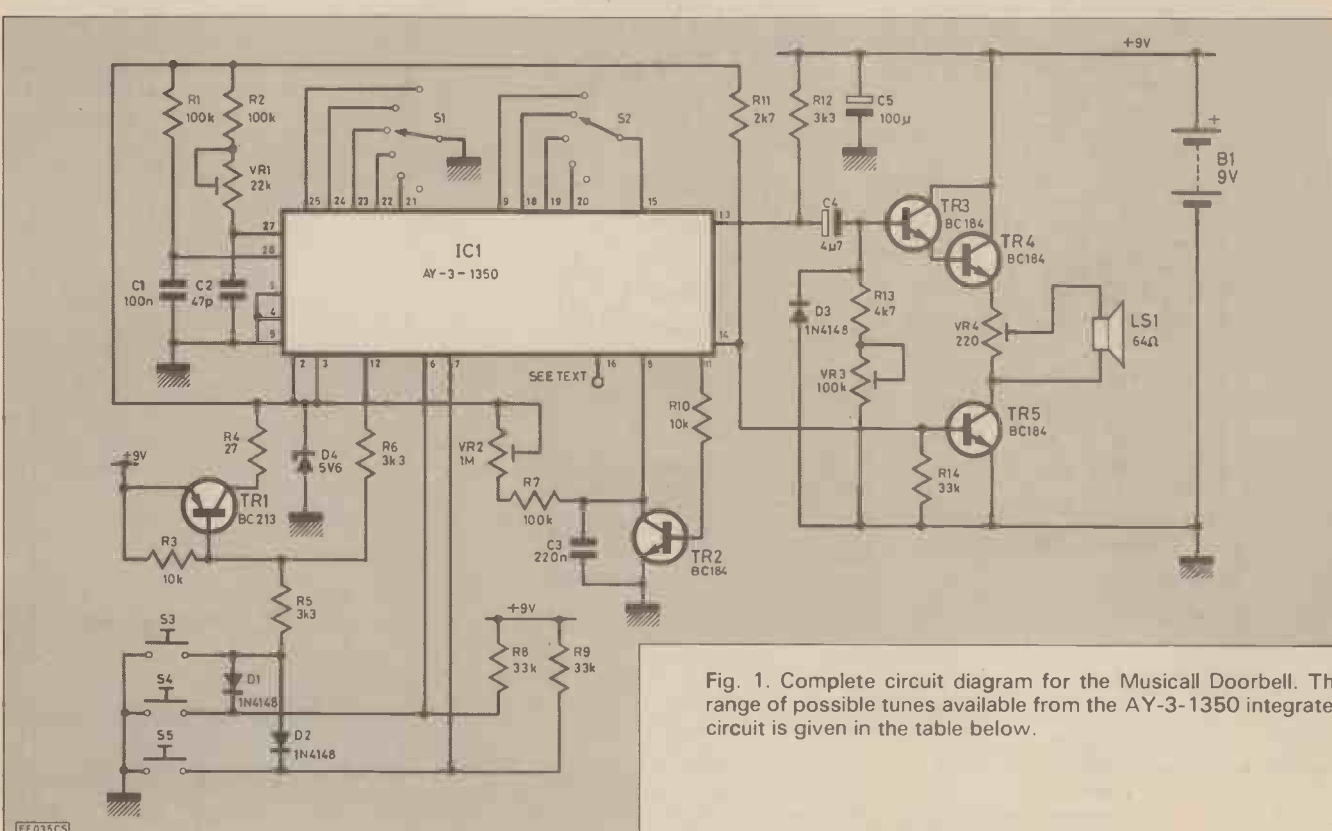


Fig. 1. Complete circuit diagram for the Musicall Doorbell. The range of possible tunes available from the AY-3-1350 integrated circuit is given in the table below.

Table 1. AY-3-1350 Tunes

A0	Toreador	A2	America, America	A4	Hell's Bells
B0	William Tell	B2	Deutschland Leid	B4	Jingle Bells
C0	Hallelujah Chorus	C2	Wedding March	C4	La Vie en Rose
D0	Star Spangled Banner	D2	Beethoven's 5th	D4	Star Wars
E0	Yankee Doodle	E2	Augustine	E4	Beethoven's 9th
A1	John Brown's Body	A3	O Sole Mio	Chime X	Westminster Chime
B1	Clementine	B3	Santa Lucia	Chime Y	Simple Chime
C1	God Save the Queen	C3	The End	Chime Z	Descending Octave Chime
D1	Colonel Bogey	D3	Blue Danube		
E1	Marseillaise	E3	Brahms' Lullaby		

single PP3 nine volt battery. Current drain is zero except when a chime or tune is being played, so a very long battery life can be expected.

CIRCUIT

The circuit diagram is shown in Fig. 1; IC1 provides all of the main functions of the circuit. The tune select switch S1 and bank select switch S2 connect directly to the i.c. Resistor R1 and capacitor C1 provide a brief negative reset pulse to ensure that IC1 starts correctly when power is applied. The timing components R2, VR1 and C2 are

COMPONENTS

Resistors

R1,R7	100k (2 off)
R2	2k2
R3,R10	10k (2 off)
R4	27
R5,R6,R12	3k3 (3 off)
R8,R9,R14	33k (3 off)
R11	2k7
R13	4k7

All $\frac{1}{4}$W ±5% carbon film

Potentiometers

VR1	22k
VR2	1M
VR3	100k
VR4	220

All miniature horizontal presets

See **Shop Talk** page 25

Capacitors

C1	100n polyester
C2	47p ceramic
C3	220n polyester
C4	4µ7 25V radial elect.
C5	100u 16V radial elect.

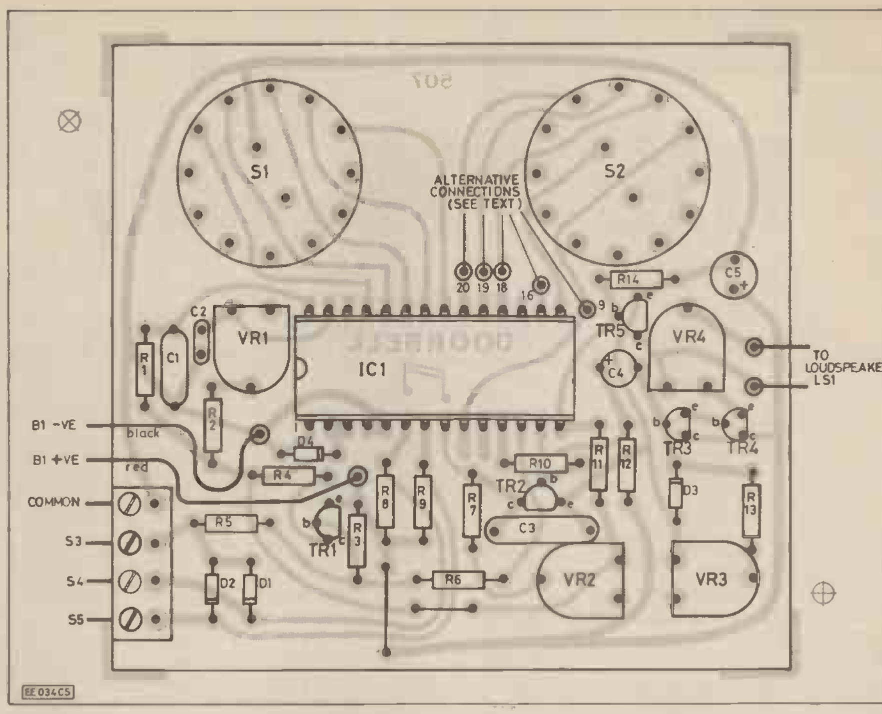


Fig. 3. Printed circuit board component layout and wiring details.

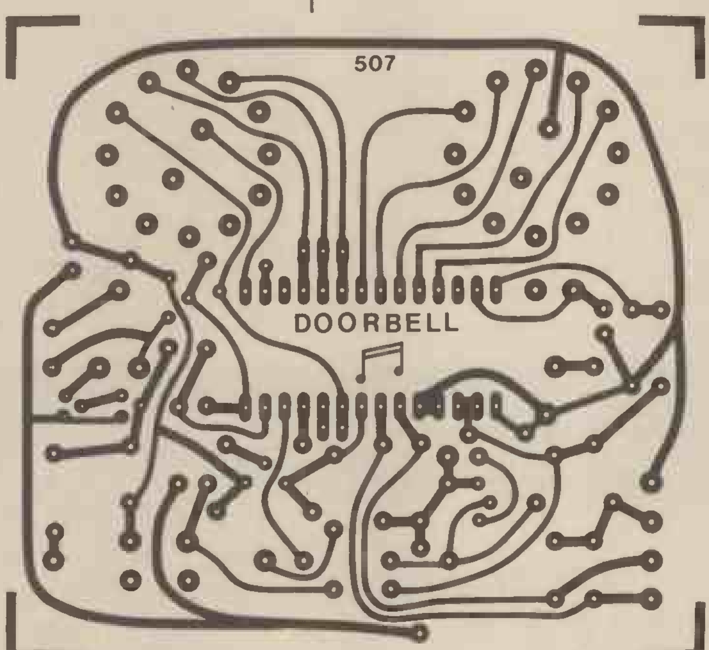


Fig. 2. Full size printed circuit master. This board is available from the *EE PCB Service*: code EE-507.

Semiconductors

D1–D3	1N4148 (3 off)
D4	5V6 400mW Zener
TR1	BC213
TR2–TR5	BC184 (4 off)
IC1	AY-3-1350

Miscellaneous

B1	9V PP3 battery
LS1	64 ohm speaker (approx. 65mm diam.)
S1,S2	Two pole six way rotary switches (2 off)
S3–S5	Door mounting bell pushes, single pole push to make—number as required

Four way p.c.b. mounting terminal block; 28 pin i.c. socket; PP3 clips; two knobs; p.c.b., available from the *EE PCB Service*, order code EE-507; plastic case approx 160 × 96 × 53mm; grommet, wire etc.

Approx. cost Guidance only £18.00

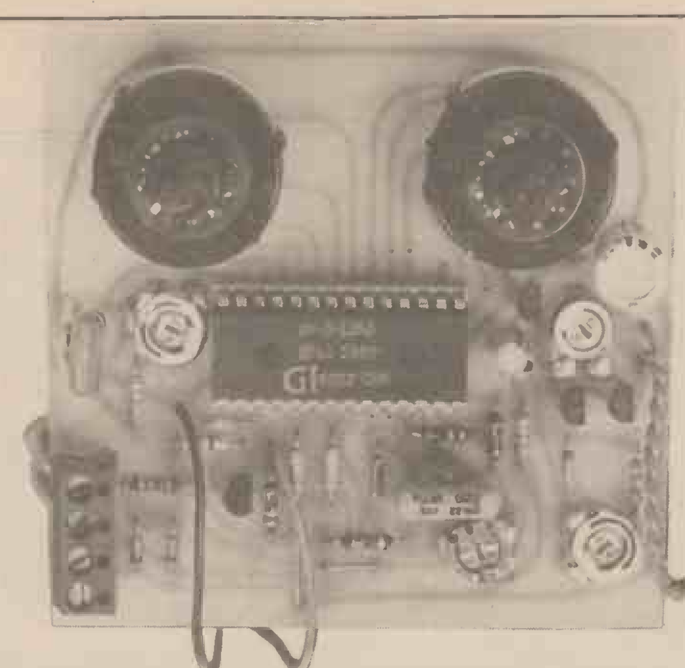
The audio output from IC1 is a square wave which appears on pin 14 and drives the loudspeaker via TR5. Transistors TR3 and TR4 are driven by a positive going pulse which is derived from IC1 via the pulse forming network C4, R13, VR3 and D3. Each time a new note is played the voltage on pin 13 of IC1 switches from negative to positive. This change is coupled via C4 to the base of TR3 which also turns on TR4 providing almost the full supply voltage to the loudspeaker. During the note C4 gradually charges via R13 and VR3 and the voltage on TR3 base falls towards zero.

This falling voltage is coupled via TR3 and TR4 to the loudspeaker supply causing the output voltage to decay and giving the characteristic envelope to the sound. At the end of the note the voltage on pin 13 falls to zero and C4 is quickly discharged via D3 ready for the next note.

The volume is set by VR4 which is a simple high level volume control. The speed of playback of the tunes can be adjusted independently of the pitch by means of VR2 and R7 as the note is played. The voltage on C3 is monitored by pin eight of IC1 which detects when it has charged to a fixed threshold level. When this level is reached the note is ended and the circuit is ready for the next note. VR2 adjusts the charge current flowing into C3 and so determines the time taken to reach the threshold, therefore it sets the tempo.

CONSTRUCTION

The circuit is constructed on a single printed circuit board, Fig. 3 shows the component overlay. Begin construction of the board by fitting Veropins at the points where the battery clip and loudspeaker connections are to be made. Also fit five pins at the points marked "alternative connections" in Fig. 3.



The completed circuit board ready for inserting in a suitable case.

Next fit the resistors, presets, diodes and capacitors in that order. Be sure to observe polarity when fitting the diodes. Then fit a 28 pin low profile socket for IC1 and fit the transistors with their flat sides correctly orientated as shown. Note that TR1 is different from the others. The rotary switches should now be fitted, these may be the type with tags that have loops in the ends for direct wiring, cut off the loops leaving only the straight parts which will pass through the board.

The bell push connections are made to four board mounting terminal blocks. A single common connection serves all three pushes. Finally connect the battery clip and loudspeaker and insert IC1 taking care to get it the right way round. The board is now ready for testing.

TESTING

Set all the presets to mid position and connect a suitable battery. If all is well the current drain should be zero. Now temporarily link S3 and the common terminals via a push to make switch and check that one of the tunes is played each time the switch is pressed. Go through the various positions of S1 and S2 and check that the tunes correspond to Table 1. The action of the presets is self explanatory. Make a brief check that they are all working before setting them up to your own liking.

The operation of S4 and S5 should now be checked; S4 will play the descending octave chime for all settings of the switches, S5 will play any of the tunes A0, B0, C0, D0 and E0 depending upon the setting of S1, regardless of the setting of S2. When S1 is in the F position the three chimes are available—X from S3; Y from S4; and Z from S5. The alternative links shown on the board allow the tunes from several different banks to be selected for S5 as shown in Table 2.

Table 2. Alternative tune links

LINK PIN 16 TO	S5 TUNES
No other pin	A0–E0
PIN 20	A1–E1
PIN 19	A2–E2
PIN 18	A3–E3
PIN 9	A4–E4

FINAL ASSEMBLY

Once everything is working correctly the board can be mounted inside the front panel of a suitable case by means of the bushes on S1 and S2. The speaker should be glued in position over a pattern of holes or a large hole covered with speaker fabric.

The unit may be linked to the doorbell push switch (or switches) by ordinary twin "figure 8" wire or similar. □

TEACH-IN 86

PART 4 · Michael Tooley BA David Whitfield MA M Sc C Eng MIEE

AMPLIFIERS

AMPLIFIERS are crucial to the functioning of almost every conceivable electronic system. Consider, as an example, the operation of a radio receiver. The signal voltage produced by the aerial (whether it be an external wire or internal ferrite rod) rarely exceeds a hundred microvolts, or so. The voltage required to drive the loudspeaker, on the other hand, may be several volts. Hence, leaving aside all of the other signal processing that may be necessary (e.g. frequency changing and de-modulation), the need for amplification is paramount.

GAIN

Amplifiers are said to exhibit "gain". The gain of an amplifier may be quantified by comparing its output with its input. Voltage gain, for example, is simply the ratio of output voltage to input voltage.

The voltage transfer characteristic of an amplifier is shown in Fig. 4.1. Assuming that the amplifier is linear (which is a normal requirement) doubling the input voltage will produce a doubling of the output voltage, and so on.

Since voltage gain is simply a ratio of two voltages, there are no units. Using A_V to denote the voltage gain of an amplifier, we thus deduce that:

Voltage gain,

$$A_V = \frac{\text{Output Voltage, } V_{OUT}}{\text{Input voltage, } V_{IN}}$$

Thus, $$A_V = \frac{V_{OUT}}{V_{IN}}$$

We can define "current gain" in a similar manner. Here we are dealing with the ratio of output current to input current:

Current gain,

$$A_I = \frac{\text{Output current, } I_{OUT}}{\text{Input current, } I_{IN}}$$

Thus, $$A_I = \frac{I_{OUT}}{I_{IN}}$$

Finally, in some cases it is useful to talk in terms of "power gain". In this case:

Power gain,

$$A_P = \frac{\text{Output power, } P_{OUT}}{\text{Input power, } P_{IN}}$$

Hence, $$A_P = \frac{P_{OUT}}{P_{IN}}$$

There is, as you might expect, a relationship between the power, voltage, and current gains of an amplifier. Since power is the product of voltage and current, the power gain of an amplifier is the product of its voltage and current gains.

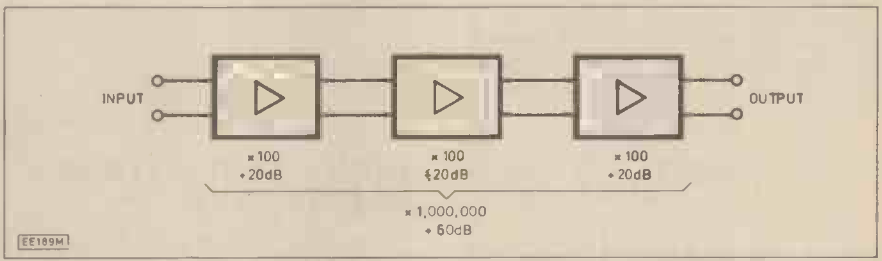


Fig. 4.2. Cascade arrangement of three amplifiers.

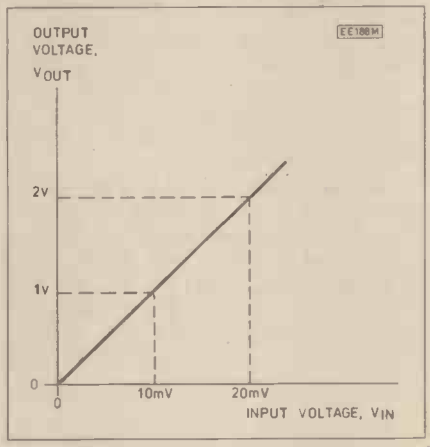


Fig. 4.1. Voltage transfer characteristic.

DECIBELS

Since voltage, current, and power gains can often be extremely large quantities and since we are often concerned with the combined effects of cascading amplifiers and other devices (such as filters and attenuators), it is convenient to make use of a logarithmic ratio rather than a linear one. The beauty of this system is that not only are the numbers smaller but the arithmetic is kept simple.

Consider, for a moment, the arrangement shown in Fig. 4.2. Here we have a cascade arrangement of three amplifiers; each having a power gain of 100. The overall power gain (i.e. taking the final output power and dividing it by the input power) will be 100 × 100 × 100 or 1,000,000.

If, on the other hand, we take the logarithm (using base 10) of the power gain of each stage (we call this the Bel, B) we would conclude that the power gain of each amplifier was 2 Bels and the overall power gain *adding* the values rather than multiplying them was 6 Bels.

In practice, we use one-tenth of a Bel (known as the "decibel", or dB). There are then ten decibels in one Bel.

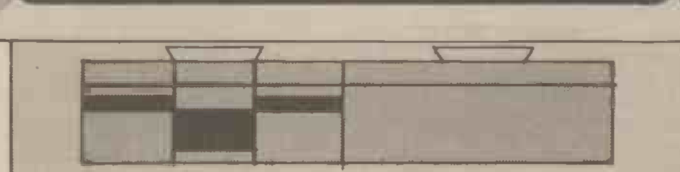
i.e. 10dB = 1B

TEACH-IN SOFTWARE

To complement each published part of the Teach-In series, we have produced an accompanying computer program. The Teach-In Software is available for both the BBC Microcomputer (Model B) and the Sinclair Spectrum (48k) or Spectrum-Plus. The programs are designed to reinforce and consolidate important concepts and principles introduced in the series. The software also allows readers to monitor their progress by means of a series of multi-choice tests, with scores at the end.

Tape 1 (Teach-In parts 1, 2 and 3) is now available for £4.95 (inclusive of VAT and postage) from Everyday Electronics and Electronics Monthly, Westover House, West Quay Road, Poole, Dorset, BH15 1JG.

IMPORTANT *State BBC or Spectrum; add 50 pence for overseas orders; allow 28 days for delivery.*



The power gain (in decibels) can be evaluated using the relationship:

$$A_P = 10 \log_{10} \left(\frac{P_{OUT}}{P_{IN}}\right) \quad \text{(dB)}$$

The overall power gain of the arrangement shown in Fig. 4.2 is thus 60dB. Some common power ratios and their corresponding decibel values have been shown in Table 4.1.

Just as we use decibels to represent power ratios we can use them to represent voltage or current ratios. In such cases the gain in decibels is given by:

$$A_V = 20 \log_{10} \left(\frac{V_{OUT}}{V_{IN}}\right) \quad \text{(dB)}$$

or,

$$A_I = 20 \log_{10} \left(\frac{I_{OUT}}{I_{IN}}\right) \quad \text{(dB)}$$

Some common voltage and current ratios have been shown with their corresponding decibel values in Table 4.2.

POWER GAIN	DECIBELS
1	0
2	3
4	6
8	9
10	10
100	20
1,000	30
10,000	40

Table 4.1. Decibels of power.

VOLTAGE OR CURRENT GAIN	DECIBELS
1	0
2	6
4	12
8	18
10	20
100	40
1,000	60
10,000	80

Table 4.2. Decibels of voltage or current.

BANDWIDTH

Whilst the voltage gain of an amplifier can be expected to be substantially constant over a reasonably wide range of frequencies, it tends to fall at both extremely high and extremely low frequencies. In the former case this is due to internal stray capacitance (the effects of which become more pronounced as frequency increases) whilst in the latter case the deficiency arises from the inability of coupling and de-coupling arrangements to work effectively at very low frequencies.

A typical amplifier frequency response is shown in Fig. 4.3. The voltage gain in the "mid-band" region remains reasonably constant over a wide frequency range.

In order to specify the normal working range of an amplifier we define its "cut-off" frequencies as the frequencies at which the voltage gain falls to 70·7% of its maximum value (corresponding to the "half power" or "–3dB" point). The "bandwidth" of the amplifier is then simply the difference between these frequencies, i.e.:

$$\text{Bandwidth} = f_2 - f_1$$

where f_2 is the upper "cut-off" frequency, and f_1 is the lower "cut-off" frequency.

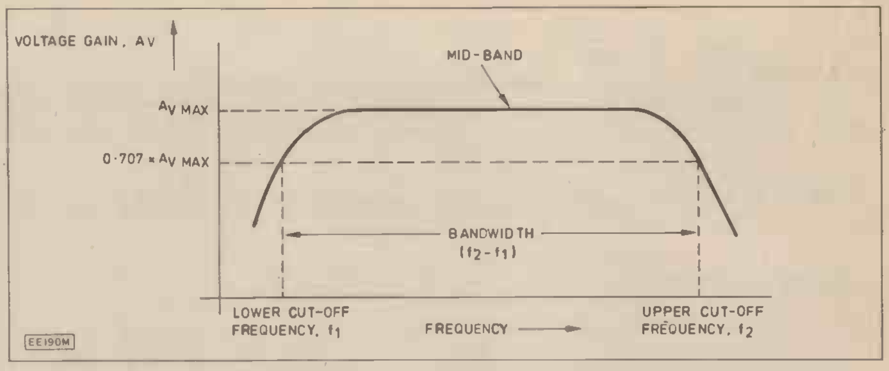


Fig. 4.3. Typical frequency response characteristic.

INPUT AND OUTPUT RESISTANCE

Another important consideration is the resistance which effectively appears at the input and output of an amplifier. Fig. 4.4 shows the simplified equivalent circuit of an amplifier including its input and output resistances. The output voltage is assumed to arise from a voltage source within the amplifier.

The resistance seen at the input of the amplifier is its input resistance, R_{IN}. Similarly, the resistance seen at the output of the amplifier is its output resistance, R_{OUT}. In practice, the situation is often a little more complicated when we need to take into account the presence of capacitance and/or inductance. In such cases we refer to "impedance" rather than "resistance".

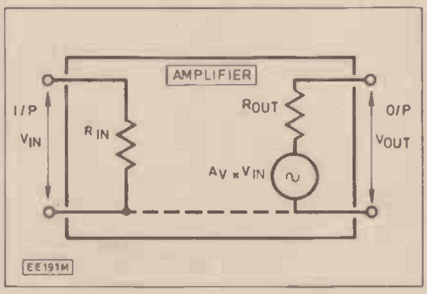
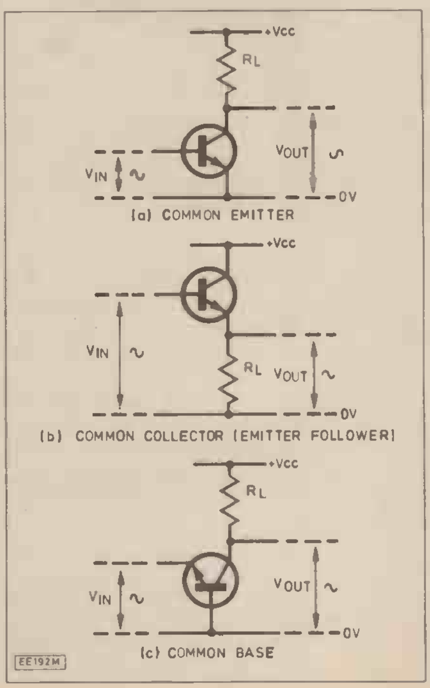


Fig. 4.4. Equivalent circuit of an amplifier.

Fig. 4.5. Modes of operation.



TRANSISTOR AMPLIFIERS

Transistors are "three-terminal devices". Amplifiers, on the other hand, have four terminals. It should thus be readily apparent that one terminal of a transistor must be "common" to both the input and output of any practical circuit.

There are, therefore, three different circuit configurations in which transistors can be operated. These are "common emitter"; "common collector" (often called "emitter follower"), and "common base". These three configurations have been depicted in Fig. 4.5 and their characteristics summarised in Table 4.3. Since the common emitter configuration is most popular, we will concentrate our attention on this mode.

A SINGLE STAGE TRANSISTOR AMPLIFIER

The operation of a simple single-stage common emitter transistor amplifier can be explained quite simply by constructing a "load line" on the transistor's output characteristics. This procedure allows us to predict the output (collector) current and voltage change that would result from a given change in input (base) current. All we need to know is the resistance of the collector load (R_L) and the value of the collector supply voltage (V_{CC}).

Fig. 4.6 shows a typical set of output characteristics on which a load line for R_L = 500 ohm has been drawn. The ends of the load line are fixed as follows:

(a) when I_C = 0mA the value of V_{CE} must be equal to the supply voltage, V_{CC} (i.e. 12V)
(b) when V_{CE} = 0V the value of I_C must be equal to

$$\frac{V_{CC}}{R_L} \text{ (i.e. 24mA).}$$

If we now assume that the transistor is operated with a base bias current of 100μA (determined by a suitable choice of resistor) we can identify an "operating point" which corresponds to the conditions (in terms of currents and voltages) which

	MODE OF OPERATION		
	COMMON EMITTER	COMMON COLLECTOR	COMMON BASE
VOLTAGE GAIN	MEDIUM/HIGH (50)	UNITY (1)	HIGH (500)
CURRENT GAIN	HIGH (200)	HIGH (200)	UNITY (1)
POWER GAIN	VERY HIGH (10,000)	HIGH (200)	HIGH (500)
INPUT RESISTANCE	MEDIUM (1·5kΩ)	HIGH (100kΩ)	LOW (200Ω)
OUTPUT RESISTANCE	MEDIUM/HIGH (20kΩ)	LOW (500Ω)	HIGH (100kΩ)
PHASE SHIFT	180°	0°	0°
TYPICAL APPLICATION	GENERAL PURPOSE AUDIO AMPLIFIER	POWER OUTPUT STAGE	HIGH GAIN R.F. AMPLIFIER
NOTE: Typical values are shown in brackets			

Table 4.3. Comparison of the modes of operation of a transistor amplifier.

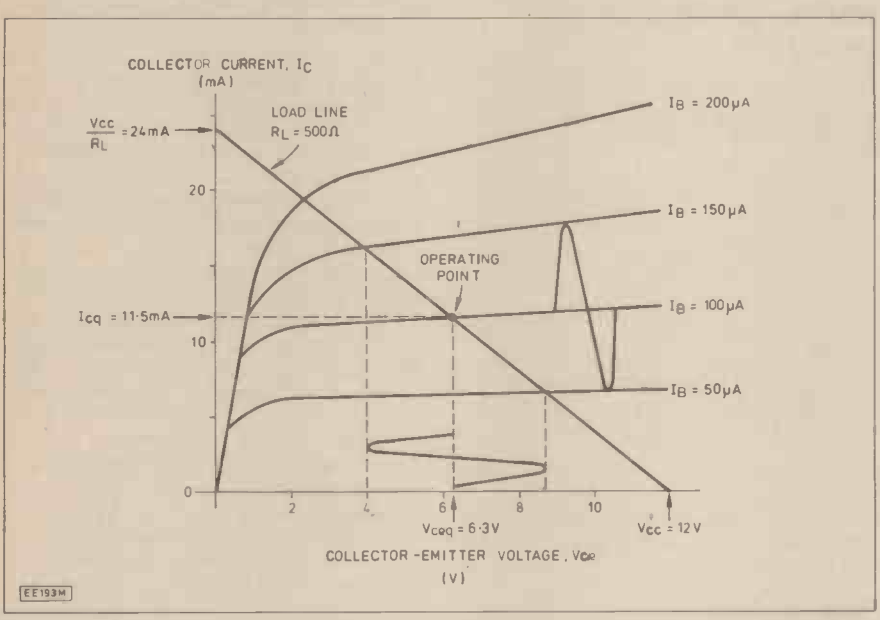


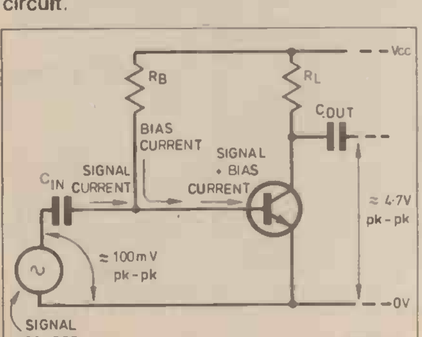
Fig. 4.6. Use of output characteristics and load line to predict the performance of a common emitter amplifier.

the transistor experiences when no signal is applied (the "quiescent state"). The quiescent values of collector current and collector-emitter voltage are denoted by I_{Cq} and V_{CEq} respectively.

From Fig. 4.6 it will be seen that I_{Cq} = 11·5mA and V_{CEq} = 6·3V. It should also be noted that, in order to obtain the maximum undistorted output voltage swing, it is necessary to ensure that V_{CEq} is approximately half the value of collector supply voltage, V_{CC}.

Now consider a change in base current produced by applying a signal to the input of the stage (see Fig. 4.7).

Fig. 4.7. Basic common emitter amplifier circuit.



A base current swing of ±50μA (i.e. 100μA pk-pk) will result in a collector-emitter voltage swing (developed across the load) of approximately 4·7V pk-pk.

If the stage has an input resistance of 1k, the pk-pk input voltage required to produce a 100μA pk-pk base current change is 100mV. The voltage gain of the stage, A_V, is thus:

$$A_V = \frac{4{\cdot}7\text{V pk-pk}}{0{\cdot}1\text{V pk-pk}} = 47$$

COUPLING

Readers may have noticed that we have included two capacitors in the circuit of Fig. 4.7. These provide a means of coupling signals into, and out of, the stage and we have thus labelled them, C_{IN} and C_{OUT}. The capacitors allow alternating current to flow into, and out of, the stage whilst effectively blocking the passage of direct current.

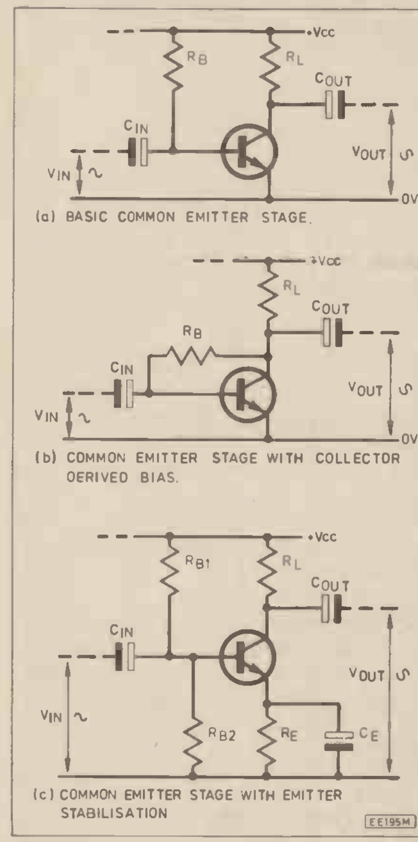
One further point should be made. In order to maintain voltage gain at low frequencies the capacitors need to have relatively large values and thus they are often electrolytic types.

BIAS

By comparison with the arrangement of Fig. 4.7, several more sophisticated techniques for applying bias are in common use. These allow us to compensate both for variations in individual transistor current gain and changes in temperature. Representative circuit arrangements have been shown (together with the basic stage common emitter amplifier circuit) in Fig. 4.8.

The circuits in Figs. 4·8(b) and 4·8(c) are superior because they supply direct coupled negative feedback, a subject we shall learn more about next month!

Fig. 4.8. Bias arrangement used in common emitter amplifiers.

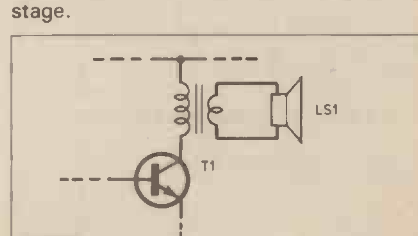


COMPLEMENTARY OUTPUT STAGES

One disadvantage of our simple single-stage transistor amplifier is that it will not directly drive a loudspeaker. The reason for this is that most loudspeakers exhibit a rather low impedance (typically between 4 and 16 ohms) and thus will not present an efficient match to the collector. One solution is the use of a coupling transformer (as shown in Fig. 4.9) but even then the output power and efficiency of the stage is somewhat limited.

A better solution is that of using a purpose designed "output stage". Here we require power gain rather than just voltage gain and thus we opt

Fig. 4.9. Transformer coupled output stage.



for an emitter follower configuration. This, of course, provides a great deal of current gain but has a voltage gain of only slightly less than unity. This, however, is no great disadvantage since we can easily provide voltage gain in one or more preceding common emitter stages.

A further refinement is that of using two transistors, rather than just one, in the output stage. If the transistors are selected with similar characteristics but with one being of *NPN* construction whilst the other is *PNP*, we arrive at the elegantly simple "complementary symmetrical" output stage arrangement shown in Fig. 4.10.

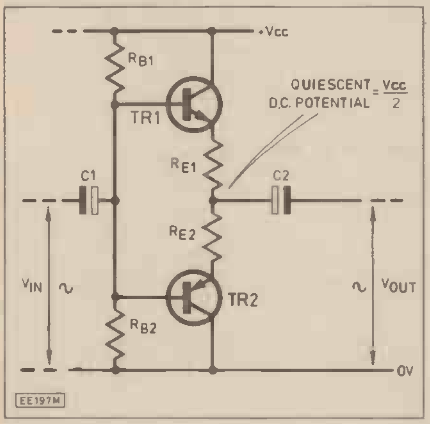
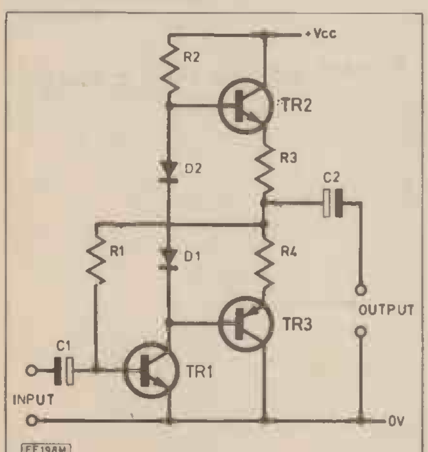


Fig. 4.10. Simplified complementary symmetrical output stage.

Whilst the circuit shown here does not include any provision for bias (we will come to that in a moment) it does include some low value resistors which help protect against overloading the output transistors. Their operation is simple; as the load current increases, the voltage dropped across these resistors increases in such a sense that it tends to oppose the applied signal. The transistor is thus "throttled back" to a safe operating level.

A more complete complementary symmetrical output stage (including bias and a driver stage) is shown in Fig. 4.11. The driver stage, TR1, operates as a common emitter amplifier with base bias provided by means of R1. The collector load for TR1 is provided by R2 whilst the two forward biased diodes, D1 and D2, provide a constant voltage drop (of approximately 1·2V) in order to bias the output pair, TR2 and TR3, to the threshold of conduction.

Fig. 4.11. Practical complementary symmetrical output stage.



When a signal is applied to the stage, an amplified (but inverted) signal is produced at the collector of TR1. On positive going half-cycles the collector voltage of TR1 is driven positive and TR2 conducts more heavily (i.e. it turns "on") whilst TR3 conducts less heavily (i.e. it turns "off"). This process reverses on the next (negative going) half cycle when the collector voltage of TR1 is driven negative. This action is rather aptly known as "push-pull".

LINEAR INTEGRATED CIRCUITS

Recent advances in technology have largely rendered the discrete transistor amplifier obsolete and it is often now more cost effective to make use of one or more of the ever increasing range of consumer linear integrated circuits. These devices offer the designer considerable savings in space coupled with the need for very few additional (discrete) components. Indeed, with the exception of larger value capacitors, linear integrated circuits can contain all of the components necessary to realise a multi-stage audio amplifier. Their principal disadvantage, however, is that output powers are restricted by the need for adequate power dissipation. This usually limits the output power of integrated circuit amplifiers to no more than a few watts.

THE LM380

We shall conclude this month's instalment of Teach-In by taking a brief look at a typical consumer linear integrated circuit, the National Semiconductor LM380. This device is a monolithic audio power amplifier which provides a typical output of 1W into an 8 ohm load when operated from a 12V supply. The voltage gain of the LM380 is internally fixed at 50 and the device has a nominal input impedance of 150k.

The internal circuit diagram of the LM380 is shown in Fig. 4.12 (readers may like to compare the output stage circuit with that shown in Fig. 4.11.) The device is housed in a 14-pin d.i.l. (dual-in-line) package, the pin connections for which are shown in Fig. 4.13. Readers should refer to this month's Practical Project (a Signal Tracer) for a practical application of the device. See page 28.

Next Month we shall be dealing with oscillators.

PROBLEMS

Difficulty rating: (e) easy; (d) difficult; (m) moderate

4.1 An amplifier has a voltage gain of 2500. What is the maximum input voltage that should be applied if the output is not to exceed 4V? (e)

4.2 Three identical power amplifiers are arranged in cascade. If the overall power gain is 18dB what is the power gain (in dB) of an individual amplifier? (e)

4.3 Using the arrangement in Problem 4.2, what output power results from an input of 5mW?

4.4 A power amplifier produces an output of 80W for an input of 2V. If the unit has an input resistance of 1k, what is its power gain (expressed in dB)? (m)

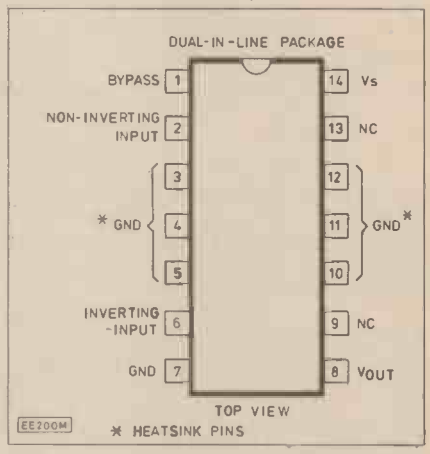
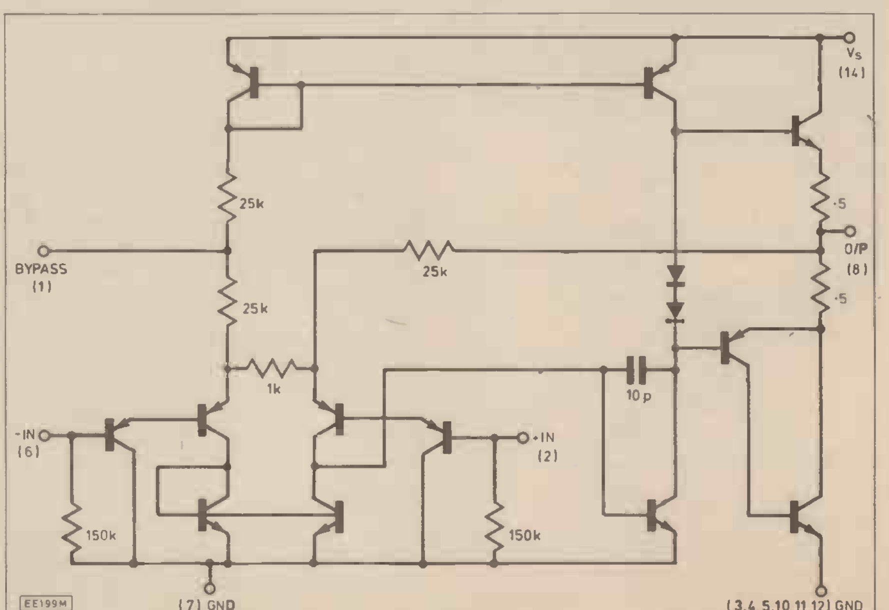


Fig. 4.12. Internal circuit of an LM380.

Fig. 4.13. Pin connections for an LM380.



4.5 A single-stage transistor amplifier is to be operated from a 6V d.c. supply. If the transistor is to be operated with a nominal collector current of 2mA, which one of the following preferred value resistors is the most appropriate for use as a collector load; 680 ohm, 1·5k, 2·7k, 3·9k? (m)
4.6 A power amplifier uses a complementary symmetrical arrangement of output transistors which operates from a 12V d.c. supply rail. What is the maximum RMS output voltage that can be produced without appreciable distortion? (d)

THE ANSWERS TO THESE PROBLEMS WILL APPEAR IN TEACH-IN PART 5

ANSWERS TO LAST MONTH'S PROBLEMS

3.1 None of the lamps will be illuminated
3.2 2·4V, 14mA
3.3 2mA
3.4 39
3.5 400

Practical Assignments

COMPONENTS

Besides the items used in earlier parts, you will need the following components in order to complete the practical assignments described in this part of Teach-In:

Resistors ($\frac{1}{4}$W, 5%); 470 ohm (2 off); 1k (1 off); 2·2k (1 off); 15k (1 off); 47k (1 off)
Capacitors (16V p.c. electrolytic); 10µ (2 off); 100µ (1 off)
Semiconductors 1N4148 (2 off); BC108 (1 off); BC461 (1 off); BFY50 (1 off)
Miscellaneous Small 40–80 ohm loudspeaker

ASSIGNMENT 4.1

Single Stage Transistor Amplifier

This assignment is designed to demonstrate the action of a complete single-stage transistor amplifier. The circuit can be tested in a number of ways depending upon whether or not readers have access to an audio amplifier/cassette player having external input facilities.

PROCEDURE

Connect the circuit shown in Fig. 4.14 on your breadboard using the wiring diagram shown in Fig. 4.15. Take care to ensure that the transistor is correctly orientated and check that the polarity of the electrolytic capacitors is also correct. The capacitors shown are radial types, i.e. both the leads are at the same end, as opposed to axial types where the leads are at each end. Either type can be used.

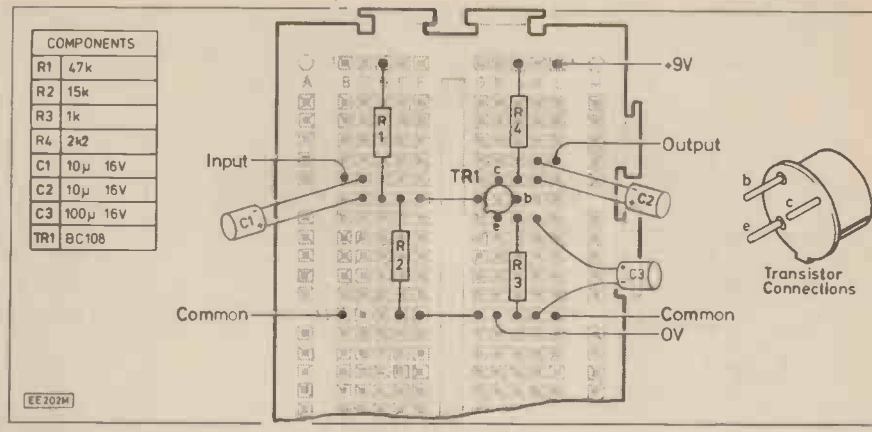


Fig. 4.15. Wiring diagram for the circuit of Fig. 4.14.

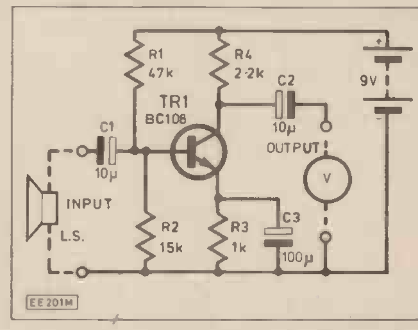


Fig. 4.14. Circuit used in Assignment 4.1.

Connect the 9V supply (two 4·5V batteries in series) and measure the direct voltages present at the collector, base, and emitter of TR1 using the multimeter switched to the 10V d.c. range. For guidance, typical values are; V_C = 5·6V, V_B = 2·1V, and V_E = 1·5V. (If your readings do not agree with these carefully check your breadboard wiring!).

Now switch the multimeter to the 10V a.c. range (readers not using the recommended multimeter should use a more sensitive range if one is available) and connect the loudspeaker to the input of the amplifier.

The loudspeaker can now be used as a microphone; talking or whistling into it should produce a deflection of around 1V, or so, on the meter. Readers may now like to transfer the meter to the input of the amplifier in order to measure the input voltage. Whilst this may be barely perceptible, provided a constant level of signal can be maintained, it should just be possible to measure the input and then determine the voltage gain of the circuit.

Readers having access to a cassette tape recorder or hi-fi system should now connect the output of the single-stage amplifier to the "aux", "tape", or "radio" input (taking care to ensure that the common rail is connected to "earth" or "chassis"). The single-stage amplifier should now act as a simple microphone pre-amplifier; a gentle whisper producing more than ample output!

RESULTS

See if you can justify the d.c. voltages present at the collector, base, and emitter of the transistor. The collector and emitter currents can be calculated by applying Ohms Law whereas the base current can be estimated by dividing the collector current by the current gain (approximately 200).

The voltage gain of the stage can be calculated by dividing the output voltage by the input voltage. Due to limitations imposed by the sensitivity of the multimeter on the a.c. voltage ranges this measurement will be rather inaccurate!

ASSIGNMENT 4.2

Complementary Output Stage

This assignment demonstrates the operation of a simple complementary symmetrical output stage.

PROCEDURE

Connect the circuit shown in Fig. 4.16 on your breadboard, using the wiring diagram shown in Fig. 4.17. As before, take particular care to ensure that all polarised components (capacitors, diodes, and transistors) are correctly connected.

Measure the direct voltage present at the collector, base, and emitter of each transistor using the multimeter switched to the 10V d.c. range. Typical readings are;

TR1 V_C = 3·9V, V_B = 0·6V, V_E = 0V
TR2 V_C = 9V, V_B = 5·1V, V_E = 4·5V
TR3 V_C = 0V, V_B = 3·9V, V_E = 4·5V

If your readings differ markedly from these, carefully check the breadboard wiring.

Connect the loudspeaker to the output of the amplifier (there will be a "click" from the loudspeaker as C2 charges momentarily). The input of the amplifier can be derived from a number of sources including the "tape" output of a radio or the "line" output of a cassette recorder or hi-fi amplifier. It should then be possible to monitor signals using the complementary output stage.

RESULTS

See if you can justify the d.c. voltages present at the collector, base,

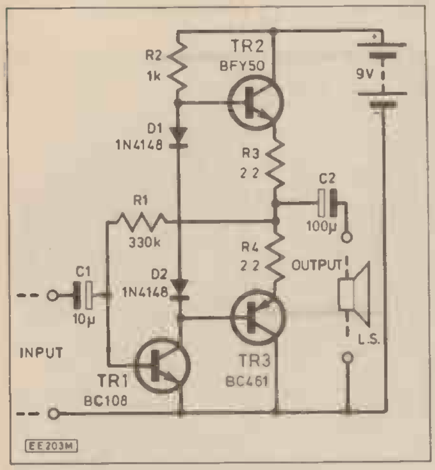
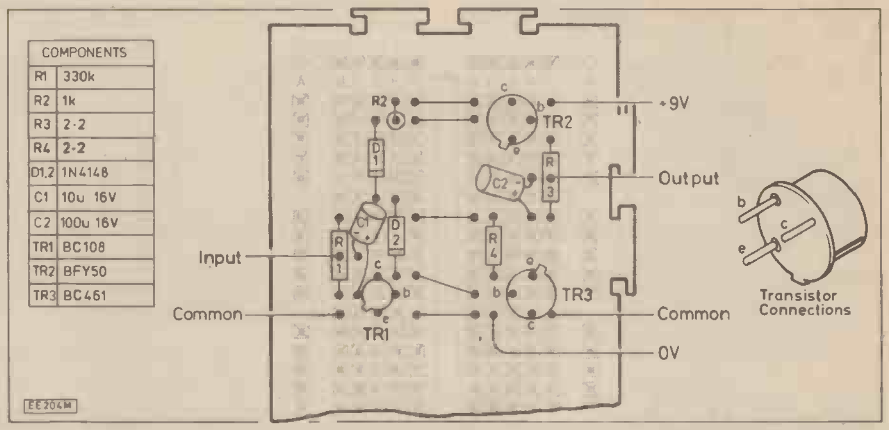


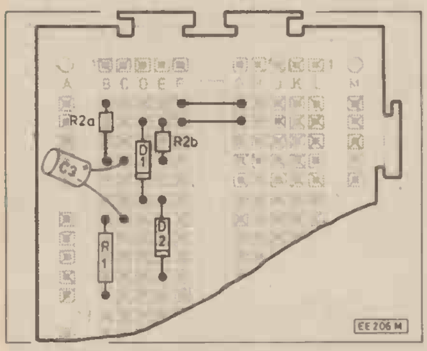
Fig. 4.16. Circuit used in Assignment 4.2.



COMPONENTS	
R1	330k
R2	1k
R3	2·2
R4	2·2
D1,2	1N4148
C1	10u 16V
C2	100u 16V
TR1	BC108
TR2	BFY50
TR3	BC461

Fig. 4.17. Wiring diagram for the circuit of Fig. 4.16.

Fig. 4.18. Modification to the circuit of Fig. 4.16.



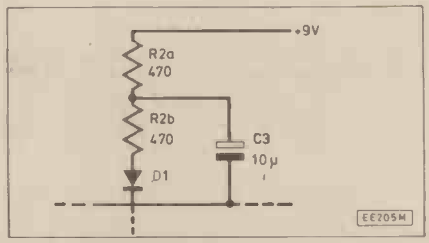


Fig. 4.19. Wiring diagram for Fig. 4.18.

and emitter of each transistor. If time permits, disconnect the supply, remove D1 and D2 and replace them with a short circuit (this removes the bias from the output transistors). Note the distortion produced and compare the results with those obtained earlier.

Finally, modify the circuit as shown in Figs. 4.18 and 4.19. This arrangement provides "bootstrapped" feedback and raises the voltage gain by effectively increasing the collector load seen by TR1. Notice how this affects the sensitivity of the amplifier.

Next Month: You will need the following additional components in order to carry out the practical assignments:

Resistors ($\frac{1}{4}$ Watt, 5% carbon). 2k2 (2 off); 47k (1 off); 100k (1 off).
Capacitors (160V, Polyester). 10n (1 off); 100n (4 off).
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The biennial Berlin Funkausstellung is the largest consumer and communications electronics exhibition in the world. It ran for ten days in early September with 350 exhibitors spread through 27 halls and over 79 000 sq metres of exhibition space.

German broadcasting stations ARD and ZDF transmitted over 100 hours of live TV from the show, with visitor participation. Half a million visitors attended. EE was there.

European Audio Show

BARRY FOX

In many respects the *Funkausstellung* is now too big for its own good. No-one can see everything. Also, despite the "international" tag, it is still very much a German show.

Few exhibitors bother to produce literature, even for the press, in any language other than German. Company press conferences, to launch new products, are very much German language affairs even though the companies and products are now often Japanese. Nevertheless anyone visiting the *Funkausstellung* still comes away with an overload of information.

The *1985 Funkausstellung* opened with a speech by Chancellor of the Federal Republic of Germany, Helmut Kohl. Germany adopted what Kohl describes as a "comprehensive concept of Information Technology" in March 1984. Although later into IT than the UK, Germany is carrying the plan through with more vigour. A direct broadcasting satellite service is scheduled for mid 1986 and the government is backing pilot cable projects in several cities, now including Berlin.

No longer strictly the "radio" show which the German name suggests, the *Funkausstellung* still has a heavy emphasis on radio and TV. No-one who visits the Berlin show can fail to admire how the German electronics industry, broadcasters, Post Office and Government cooperate to generate interest and create sales of whatever new idea looks likely to open up a new market.

In past years the central theme at Berlin has been teletext, viewdata and stereo TV sound. The emphasis at Berlin 1985 was on satellite, cable and a new idea called VPS—Video Programme System. The concerted emphasis was, as always, clearly well planned in advance.

By opening the show in person, Chancellor Kohl guaranteed wide coverage by the media. At the opening press conference Kohl's speech had been translated in advance into foreign languages and made available to the press; so had speeches by other industry figure-heads who admitted that the sale of both video recorders and colour TV sets was in decline by around 10 per cent.

"Given saturation in the region of 80 per cent to 90 per cent in virtually every category" admitted industry spokesman Peter Bergmann with commendable frankness "we are relying on new possibilities and applications on display here which will no doubt provide new inducements to purchase."

A similar concerted effort and positive attitude could only benefit the UK electronics industry. But what happens?

The *Vidtel* show was the first serious attempt for several years at staging a TV and video show for the British trade, press and public. It was held at the Birmingham Exhibition Centre on the first weekend of the Berlin show, i.e. a direct clash. So for many of the trade this masterpiece of bad timing meant a blunt choice, Birmingham or Berlin.

VIDEO PROGRAMME SYSTEM

In Germany the broadcasters regard video as a friend, or at least an inescapable fact of modern life. By the end of the year all German TV stations will be equipped to transmit VPS, or Video Programme System, codes. Already VPS codes are broadcast with the evening news.

The system works in much the same way as teletext. Instruction codes are injected into Line 16 of the TV picture signal. In any TV signal there are unused picture lines, which are lost to view at the top of the screen. These are the lines used for teletext. The extra short digital code in line 16 gives the date, start and stop time of the programme being transmitted.

In Europe TV stations frequently stray from the schedules which they publish in advance. The aim of VPS is to re-adjust the timers on any video recorders which viewers have pre-set to tape a programme at an advertised time which is no longer correct.

Conventional recorders ignore the line 16 code, but those with a VPS circuit start searching for a code instruction ten minutes before the switch-on time. Recording begins only when the right code for the pre-set programme time has been received by the recorder's VPS circuit.

If the programme begins ten minutes late, the video recorder switches on ten minutes late. In fact on some machines the recorder continues searching for up to four hours after the pre-set time. So even a three or four hour delay will not stop the recorder taping the whole programme.

If no VPS code is transmitted, the recorder simply switches on as set. If the recorder does not have VPS circuitry it ignores any VPS codes and switches on at the set time.

It remains to be seen whether the British broadcasters will be prepared to let video viewers dodge party political broadcasts with VPS. Perhaps after all the recent fuss over the BBC's independence, the Governors might adopt the system, just to prove a point.

VIDEO MEMORY

Toshiba of Japan is the first video manufacturer to incorporate a solid state memory in a domestic recorder. They are routinely used in broadcast and professional machines.

The aim is to offer perfect still frame, slow motion and fast trick play effects without the need to provide extra video heads on the drum which scans the tape.

Normally extra heads are necessary to compensate for the fact that when a video tape is replayed at a different speed from that at which it was recorded, the angle of the tracks on the tape cannot exactly match the angle of the recording heads. The pictures on screen are blemished with interference bars. An extra pair of heads gives clear pictures on trick playback but increases the machine cost because they must be of micrometre precision construction.

Instead of mounting extra heads on the video drum, Toshiba incorporates around one mega-bit of RAM in the player circuitry. This is built up from four 256k bit chips and is enough to record one field, or half the lines which make up a TV picture.

When replaying tapes at normal speed, the video signal bypasses the memory. For still pictures, the signal coming off tape is fed into the memory. The picture on screen is thereafter sourced from the memory rather than the tape.

The tape drive can be switched off, and the still displayed for weeks on end. There is no wear on the heads or tape. Although the displayed still picture is made up from only half the normal number of lines it is still clearer than a still picture sourced from tape by heads which are scanning the tape at the wrong angle.

The Toshiba people in Berlin seemed thoroughly muddled about how the system worked for fast and slow motion replay. Presumably the recorder sources from both the tape and memory.

VIDEO SOUNDS

On the home video front, Sony is showing increasing commitment to the new 8mm format, even though it is still selling improvements on the 12.5mm Beta format which is struggling against the commercially much more successful VHS format.

Sony launched 8mm earlier this year as a camcorder format, for point and shoot video filming. But the company is now developing 8mm as a domestic system for taping TV programmes off-air and watching pre-recorded video tapes of music and feature films.

The 8mm format, as agreed two years ago by all the major electronics manufacturers, leaves room in the video waveform for a PCM digital stereo sound signal. This is in addition to the conventional sound tracks.

The two channels of sound to be recorded are first compressed in dynamic range; loud sounds are made quieter and quiet sound made louder. The compressed audio is now digitally sampled by chopping at twice the TV line frequency, 31.25kHz, and each sample quantised by a 10 bit code. The 10 bit words are then reduced to 8 bit length, by non-linear coding.

On replay the 8 bit PCM words are decoded and the analogue signal expanded in mirror image to the compression, so that quiet passages are made quieter and loud passages louder. In this way the system records and replays a stereo signal with quality comparable to compact disc which uses 16 bit words.

One Sony 8mm recorder can be switched to record only digital sound, with no TV pictures. The full length of each magnetic track across the tape is used to store audio. Because two channels of 8 bit PCM audio need only occupy one sixth of the track length, the tape can be run up to six times through the machine with a different signal recorded on each pass. One 3 hour cassette can store 18 hours of stereo in six passes.

Sony's biggest surprise was Handycam, a combined 8mm video camera/recorder, or camcorder, which is far smaller and lighter than any VHS machine. Handycam weighs only 1kg, and is no bigger than a paperback book. The VHS family, led by JVC, is known to be developing a miniature version of its own camcorder. An announcement was expected at Berlin, but it never came.

Handycam, like all Sony's 8mm equipment for European PAL working, can be switched to run at either 2 cm/second or 1 cm/second, giving a maximum recording time of either 90 minutes or three hours from a single cassette. (Hence the 18 hours for audio-only on the PCM machines).

Battery drain in the camera is reduced to 5W, because the image sensor is a solid state charge coupled device chip (CCD), instead of the conventional picture tube. The CCD chip has 290,000 discrete picture elements or pixels, and captures a picture of quality indistinguishable from conventional tubes. Battery drain is further reduced by using an optical viewfinder, like that in a photographic still camera, instead of the miniature picture tube used in other camcorders.

The Sony Handycam will cost £799 in Britain and should by now be available. It does not replay tapes, only records them. Despite the low tape speeds, sound quality is hifi because the audio is recorded as an f.m. signal along with the video pictures. Handycam does not record PCM.

TIME CHECK

While in Berlin I spoke with the new top man in Grundig, Hermanus Koning, Chairman of the Board and successor to the now-departed Max Grundig. Koning started out in Eindhoven, with Philips. Already there are signs that Koning is sorting out the muddle into which Grundig had fallen. At the Berlin Funkausstellung Grundig was showing a VHS video recorder which boasts a remarkable feature which other companies in the VHS family may well adopt.

Philips latest information-storage medium consists of a Philips MSX computer, CD player, video monitor and Software. Future CD systems will allow all kinds of text, graphic and sound information to be stored and combined. The function of the computer is to enable information to be accessed selectively.

For the first time people using VHS recorders will be able to load a cassette and immediately see a display in hours and minutes of the amount of tape remaining. So there will be no risk of losing the end of a recording because the tape has run out too early.

Also, companies which release pre-recorded programmes on VHS video will now be able to give an accurate time index of the sequences contained. Until now indexing has been unreliable, because the counters on different machines may give different readings. The user has to re-wind a tape to the beginning and then re-set the counter to zero.

Grundig now makes VHS recorders and has cracked the problem with an optical sensor system inside the machine. This registers the angle at which the tape leaves the cassette when threaded through the recorder mechanism.

A microprocessor compares the angle at each side of the cassette. When the left and right angles are the same, half the tape in the cassette has been used; when the angles are uneven, the chip can work out what fraction of the tape is on each spool inside the cassette.

The sensors also register the absolute value for the angles. This tells the chip the size of spools in the cassette and this in turn tells the total length of tape. When all these measurements are juggled, the recorder can work out the amount of tape on each spool in hours and minutes.

It displays this on the control panel soon after the cassette is loaded. So the user can tell at a glance whether a part-used cassette contains enough tape to record a programme in full.

The Sony Handycam 2-speed camera/recorder with hi fi sound.

The Salora Satellite TV Receiver Module can be installed in their latest TV sets when the service becomes operational.

The Satellite TV Receiver system from Grundig.

SATELLITE SERVICE

The *Funkasstellung* made a valuable sounding board on progress towards DBS. West German Chancellor Helmut Kohl, and President Mitterrand of France, may think their agreement on the technical standards for DBS on the Continent are binding, but engineers think differently. It is clear that the continental electronics industry is just not ready for the technology which Kohl and Mitterrand have told their broadcasters to use.

Germany and France originally hoped to launch their TV-SAT and TVF-1 DBS satellites at the end of 1985. Now launch will not be until mid 1986. Programmes will probably begin in September or October, after a couple of months of transmission tests. The Berlin exhibition was ankle-deep in demonstrations of satellite and cable reception, but all using conventional low power communications.

Kohl and Mitterrand have decreed that their countries' direct broadcasting satellites must use the D-2 MAC system. Ostensibly this is to provide better picture and sound quality. But equally important the adoption of MAC could create a wall of patent protection against Japanese competition because the MAC system is heavily patented by the IBA.

This is exactly what happened with the PAL colour TV system, which was patented by Telefunken. Until they recently expired the PAL patents tightly limited the import of PAL sets into Europe.

Philips and Thomson developed the D-2 MAC modification of the British choice, C-MAC. But at Berlin no one could give a working demonstration of MAC. At the time of the Berlin show there was believed to be still only one prototype D2-MAC decoder in Europe; that was being studied by engineers at the German radio research laboratory in Munich.

Electronics manufacturers, other than Philips and Thomson of course, do not like D-2 MAC. They believe the extra cost involved (around 1,000 DMarks or £250) will deter customers. Programme providers are not keen either. They fear that they will be providing D2 MAC programmes for viewers who are unable to watch them. The manufacturers and the broadcasters also worry that if Britain does ever get DBS, we shall be using a different system. This will create a standards barrier, and make sets more expensive by curbing mass-production.

Some manufacturers at Berlin were showing DBS-ready adaptors. But they simply had a bet-hedging space inside for a D-2 MAC decoder. Salora, the Finnish company which has committed heavily to satellite technology, believes the Germans and French may for once in their lives adopt a compromise.

When the satellites go up next year, suspects Salora, they will transmit programmes in PAL and SECAM. But one of the four 230W transponders on board will broadcast the same signals in D-2 MAC. This will give engineers the chance to carry out ground tests on reception equipment and let the industry and public make a gradual transition from old style PAL/SECAM to new style MAC.

POCKET TV

Casio created some interest at Berlin with a new range of pocket TV sets, similar in size to the Sinclair receiver but using an LCD screen instead of a flat tube. Several small screen colour LCD receivers are already on sale in the US and Japan, for instance from Seiko. Quality is reasonably good but the price high—several hundred dollars for a 2.5 inch colour screen.

The popular press has foolishly extrapolated, suggesting that we shall soon be seeing large screen LCD sets. Not so. Set price will double or even quadruple as screen size doubles, because the factory failure rate for LCD screens increases in direct relation to the area. It only needs one faulty cell and the whole screen is useless because it will then be blemished by a permanent black spot or dot of incorrect colour.

The TV-5000 colour set from Casio has a 2.5inch screen and costs around $350 in America. Although on demonstration at Berlin the set is in fact available so far in NTSC standard only. Casio's other pocket set, the TV-60 is however already on sale in Germany, in PAL format. It costs 360D marks which is around £100. You can buy it in German gift shops and drug stores.

Frankly I wouldn't bother. Although the technology is clever, the set is really nothing more than a gimmick. The two inch screen is a monochrome LCD panel built into the flat lid of a tiny case.

When the lid is partly raised to an angle, light from the sun or a room lamp passes through the translucent LCD panel and down onto a polished mirror. The viewer watches by looking down on the mirror which reflects the screen image. The original image is of course electrically reversed, so that the viewed picture is the right way round.

Sound is heard through a small deaf-aid style ear piece. The set works, but only after a fashion. The picture is of low contrast and two inch screen is really not watchable for anything other than a brief news bulletin.

CORDLESS VIDEO

British video wholesaler Lightning announced that it would be launching the Mastertronic "Video-Plus" simultaneously at the Vidtel home video show in Birmingham and Berlin Funkausstellung. For £149.95, said Lightning, Video-Plus represents a "major breakthrough in home video technology which enables the user to watch a movie anywhere in the house irrespective of where the videocassette recorder is located". The unit, as you can guess, is a radio transmitter.

Unashamedly the company's literature boasts that "Video-Plus can transmit crystal clear video pictures to any TV in your home". It works by broadcasting a video signal on any u.h.f. channel between Ch21 and Ch60. You plug in a video recorder or camera, so that its output signal is transmitted round the house.

When a TV set is tuned to the transmitted channel, it picks up signals from the Video-Plus and displays them just like a broadcast signal. Pre-amplifier gain is 40dB over the range 23MHz–600MHz and power amplifier gain is 13.6dB over the band around 400MHz–600MHz.

Isn't this illegal, I asked both Lightning in Britain, and Mastertronic in Berlin? Both gave the same reply: "Cordless telephones".

"Cordless telephones are legal and it works in the same way" elaborated Lightning.

"Cordless telephones aren't legal, but no-one stops it" said Mastertronic in Berlin.

"The question of legality has never arisen" added Lightning.

The latest in-car player from Philips incorporates a "security" code facility.

The JVC HR–D565EG hi fi stereo video cassette recorder.

The CD10 compact disc player from Philips comes complete with a car security mounting tray.

The SL–XP7 portable digital CD player from Technics.

Well it has now. At the Birmingham show an inspector from the DTI called and asked for the Video-Plus to be taken off display. The DTI says its output ERP is 200mW and total gain 62dB, with a broadcast range of 45 feet. "Our view is that this is a radio transmitter and therefore needs a licence under the WT Acts; we would not licence it" adds the DTI. "The Home Office has now written to the makers advising that a licence 'will not be granted'."

This episode makes a timely reminder and warning for electronics firms who are thinking of making or selling radio relays. They are putting customers at risk of prosecution.

It is true that cordless telephones in Britain are legal, but only on narrow bandwidth at specified frequencies. There is no provision for broadcast colour TV bandwidths on the broadcast u.h.f. channels. Use can cause interference to another set in the vicinity, especially if it is tuned to the same or similar frequency.

Anyone convicted of contravening the Wireless Telegraphy Acts, by making unauthorised transmissions, is liable to a fine of £2,000, three months in jail and confiscation of equipment. The law has been the same since long before video recorders became available.

CD SECURITY

The risk of theft now deters drivers from buying expensive audio equipment for their cars. Philips has developed two gadgets which will make life more difficult for thieves.

Philips' new CD 10 portable compact disc record player is similar in size to the portable players already developed by Sony and Matsushita. But the Dutch unit can be used in three ways—with a mains adaptor, battery pack or in a car mount. The mount is a tray which bolts to the car dashboard.

The CD player slides in and mates with a socket which connects it to the car battery. As the player slides into the mount it also latches with a sprung hook on a solenoid.

The hook can only be released by switching on the car ignition, which operates the solenoid. The latch gives temporary protection against theft, eg when the driver stops at a shop. For long term parking, the driver slides out the player while the ignition is on and the solenoid catch open, and pockets it.

A new car radio from Philips has a numeric key pad. The radio will not work until a pre-set three digit code has been entered. The short code is easy for the driver to remember.

It would also be easy for a thief to guess, so the code recognition circuit in the radio allows only three incorrect entries. After that it shuts down for 15 minutes. Each incorrect entry then means another quarter of an hour wait. So without the correct code the radio is not worth stealing. Stickers on the car window warn potential thieves.

Incidentally, Grundig video recorders have a similar feature. The owner keys in a security code and thereafter the machine will not work until the same code has been keyed in again. This makes the recorder not worth stealing; it also lets parents disable their video recorders before going out, for the evening, when the children are supposed be doing their homework.

COMPACT ROM

Berlin left no doubts on the future of compact disc. Around 2.5 million compact disc digital audio recorder players have now been sold around the world. All so far are suitable only for playing music. The next players, due early next year, will have outputs which deliver "raw" digital signals. So as well as reproducing audio, they can be used to play a CD with graphics or a DC ROM disc.

Conventional CD's have room in the data stream for a sub-code of text or graphics, for instance the lyrics of a song can be displayed while the music plays. A CD ROM disc contains no music, just data, like a very large solid state memory. In each case the data stream is fed to a decoder which generates program codes or text and graphics for display on a computer screen.

Philips has already demonstrated a CD ROM system, which allows a dictionary on disc to be searched by home computer. Japanese company Denon has been carrying on simultaneous development. I am pleased to report that both systems work to the same coding standard, so there will not be a clash on compatibility.

Denon is currently wooing US publishers who provide bookshops and libraries with an on-line reference service. Denon believes its CD ROM service will be cheaper.

A master CD ROM disc is cut from standard IBM mainframe computer data tapes (around 20 tapes are needed to fill the 600 Mbyte capacity of a single-sided disc), and several thousand identical discs pressed. These can then be sent round the country by post for use with a modified IBM PC, which has a compact disc drive instead of floppy or hard drive.

Denon says it can offer a turn round time (tapes to discs) of 30 days, at a mastering cost of $5000 and pressing cost of $4 a disc for runs of 1000 and over.

ANIMATION

There was one happy innovation at Berlin. Many exhibitors use animals on their stands to demonstrate video cameras and colour TV sets. Gaily coloured parrots, cockatoos and even elephants were everywhere to be seen.

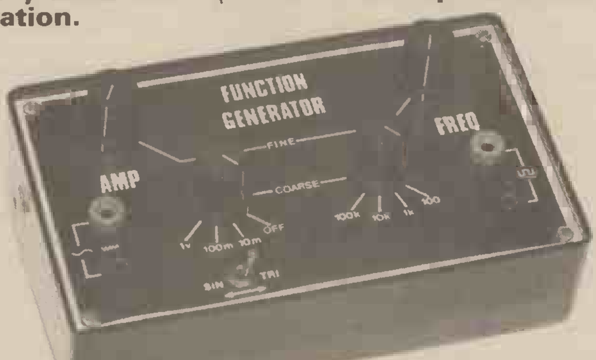
But this time there was a difference. All the animals were models, with electronic and hydraulic controls to make them move in life-like fashion. This trend will be welcomed by anyone, like myself, who finds it repugnant to use live animals as props at a crowded electronics show.

The first thing I read when I got back to Britain from Berlin was a gossip column item joking about the difficulty a British PR man had found in obtaining an orang-outang to appear on a video software company's stand at Vidtel.—Yuk. □

FEBRUARY FEATURES...

FUNCTION GENERATOR

Produces sine, square and triangular waveforms over the range 0·01Hz to 1MHz at up to 1V output, thus forming a very useful piece of test equipment. The article includes a simple battery eliminator for those that require mains operation.



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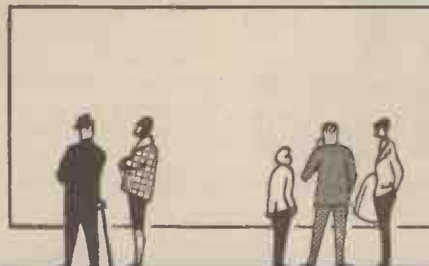
SHOP TALK



BY RICHARD BARRON

Electronic hobbyists, at this time of year, are too full of Christmas pud or Christmas cheer to do much in the line of construction. Maybe this is the time to do a bit of reading. In Shoptalk, this month, we have news of plenty of suitable reading matter including catalogues, a new book service and a free booklet about TV and radio.

Getting Rid Of Ghosting

During this festive season, you don't want the *"Ghost Of Christmas Past"* interfering with the delights of "the box", even if they are all repeats.

If ghosting, co-channel reception or electrical interference are spoiling enjoyment of television or radio programmes, help is available from a new guide published by the Department of Trade and Industry. Called "How To Improve Television And Radio Reception" it is available free of charge from main post offices throughout the country.

The guide is aimed at giving d.i.y. solutions for reception problems as nearly half of all reception problems are due to deficiencies or faults in the radio or televison, the aerial lead or aerial, many of which can be remedied by the owner. The first part of the illustrated guide is for householders and explains how to check equipment, diagnose the type of interference and gives simple and safe ways of solving the most common problems.

If, however, the problem is more complicated the second part of the guide is a technical section to help TV and radio dealers identify and resolve the interference. It deals with classes and sources of interference, check charts and information about filters, aerials and the relevant regulations and British Standards.

Computer Programs For The Young

Children as young as three-year-olds can now enjoy using the micro to develop early learning skills.

Colourcopter and other early learning programs is a new suite of seven programs published by ESM for nursery and infant education. It includes games and ideas for colour, shape, letter and word recognition, left and right orientation and co-ordination.

The authors Elizabeth Keate, a teacher of the deaf specialising in early development, and Robert Harding, a maths lecturer at Cambridge University, have developed the programs over three years with the help of many teachers, parents and children throughout the UK.

A set of seven programs is available for the BBC micro for £14.85 on disk or tape from: **ESM, Duke Street, Wisbech, Cambs PE13 2AE.**

Book Service

Whilst *Everyday Electronics* provides lots of information about electronics and related technology, many readers like to read specialist books which concentrate on a particular area of the hobby.

Often these books are difficult to locate and in many cases potential readers are not even aware of their existence. To overcome some of these problems, *Everyday Electronics* have now started a Book Service which covers a variety of subjects. Books can be ordered direct from our editorial office, see page 19 for details.

CATALOGUES RECEIVED

Over the last few weeks we have built up quite a collection of new catalogues and bulletins, and as always they have proved to be varied and interesting, with information of new products, prices and applications. We have received too many publications to describe each one in detail, but the following information is sufficient to give you some idea of what has recently become available.

The 1985-86 catalogue from Marco Trading can be obtained from: **Marco Trading, Dept. EE, The Maltings, High St., Wem, Shropshire, SY4 5EN. ☎ (0939) 32763.** It costs £1 but includes a 50p credit note which may be used against any order of £10 or more. Also included with the catalogue is a "monthly special offer", which this month is a desoldering pump for only £2.99.

Rapid Electronics (Oct 85–March 86) catalogue is also available for £1. Their new catalogue is far more comprehensive than their previous offerings and includes plenty of well illustrated and useful data on a wide range of electronic components. It can be obtained from: **Rapid Electronics, Dept. EE, Hill Farm Ind. Estate, Boxted, Colchester, Essex, CO5 5RD. ☎ (0206) 36730.**

An opportunity to win a Sinclair QL Computer is offered with B&R's free new catalogue. The catalogue, described by B&R as "an electronic engineer's reference book", is available free of charge from; **B&R Electrical Products Ltd., Templefields, Harlow, Essex, CM20 2BG. ☎ (0279) 443351.**

The latest price list from C.P.L. Electronics contains a straightforward, easy to follow price guide covering their current stock list. C.P.L. also inform us that they are able to supply non-stock or difficult to obtain items for specific projects published in EE. For more details contact: **C.P.L. Electronics, 8 Southdean Close, Hemlington, Middlesbrough, Cleveland, TS8 9HE.**

CONSTRUCTIONAL PROJECTS

Circuit Exchange

Although the circuit ideas described in Circuit Exchange are not, strictly speaking, intended as constructional projects, many readers do in fact build them. There should be no problem with this, as we do check that the components suggested are available.

Mains Delay Switch

The components for the Mains Delay Switch are readily available from many suppliers.

Musical Doorbell

A full kit of parts for the Musical Doorbell project is available from: **Magenta Electronics, EE34, 135 Hunter St., Burton-on-Trent, Staffs, DE14 2ST.** The complete kit costs £16.98 inc. VAT plus 60p per order p&p. Also available from Magenta is bell wire and bell-push switches.

One Chip Alarm (Building Blocks)

Components for the One-Chip Alarm can be obtained from most advertisers as they are commonly available items. The p.c.b. is available from the EE PCB Service and is part of a larger board which allows several projects to be constructed.

The connections for the alarm loop on the prototype were made using quick release terminals but a cheaper and just as efficient method would be to use screw terminals such as those available from **Maplin Electronics** (Order Code FK16F).

O-Port

Most of the components for the O-Port are available from a number of suppliers; however, the relay used in the prototype was a Verospeed 258-4101K. If this type is used, make sure that the connections are compatible with the Veroboard layout as the Verospeed catalogue shows them slightly different.

On-Spec

On-Spec has featured several projects in recent months, the components for which are commonly available. If you have any ideas or questions regarding On-Spec please send them together with a stamped, addressed envelope to: **Mike Tooley, Dept. of Technology, Brooklands Technical College, Heath Rd., Weybridge, Surrey, KT13 8TT.**

Tachometer (Transducers-5)

This month's Transducer project is a frequency transducer which may be used in a variety of applications. The heart of the circuit is the LM2917N-8, a frequency to voltage converter. It can be used in conjunction with a number of opto devices, Hall effect i.c.s or direct signal input. The LM2917N-8 is available from: **Rapid Electronics, Dept. EE, Hill Harm Ind. Estate, Boxted, Colchester, Essex, CO4 5RD.**

Audio Signal Tracer (Teach In '86)

No component buying problems are envisaged for the Audio Signal Tracer, as a number of advertisers are supplying kits for the *Teach In '86* series.

CIRCUIT EXCHANGE

This is the spot where readers pass on to fellow enthusiasts useful and interesting circuits they have themselves devised. Payment is made for all circuits published in this feature. Contributions should be accompanied by a letter stating that the circuit idea offered is wholly or in significant part the original work of the sender and that it has not been offered for publication elsewhere.

COMPUTER BUGGY CONTROLLER

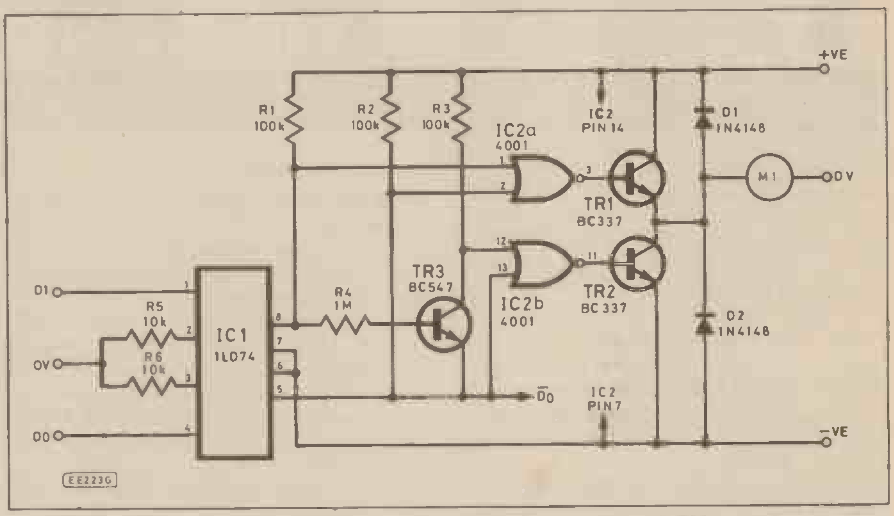
THIS circuit is intended to control one of the motors of a computer buggy. D_0 switches the motor on when it is at logic 1. D_1 switches TR1 on when at logic 1 and TR2 on when at logic 0 giving forward and reverse motion.

The second motor is controlled in the same way from D_2 through the other two gates of IC2.

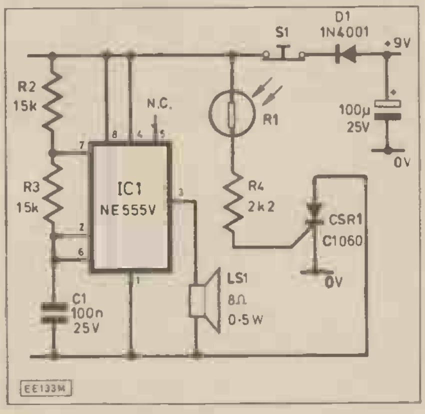
With no input the motors are off and the circuit draws negligible current, so no switch is required.

Using *'Big Trak'* motors ±3·5 volts is required to "break" the magnetic clutch.

W. A. Adam,
Kettering,
Northants.



LIGHT OPERATED OSCILLATOR



THE light operated oscillator described here is a very useful project for use in rooms where light is the enemy. An obvious example of this would be a photographic lab.

The first half of the circuit is a light operated latch comprising the light dependent resistor, R1 and the thyristor, CSR1. R1 has a resistance of around 100MΩ until it is exposed to light when the resistance will fall to about 100Ω. When this occurs CSR1 will fire and thus provide current to the second half of the circuit.

When CSR1 fires, a low pitch noise is emitted from LS1 which is driven from the 555 timer, IC1. Once started the tone will continue until the circuit is reset via S1.

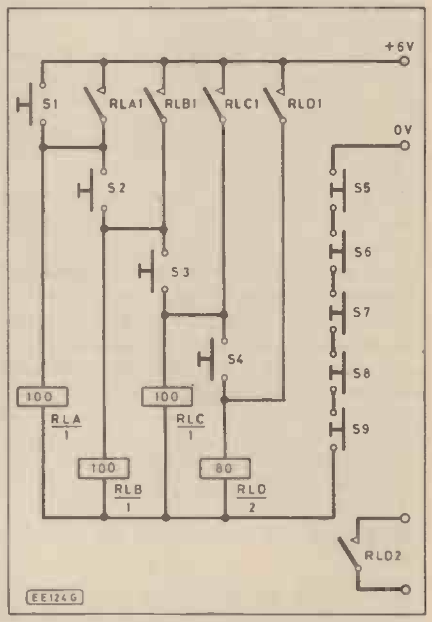
J. Short,
Southend on Sea,
Essex.

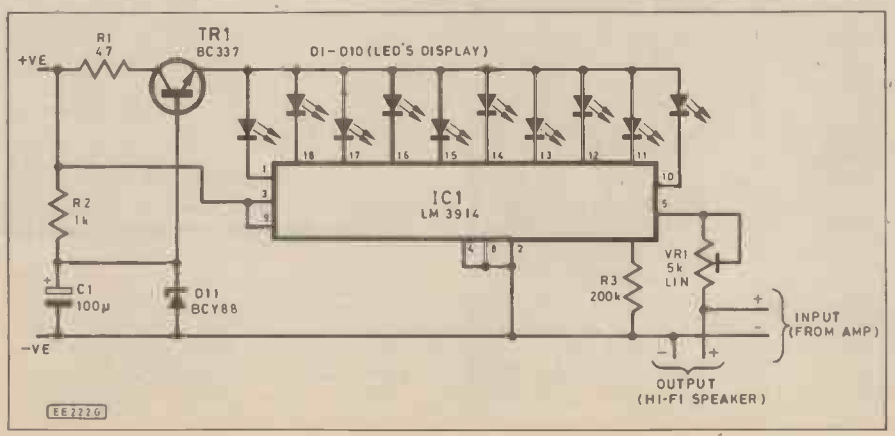
RELAY COMBINATION LOCK

THE circuit shown here is a simple but effective combination lock. The circuit comprises of just relays and press-button switches. When S1 is depressed RLA is activated and latches on. This also connects S2 to the positive rail, thus enabling S2 to be activated and so forth through the circuit.

RLD contains two sets of contacts to switch an external device on such as a motor or a solenoid. There are over 3000 different combinations using four relays and a nine-key keyboard. If any switch S5–S9 is pressed this will temporarily disconnect power to the circuit and reset the latches. The switches can be arranged on a 3 × 3 keyboard labelled 1 to 9.

A. West,
Earl Shilton,
Leicestershire.





AUDIO AMPLIFIER OUTPUT POWER METER

THE circuit uses the LM3914 Bargraph Display i.c. which is capable of driving ten l.e.d.s and is therefore ideally suited to the readily available bargraph modules which are easily obtained through most high street component shops.

The circuit here shows only the single channel meter but, obviously, an identical circuit can be made and a stereo power meter can be constructed using the two circuits together.

The unit can operate on a voltage range of between 3V and 18V and it is therefore ideally suited to portable use.

N. Walker, Scunthorpe.

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Fax of Life

We talk a lot about new Information Technology in Britain, but don't seem too keen on using it. In Japan, industry uses IT so routinely that no-one would think it worth wasting time on talking about it.

Recently I was in Tokyo. At an electronics exhibition I saw a demonstration of JVC's new high definition and 3D video disc systems. No-one at the show could both speak English and explain how it worked, so next morning I phoned JVC in Yokohama from my hotel.

One of the engineers on the video disc design team speaks good English but the new systems rely on tricky technology, which is almost impossible to explain by telephone. "What you need, to understand it, is a diagram of the disc track format," he said.

"Unfortunately I am leaving Tokyo tomorrow," I explained, "and I don't expect we can rely on the post can we?"

"No problem," he told me, "we are already sending over some sketches by facsimile."

A couple of minutes later the hotel receptionist sent up a folio of technical sketches to my room. The JVC engineer was then easily able to explain how the system worked by referring to the diagrams. Then we hit another tricky area. Five minutes later the hotel receptionist sent up another bunch of sketches. Within half an hour I had a clear understanding of the whole thing.

What interested me is not that the JVC engineer had facsimile technology at his disposal or that the hotel was geared to receive incoming material and get it up to a guest's room within minutes of arrival. Most UK firms have fax hardware. Some UK hotels have it, too. The interesting point was that in Japan it was the obvious thing to do.

I can't recall a single occasion in Britain when I have been querying a tricky technical point and someone at the other end has even considered the possibility of helping the discussion along with a fax transmission. One explanation is that the Japanese are very fax-conscious, because their language can't be transmitted by telex. (There are not enough characters in the telex alphabet to cope with Far East text.) But that isn't the only reason. It's a state of mind and it's just one of the many reasons why Japanese industry is so darned successful.

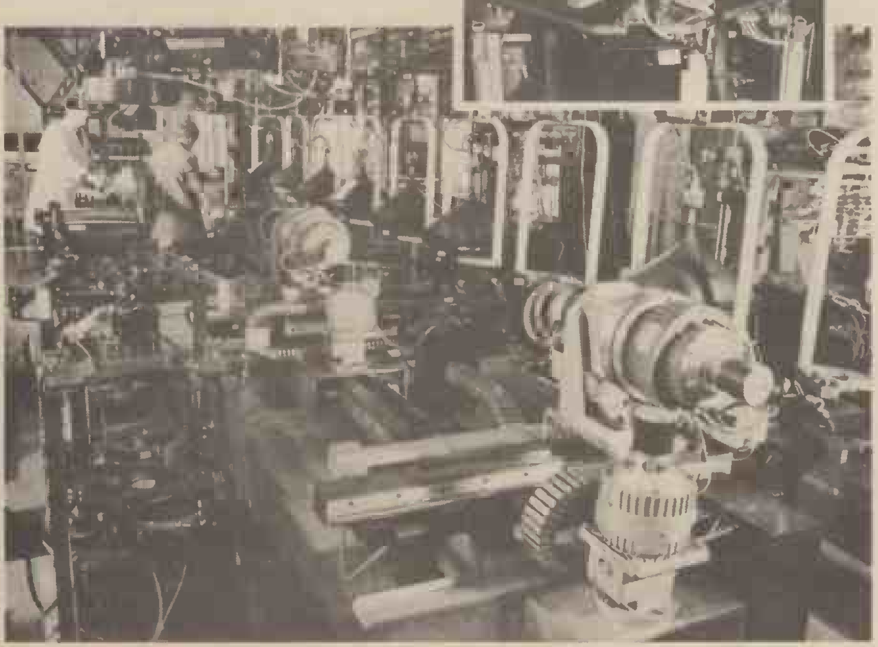
Another reason is that Japan has never had any oil of its own. Almost all energy is imported. Information Technology saves energy because data, rather than people, travel.

No Competition

When the North Sea oil starts to run out in 1990, the firms which survive in Britain will be those which have made themselves as efficient as the foreign competition. On present showing there may not be many native British manufacturers left.

When the oil dries up there should be at least one electronics factory in Britain still resisting the Japanese competition. The Mullard TV tube plant at Durham has just been heavily modernised and will make a completely new range of tubes, 45AX. Strictly speaking Mullard isn't British, like Pye, it is part of the Philips empire.

General view of the Mullard, Durham automatic process and measurement area. In this section the 45AX tubes automatically undergo a series of complex tests, including one for cathode emission—inset photo.



The new tubes are of the FST type. That stands for Flatter Squarer Tube or Full Square Tube, depending on who you ask. For Mullard it's the former; for ITT the latter.

A Flatter Squarer Tube has sharper corners, and a flatter front surface. The radius of curvature of the glass is almost doubled, which is why in the trade they talk about R (old type tubes) and 2R (new flatter tubes). A Full Square Tube has square corners and the same curvature as before. Philips and Mullard went the whole hog; ITT went halfway.

The investment in going all the way is very heavy. Virtually nothing in the new tube is the same. In fact the only unchanged part in Mullard's new range is the anode cap.

Philips is spending £175 million on 10 tube factories around the world for the switch to FST. Total production is 12 million tubes a year, a quarter of world consumption.

In Britain the Mullard factories will get £14 million by the end of 1986. Together, Simonstone, (where they make the glass and make the shadow mask electron guns), Southport (where they make the yoke ring), Washington (where they make the deflection coils) and Durham (where there is final assembly) turn out 1·6 million tubes a year. Two-thirds are exported.

Winding the coils which deflect the beam is part science, part black art. Although computers are used to design the tube, there is no perfect program to control the computer. So in the final analysis the tube maker has to build one, try it, see what's wrong and try again. A couple of specific examples make the point.

Hot Spots

In any colour TV tube, the shadow mask grid of around 0·5 million tiny slots is mounted just behind the colour phosphors on the inside front surface of the glass. Some electrons from the beam are inevitably stopped by the metal. So the metal gets hot. It then expands and distorts the shape of the mask, causing the colours on screen to sour.

This may happen in selected areas, for instance where a part of the picture is reproducing a brilliant white patch—like someone's shirt. The mask then "domes" in just that area and the white starts looking mauve.

The Mullard 45AX tubes mount the shadow mask in novel manner. Instead of the usual bimetallic strip used to suspend the mask near the centres of its sides, Mullard uses four metal brackets, one at each corner. These are welded by laser and carefully dimensioned so that as the tube gets hot and expands it moves forward by just the right amount to compensate for doming.

Additionally, bismuth oxide is sprayed onto the shadow mask, during production. This reflects back some of the electrons, reducing the mask temperature, even during a long evening's viewing.

Early tube samples still domed a little. The surprising answer turned out to be to reduce the thickness of the metal. This is the opposite to what would be logically expected; thicker metal is usually better at dispersing heat.

TEACH-IN '86

PROJECT 4

AUDIO SIGNAL TRACER

Michael Tooley BA **David Whitfield** MA MSc CEng MIEE

TRACING signals for troubleshooting in audio circuits is ideally done using an oscilloscope. This allows you to see the waveform (usually provided by an audio signal generator) as it passes through the various stages. Diagnosis of any problems is then very much simplified by being able to see where the signal stops, or where significant distortion occurs. Invaluable though they undoubtedly are, oscilloscopes do have one major drawback: they are expensive. With price tags starting at over £150, and going on up to well over twenty times that amount, they are placed out of reach of many would-be users.

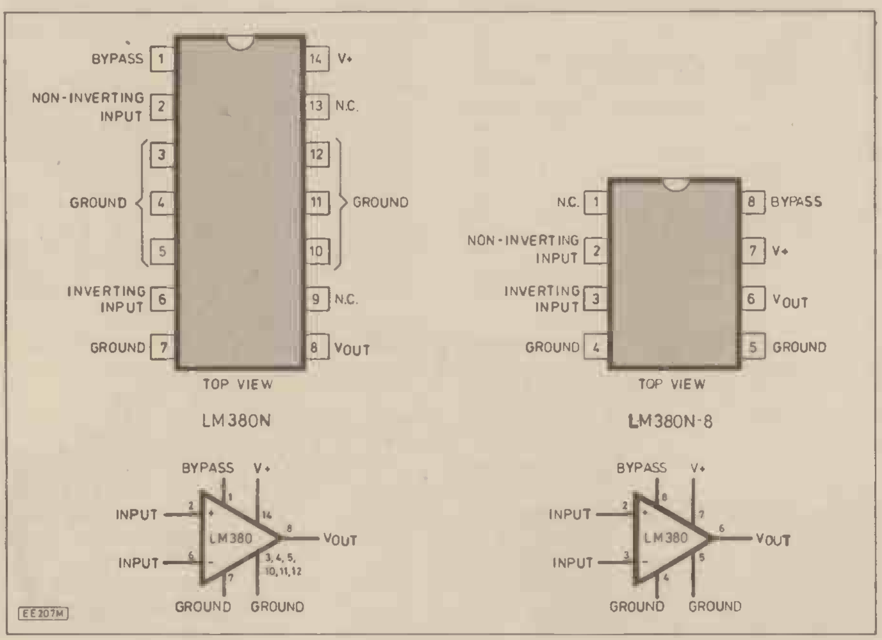


Fig. 4.1. LM380 pin connections.

The audio signal tracer to be described this month offers an alternative tool for troubleshooting. The audio signal tracer is a self-contained variable gain audio amplifier which provides sufficient amplification to allow even the lowest level signals to be traced. It can be operated from the power supply described in the first part of this series, or from any convenient d.c. supply in the range 9V to 20V, and features its own monitor loudspeaker.

CIRCUIT DESCRIPTION

The signal tracer is designed around a fixed gain integrated circuit audio amplifier. The LM380 is an audio power amplifier featuring short circuit protection and internal thermal limiting. The gain of the amplifier is fixed at 34dB (i.e. 50 times), over a bandwidth of 100kHz, i.e. the gain never falls below 25 at any frequency up to 100kHz. The LM380 operates over a wide range of supply voltages, automatically setting the quiescent output voltage to half of the supply voltage. The input resistance of 150k, minimises the need for any input buffer stages, and an output power of up to 2·5WRMS is available into an 8Ω load when operated with a suitable heatsink and power supply.

The internal circuit for the LM380 is shown in this month's part of *Teach-In*. The amplifier itself comes in two different packages, as shown in Fig. 4.1. The 14-pin d.i.l. package (LM380N) has the centre three pins on either side connected to ground. This is intended to allow copper heatsink fins to be soldered to these pins for high power running. The heatsinking can alternatively be provided by a suitable printed circuit layout, with a minimum of 40cm² of 2 ounce copper foil area connected to these pins. The smaller package (LM380N–8) is intended for lower power applications. The important point to note is that these two packages are electrically compatible, but are *not* interchangeable due to the different pin ordering.

The circuit diagram for the complete signal tracer is shown in Fig. 4.3. The input signal from SK1 is a.c. coupled to the non-inverting input of IC1 via C2. The gain of the tracer is set by VR1, and C3 provides the necessary bypass. The output from IC1 is coupled to the loudspeaker via C6. A.c. coupling is necessary because the no-signal output of the amplifier is automatically set to half of the supply voltage.

JK1 is a switched jack socket which allows an external loudspeaker to be used in place of the integral monitor, LS1. This is particularly useful if the tracer is being used simply as an audio amplifier, rather than as a tracer. The series network formed by C4 and R2/R3 prevents oscillation of the amplifier, which may otherwise occur under some load conditions. The tracer is protected against incorrect supply polarity by D2, while S1 and D1 provide power supply switching and indication functions, respectively.

CONSTRUCTIONAL DETAILS

The audio signal tracer is built in the standard case for this series. The majority of the small components are mounted on a standard piece of 0·1" Veroboard, and the layout for this board is given in Fig. 4.4. Only four track cuts are necessary, and these should be made with a track cutter, or using a large diameter sharp drill turned slowly by hand. Before starting to mount the components, four mounting holes should be drilled to allow the board to be mounted in the case.

No special sequence is necessary in mounting the components, and the only precaution necessary is to make sure that all of the polarised componenets are correctly orientated. The i.c. should be fitted with a heatsink only if prolonged operation at high power is expected. However, no heatsink will be necessary if only the small internal monitor speaker is to be used. Small loudspeakers of this type are typically only rated at around 0·3W. Terminal pins are recommended for all off-board wiring since this allows the wiring to be installed after the board has been mounted in the case.

Once construction of the circuit board is complete, check for any solder splashes or

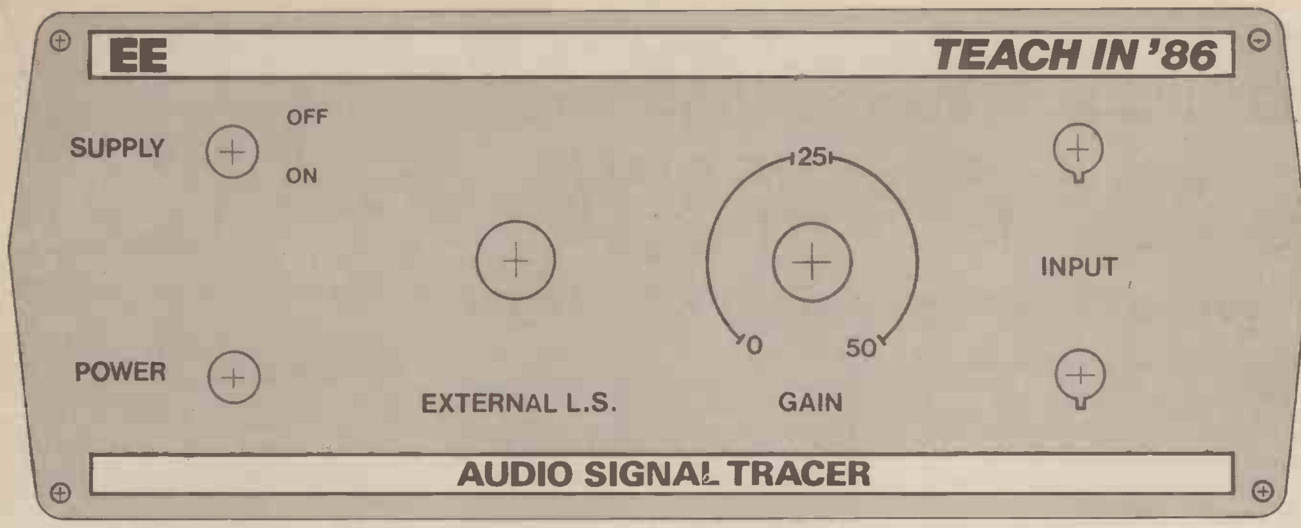


Fig. 4.2. Front panel design of the Audio Signal Tracer.

inadvertent short circuits. Next drill the front panel in accordance with the layout given in Fig. 4.2. The panel overlay should then be attached and protected with transparent library film. The panel mounting components should then be fitted. In order to reduce the chance of hum pick-up, it is desirable to connect the front panel to the signal ground. On the prototype this was done using a 0 BA earth tag fitted between S1 and the panel (on the rear side), but any other convenient method may be used.

The loudspeaker should be mounted at the rear of the case over the ventilation holes. Mounting it on the lower half of the case will protect it against the intrusion of foreign bodies, while mounting it on the upper half will give slightly better output quality; the choice is yours. The main circuit board should then be mounted so as to give adequate clearance to both LS1 and the front panel mounting components. The remaining components (SK3 and SK4) should be mounted on the rear panel in any convenient position.

The final step is to complete the interconnection wiring as shown in Fig. 4.5. This completes the construction of the audio tracer. After a final check on the wiring, reassemble the case using the four screws to attach each panel to the case halves.

USING THE TRACER

The first check on the completed tester is to measure the supply current when the unit is connected to a d.c. supply of between 9V and 20V. With the gain setting at minimum, the current should be between approximately 20mA and 50mA, and D1 should be illuminated. If there is no current, check the

COMPONENTS

See **Shop Talk** page 25

Resistors
- R1 1M
- R2 4Ω7
- R3 4Ω7
- R4 1k
- All 0·25W 5%

Potentiometer
- VR1 100k linear potentiometer

Capacitors
- C1 4n7 polyester 250V
- C2 100n polyester 250V
- C3 47µ 25V electrolytic
- C4 100n polyester
- C5 10µ 25V electrolytic
- C6 470µ 25V electrolytic

Semiconductors
- D1 0·2" l.e.d. and panel holder
- D2 1N4001
- IC1 LM380N

Miscellaneous
- LS1 2·5" 8Ω loudspeaker
- SK1 4mm terminal (red)
- SK2 4mm terminal (black)
- SK3 4mm socket (red)
- SK4 4mm socket (black)
- JK1 switched standard jack socket
- S1 s.p.s.t. toggle switch

Knob with pointer; stick-on plastic feet (4 off); Veroboard 0·1" pitch 5" × 3·75" and mounting hardware; Vero terminal pins (8 off); case (West Hyde Developments type TEK A22)

Approx. cost Guidance only £19.00

Photo 2. The external details of the Audio Signal Tracer.

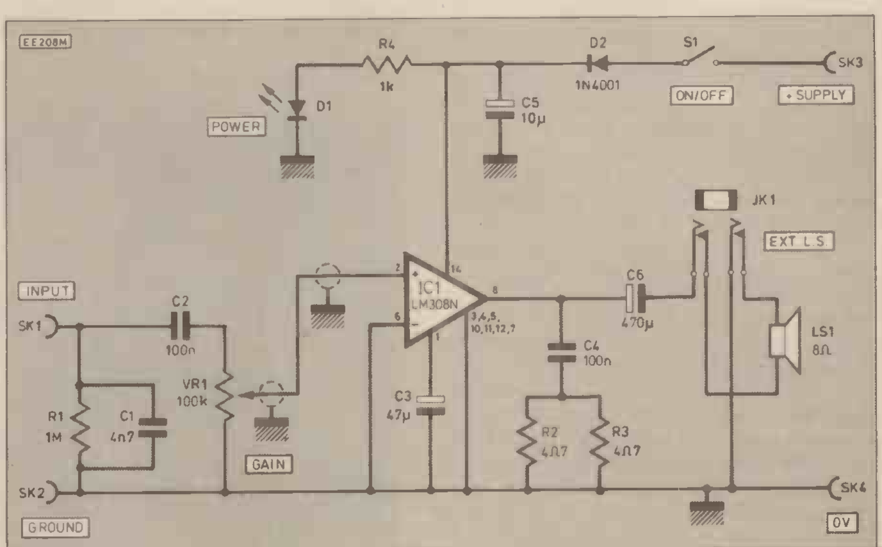


Fig. 4.3. Circuit diagram of the Audio Signal Tracer.

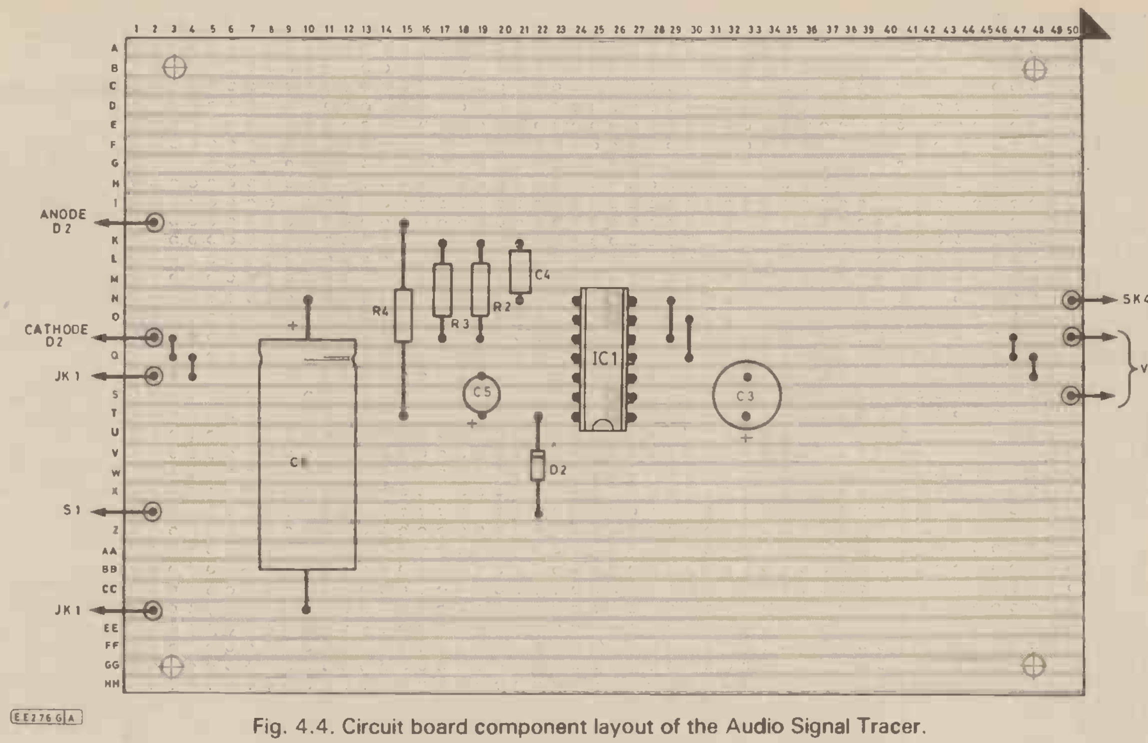
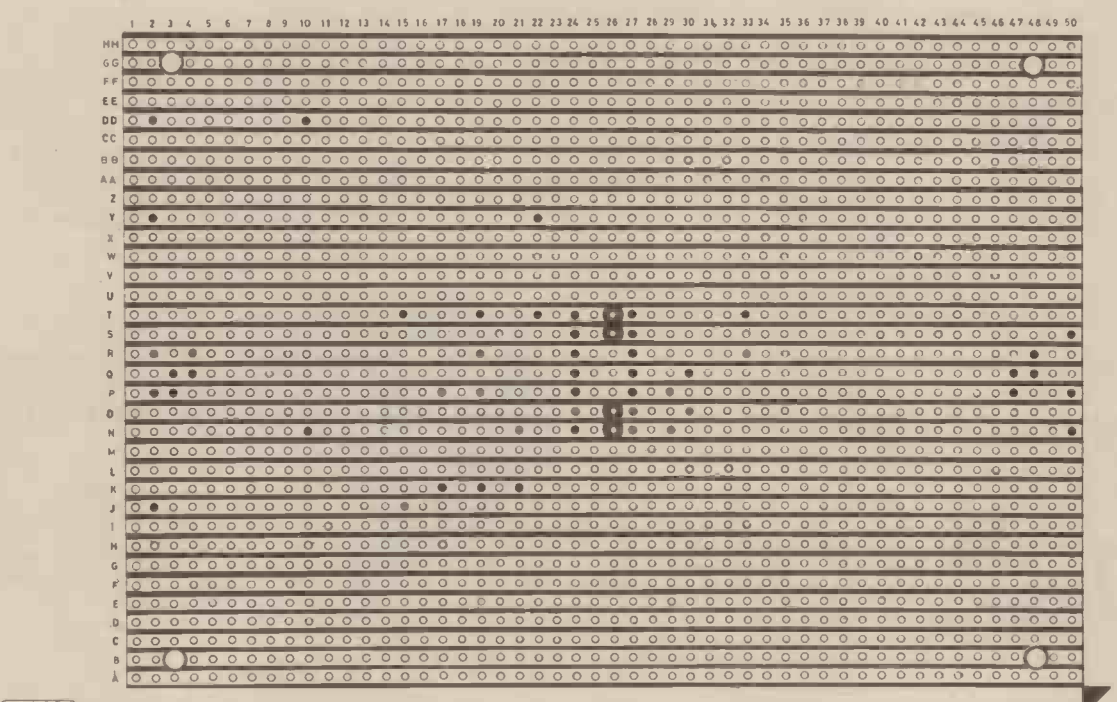


Fig. 4.4. Circuit board component layout of the Audio Signal Tracer.



polarity of D2, and the power supply wiring. Any significantly higher current should be investigated before proceeding.

As the gain is increased, a low hum may become audible, particularly if a finger is touched on SK1. This indicates that all is well, and the tester is ready for use. The maximum output power available in use will depend on the impedance of the loudspeaker used, and on the power supply voltage. To use the tester, you will require a test lead, which ideally should be screened. This requires a length of screened cable, with 4mm plugs at the tester end, and insulated crocodile clips at the other. The tester will produce a clearly audible output from signals as small as 1mVRMS.

To troubleshoot a circuit, the first requirement is to provide an input signal for the circuit under test. The audio generator to be described next month is one such

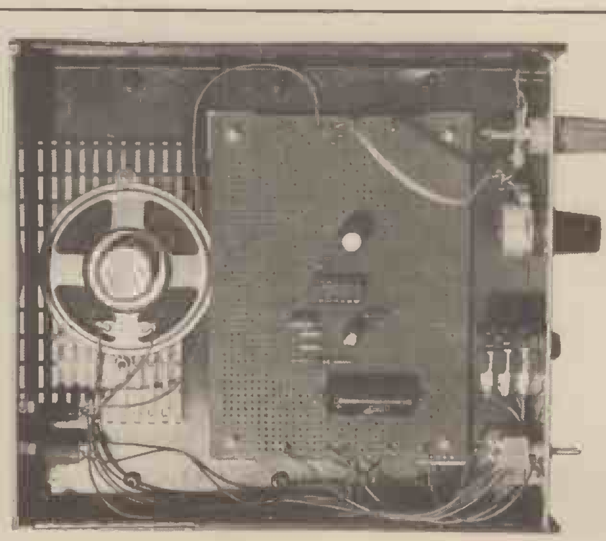


Photo 3. The internal details of the Audio Signal Tracer.

See **Shop Talk** page 25

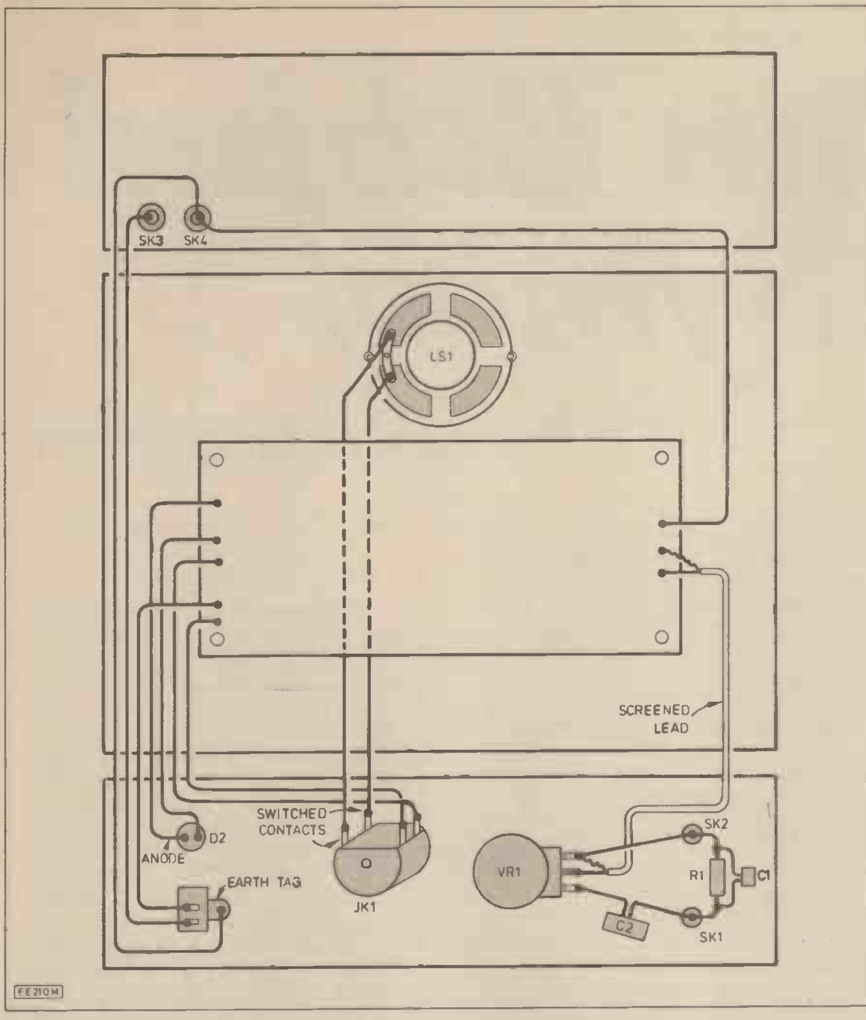


Fig. 4.5. Overall wiring diagram of the Audio Signal Tracer.

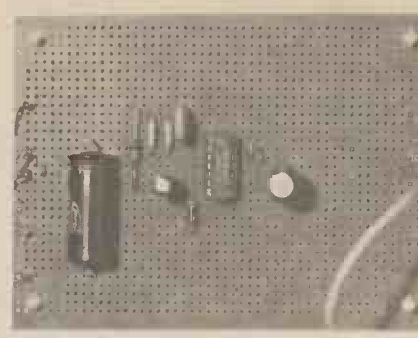


Photo 4. Veroboard layout of the Audio Signal Tracer.

source, but in many audio projects a tuner or tape deck is a readily available and suitable alternative. The tracer can then be used to follow the signal from the source (where the signal level may be very low) through the various stages to the output. The change in setting of the gain control to keep the output approximately the same will give some idea of the gain of the various stages under test. This should allow the location of any change of signal, loss of gain, gain or distortion to be identified.

It must be stressed that the audio tracer is intended for use on transistorised equipment. *Under no circumstances should it be connected to mains potential.* If in doubt, check the potential in the circuit with a meter *before* using the tracer.

Finally, it is worth noting that the audio tracer is also usuable as an audio amplifier in its own right. There are many situations where this can be extremely useful in the lab or workshop, and is one point where it definitely scores over an oscilloscope!

NEXT MONTH: Next month's project is an Audio Signal Generator, an instrument which is the natural counterpart to this month's signal tracer.

BOOK REVIEWS

USING COMPUTERS IN EDUCATION

Author Clive Gifford
Price £5.25 paperback
Size 210 × 147mm. 220 pages
Publisher Interface Publications Ltd.
ISBN 0 907563 68 6

THERE HAS BEEN considerable debate recently about the real value of computers in education, both within the teaching profession and outside it. This book attempts to show that "computer education cannot only mean being aided by a computer to learn about a subject . . . but also learning about computers themselves and how to use them".

The elements of computer hardware, software, and program-writing in BASIC are well-covered and attractively-presented. This section is aimed at the teacher, and given as a course of 20 lessons of programming together with complementary material, complete with teachers' notes. There are some good ideas here, but few teachers will feel the need for such a detailed scheme of work.

There are also a dozen complete listings given for "educational" programs. However, the value of using a computer to learn French verbs—one of the example programs—is dubious, and is just the kind of application that is often quoted as a mis-use of the machine. Mr Gifford claims that this kind of mechanised rote-learning saves the language-teacher much time; this *might* be true *if* the teacher had a machine (or interactive terminal) per pupil at his disposal.

The listings given for file-handling, accounting, and quizzes will be of general interest, and also teach a great deal about program-writing in BASIC. There is also a complete listing for a CESIL interpreter: CESIL is a language first developed by ICL for educational purposes—though without an interpreter, which hindered its widespread adoption. The short chapter on LOGO is welcome, but this important language really deserves better than a six-page appendix.

It is, perhaps, a sign of the accelerating pace of development in computing generally, that *Using Computers in Education* feels rather out-of-date. If it does indeed reflect the "day-to-day experience of many teachers working with computers in the classroom", then it serves as a good argument for much closer links between schools and industry.

D.A.B.

EE BOOK SERVICE
See Page 19

The Man Behind the Symbol

Nº6 H.C. Oersted

by Morgan Bradshaw

THIS month we move to Denmark to meet the man who discovered the connection between electric current and its magnetic effect, Hans Christian Oersted who gave his name to the absolute unit of magnetic field strength (Table 1).

Hans Christian Oersted was born into a large family on the island of Lolland, on August 14, 1777. The son of the local pharmacist, Hans' interest in science was aroused early in life when together with his brother Anders (later to become a well known politician and professor of jurisprudence) the two boys worked in the family pharmacy. Their father noticing their high intellect arranged for them to have a private tutor, this together with an intensive programme of self study enabled the two lads to travel to Copenhagen in 1793 and in the next year pass the university entrance examination.

Hans made an instant impact at Copenhagen University passing the pharmaceutical examination with distinction having already written prize winning papers in both aesthetics and medicine, he completed his studies with a thesis on Kant's *Limits of Poetry in Prose* and became chemical assistant to the medical faculty in 1799.

TRAVELS ABROAD

Oersted knew he must travel if he wanted to increase his knowledge but Denmark was at war with Britain, over the right to search merchant ships, and a British fleet under Nelson was bombarding Copenhagen, but at last in the summer of 1801 he was awarded a travel scholarship, which together with a public grant enabled him to spend three years abroad visiting Germany, Holland and France. Returning home he was appointed to the first professorship in the chair of physics at his old university.

Further travels during 1812/13 saw him in Germany, Belgium and France, and at this time he published his first paper entitled *View of Chemical Laws* in which he expressed the view that there was a connection between electricity and magnetism.

Back home in 1814 he married Brigette Ballum. It was in 1820 "the happiest day of my life"—the great event which at one stroke made him known all over the world; the discovery of electromagnetism.

MAGNETIC BREAKTHROUGH

He himself told the story of how one day in April when he was pondering on a lecture about electricity and magnetism in which he would employ the new voltaic electric battery it occurred to him that just as light and heat radiate from all sides of a live wire, so conceivably magnetic action might similarly be emitted from the wire. He resolved to investigate this by inserting a platinum filament in the wire between the battery terminals and causing them to glow by means of the current, meanwhile holding it over a small compass needle in the line of it.

Oersted found that the needle was deflected and that it was deflected in the opposite direction when the current was reversed, and that it was without effect when the needle was held at right angles to the wire. The effect was only slight since the current was so low. After further research in July he commenced a very extensive and well documented paper in Latin which he unselfishly circulated to all the leading academies and scientists resulting in a paper that was quickly translated into major languages in leading scientific journals.

It was a breakthrough! Before long Ampere, as we have seen in an earlier article, had arrived at the mathematical laws of electromagnetism and in 1830 Faraday had discovered electromagnetic induction but more of him later.

These last two discoveries which were a consequence of Oersted's fundamental experiments are the basis of the electric motor and generator. Now everyone wanted to meet the great "Dane".

ROYAL SUPPORT

In 1822/23 Oersted went on his third major journey abroad to Germany, England and France with royal support and money for buying instruments. On this journey he conceived the idea for the society for the dissemination of natural science based on the British Association for the Advancement of Science to which he was later appointed a member.

But there was time for other scientific work, Oersted was the first to produce pure aluminium and carried out a series of original experiments on the compressibility of fluids, he also had a lasting influence on many other aspects of Danish culture and life and was one of the first to appreciate and encourage Hans Christian Andersen of fairy tale fame.

In 1850 Oersted, now rector of Copenhagen University, was awarded an honorary residence in Copenhagen for life to mark the 50th anniversary of his appointment as a University lecturer, but unfortunately he died on 9th March 1851 before he could take possession.

A funeral service was held at Copenhagen Cathedral on the 18 March, a national day of mourning, and students laid a silver wreath upon his coffin.

Table 1

In the scientific system of units of measurement, which is based on the fundamental units of centimetre, gram and second (the CGS system), the absolute unit of magnetic field strength is one oersted.

It was the German scientist Carl Fredrich Gauss who suggested the introduction of a system of absolute units, in 1832. At an International electricity conference in Paris in 1881, it was agreed that the centimetre, gram and second should be the primitive units. As all other units are derived from them, it was resolved to name these "derived units" after the man who had contributed to this particular branch of physics.

Danish scientists sought to have Oersted's name identified with an electromagnetic unit, but it was not until the meeting of the International Electrotechnological Commission in Scandinavia in 1930, that their efforts were rewarded.

Everyday Applications

If we take a simple horseshoe-shaped permanent magnet, there will be a magnetic field between the two poles of the magnet. The more powerful this field is, the more oersteds the field strength is said to be. Our ordinary magnet may have a field strength of several hundred oersteds, whilst a large electromagnet may have a million. The earth is also a magnet but its surface field strength varies according to location.

There is a drawback to the oersted unit, as strictly speaking it applies only to a magnetic field in a vacuum, introduce any other material into the magnetic field this is described as "induced" and is measured by the gauss unit.

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NEWS ...from the world of electronics

CHAMPION for CAMPION

BP Challenge to Youth

*1st CAMPION SCHOOL—Trophy & £1000
*2nd TUDOR GRANGE—£500

THE BP 1985 Buildarobot finals held at Arborfield Garrison near Reading, the home of the Royal Electronic & Mechanical Engineers (REME) Corps, was won by Campion School of Leamington Spa. *Jeeves*, a "Buildabutler" entrant was truly of the old mould, serving drinks to each of two people sitting in a room without the intellectual advantage of the microprocessor. Although many "butlers" took drinks orders verbally, through an optical link or onboard keypad, Jeeves took his over a radio link and earned his creators £1000 and a trophy.

Another mixed comprehensive, Tudor Grange of Solihull, took the second prize of £500 with *AVERY*. This team rightly won the Craftsmanship class too, the robot's construction having involved students in woodworking, aluminium casting and acrylic thermaforming, all skills with an equal claim on the future.

Many of the mobiles carried complete home computers onboard, no shortage of programming skill being evident. If a weakness was evident it appeared to be in linear circuit technique of the kind that would have immunised light-seeking robots from camera flashes and artificial lighting. Nevertheless a great deal of work has gone into the robots, their sophisticated drinks-vending base stations and also the "hi-tech" stools that you just happen to have to be sitting on to be served. *Garfield*, the brainchild of a team from Tonbridge School, "pulled his pints" from an imaginative miniature pub called the Boars Head!

The team from Campion School, winners of the BP Buildarobot Competition, display their trophy and "Jeeves" the robot butler. From left to right: Steven Ray, Tarlochan Gill, Philip Parker and Derron Taylor—all 15 years old.

CLASS AWARDS

Various Class awards went to competitors for Ingenuity; Versatility; Presentation and Documentation etc., but noticeably absent was *Reliability*. Proof that British ingenuity is superior to others' these days may not be as easy to find as proof that British manufactured goods no longer enjoy the reputation for quality and reliability they once did.

The sponsors are to be congratulated for encouraging youngsters to take their first steps in engineering. First steps need to be in the right direction. Four demonstrations in a row were marred by unreliability manifestly not caused by lack of ingenuity. One butler "threw a tantrum", another took an unprogrammed "lap of honour".

Whilst no doubt the judges differentiated between abberations and the state of the art of those younger contestants, sadly technical faults brought the cancellation of some demonstrations so perhaps the sponsors would consider a Class award aimed at bestowing glory on the kind of "backroom" talent that ensures a model will work on the big day.

If Britain is to win more overseas orders then this is a capability which must also be highlighted.

Interestingly only a few of the finalists had chosen the "Domestic Freestyle category". One such robot was a vacuum cleaner that could be left to do the chore by itself. Alas this spectacle was not witnessed, nor was that of the floor and table polishing robot.

Relief from drinks serving was provided by Much Birch C.E. Primary School with its *Roboroom*, a dolls' house size model room demonstrating what technology can do for the physically handicapped. The project was an excellent choice and manifestly enthused its team members, winning the school a class award.

Pupils, and teacher, from Tudor Grange demonstrate one of the capabilities of their mobile robot. Instructions are given by infra-red remote control and has its own onboard computer. Left to right: Paul Tottman (teacher), Paul Edmonds (15), Amanda Murray (15), Emma Anderson (14), and Peter Kirkman (15).

Pupils from Much Birch Primary School with their prize winning "Roboroom". From left to right: Carol Nichol, Daniel Sime, Jonathan Porter and Jacqueline Ross—all aged 11.

TRANSDUCERS

PART 5 ANGULAR VELOCITY MEASUREMENT AND A TACHOMETER PROJECT... MIKE FEATHER BSc

Techniques for measuring the shaft speed of, for example, an electric motor have traditionally relied upon the use of some form of mechanical tachometer, in which the speed is displayed directly on an analogue scale.

These devices provide a useful check on the speed of large motors, but the speed of smaller motors is likely to be considerably reduced if tachometers are coupled up to them.

Other methods employ a small d.c. generator coupled directly to the motor shaft. The output of the generator can be made to vary directly with the motor speed and a voltmeter may be used to provide an indication of this. Once again, the arrangement is really only suitable for use with large motors.

ELECTRONIC METHODS

Most electronic methods employ some form of arrangement in which a sensor of one type or another picks up the shaft speed without the necessity for any mechanical coupling to it.

Such sensors include magnetic, slot optical and photo-reflective types and these are described later in this article.

Each of these sensors provides a pulsed output, the pulse frequency being proportional to the shaft speed, so that the task of speed measurement becomes one of determining the frequency of the sensor output pulses. Frequency meters, both analogue and digital, are available, but they tend to be rather expensive instruments and this month's practical project describes the theory and construction of a frequency meter/tachometer unit based on the inexpensive 2917 tachometer i.c.

The completed unit provides a calibrated analogue output voltage which varies directly with the frequency of the input signal. For shaft speed measurement, any of the sensors described may be used.

THE 2917 TACHOMETER CHIP

The 8-pin tachometer d.i.l. i.c. is a frequency-to-voltage (F/V) converter. It employs a charge pump technique in which the input frequency produces a directly proportional d.c. output voltage. The pin-out and internal circuitry of the chip are shown in Fig. 5.1, and Table 1.

The first stage consists of a differential amplifier, one input of which is grounded whilst the other serves as the signal input. The signal voltage required for correct operation is typically 250mV peak, but the input is protected for voltage swings of up to +28V.

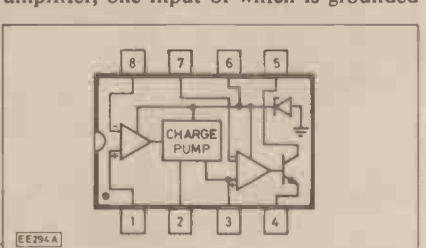


Fig. 5.1. Internal circuitry of the 2917 tachometer i.c.

Table 1: Pinout details of the 2917 i.c.

Pin	Function
1	Frequency input
2	Timing capacitor
3	Filter capacitor/resistor
4	Output transistor emitter
5	Output transistor collector
6	Vcc
7	Bias current
8	Ground

If the frequency of higher voltages is to be determined—e.g. the contact breaker pulses of a car engine—then some form of potential divider network must be used.

The next stage comprises the charge pump circuitry. An external capacitor and resistor determine the d.c. output voltage for a given pulse input frequency. The output of the charge pump is applied to an operational amplifier which can be used in the op-amp or comparator mode, so allowing either proportional or speed-switched outputs.

The final stage consists of a floating *npn* transistor which can be used to drive a variety of loads, the maximum sinking current being approximately 50mA.

The chip includes an internal Zener diode which, with the addition of an external dropping resistor, allows operation from unregulated power supplies.

As mentioned, three basic speed sensing arrangements are employed with the tachometer unit: magnetic, optical switch, and photo-reflective sensors.

MAGNETIC SENSORS

The arrangement of the magnetic sensor type of pick-up is shown in Fig. 5.2 below. Rotating of the toothed ferrous wheel (e.g. a gear wheel) adjacent to the pole of the pick-up develops an alternating voltage at the output terminals of the device. The frequency of this a.c. output is proportional to the speed of rotation of the wheel. The clearance between wheel teeth and pick-up pole should not be greater than 2·5mm for correct operation of the sensor.

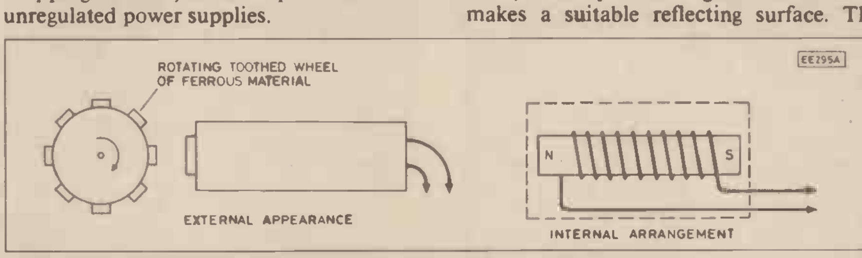


Fig. 5.2. Magnetic pick-up used for speed sensing.

SLOTTED OPTICAL SWITCH SENSOR

A typical slotted opto-switch is shown in Fig. 5.3. The device consists of an infra-red l.e.d. and a phototransistor sensor mounted in a slotted plastic housing.

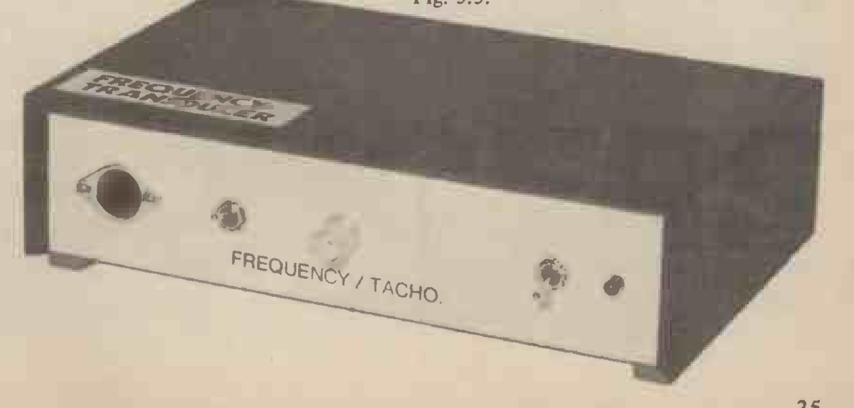
A rotating opaque disc with holes or slots around its circumference may be situated in the slot and the phototransistor can be used to provide a pulsed output voltage, the frequency of which varies directly with the speed of the disc. Fig. 5.5 shows the circuitry used with this type of sensor.

INFRA-RED

Photo-reflective sensors also use an infra-red l.e.d./phototransistor combination, but the phototransistor responds to reflected radiation from objects placed close to the device. Two types are commonly available and these are shown in Fig. 5.4.

For shaft- or wheel-speed sensing applications, a small piece of bright aluminium foil makes a suitable reflecting surface. The optimum sensor/reflector distance is approximately 5mm for the larger device and 1·2mm for the miniature version.

The associated l.e.d./phototransistor circuit arrangement is the same as that used for the slotted opto-switch sensor shown in Fig. 5.5.



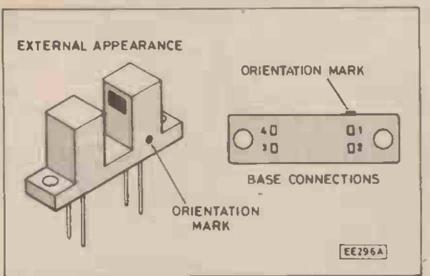


Fig. 5.3. Details of the slotted optical switch sensor.

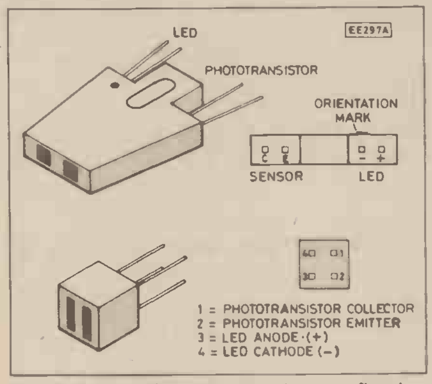


Fig. 5.4. The diffuse scan photo-reflective sensor: top, the large type is shown and, above, the miniature version.

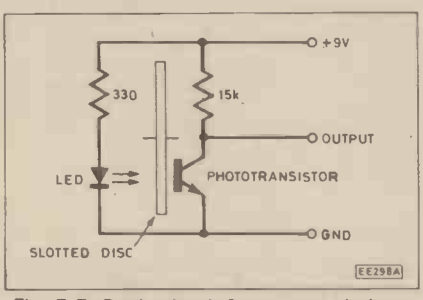


Fig. 5.5. Basic circuit for opto-switches.

THE FREQUENCY/ TACHOMETER TRANSDUCER UNIT

The circuit of the main unit is shown in Fig. 5.6. The design provides two ranges of speed and frequency measurement: 0–500Hz and 0–5000Hz. For direct measurement of the frequency of pulse trains or alternating voltages, no transducers are required and the unit may be used as it stands. A 5V d.c. voltmeter is used for indicating the frequency.

The signal from the sensor is applied to the input of the 2917 i.c. via C2. A 5-pin DIN socket is used for the input connector. The frequency range is selected by S1 which switches the appropriate capacitor into the charge pump circuitry. R1 determines the charge pump output voltage and a 100k resistor is used in this application.

The op-amp/comparator is used in the linear mode and the output voltage from the device is taken between pin 4 (the transistor emitter) and ground. VR1 is a potential divider circuit which allows variation of the output voltage for calibration purposes. R2 is the dropping resistor for the Zener diode circuitry. The l.e.d. and its series resistor provide a visual "on" indication for the unit.

Note the connection from the +9V supply line to the input DIN plug. This is used for providing a supply for opto-probes. The current drain of the circuit is small and a PP9 battery will allow long periods of continuous operation.

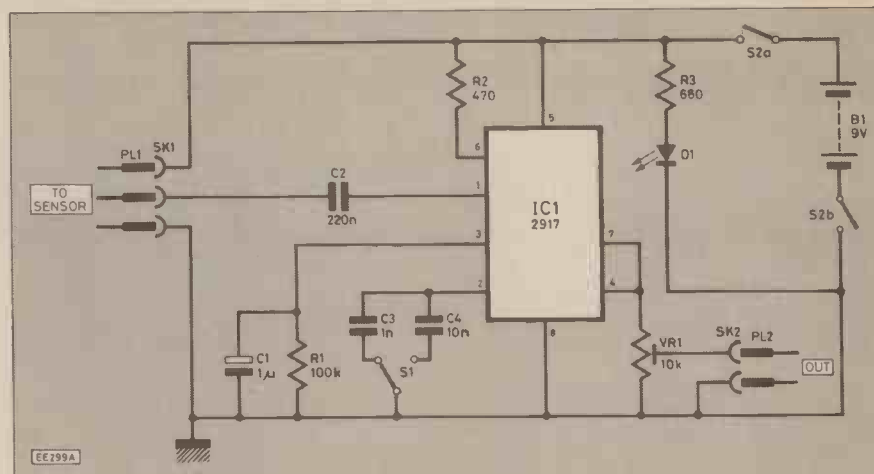


Fig. 5.6. Circuit diagram for the frequency measurement/tachometer unit.

CONSTRUCTION

Construction of the circuit is very straightforward. The p.c.b. design and component overlay diagrams are shown in Fig. 5.7, although the circuit could be constructed on a small piece of Veroboard.

Connection pins should be inserted and soldered into the p.c.b. at the points shown. Other components can now be inserted and soldered on to the board.

The front panel of the case should now be drilled and its components mounted as indicated in the photograph. Connections between the front panel and the p.c.b. pins can now be made using 7/0·2mm p.v.c. insulated wire. Care should be taken to ensure that the connections to the panel l.e.d. are the "right way round". The battery connector is soldered to the on/off switch,

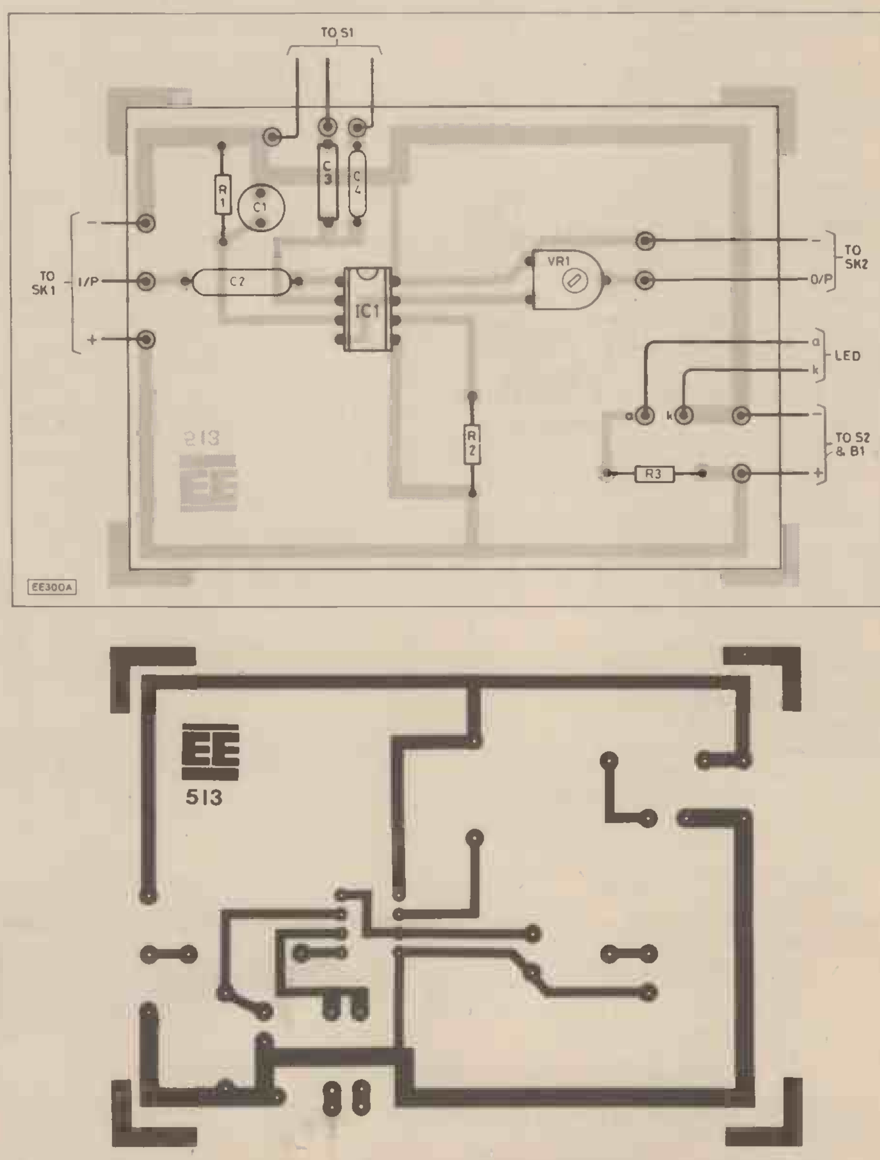
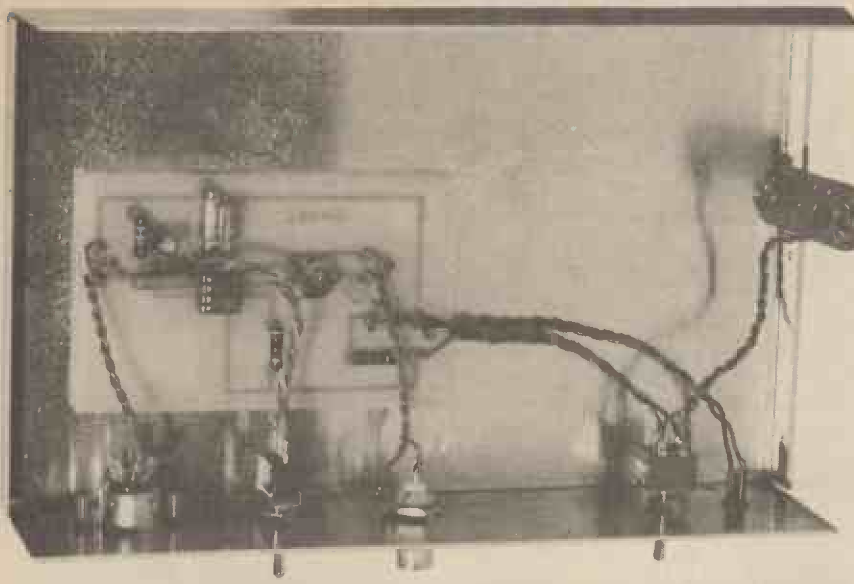


Fig. 5.7. Top, the component overlay for the frequency measurement/tachometer unit and, above, the p.c.b.—available from the *EE PCB Service*.



Internal details of the prototype frequency measurement unit: the +9V line was not taken to the DIN socket in the prototype, but is made available as a pad on the p.c.b. supplied from the *EE PCB Service*.

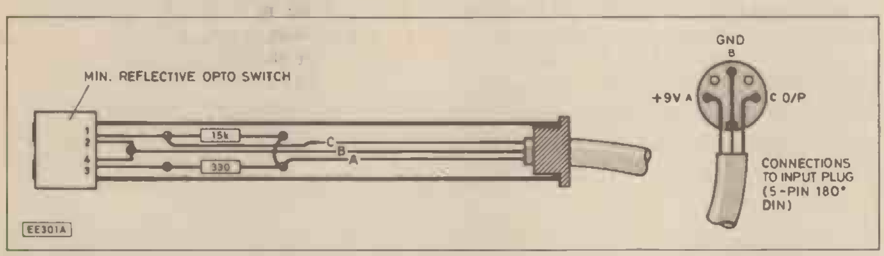


Fig. 5.8. The photo-reflective probe assembly—suggested method of construction.

COMPONENTS

See Shop Talk page 25

Resistors
R1 100k
R2 470
R3 680
All $\frac{1}{4}$W ±5% carbon

Potentiometer
VR1 10k min. horiz. skeleton

Capacitors
C1 1µ radial elect.
C2 220n polyester
C3 1n polystyrene
C4 10n polycarbonate

Semiconductors
D1 red l.e.d.
IC1 2917 tachometer i.c.

Miscellaneous
B1 9V PP9 battery
PL1 5 pin DIN plug
PL2 BNC plug
S1 min. toggle switch
S2 d.p.d.t. toggle switch
SK1 5 pin DIN socket
SK2 BNC socket
Case—approx. 203 × 127 × 51mm; printed circuit board, available from the *EE PCB Service*, order code EE-513; terminal clips for batteries; adhesive feet for case.

Approx cost Guidance only £17.50

again noting carefully the polarity. Finally, the 2917 i.c. is inserted into its socket in the correct orientation.

If an optoelectronic sensor is to be used in combination with the unit, this should now be constructed. Fig. 5.8 shows a prototype probe arrangement which uses the miniature photo-reflective switch device.

TESTING AND CALIBRATION

The p.c.b. and all external connections should be checked for dry joints, solder bridges and other wiring faults.

An audio signal-generator (20Hz–20kHz) and a 5V d.c. voltmeter are required for calibrating the unit. The frequency range switch is set to select the 0–500Hz range (the 1n capacitor is in circuit). Connect up the signal-generator to the input and set it to 500Hz, 1V p/p output. VR1 can now be adjusted to give a 5V indication on the meter.

Adjust the signal-generator to other frequencies within the 0–500Hz range and check the linearity of the unit. The frequency range should now be switched to 0–5kHz and this range checked against the signal generator.

NEXT MONTH: In the final part of this series, the subject will be pH transducers, and a pH test project will be included.

a regular feature for the Spectrum Owner...

by Mike Tooley BA

AT THE END of the year it is customary to review the past twelve months, noting the successes and failures along the way. As far as *On Spec* goes, it has been particularly pleasing to note that, during the last eleven months, the demand for our regular "Update" has continued at a steady level. Indeed, it was unusual not to receive at least one letter every day on some Spectrum related topic.

Quick Feedback

For the benefit of anyone who may have missed some of the earlier instalments of *On Spec*, the original concept of our "Update" was to provide readers with some quicker feedback than is possible with the usual lead time required to get material into this column. Furthermore, by supplying some of the longer program listings as part of the "Update" service, we hoped to devote more space to projects.

The original aim was that of producing around 4 to 6 Updates per year, each covering two to three issues of the magazine. With this scheme in mind I even kept a list showing who had received which Update!

This seems to have worked reasonably well at first, but so many of you have asked for *all* of the Updates right back to the start of the column that my list grew longer and longer and longer . . .

As a result, I have adopted a somewhat simpler approach, i.e. unless you tell me otherwise, I will simply send all of the Update sheets available (now numbering about ten A4 pages). This, of course, always assumes that your s.a.e. is large enough for me to cram them all in.

Another point worth making is that I cannot provide copies of the *On Spec* articles. For these, readers should contact the Post Sales Department (see page 7).

Lastly, a big thankyou to those of you who have sent in ideas for projects. Many of these have been excellent and, if yours hasn't appeared yet I can only apologise—I have simply received rather more ideas than space is available for. I will do my best to cover most, if not quite all, in 1986. It looks as if it's going to be a busy year!

Setting Up The Analogue-To-Digital Converter

Only one simple adjustment is required in order to calibrate the analogue-to-digital converter described last month. Readers should, however, have access to an accurate d.c. voltmeter and a variable d.c. power supply.

First ensure that you have disconnected the power lead to the Spectrum and then connect the ADC. Reconnect the power and check that the usual copyright message appears. If this is not the case, disconnect the power lead, remove the interface from the rear of the Spectrum, and carefully check the wiring of the board and edge connector.

When the correct power-up message appears, check that D1 is illuminated and also measure the potential at the test point. This should be approximately 1·26V. If there is an appreciable deviation from this value check the connections of D2 and pin 9 of IC3.

Now connect the variable d.c. power supply to the input of the ADC. Increase the power supply output until it reads exactly 10V and then key in the following program:

```
10 OUT 191,255
20 LET v=IN 191
30 PRINT AT 0,0;v
40 PAUSE 50
50 PRINT AT 0,0;"  "
60 GO TO 10
```

Run the program and adjust VR1 for a reading of exactly 100. The input voltage should now be reduced to 5V and the reading should fall to exactly 50. This completes the initial adjustment of the analogue-to-digital converter which now provides indications over the range 0V to 25·5V in 255 steps of 100mV.

Driving The Analogue-To-Digital Converter

The analogue-to-digital converter is extremely simple to use from BASIC, as the following program shows:

```
10 OUT 191,255
20 LET v=IN 191
30 LET v=v/10
40 PRINT AT 0,0;v
50 PRINT #0;AT 0,4;"Press any key to
   continue"
60 PAUSE 0
70 CLS
80 GO TO 10
```

The above program prints the value of input voltage (in V) every time any one of the Spectrum's keys is depressed.

As an alternative to BASIC, some readers may wish to exploit the compactness of machine code for driving the analogue-to-digital converter. A typical assembly language routine for initiating conversion and returning a value (in the C register) would be as follows:

```
LD A,255     ; Start conversion
OUT (191),A  ; by writing all 1's to the
               port.
IN A,(191)   ; Read the input
LD C,A       ; and place the value in
               the C register.
LD B,0       ; Set the B register to
               zero as the
RET          ; BC register pair returns
               the value.
```

The necessary object code can be generated by an assembler but readers can also make use of our own hexloader (see December's issue). In this case, assuming a decimal start address of 30000, the code is entered as follows:

Address (dec)	Contents (hex)
30000	3E
30001	FF
30002	D3
30003	BF
30004	DB
30005	BF
30006	4F
30007	06
30008	00
30009	C9

(A total of 10 bytes.)

The machine code routine is fully relocatable so that almost any suitable start address in unreserved RAM may be employed. The value of 30000 has been chosen simply as it is convenient to remember and suits both the 16k and 32k Spectrum. When the machine code routine is called, the C register will return the input value.

It is, of course, also possible to use the routine from BASIC. Again, assuming a start address of 30000 decimal, a statement of the form:

```
120 PRINT USR 30000
```

will print on the screen the input as a value in the range 0 to 255. Alternatively, we could use a variable to hold the returned input as in the case of:

```
120 LET z=USR 30000
```

A complete alternative to our earlier BASIC program thus takes the form:

```
10 LET z=USR 30000
20 PRINT AT 0,0; z/10
30 PRINT #0;AT 0,4;"Press any key to
   continue"
40 PAUSE 0
50 CLS
60 GO TO 10
```

As a further example, the latest "Update" contains a full listing for a digital/analogue voltmeter (reading 25·5V full-scale in 100mV steps). The program provides simultaneous digital and analogue (bar) readout and takes approximately 4 samples of the input voltage every second.

NEXT MONTH: A general purpose interface for the Spectrum using a Z80 PIO. This provides an 8-bit port for byte I/O together with eight individual I/O lines.

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4012	16p
4013	20p
4014	40p
4015	40p
4016	27p
4017	39p
4018	40p
4019	33p
4020	50p
4021	45p
4022	43p
4023	16p
4024	30p
4025	16p
4026	68p
4027	30p
4028	38p
4029	53p
4030	28p
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4032	54p
4033	60p
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4044	40p
4045	72p
4046	49p
4047	49p
4048	32p
4049	26p
4050	26p
4051	42p
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4506	60p
4507	33p
4508	85p
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4520	44p
4521	90p
4522	50p
4526	48p
4527	48p
4528	44p
4529	78p
4532	55p
4551	85p
4553	190p
4555	29p
4556	41p
4557	190p
4583	65p
4584	36p
4585	46p

74LS SERIES

74LS00	17p
74LS01	17p
74LS02	17p
74LS03	17p
74LS04	17p
74LS05	17p
74LS08	17p
74LS09	17p
74LS10	17p
74LS11	17p
74LS12	17p
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74LS14	30p
74LS15	17p
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74LS245	78p
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74LS279	46p
74LS280	140p
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74LS365	42p
74LS366	44p
74LS367	43p
74LS368	41p
74LS373	68p
74LS374	68p
74LS375	58p
74LS399	80p
74LS670	80p

VALVES

DAF96	60p
DF96	50p
DL92	47p
DY87	50p
DY802	45p
EABC80	50p
EB91	44p
EBF80	45p
EBF89	50p
ECC82	40p
ECC83	43p
ECC84	40p
ECC85	40p
ECH81	49p
ECH84	52p
ECL80	57p
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EF80	31p
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EF183	45p
EF184	53p
EL34	190p
EL36	60p
EL84	50p
EL95	50p
EL500	80p
EL504	100p
EY86	31p
EY87	31p
EY88	32p
EZ35	45p
EZ80	50p
EZ81	55p
GZ34	180p
PC97	100p
PCC85	42p
PCF80	58p
PCF200	135p
PCF801	110p
PCF802	57p
PCF806	115p
PCH200	100p
PCL81	54p
PCL82	63p
PCL84	50p
PCL85	55p
PCL86	55p
PCL805	55p
PFL200	85p
PL36	80p
PL82	45p
PL83	32p
PL84	50p
PL95	40p
PL500	110p
PL504	95p
PL508	170p
PL519	450p
PY81	70p
PY88	48p
PY500A	160p

74 SERIES

7400	22p
7401	16p
7402	18p
7403	22p
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7406	40p
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7409	20p
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7475	25p
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7490	35p
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74119	85p
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74145	70p
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74160	50p
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74167	35p
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74174	70p
74175	65p
74176	45p
74180	50p
74182	45p
74192	40p
74196	40p
74197	45p
74393	70p

VOLTAGE REGULATORS

7805	35p
7812	35p
7815	35p
7818	35p
7824	35p
7905	35p
7912	40p
7915	40p
7918	40p
7924	40p
78L05	28p
78L12	28p
78L15	28p
78L18	28p
78L24	28p
79L05	40p
79L12	45p
79L15	48p
LM309K	100p
LM317K	220p
LM317T	180p
LM323K	420p
LM723	32p
78HGKC	570p
78H05KC	520p
78GU1C	190p
79GU1C	215p
79HGKC	670p

LINEAR IC'S

AN-214P	200p
AN-240P	150p
AN-360	120p
AN-7110	140p
AN-7114	160p
AN-7115	160p
AN-7120	140p
AY3-1270	680p
AY3-1350	300p
AY3-8910	360p
AY3-8912	400p
AY5-3600	570p
CA270	40p
CA3046	60p
CA3048	190p
CA3060	280p
CA3080E	70p
CA3086	55p
CA3089E	150p
CA3090AQ	300p
CA3130E	80p
CA3130S	100p
CA3140E	38p
CA3189E	250p
HA-1156W	110p
HA-1197	150p
HA-1306W	170p
HA-1319	250p
HA-1339	170p
HA-1342	170p
HA-1366WR	160p
HA-1368	160p
HA-1377	220p
HA-1389	140p
HA-1392	230p
HA-1397	250p
HA-1398	240p
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LA-4032	140p
LA-4050	130p
LA-4051	160p
LA-4100	120p
LA-4101	100p
LA-4102SK	140p
LA-4112	250p
LA-4125	210p
LA-4140	70p
LA-4201	120p
LA-4220	120p
LA-4400	190p
LA-4420	140p
LA-4422	130p
LA-4430	130p
LA-4460	170p
LA-4461	180p
LA-5112	120p
LM301	26p
LM311	35p
LM324	35p
LM325	45p
LM339	40p
LM348	60p
LM380	100p
LM381	150p
LM382	130p
LM387	100p
LM709 DIL	30p
LM723	40p
LM741 DIL	18p
LM741 MET	45p
LM747	58p
LM748	35p
LM1458	33p
LM3900	30p
M-51513L	180p

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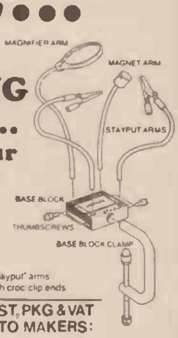

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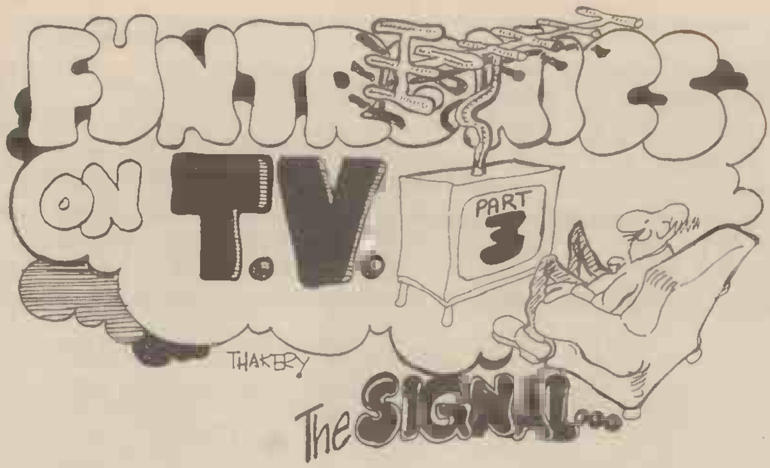
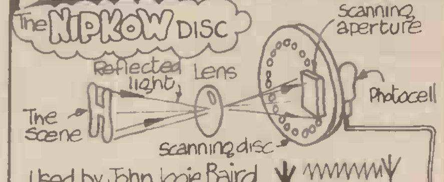


FUNTASTICS ON T.V. — PART 3

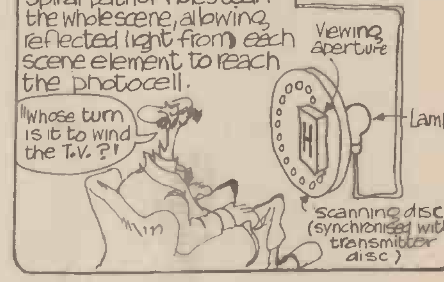
The SIGNAL...

FUNdamental FACTS

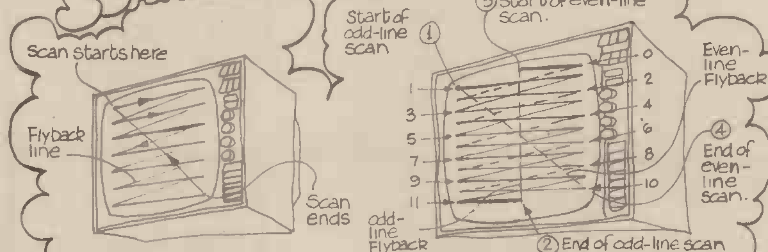
The NIPKOW DISC



Used by John Logie Baird and design by Paul NIPKOW in 1884.
As the disc rotates the spiral path of holes scan the whole scene, allowing reflected light from each scene element to reach the photocell.



SCANNING



The Scanning Raster

When the electron beam strikes the screen of the picture tube a bright spot will be seen. Now, if this spot sweeps across the screen from Left to Right so as to cover the screen and do it 50 times per second then the eye will see a bright screen. Since the brightness of spot doesn't vary it's called the scanning raster.

Interlaced Scanning

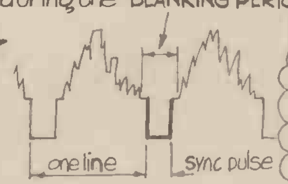
A picture-repetition frequency as high as 50 per second would mean a very high frequency bandwidth for transmission of video signal. Interlaced scanning overcomes this problem by effectively building up the picture in two halves.

Say Nº1 scan completes 25 lines in 1 sec. and of course Nº2 scan completes 25 lines in 1 sec. giving a total of 50 lines per second. In this way a continuous picture is achieved at a frequency of 25 per second.

by Thakery

SYNC PULSES

The Sync pulses take the form of rectangular shaped pulses of voltage. They are very accurately defined and introduced into the signal during the BLANKING PERIOD

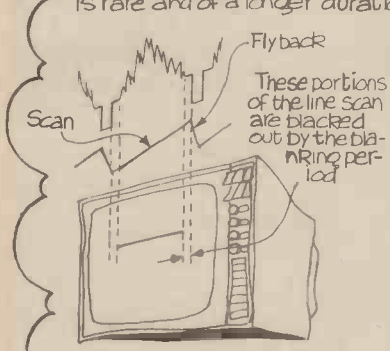


REMINDER

The Sync pulse synchronizes signals between transmitter and receiver. The Blanking period ensures the Flyback is not visible on screen and protects the charge on the Target.

The LINE SYNC PULSE

It takes hundreds of lines to make up one complete field or picture hence many hundreds of Line Sync pulses. The Field Sync pulse on the other hand is rare and of a longer duration.



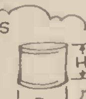
The EFFECTIVE period of the line duration.

The Blanking period is about twice as long as the sync pulse duration. This means, of course, that the actual picture visible on the screen is determined by the time interval seperating the line blanking periods.

EASY LOOK at maths

Solution to TIN problem...

The solution involves the application of $dy/dx = anx^{a-1}$ and mostly basic algebra



Step 1 Write formula for Area and Volume

ⓐ $\text{Area} = 2\pi\frac{D^2}{4} + \pi DH$

ⓑ $\text{Volume} = \pi\frac{D^2}{4}H = 27\pi$

Step 2 Find value of H in terms of D

ⓑ $27\pi = \pi\frac{D^2}{4}H$

$H = \frac{108}{D^2}$

I chose 27π for volume so as to get rid of π from the equation

Step 3 Insert this value into formula ⓐ

ⓐ $\text{Area} = 2\pi\frac{D^2}{4} + \pi D\left(\frac{108}{D^2}\right)$

$= \frac{\pi D^2}{2} + \frac{\pi 108}{D}$

$= \frac{\pi D^2}{2} + \pi 108 D^{-1}$

Step 4 Differentiate with respect to D

$\frac{dA}{dD} = \frac{2\pi D}{2} + \left(-\pi 108 D^{-2}\right)$

$= \pi D - \frac{\pi 108}{D^2}$

It would help at this stage to understand about TURNING POINTS but for the moment we'll just say that for a maximum or minimum value $\frac{dA}{dD} = 0$

$\therefore \ \pi D - \frac{\pi 108}{D^2} = 0$

$\cancel{\pi} D = \frac{\cancel{\pi} 108}{D^2}$

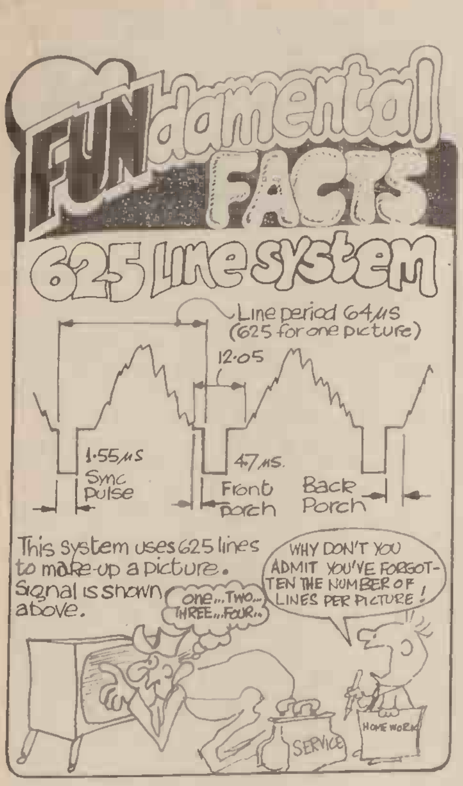
$D = \sqrt[3]{108} = 4{\cdot}76$

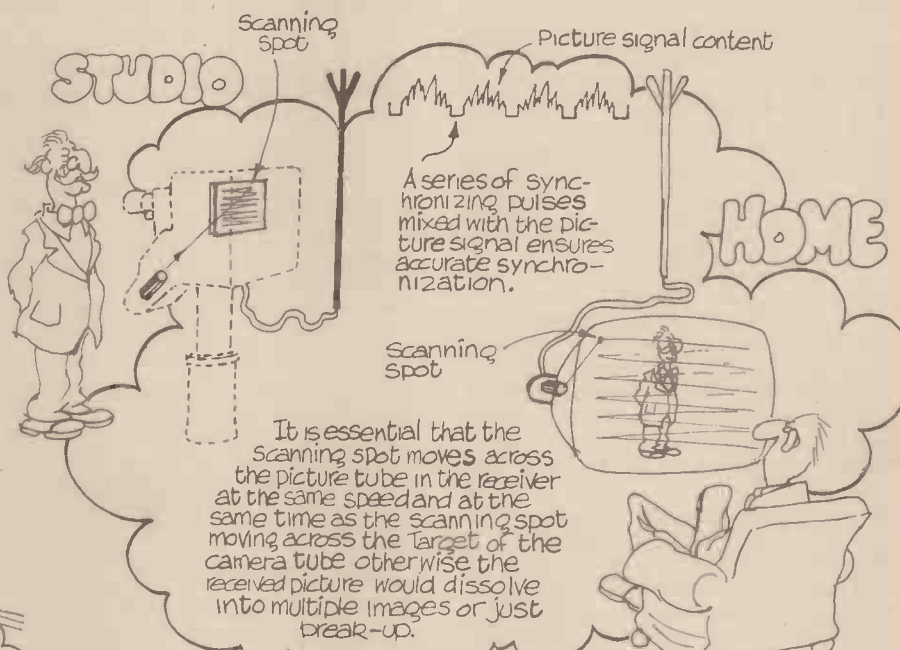
$H = \frac{108}{D^2} = 4{\cdot}76$

Answer: For mimimum use of TIN in making a cylindrical can

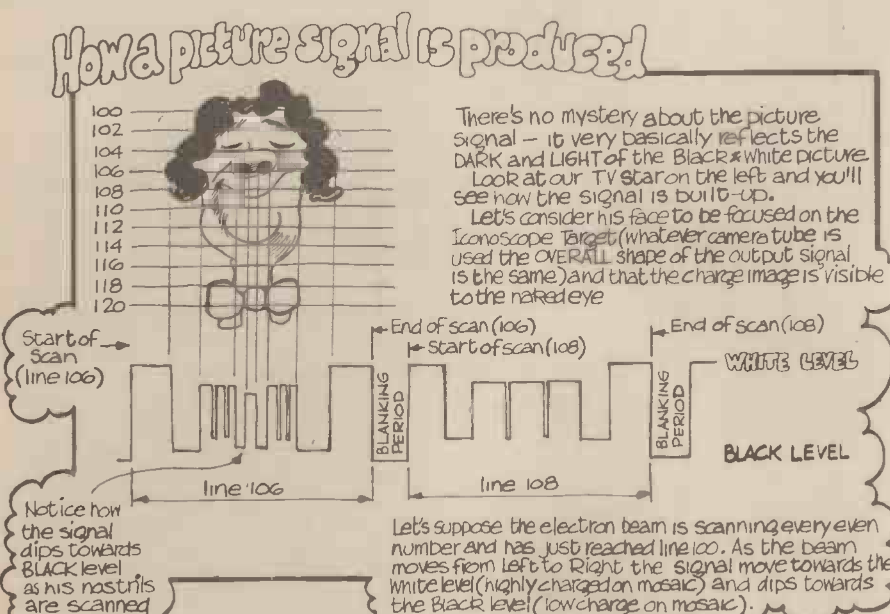
$D = H$

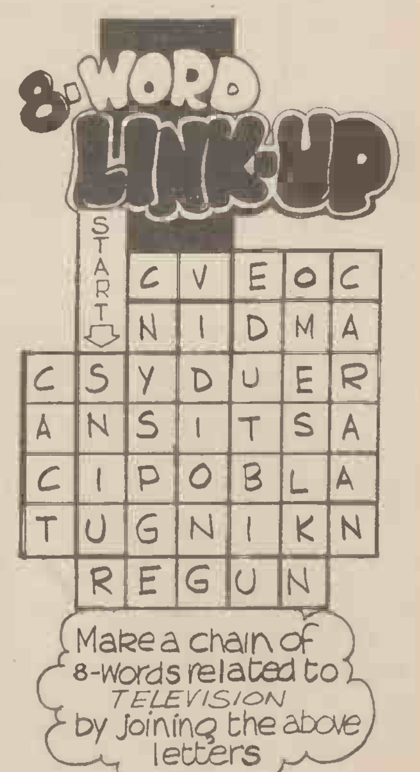
NOTE Try differentiating Formula ⓐ with respect to D for a even simpler solution.





Solution on page 51





ELECTRONIC BUILDING BLOCKS

PART 6 RICHARD BARRON

THIS month, *Electronic Building Blocks* will take a look at some useful applications of TTL logic. For the purposes of this article it is not necessary to fully explain the internal workings of these i.c.s, but merely show how they may be used to provide a variety of effects.

LOGIC FUNCTIONS

There are three basic logic gates; AND, OR and Ex-OR (exclusive-OR) gates. Also available and just as important are buffers, inverters and standard gates with inverted outputs, the latter being NAND, NOR and Ex-NOR gates. The circuit symbols for all these devices are shown in Fig. 1, all of them being illustrated as 2-input devices (except buffer and inverter). In actual fact, these gates are generally available with two or more inputs, but the rules affecting their operation are just the same.

There are several methods of describing the operation of logic including the use of truth tables, Boolean expressions and plain English. When designing complex digital circuits, it is essential to use truth tables or Boolean algebra or both, but for our purposes, the following simple rules will suffice.

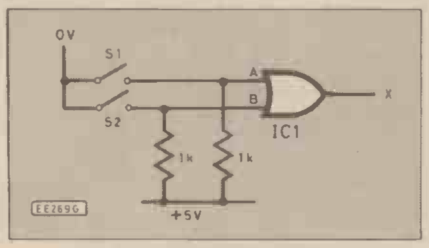


Fig. 2. The OR gate in action.

RULES FOR LOGIC

1. Any 0 into an AND gate will give a 0 out
2. Any 1 into an OR gate will give a 1 out
3. Both inputs to an Ex-OR gate the same will give a 0 out
4. For inverted output gates the same rules apply except the outputs are inverted.

The above rules can be better understood by considering real applications. Fig. 2 shows a single 2-input OR gate with both inputs connected to 5V via 1k resistors. The output of the gate will be high. It will remain high even if one of the switches, S1 or S2, is closed because, as stated, any 1 in will give a 1 out. The output of the gate will only go low if both switches are closed causing both inputs to be low.

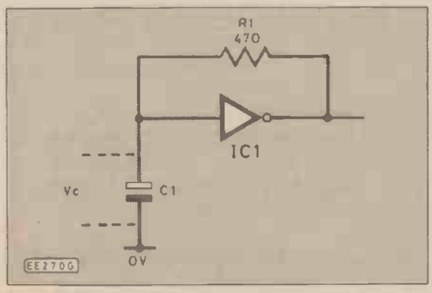


Fig. 3. A simple oscillator.

FLIP-FLOPS AND OSCILLATORS

Logic gates are ideally suited to producing flip-flops and oscillators as by their nature, their outputs are designed to swing between high and low limits.

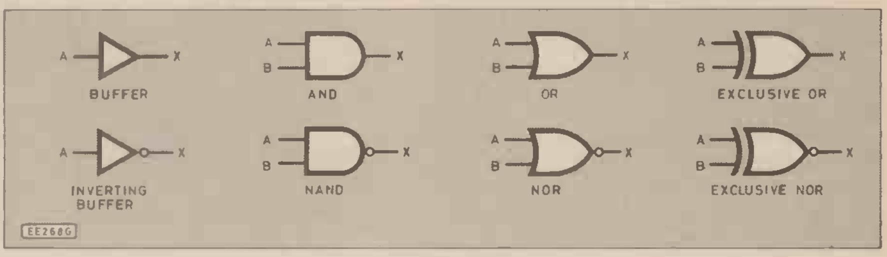


Fig. 1. Logic symbols.

Fig. 3 shows an inverter whose input is connected to its output via a resistor. Also a capacitor is connected between the input and 0V to provide a CR time delay. If we assume the output is high then the capacitor, C1, will charge through R1 and when the voltage, V_C, reaches around 2V, the output of the inverter will go low. C1 will then discharge causing the input to go low and the output to go high, and so on.

Fig. 4 shows how two NAND gates may be wired to produce an SR bistable. It can be seen that if S1 is depressed, the reset input will go low causing IC1a and thus the Q output to go high. This will cause both inputs to IC1b to be high and thus output $\overline{Q}$ to be low, maintaining a low input to IC1a regardless of the condition of S1.

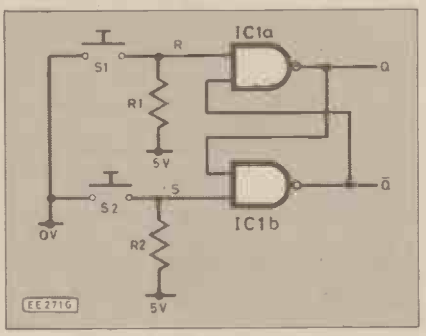


Fig. 4. A 2-gate SR bistable.

Under these conditions, the outputs may only change when S2 is operated causing a similar action to that described above. This type of circuit may be used to provide switch debouncing or used in a number of control applications.

DATA SWITCHES

Fig. 5 shows a 2-input AND gate with one input connected to +5V via a 1k resistor. With S1 in the normally open positon, the output will follow the input, i.e. the output logic level will be the same as the input. If S1 in now closed, the output will go low regardless of the state of the input.

A similar circuit is shown in Fig. 6. This time an Ex-OR gate is used which allows the signal to be controlled in a different way. With S1 open, the input signal is inverted at the output but with S1 closed, the signal out, follows the signal in.

Circuits similar to those shown so far are very useful and commonly used in logic circuits. By using different combinations of these circuits, a number of applications may be achieved, this month's project being just one.

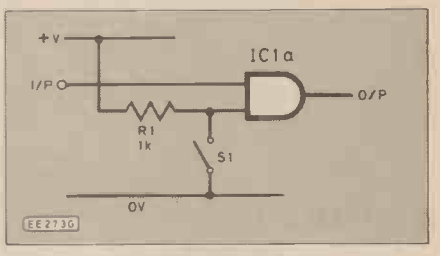


Fig. 5. Data control.

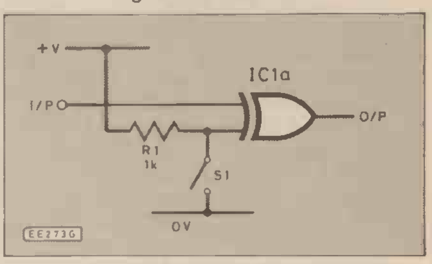


Fig. 6. Switched inverter.

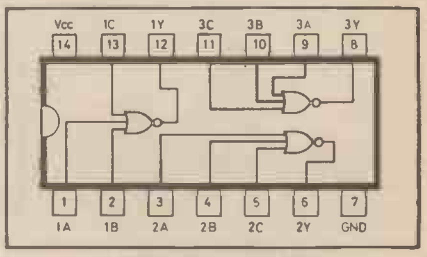


Fig. 7. Example of TTL (7427 Triple 3-input NOR).

Usually, a number of gates are found in a single i.c. package, a typical example being shown in Fig. 7. Notice that the supply to the chip powers all the gates contained inside.

NEXT MONTH: More about logic circuits including some useful applications.

ONE CHIP ALARM

This month's constructional project is a simple loop alarm based around a single TTL i.c., a quad 2-input NAND Schmitt device. The alarm may be used for a variety of applications such as a "goods" alarm (in a shop), a simple loop burglar alarm or it may be triggered from another TTL circuit to indicate mains failure, etc.

THE CIRCUIT

The circuit may be split into three component parts, a flip-flop, an oscillator and a data control gate. The flip-flop is used to initialise the circuit and detect an intruder or break. The data gate is connected to the oscillator and will only allow the speaker to sound when an alarm condition has been detected.

The complete circuit diagram of the Alarm is shown in Fig. 8. If we look first at the flip-flop, formed by IC1a and IC1b, it can be seen that when the reset switch S2 is pressed, providing the loop to 5V is intact, the output of IC1b will go low. Under these conditions, D1 will light indicating that the alarm is armed and the output of IC1c will go high regardless of the oscillator.

Now if the loop is broken, pin 5 of IC1 will go low and pin 6 high. This will illuminate D2 showing that the alarm has been activated. Also, pin 9 of IC1 will go high, thus enabling the speaker to be sounded. The output of the oscillator will pass through IC1c and sound the speaker.

At this time, even if the loop is reconnected, the alarm will continue to sound and D2 will remain lit. The alarm can only be reset if the loop is intact and the reset switch is operated.

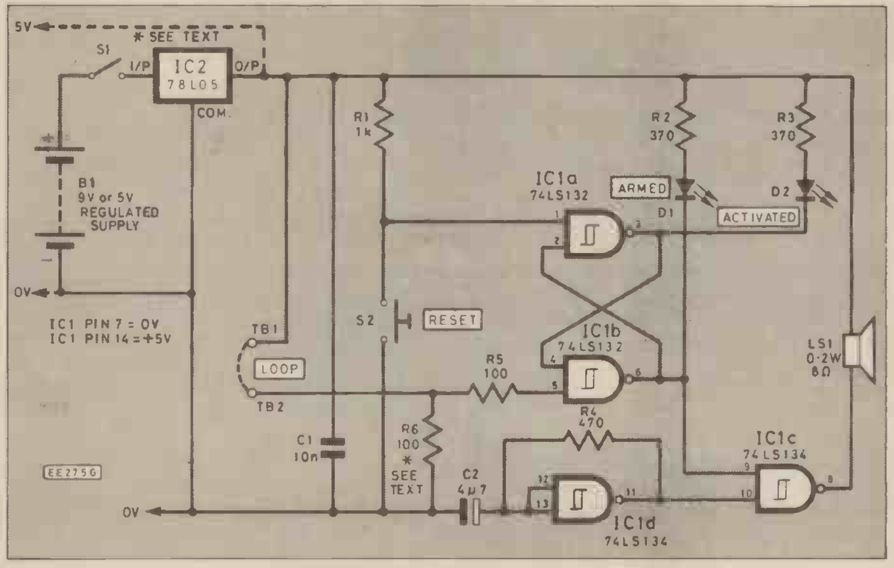


Fig. 8. Complete circuit diagram of the One-Chip Alarm.

CONSTRUCTION

As always in this series, the electronics can be mounted on a small p.c.b. which is part of a larger board designed to be cut into several sections. The relevant p.c.b. section is shown in Fig. 9 together with the component overlay and wiring diagram.

After carefully cutting the board, the smaller components such as the capacitors and resistors should be mounted first. Following these, Veropins should be soldered to the board to make interwiring easy and lastly, the i.c. or i.c. holder should be mounted.

The speaker, l.e.d.s, switches and terminal posts should be mounted in a suitable case and connected via short wires to the p.c.b. A battery (9V) may be used to power the project, or the 5V regulated supply from Part 1 may be used. If a battery is used, provision has been made on the p.c.b. for a 5V regulator, IC2, to be fitted. This may be omitted if an alternative supply is used.

As can be seen from the circuit diagram and the wiring diagram, if the regulator i.c. is not used, then the regulated supply line is wired via S1 to the space left by the output pin of IC2. Otherwise, the battery should be fitted to a suitable holder and connected to the input of the regulator.

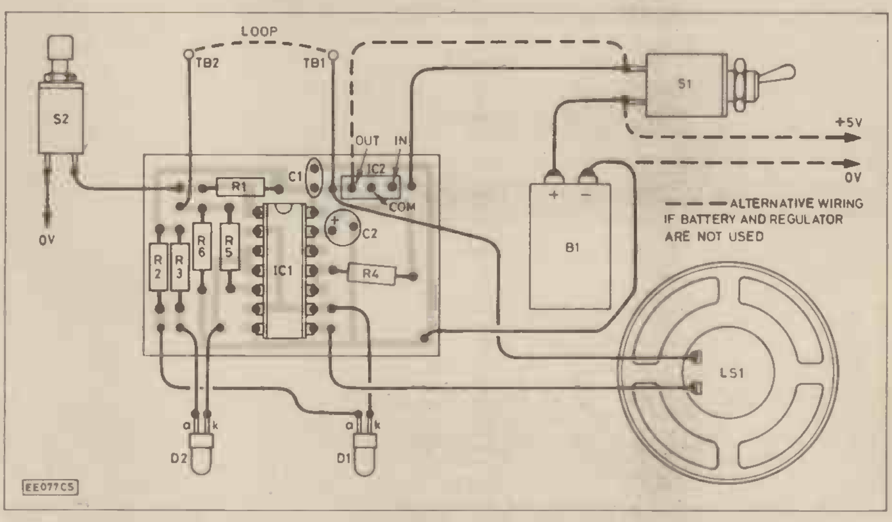


Fig. 9. P.c.b. design, component layout and wiring diagram of the One-Chip Alarm.

COMPONENTS

See Shop Talk page 25

Resistors
R1 1k
R2,R3 370 (2 Off)
R4 470
R5,R6 100 (2 off)

Capacitors
C1 10n disc ceramic
C2 4μ7 tant.

Semiconductors
D1,D2 0·2 inch l.e.d. (2 off)
IC1 74LS132
IC2 78LO5 (see text)

Miscellaneous
S1, on/off switch; S2, push-to-make switch; miniature 8Ω speaker; terminal posts; battery holder; wire; cable; etc.

Approx. cost Guidance only **£5.00**

Photo illustrating the constructional details of the One-Chip Alarm.

IN USE

The loop should be connected to the terminal posts or sockets and passed through objects to be protected. If the unit is being used as a burglar alarm, normally closed security switches may be placed in the loop circuit and fitted to doors and windows as required. It is probably better to use screened cable for this purpose with the screen connected to earth. This will prevent spurious interference which may cause false triggering.

TTL TRIGGER

As stated earlier, the alarm may also be triggered from another TTL circuit to indicate fault conditions. If this is the case, R6 may be left out of the circuit and a TTL level signal connected to the TB2 terminal. The "OK" condition should be normally high, a fault being indicated by a low signal.

NEXT MONTH: The constructional project will be a Lights Effect/ Games Unit.

BOOK REVIEWS

LISP: THE LANGUAGE OF ARTIFICIAL INTELLIGENCE

Author	A. A. Berk
Price	£9.95 paperback
Size	235 × 152mm. 160 pages
Publisher	Collins
ISBN	0 00 383130 2

HIGH-LEVEL computer languages are, in general, designed with a particular application in mind: COBOL, for example, for business use, and FORTRAN for mathematical applications. LISP is designed for list processing, from which activity it derives its name; and list processing is an important aspect of research into Artificial Intelligence (AI).

It may not be immediately obvious why establishing relationships between words in a list is an attribute of intelligence, and Dr Berk prefaces his explanation of how to use LISP with a chapter which considers the idea of intelligence itself: what does it mean to be intelligent? Or, put another way, how do we recognise intelligent behaviour? This fundamental question needs to be addressed before even considering developing any artificial kind of intelligence. The ultimate aim of AI, after all, is to develop machines whose behaviour is indistinguishable from that of an intelligent being.

The achievement of this aim may seem at first to be somewhere in the rather distant future, but, in a very limited way, it has already been realised. A good club-strength chess-player, keying in moves at a VDU against a distant opponent whose responses appear on the player's screen, will not be able to tell whether his opponent is in fact another human being, or whether he is playing against a computer. The best of the new chess-playing programs will certainly beat most amateur chess players, and this raises some interesting points.

Intelligent behaviour, it can be argued, has to do with being rational—that is, to proportion one's belief to the evidence available for it. Decision procedures, so this argument goes, are then based on rational beliefs, so that there is reflection prior to action. The avoidance of self-contradiction is a clear necessity; and there must be, at least in principle, the possibility of communication. Dr Berk implicitly accepts this description, citing chess-playing programs and the famous Turing test. Probably correctly, he does not consider further any alternative or counter-arguments, but shows how the knowledge bases of expert systems are structured so that the facts relevant to the operation in hand can be readily retrieved, and related to other pieces of information which may have some bearing on the matter.

Evidently, storing thousands of pieces of data alphabetically, say, would very rarely be efficient. In order to answer *any* question about any piece of data, the machine would have to sort through the whole list each time. A hierarchical, or "tree" structure is much more appropriate: each piece of data points to another, more specific, piece.

The data elements in any knowledge base, then, must be organised so that any piece of data in the database "pulls out" other data deriving from it, or related to it. This kind of data structure—a linked list—can be set up in BASIC, but it is not particularly easy or natural to do. LISP, on the other hand, is designed precisely for list processing. The elements of a list are just words, letters, or numbers, separated by spaces and enclosed in brackets. The standard LISP functions can then be used very simply to organise the data into a hierarchical structure, and to operate on it in a way that looks very natural.

There are, in fact, remarkably few standard functions to learn, though they are extremely powerful, and are designed to allow the user to "talk" to his machine in a very human way. A simple example, given early in the book, is a two-line routine to double a number. This routine is then an internal function of LISP, and a user who inputs (DOUBLE 24) will get the answer 48. It is also easy to set up property-lists relating to people, dates or events: thus the machine may hold an automated diary, or the complete medical history of each of a G.P.'s patients, fully and automatically cross-referenced.

So far, LISP seems to fulfill the criteria for intelligent behaviour fairly well: it uses a structured knowledge-base to enable rational decision-making, and communicates sensibly. However, it is legitimate to ask whether such a system can ever actually *learn* anything. The answer is "Yes", and an example is given of a program to print the decoded version of messages input in code. The whole program is remarkably short—only nine lines, making use of previously-defined functions—and it works by comparing the letter-frequency of uncoded with coded input.

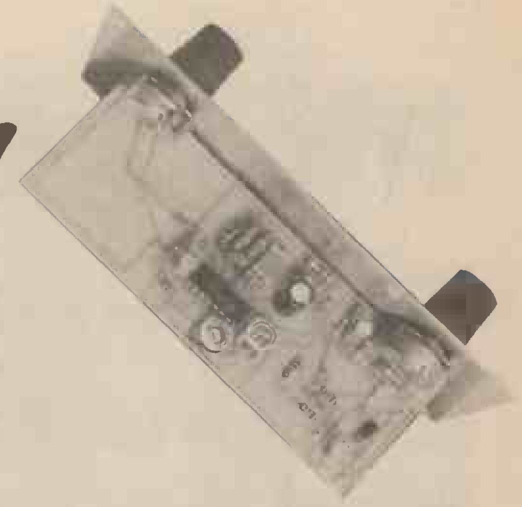
Initially, this method will work very poorly, because the knowledge-base will be so small. However, as the amount of input increases, the system will produce increasingly accurate translations: a true learning system.

Considering this book purely as a teaching manual, it is hard to see how it could be improved on: beginning with simple data types, Dr Berk then goes on to consider some of the simpler constructs of the language, comparing them, where appropriate, with similar BASIC keywords. Actual program-writing is also contrasted with BASIC, so that the reader both has a reference to compare the LISP version with, and is able to see the considerable advantages of LISP for AI applications. Database-manipulation, recursion, and more advanced functions are dealt with, and throughout the text there are plentiful examples and exercises (with solutions) for the reader. Dr Berk's fluent writing style reflects his experience in teaching, and the examples given have the aims of AI constantly in mind.

LISP is not the only contender for the title, "The Language of Artificial Intelligence", but this book makes a strong case for it, and is highly recommended.

D.A.B.

Actually Doing it!!



A p.c.b. mounted using the controls.

LAST month we looked at mounting component boards and mentioned that most controls require a 10mm diameter mounting hole, there are however several other sizes in use. Table 1 lists a number of controls and the size of mounting hole they require. This also includes the mounting hole sizes for some popular types of socket.

Obviously in order to undertake project construction a range of twist drill bits and some form of drill are required. The drill sizes you will need can be ascertained from Table 1, and the average handy-man will already have many of these. If you do have to buy some drills specially it is almost certainly worthwhile buying good quality types. These should last many years, whereas cheaper types often break and blunt easily. A power drill or a hand type of reasonably heavy-duty construction is satisfactory for this application. Much of the drilling will be into soft materials such as aluminium and plastic, and this can be rather awkward as the drills tend to "snatch" into these materials rather than steadily cutting through. I prefer to use a hand-drill when working on soft materials as the holes can then be drilled slowly and carefully. If you use a power drill and it is a two-speed type, results will probably be best using the slower speed.

It is a good idea to have a piece of waste timber under the front panel when drilling the mounting holes. This helps to give neater and cleaner holes, especially if the panel can be clamped firmly to the piece of timber. However, be careful not to damage the front panel, and protect it from the clamps with pieces of cardboard. With aluminium and plastic panels any roughness around edges of mounting holes can be carefully trimmed away using the small blade of a penknife. With steel panels a small round file can be used.

Table 1. Control Mounting Sizes.

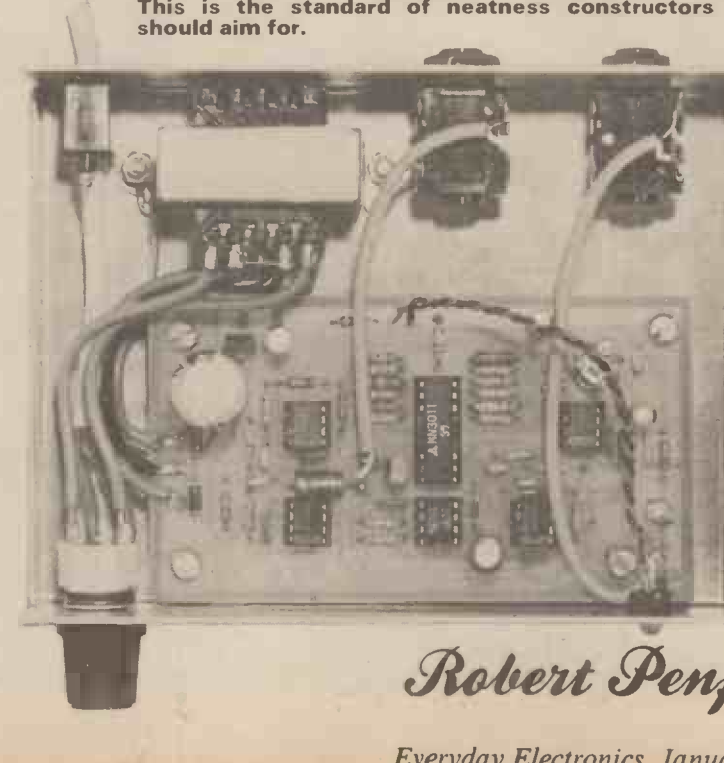
Control/socket type	Dia. (mm.)	Dia. (ins.)
Rotary switch	10	
Potentiometer	10	
Sub-min. toggle switch	5·2	0·2
Miniature toggle switch	6·35	0·25
Standard toggle switch	12·7	0·5
Min. push button switch	7	
Table light switch	10	
Heavy-duty push button switch	12·7	0·5
3·5 mm jack socket	6·35	0·25
Standard jack socket (open)	9·5	$\frac{3}{8}$
Standard jack socket (insulated)	11	$\frac{7}{16}$
1 mm socket	5	
2 mm socket	5	
4 mm socket	8	$\frac{5}{16}$

Constructional articles do not normally include a diagram giving drilling details for the front panel. This is simply because most constructors prefer to use a case and layout of their own choice, rather than just produce an exact replica of the published design. The increasing use of printed circuit mounted controls and sockets means that the option of designing one's own front panel layout is not always there. The panel layout has to match the layout and spacing of the controls and sockets on the board. With this method of construction the mounting bushes and nuts of the controls and sockets are often used to effectively mount the printed circuit board on the front panel of the case (although some additional support for the board may also be provided by mounting bolts or pillars). It is not actually essential to use printed circuit mounting controls and sockets, and it would be quite feasible to use ordinary types and hardwire them to the printed circuit board, provided the board has some adequate means of mounting. Most constructors prefer the printed circuit mounted option when it is available though, as it is a neater and quicker way of doing things.

Assuming that the controls and sockets are to be hard-wired to the board, any sensible layout can be used. In general it is best to arrange things so that the physical layout of the front panel components matches up well with that of the take-off points on the printed circuit board. This avoids lots of crossed wires and "birds nests" of wiring. Apart from looking untidy, numerous crossed wires increase the risk of wiring errors and make fault finding more difficult.

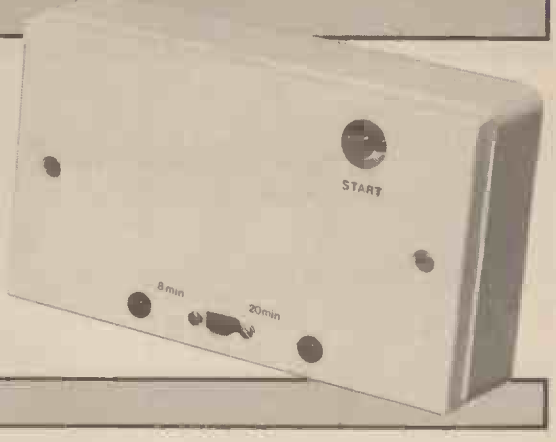
A good way to design the precise layout is to place the case with its front panel uppermost, and then position the control knobs and socket mounting nuts on the front panel. These can be shuffled around to find the layout you like best, and then their positions are accurately measured and marked onto a simple layout diagram. It is usually possible to mark the grid showing mounting hole positions direct onto the front panel using a soft pencil, or a fine fibre-tipped pen which contains a spirit based ink, but this is not always a good idea as it might leave lines that cannot be properly erased. The usual solution to this problem is to cover the panel with paper affixed using double sided tape. The layout is then marked on the paper, which is easily removed after drilling has been completed.

A neat project using a p.c.b. mounted on spacers. This is the standard of neatness constructors should aim for.



Robert Penfold

MAINS DELAY SWITCH



T.R. de Vaux Balbirnie

Switches off lights or other appliances after a preset time

THIS project would be particularly useful for controlling an outside light; a porch lamp, for example. This allows the user time to lock the door and walk away from the house before it switches off. It must be stressed that the unit must not be situated outdoors since it would be impossible to weatherproof it to the necessary high standard. Possible applications are not restricted to lights. The circuit can control any mains equipment up to 3A rating (720W on 240V mains). It could be usefully employed in switching off an easily forgotten soldering iron, for instance.

The circuit is mains-operated and draws current only while operating. The case is a standard plastic surface-mounting box of the type normally used for mains double sockets. This form of construction provides high mechanical strength as well as promoting a pleasing appearance to the finished work. The circuit should not be mounted in a metal box. Before beginning construction work, ensure that a complete mains supply, Live, Neutral and Earth can be made available at the place chosen for the unit. Check also that this place is free from dampness and condensation as this could result in faulty timings.

CIRCUIT DESCRIPTION

The circuit for the *Mains Delay Switch* is shown in Fig. 1. IC1 is a CMOS integrated circuit timer. When S2 is pressed, mains current flows through the primary of T1. The low-voltage secondary output is then rectified by D4–D7 and smoothed by C3. Thus, a supply is established for the rest of the circuit. A current pulse through R2 charges C1 and makes pin 2 go low for an instant. This "triggers" the i.c. and begins a timing cycle during which the output, pin 3, goes high. This turns TR1, TR2, and hence RLA on. This relay has two sets of "make" contacts, RLA1 and RLA2. RLA1 bypasses S2 and maintains supply during the timing cycle even after the finger has been removed from the button. RLA2 switches mains through the appliance.

The length of the delay depends on the values of the timing components R3, R4 and C2. With S1 set in position number one, R4 is short-circuited by pole c and C2 charges through R3 alone. This provides the shorter interval. With S1 set to the opposite extreme position (position 3), the "short" is removed and R3 and R4 are connected in series. This increases the time constant so extending the delay. C2 *must* be of the low-leakage type and this precludes the use of electroytic (including tantalum) capacitors. It will necessarily have a low value, so to obtain the required timings, R3 and R4 will need to have exceptionally high values—far greater than those normally encountered in electronic circuits. When C2 has charged to a certain voltage level, the system resets and reverts to its former state with RLA and the mains load off. Manual cancellation is effected by moving S1 to its centre position (position 2) whereupon pin 4 is made low through pole a. Pole b of S1 operates the two l.e.d.s, D1 and D2, which indicate the short and long time intervals respectively. The l.e.d.s could be omitted if desired. With the circuit off the capacitors discharge in a few seconds and are ready for a further cycle.

CONSTRUCTION

First choose a plastic surface-mounting double socket box and blank lid to fit. This lid should be without internal ribbing if

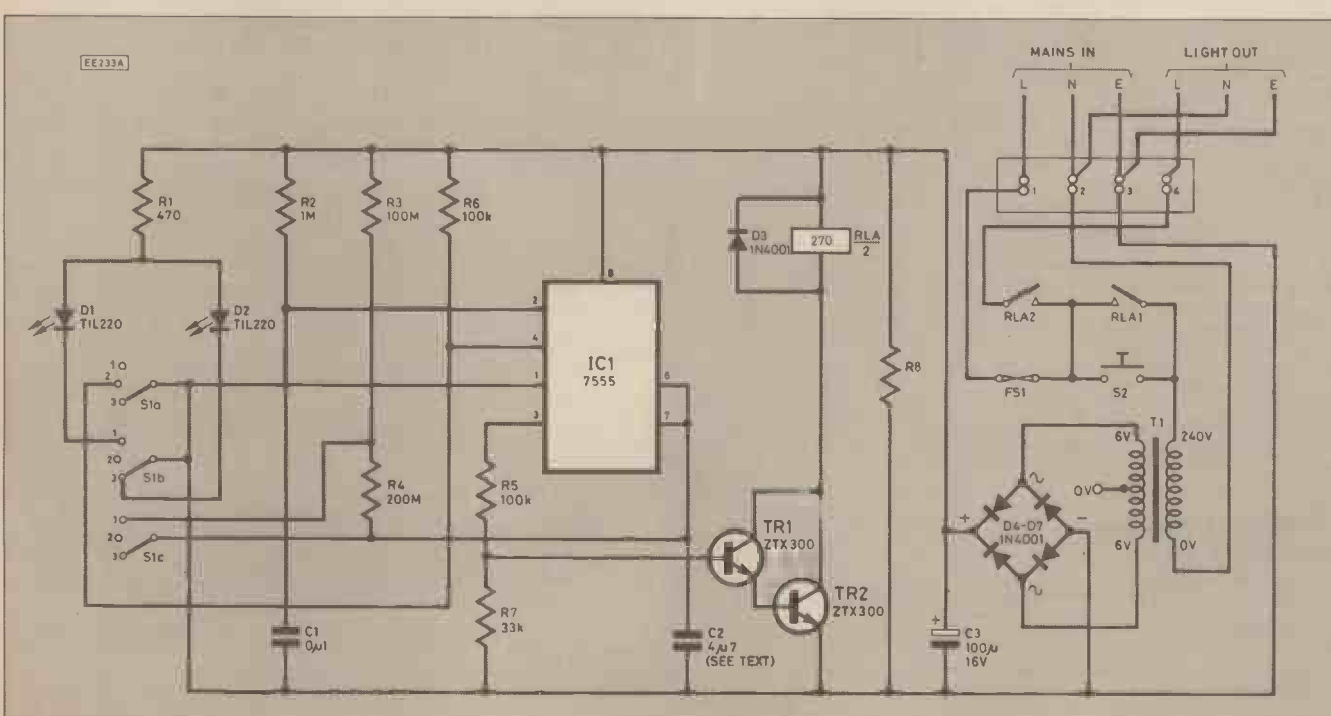


Fig. 1. Circuit diagram.

COMPONENTS

Approx. cost Guidance only **£25**

Resistors
- R1 470
- R2 1M
- *R3 100M
- *R4 200M
- R5,R6 100k
- R7 33k

*For R3 and R4 see text.
All resistors $\frac{1}{4}$W ±5%

Capacitors
- C1 100n
- C2 4·7μ (not electrolytic or ceramic type). See text.
- C3 100μ/16V electrolytic p.c.b. mounting.

Integrated circuit
- IC1 ICM 7555 CMOS timer

Semiconductors
- D1,D2 TIL220 5mm red l.e.d.s with mounting clips (2 off)
- D3–D7 1N4001 (5 off)
- TR1,TR2 ZTX300 *npn* silicon (2 off)

Miscellaneous
- T1 1·2W p.c.b. mounting mains transformer. 240V primary, 6V-0-6V secondary (R.S. stock No: 207-879)
- RLA P.c.b. mounting relay 270Ω coil and 2 sets of 5A 240V contacts. (Maplins 5A mains relay)
- S1 4-pole 3-way miniature slide switch.
- S2 Push-to-make switch with 1A *mains-rated* contacts.

P.c.b. available from *EE PCB service.* Order No. EE503.
Standard plastic double socket outlet box 25mm deep (1 in.) with blanking-off plate to fit.
20mm chassis fuseholder and ceramic tube fuse—1A rating up to 240W otherwise 3A.
3A 4-way terminal block.

See Shop Talk page 25

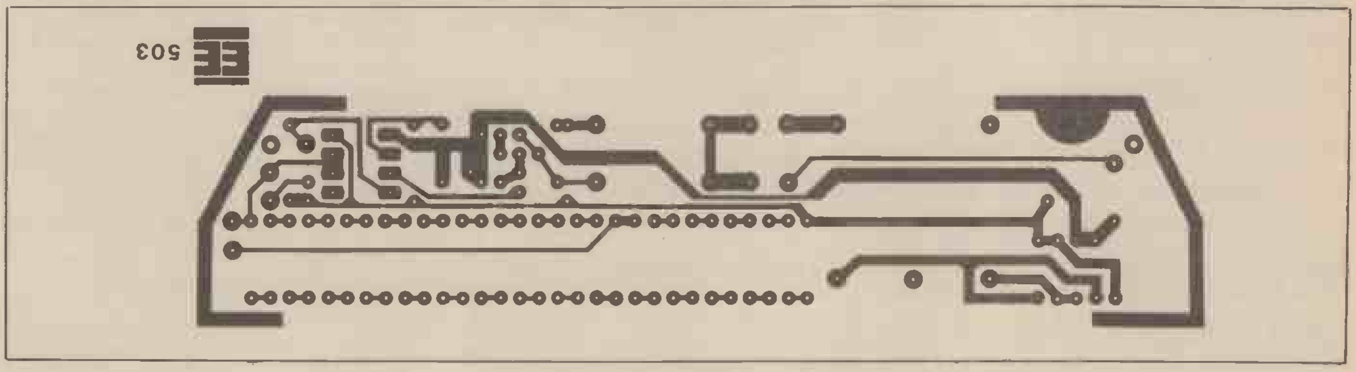


Fig. 2. P.c.b. (actual size).

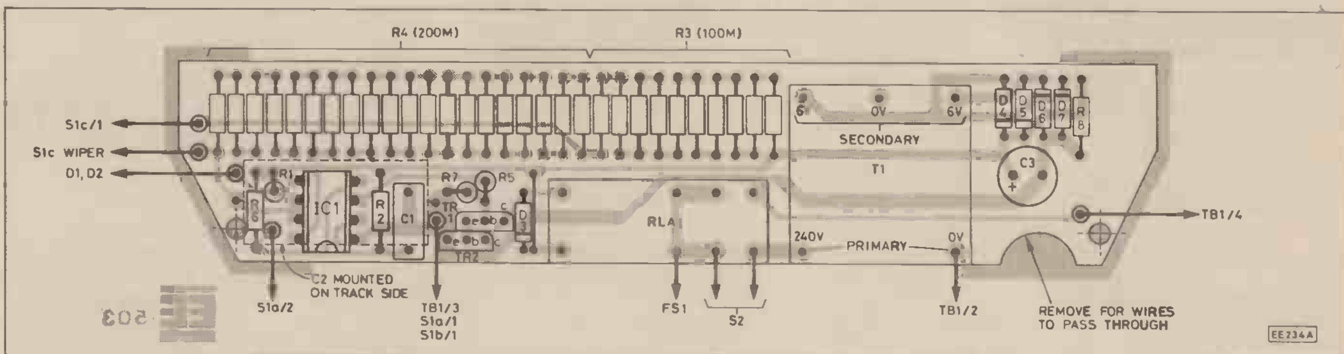


Fig. 3. Component layout.

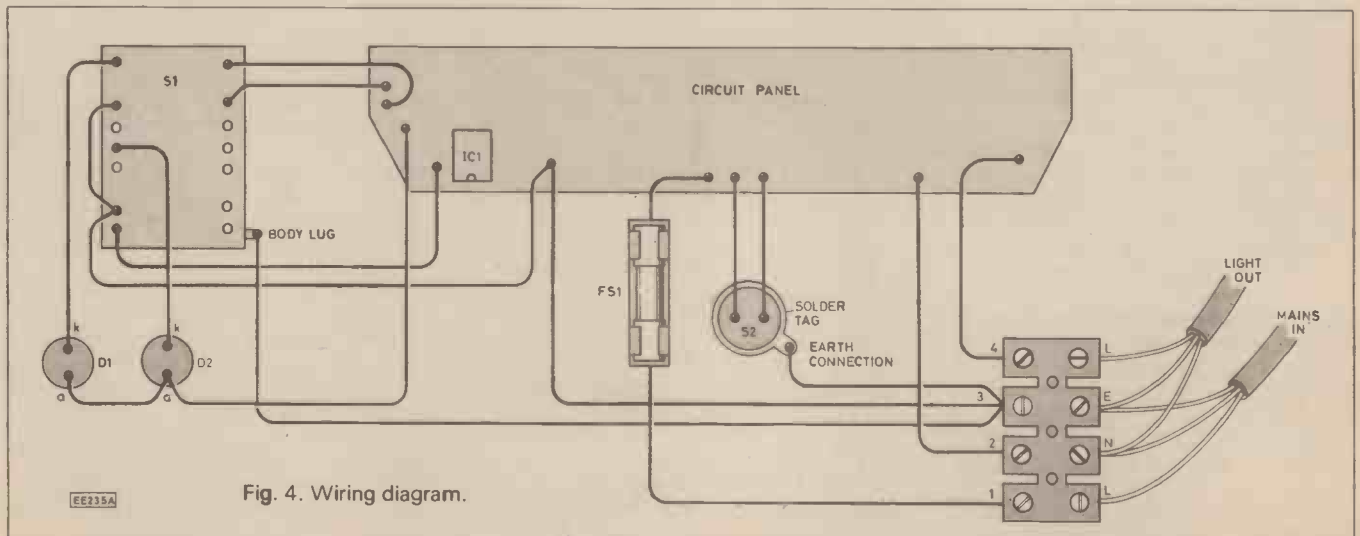
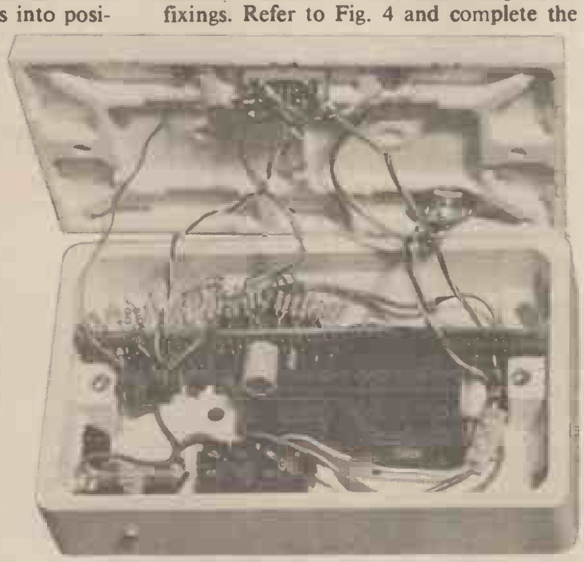


Fig. 4. Wiring diagram.

possible since depth is at a premium. Refer to Fig. 2 and construct the circuit panel which is based on the printed circuit board shown, and available through the *EE PCB service*, No. 503. This is slightly deeper than the box but the lid provides the additional clearance. Remove corners from the panel as necessary so that it fits in its correct position (see photograph). Remove the small section of panel used for the wires passing through from the copper strip side. Make all breaks and inter-strip links then solder the onboard components into position. Note that all components apart from switches, l.e.d.s, the terminal block and FS1 are mounted on the panel. C2 requires a value of approximately 4·7µ. In the prototype, a single component was used but it may be easier to buy 2 off 2·2µ capacitors and connect them in parallel (see Fig. 3). Similarly, although it is possible to buy single resistors for R3 and R4 ("high-ohmic" resistors) they may be difficult to obtain so may be constructed by connecting 30 off 10M resistors in series with a "tapping" between the 20th and 21st. This is not as laborious as it sounds! The full length of C2 leads should be used and sleeved to prevent short-circuits. When the circuit panel is in position, C2 may then be moved into a free space.



Internal view of the prototype Mains Delay Switch, the circuit of which was built on a piece of 0·1 inch gauge stripboard.

PREPARING THE CASE

Check the completed circuit panel for errors. Drill holes in the lid for the switches and l.e.d.s. Drill mounting holes and attach FS1 and the terminal block using small fixings. Refer to Fig. 4 and complete the internal wiring. Since S2 carries mains current, its connections must not be allowed to touch the circuit panel—fit an insulating sleeve for additional protection. Use 3A mains rated wire for RLA and T1 connections at the copper strip side of the circuit panel. Use short pieces of single-strand wire to reinforce the strips where indicated. S1 and S2 bodies must be earthed, for S3 use a large diameter solder tag. For S2, make a direct soldered connection to a body lug, bend it out of the way of switch connections. Note also the earth connection to the negative line on the circuit panel. Secure the panel making certain that it cannot move.

TESTING

This project requires an earthed supply, and all testing must be carried out with the lid of the case on.

Begin by switching off the mains at the fusebox. Insert a fuse into the fuseholder. For appliances up to 240W use a 1A fuse otherwise use 3A.

Refer to Fig. 4 and make the external connections. Use $1mm^2$ twin and earth p.v.c. cable. When testing, do not expect great accuracy in the timings. To *increase* them, increase the value of C2 and vice-versa.

Slight condensation on the copper strips of the circuit panel or on R3 and R4 may reduce the timings. If problems are experienced lightly spray these parts with an aerosol of silicone grease. □

COUNTER INTELLIGENCE

BY PAUL YOUNG

Old Young, incorrigible as ever, still insists that this is the Christmas issue. We will indulge him just this once, and let him wish all our readers a Merry Christmas. However, since you may all be resting, to counteract the effects of an extra large Christmas lunch, we will avoid anything that might overtax the brain.

Intelligent Computers

Arguments still go on, as to whether we shall one day produce an intelligent computer, but in view of a recent article I read, I am forced to concede that already there are computers that show more intelligence than their human operators.

When you have a faulty computer and a below average interpreter, then the combination can be lethal. The case of the senior citizen receiving an electricity bill for £1·5 million pounds and the giant intellects at the Electricity Board who insisted that it was correct is now well known, but this has been surpassed by the behaviour of the officials of the Social Security Administration and their computers in Washington.

It started when Professor Blanksten, who wrote to the department for a rebate on a medical bill, had it rejected because, said the letter, he died on the 6 August 1984. This was very embarrassing for a man who has 200 students to teach, so he wrote to Washington appealing against his own demise.

After a long delay, the department wrote and told him it had reviewed, "Whether our original determination was correct and had decided it was, and he wasn't." It was only after seeking help from his Congressman and a newspaper columnist that he persuaded the S.S.A. to change its mind.

I believe a similar thing happened to Mark Twain, his friend told him that he had read his obituary in the paper and he replied, "It seems quite evident that my death has been greatly exaggerated".

Useful Robots

In Australia they have developed a Robot that will answer the telephone, serve drinks, and mind the baby. Eventually it will be possible to give it verbal instructions and it will bring a tray of food to a particular chair, trundle from room to room and plug itself in, when its batteries are low.

This is excellent in its way, but for my money it will never replace the baby sitter that has dimensions of 36-24-36 and not only can manage all the Robots achievements, but also a few other interesting things as well.

How is Your History?

I am told that in the States, not one American in ten thousand could name the inventors of the Integrated Circuit! Naturally this would never apply to our readers, but for the benefit of the few suffering from a lapse of memory it was two Americans, Doctor Robert Noyce and Jack Kilby.

This started me thinking about who was responsible for other electronic milestones. An Englishman, Sir John Fleming invented the thermionic diode and an American Lee de Forest introduced the control grid, turning the diode into an amplifying valve, but who invented the germanium diode?

I believe it was an English team working at GEC in which case we have history repeating itself with an American William Shockley inventing the transistor.

Au Revoir

I have been writing a monthly article for *Everyday Electronics* almost continuously for ten years. It has been an enjoyable task and during that time I have made many friends. We have had many laughs together, especially in reminiscing over the past.

To name a few, the Indian gentleman who asked us to make him a talking kettle; the Russian chauffeur who wanted a seven lamp Philips; the man who complained of a squeak in his set (it turned out to be the Greenwich Time Signal). Then there was the time I was involved with sound effects for the Variety Theatre and twice nightly had to withstand the unsettling effect of twenty chorines squeezing past me, clad in little more than talcum powder and a top hat (I was single at the time, how should I explain all that powder on my navy suit today).

Unfortunately, due to my other writing commitments I am having to give up my monthly article, but I have promised the editor Mike Kenward, that I will send in an article from time to time, as often as my work load permits, and I hope it will be frequently. So may I thank all my readers who have been kind enough to read my articles over the years, and for the moment say "Au Revoir" and best wishes to you all.

PCB SERVICE

Printed circuit boards for certain constructional projects are now available from the PCB Service, see list. These are fabricated in glass-fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for overseas airmail. Remittances should be sent to: The PCB Service, Everyday Electronics and Electronics Monthly Editorial Offices, Westover House, West Quay Road, Poole, Dorset BH15 1JG. Cheques should be crossed and made payable to IPC Magazines Ltd.

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

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

NOTE: Please allow 28 days for delivery. We can only supply boards listed in the latest issue.

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User Port Input/Output *M.I.T. Part 1*	8307-01	£4.82
User Port Control *M.I.T. Part 1*	8307-02	£5.17
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Logical Lock		EM/8502/4	£3.58
Touch Dimmer		EM/8502/5	£3.29
Courtesy Light Extender	— MAR '85 —	EM/8503/4	£3.29
Disco Light Chaser		EM/8503/5	£8.11
Sound to Light Unit	— APRIL '85 —	EM/8504/1	£4.02
Car Audio Booster		EM/8504/2	£3.12
Short Wave Converter		EM/8504/3	£4.15
Car Burglar Alarm	— MAY '85 —	EM/8505/3	£2.88
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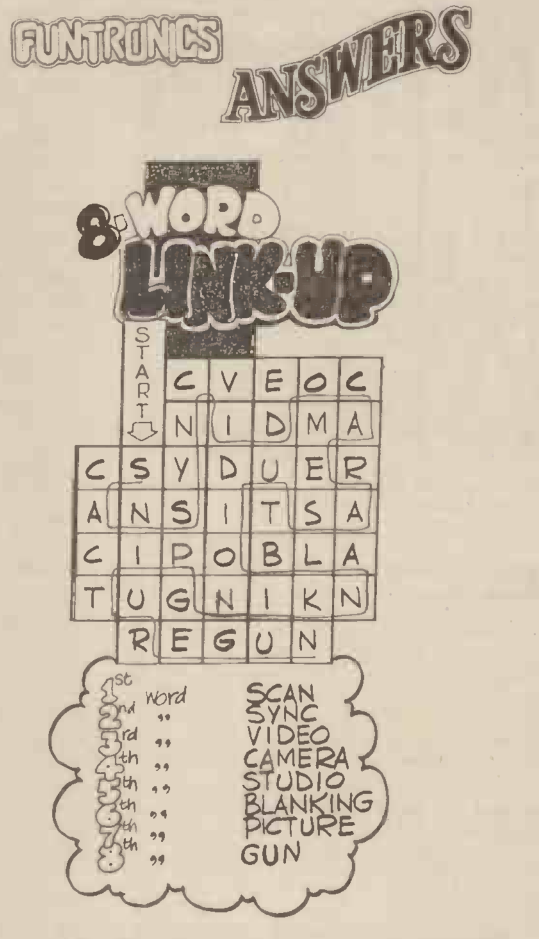


BOOK REVIEWS

ENCYCLOPEDIA OF ELECTRONICS

Authors	Various
Editor-In-Chief	Stan Gibilsco
Price	£42.95 hardcover
Size	220 × 285mm. 983 pages
Publisher	John Wiley & Sons Ltd
ISBN	0 8306 2000 1

THE Encyclopedia Of Electronics, first edition, has just been published and is claimed to "set a new standard for excellence in electronics and communications reference works". It certainly does. Prepared, checked and re-checked, this book took over four years to produce, resulting in a complete reference book for scientists, engineers, students and hobbyists.

It contains detailed, up-to-date information on more than 3,000 alphabetically arranged topics, from "A" Battery to Zone of silence. Close to the front of the book, there is a useful "Categorized List of Articles" which is designed to assist the reader in locating the correct subject. This is followed by a table of standard symbols.

The main and by far the largest section of the book, is taken up by the articles themselves. For those who know exactly what they are looking for, this section can be treated just like a dictionary. The information included in each section is presented in a straightforward, easy to follow manner without any sacrifice of thoroughness or technical accuracy.

It would be impossible to do justice to a book of this size and quality in such a short review, but without reading it from cover to cover, I would conclude that it is, indeed, excellent! Whilst being expensive, it remains good value for money.

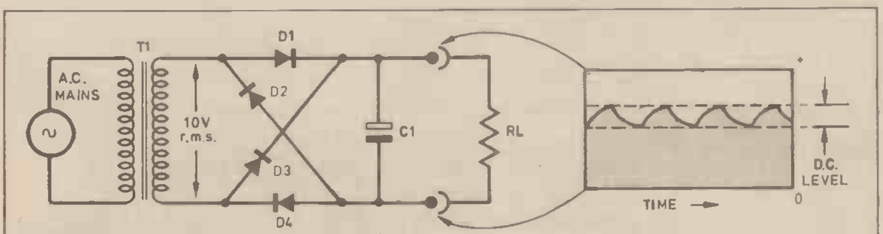
R.M.B.

DOWN TO EARTH

BY GEORGE HYLTON

How should one choose a reservoir capacitor for use in a mains power supply for transistor equipment?

In a typical mains-powered d.c. supply (Fig. 1), a rectifier (D1–D4) turns a.c. into d.c. The rectifier conducts intermittently, passing pulses of "d.c." at the peaks of the a.c. waveform. This pulsating d.c. is unsuitable for powering most types of electronic equipment, since these require a steady, smooth d.c. operating voltage. This is produced by connecting a large capacitance (C1) across the rectifier's d.c. output.



EE132M Fig. 1. Reservoir capacitor action.

Large, brief pulses of current charge this capacitance, and a smaller, steady load current can be drawn from it between pulses. The capacitance acts as a *reservoir* which is drawn upon by the equipment and replenished by the pulses of rectified current.

RIPPLE VOLTAGE

The usual full-wave rectifier circuits charge the reservoir capacitor twice every mains cycle; i.e. every hundredth of a second for 50Hz a.c. mains. The rectified current pulses charge the capacitor to something approaching the peak a.c. voltage. This is 1·4 times the r.m.s. a.c. voltage. So a rectifier fed by 10V a.c. will charge the reservoir capacitor to something approaching 14V d.c.

After a charging pulse, the steady d.c. drawn by the equipment (here represented by RL) causes the voltage to fall until the next impulse arrives to replenish the charge. So the voltage changes as shown. The sawtooth-shaped "wobble" on the d.c. output is called the ripple voltage, and if the ripple is too great, it produces "mains hum" in the equipment.

The ripple can be reduced by increasing the capacitance: doubling the capacitance halves the ripple. It is clearly impossible to totally eliminate ripple voltage by this means, since this would call for an infinitely large reservoir capacitance.

RIPPLE CURRENT

The regular topping-up and slow draining of the charge means that the reservoir capacitor is constantly accepting and releasing current. This is equivalent to an a.c. current through the capacitor. This is called the ripple current and must not be more than the capacitor can stand.

Capacitors designed for reservoir use have ripple current ratings: the ripple current increases as the d.c. taken by the equipment increases. A capacitor with a ripple current rating of at least half the d.c. load current should be used. High ripple ratings go hand-in-hand with large size, because the space-saving trick of etching the anode foil to increase capacitance can only be used to a limited extent in high-current electrolytics.

CAPACITOR VOLTAGE

The statement that the capacitor charges to the peak a.c. voltage needs qualifying. In the off-load condition (with RL disconnected) it is very nearly correct. However, there is still a small loss of voltage in the rectifier.

On the other hand, the off-load output voltage of the mains transformer may well be above the nominal voltage. Thus a nominal 9V transformer may in fact deliver 12V off-load. The peak voltage is then 12 × 1·4 = 16·8V, and the d.c. output, off-load, can approach this. The voltage rating of the reservoir capacitor must exceed this voltage.

The mains voltage may also sometimes exceed its nominal value, causing a further increase. An even higher voltage rating may be required for safety, say 25V or 30V.

As load current increases, each rectifier diode drops about 1V when it conducts. Also, the effective resistance of the transformer windings limits the current pulses and the reservoir capacitor C1 is no longer able to charge to the peak a.c. The d.c. output voltage falls and ripple voltage increases.

SMOOTH OR STABILISE?

It used to be the general practice to add a smoothing filter to reduce ripple voltage still further. Filters took the form of series resistance or inductance followed by an extra parallel capacitance like C1. An alternative is to use a voltage stabiliser.

If the a.c. output voltage required is, say, 10V, then the power supply can be designed to provide enough extra voltage to operate a "series stabiliser". If, for example, the stabiliser drops 4V, then the voltage on C1 at the troughs of the ripple must be 4V + 10V = 14V under full-load conditions. The 10V output will then be both ripple-free and stable.

Stabilisers in i.c. form are now quite cheap, possibly cheaper than the extra-large electrolytic needed in a smoothing filter, and certainly cheaper than a smoothing inductor; readers of *EE* will be familiar with projects whose power supply incorporates a voltage-regulator i.c. A typical regulated power supply may, at its simplest, consist of a transformer, rectifier, and reservoir capacitor, as in Fig. 1, followed by a three-pin i.c. which provides a stable output (±5%) of, say, 12V for an input voltage range of 14·5V to 35V.

WHAT IS hie?

On a rather different topic, a reader studying for an examination in electronics wrote to ask about a symbol which he'd encountered for the first time. The symbol was hie, and he needed to know what it meant.

The "h" shows that it belongs to a family of informative quantities known as h-parameters. "Parameter" is a word borrowed from maths. It means a quantity which helps to describe something—the shape of an ellipse, for example. Transistor parameters describe how a transistor behaves. There are several alternative sets of transistor parameters: h-parameters are one of them, and the "h" is short for "hybrid".

The h-parameters refer to bipolar (*npn* or *pnp*) transistors, not field-effect transistors. The most familiar h-parameters are the ones that describe current amplification. These are hFE and hfe. Here the "e" means that the transistor is operating with its emitter "common" ("grounded", "earthed"). The capital letters in hFE indicate that this parameter refers to "large-signal" conditions. The small letters in hfe mean that this parameter applies to "small-signal" conditions.

CURRENT GAIN

It is almost true to say that "large-signal" means "d.c." and "small-signal", "a.c.": so hFE tells you how much collector current flows when a given base current is applied. If the base current is 1mA and hFE = 100 then the collector current is 100mA. The small-signal current amplification factor, hfe, says how this collector current changes when there is a small change in the base current.

If, with the d.c. currents just given, the base current changes by 1µA, and hfe = 120, then the collector current changes by 120µA. Note that for a particular transistor hfe and hFE are not necessarily the same (though they are usually fairly close to one another).

Not too difficult is it? But what about hie, which was what started me off on this tack? The "e" shows that the transistor is operating in the common-emitter connection. The "i" means "input". It shows that hie has something to do with how the transistor looks to a signal applied to its input. The small letters "ie" show that we are dealing with small signals.

In fact, hie is the input resistance of the transistor. Knowing hie, you can work out how much base current flows when an input signal voltage is applied. Knowing hfe you can then convert this into the corresponding amount of collector current.

If you come across parameters with "o" in their names, you won't now be surprised to learn that they refer to the output side of the transistor. So hoe is the output conductance (small signal, common emitter). You may by now be wondering what the "f" means in "hfe"—it means "forward". That is, it refers to the natural direction of signal flow, which in common-emitter configuration is from the input (base) of the transistor to the output (collector).

Cirkit wishes all EE and EM readers a very happy Christmas

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C	26x49	1.2	1.2	120mA
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PP3	50x27x16	8.4	0.11	11mA

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battery type	output (V)	charge rate	charge time (hrs)
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C	2.9	120	16
D	2.9	120	16
PP3	11	11	

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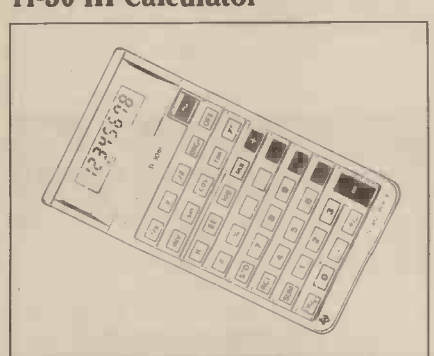

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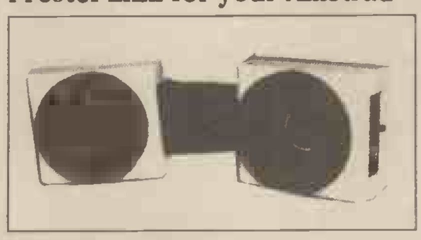

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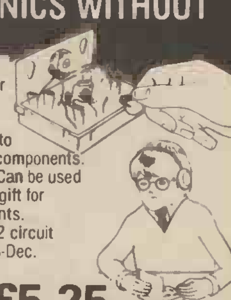

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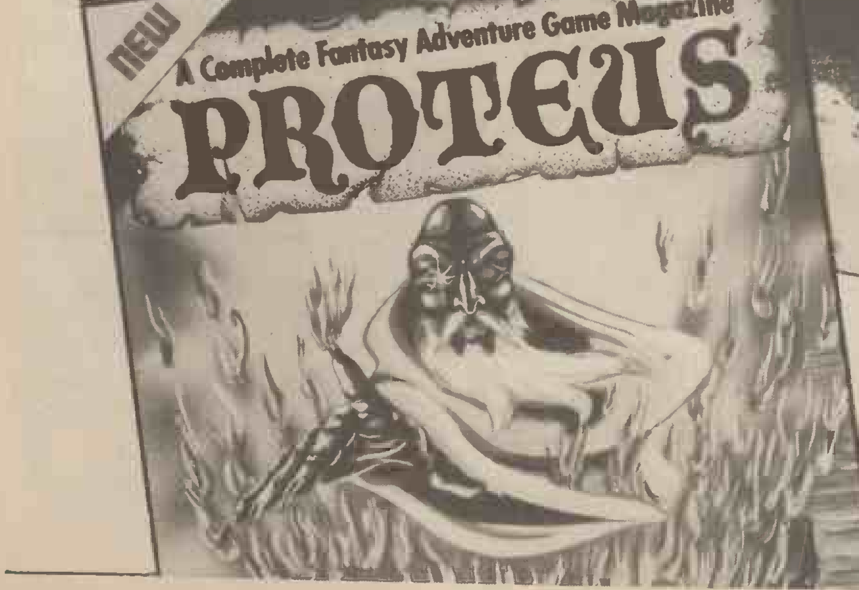

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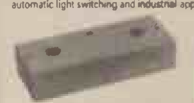

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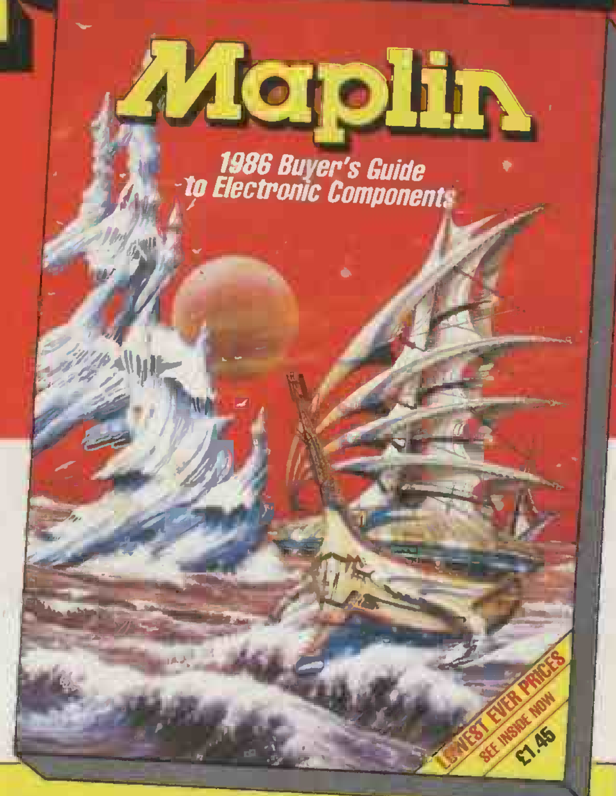

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