EVERYDAY ELECTRONICS and computer PROJECTS

FEBRUARY 1985 £1·00

8 EXTRA PAGES

LOAD SIMPLIFIER

Solid State Reverb

MAINS MONITOR PROJECT

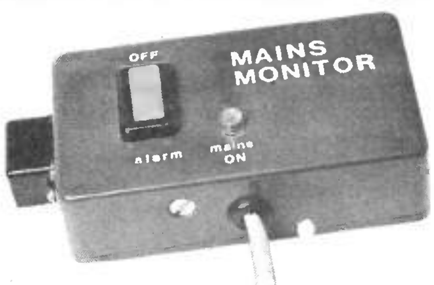
Australia $1.60 New Zealand $1.75 Malaysia $4.95

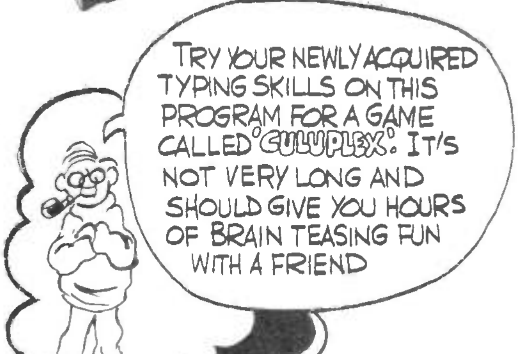
EVERYDAY ELECTRONICS and computer PROJECTS

VOL. 14 No. 2 FEBRUARY 1985

ISSN 0262-3617

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





See page 96

PROJECTS

COMPUTERISED TRAIN CONTROLLER by R. A. Penfold **72**
Program your layout to perform real-world timetables and more!
WASHING MACHINE ALERT by A. Robson **82**
Alerts the user to switch on the domestic heating boiler
SOLID STATE REVERB by Mark Stuart **90**
A cure for the acoustically dead
LOAD SIMPLIFIER by A. Flind **98**
Takes the guesswork out of cassette loading your micro
MAINS MONITOR by A. R. Winstanley **110**
Audible warning of power cuts

SERIES

COMPUTER CLUB by Thakery **96**
Games Software—Culuplex
FAULT FINDING by E. A. Rule **104**
Part Four: Multimeter, signal generator and oscilloscope techniques
DIGITAL ELECTRONICS by D. W. Crabtree **114**
Part Five: Counting systems in electronics

FEATURES

EDITORIAL **71**
Postbag Publishing
COMPARATORS by T. Prichard **78**
The simplest of ADC explained, and a cache of practical circuits to use
SHOPTALK by David Shortland **84**
Product news and component buying
FOR YOUR ENTERTAINMENT by Barry Fox **87**
Fly Pass: Access to IDA; In The Picture
NEW PRODUCTS **88**
Facts and photos of instruments, equipment and tools
EVERYDAY NEWS **102**
What's happening in the world of electronics
RADIO WORLD by Pat Hawker G3VA **107**
Radio Amateurs' Examination; Frequency Upheavals; Woodpecker; Coded Travel
COUNTER INTELLIGENCE **112**
A retailer comments
CIRCUIT EXCHANGE **120**
A forum for readers' ideas
SQUARE ONE **123**
Beginners' Page: Electricity
PRINTED CIRCUIT BOARD SERVICE **124**

Our March 1985 issue will be published on Friday, February 15. See page 95 for details.

Readers' Services ● Editorial and Advertisement Departments **71**

BI-PAK BARGAINS

HIGH QUALITY MODULES FOR STEREO, MONO & OTHER AUDIO EQUIPMENT

Audio Amplifiers

D/No.	POWER O/P R.M.S.	MAX SUP. VOLTAGE	PRICE
AL 30A	10 Watts	30V	£4.95
AL 60	25 Watts	30-50V	£5.92
AL 80	35 Watts	40-60V	£8.75
AL 120	50 Watts	50-70V	£15.22
AL 250	125 Watts	50-80V	£20.60

Stabilised Power Supplies —

Output current 2.5 Amps

D/No.	AC Input	Price
SPM 120/45	40-48V	£8.05
SPM 120/55	50-55V	£8.05
SPM 120/65	60-65V	£8.05

Mono Pre-Amplifiers – Operating Vtg. 40-65V

D/No.		Price
MM 100	Suitable for Disco Mixer	£14.75
MM 100G	Suitable for Guitar Pre-Amp Mixer	£14.75

Magnetic Cartridge Pre-Amplifier
D/No. MPA30. Sup Vtg. 20-30V. Price £4.29

Monographic Equaliser
GE 100 MKII 10 Channel OUR PRICE ONLY £20.00

Full Specifications and Data available on request. Please send self-addressed envelope.

OPTO 7-Segment Displays

Brand new 1st Quality

LITRONIX DL 707R 14-pin

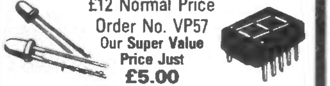
Red 0.3" Common Anode Display 0-9 with right hand decimal point. TTL compatible. 5v DC Supply. Data supplied.

IN PACKS OF	5 pieces	£3	(60p each)
	10 pieces	£5	(50p each)
	50 pieces	£20	(40p each)
	100 pieces	£35	(35p each)
	1,000 pieces	£300	(30p each)

THE MORE YOU BUY THE LESS YOU PAY

BI-PAK'S OPTO SPECIAL

A selection of large and small sized LED's in various shapes, sizes & colours, together with 7 Segment Displays both anode & cathode plus photo transistors emitters and detectors. Cadmium Cell ORP12 and Germ. photo transistor OCP71 included. In all a total of 25 Opto pieces valued over £12 Normal Price



Order No. VP57
Our Super Value Price Just £5.00

DIGITAL VOLT METER MODULE

3 × 7 segment displays Bass Circuit. 0-2v± instructions provided to extend voltage & current ranges. Operating voltage 9/12v. Typ Power Consumption 50mA.

O/No. VP99 **Once only price £9.95**

SINGLE SIDED FIBREGLASS BOARD

Order No	Pieces	Size	Sq. Ins.	Price
FB1	4	9 × 2¾"	100	£1.50
FB2	3	11 × 3"	100	£1.50
FB3	4	13 × 3"	156	£2.00

DOUBLE SIDED FIBREGLASS BOARD

FB4	2	14 × 4"	110	£2.00

EDGE CONNECTORS

50-way × 2.1 pitch Edge Connector (Gold)
(O/No. AMP163279 2) **£1.20 each. £50 per 50 off**

PICK-UP COIL

Large telephone pick-up coil for high sensitivity. Suction pad to stick to telephone. 90cm lead to 3.5 jack plug. Connects direct to cassette recorder. Dims: 32mm(dia) × 17mm(body) 36mm(dia) sucker. O/No. YP87 **£1.00**

VALUE PACKS

Pak No	Qty	Description	Price
VP1	300	Assorted Resistors Mixed Types	£1.00
VP2	300	Carbon Resistors ¼-½ Watt Pre-Formed	£1.00
VP3	200	⅛ Watt Min Carbon Resistors Mixed	£1.00
VP4	150	½ Watt Resistors 100 ohm-1M Mixed	£1.00
VP5	200	Assorted Capacitors All Types	£1.00
VP6	200	Ceramic Caps Miniature – Mixed	£1.00
VP7	100	Mixed Ceramics Disc. 1pf – 56pf	£1.00
VP8	100	Mixed Ceramic Disc. 68pf – .015pf	£1.00
VP9	100	Assorted Polyester/Polystyrene Caps	£1.00
VP10	60	C280 Type Caps Metal Foil Mixed	£1.00
VP11	50	Electrolytics – All Sorts	£1.00
VP12	60	Bead Type Polystyrene Min Caps	£1.00
VP13	50	Silver Mica Caps Ass. 5.6pf – 150pf	£1.00
VP14	50	Silver Mica Caps Ass. 180pf – 4700pf	£1.00
VP15	25	.01uF 250v Min. layer metallised Polyester Capacitors	£1.00
VP16	50	Wirewound Res. 9W (avg) Ass. 1 ohm – 12K	£1.00
VP17	50	Metres PVC Covered Single Strand Wire Mixed Colours	£1.00
VP18	30	Metres PVC Covered Multi Strand Wire Mixed Colours	£1.00
VP19	40	Metres PVC Single/Multi Strand Hook-Up Wire Mixed	£1.00
VP20	6	Rocker Switches 5 Amp 240v	£1.00
VP21	15	2" High Bright RED LED's in plastic encapsulation large area light source	£1.00
VP22	200	Sq. Inches Total, Copper Clad Board Mixed Sizes	£1.00
VP23	20	Assorted Slider Pots. Mixed Values	£1.00
VP24	10	Slider Pots. 40 mm 22K 5 × Log. 5 × Lin	£1.00
VP25	10	Slider Pots. 40 mm 47K 5 × Log. 5 × Lin	£1.00
VP26	15	Small .125" Red LED's	£1.00
VP27	15	Large .2" Red LED'S	£1.00
VP28	10	Rectangular .2" RED LED'S	£1.00
VP29	30	Ass. Zener Diodes 250mW – 2W Mixed Vlts. Coded	£1.00
VP30	10	Ass. 10W Zener Diodes Mixed Vlts. Coded	£1.00
VP31	10	5 Amp SCR's TO-66 50-400v Coded	£1.00
VP32	20	3 Amp SCR's TO-66 Up To 400v Uncoded	£1.00
VP33	200	Sil. Diodes Switching Like IN4148 DO-35	£1.00
VP34	200	Sil. Diodes Gen. Purpose Like OA200/BAX13/16	£1.00
VP35	50	1 Amp IN4000 Series Sil. Diodes Uncoded All Good	£1.00
VP37	8	Black Instrument Type Knobs With Pointer ¼" Std	£1.00
VP42	10	Black Heatsinks To Fit TO-3, TO-220 Ready Drilled	£1.00
VP43	4	Power-Fin Heatsinks 2 × 10-3 2 × TO-66 Size	£1.00
VP45	50	BC107/8 Type NPN Transistors Good Gen. Purpose Uncoded	£1.00
VP46	50	BC177/8 Type PNP Transistors Good Gen. Purpose Uncoded	£1.00
VP47	10	Silicon Power Trans. Similar 2N3055 Uncoded	£1.00
VP140	50	Precision Resistors. 2-1% tol.	£1.00
VP141	40	1N4002 Sil. Rects. 1A 100v preformed pitch	£1.00
VP142	4	40A Power Rectifiers Silicon TO48 300PIV	£1.00
VP143	5	BY187 12KV Sil. Diodes in carriers 2.5mA	£1.00
VP144	4	100K 1in. Multi-turn pots ideal vari cap tuning	£1.00
VP145	10	Assorted pots. inc. Dual & Switched types	£1.00
VP146	25	Solid Tantalum Caps. Mixed Values	£1.00

OPTICALLY COUPLED MODULES

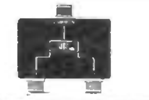
1 pair SD1/131 Consisting 1 × LS600 Silicon Light Sensor & 1× Matched Gallium Arsenide Light Source – Type TIL23, on ready mounted fibre glass board. Including Data.
BI-PAK Price ONLY £0.60 pr.
Ideal Alarm projects etc. D/No. VP147.

LED DISPLAYS

VP130	6	RED 7 Seg. CC 14mm × 7.5mm RDP FND353	£2.00
VP131	4	GREEN 7 Seg. CA .6" LDP XAN6520	£2.00
VP132	5	RED 7 Seg. CC .6" LDP XAN6940	£2.00
VP133	6	RED Over-flow .6" 3 × CA 3 × CC 6630/50	£2.00
VP134	5	GREEN Over-flow .6" CA XAN6530	£2.00
VP135	5	RED 7 Seg. CA .3" LDP XAN3061	£2.00
VP136	3	DUAL RED 7 Seg. .5" CA DL527 DPR	£2.00
VP137	3	DUAL RED 7 Seg. .51" CA DL727 DPR	£2.00
VP138	20	Assorted LED Displays – Our mix with Data	£5.00

RDP = Right Hand Decimal Point CC = Common Cathode
LDP = Left Hand Decimal Point CA = Common Anode

ANTENNA SWITCH 2 and 3 WAY



Co-axial switch for one transceiver to two antennae or one antenna to two transceivers. Dims: 86 × 55 × 32mm (Body).
D/No. VP 113 **£4.50**

As above but 3-way.
O/No. VP 114 **£4.75**

HIGH PASS FILTER/SUPPRESSOR

CB/TV. High pass filter. Reduces unwanted signals picked up by antenna. Dims: 45 × 25 × 17mm. D/No. VP 115 **45p**

LOW PASS FILTER

Designed to reduce harmonics on the VHS and TV band.
Cut-off frequency: 30MHz.
V.S.W.R.: Less than 1.2 to 1.
Insertion loss: –0.2dB @ 27MHz.
Impedance: 50 ohms.
Dims: 80 × 55 × 40mm.
D/No. VP 116 **£2.75**

IC BARGAINS

40 Assorted TTL CMDS INTEGRATED CIRCUITS 74 Series & CD4000 Series – All new Gates. Flip-Flops – MSI etc. GREAT VALUE Data Book & Sheets included. 40 Pieces (Our Mix) **£4.00** O/No. UP40

TRANSISTOR PACKS

VP150	20	BC183B Sil. Trans. NPN 30v 200mA Hfe240+ TO92	£1.00
VP151	25	BC171B Sil. Trans. NPN 45v 100mA Hfe240+ TO92	£1.00
VP152	15	TIS90 Sil. Trans. NPN 40v 400mA Hfe100+ TO92	£1.00
VP153	15	TIS91 Sil. Trans. PNP 40v 400mA Hfe100+ TO92	£1.00
VP154	15	MPSA56 Sil. Trans. PNP 80v 800mA Hfe50+ TO92	£1.00
VP155	20	BF595 Sil. Trans. NPN eqvt. BF184 H.F. TO92	£1.00
VP156	20	BF495 Sil. Trans. NPN eqvt. BF173 H.F. TO92	£1.00
VP157	15	ZTX500 Series Sil. Trans. PNP Plastic	£1.00
VP158	15	ZTX107 Sil. Trans. NPN eqvt. BC107 Plastic	£1.00
VP159	15	ZTX108 Sil. Trans. NPN eqvt. BC108 Plastic	£1.00
VP160	20	E5024 Sil. Trans. PNP eqvt. BC214L TO92	£1.00
VP161	25	BC183L Sil. Trans. NPN 30v 200mA TO92	£1.00
VP162	5	SJE5451 Sil. Power Trans. NPN 80v 4A Hfe20+	£1.00
VP163	2	NPN/PNP pairs Sil. Power Trans. like SJE5451	£1.00
VP164	4	2N6289 Sil. Power Trans. NPN 40v 40w 7A Hfe30+	£1.00
VP165	6	BFT33 NPN Sil. Trans. 80v 5A Hfe50-200 TO39	£1.00
VP166	5	BFT34 NPN Sil. Trans. 100v 5A Hfe50-200 TO39	£1.00
VP167	1	BUY69C NPN TO3 VCB 500 10A 100w Hfe15+	£1.00
VP168	10	BC478 eqvt. BCY71 PNP Sil. Trans. TO18	£1.00
VP169	10	BXS21 eqvt. BC394 NPN Sil. Trans. 80v 50mA TO18	£1.00
VP170	10	Assorted Power Trans. NPN/PNP Coded & Data	£1.00
VP171	10	BF355 NPN TO-39 Sil. Trans. eqvt. BF258 225v 100mA	£1.00
VP172	10	SM1502 PNP TO39 Sil. Trans. 100v 100mA Hfe100+	£1.00

TRANSISTORS

100 Silicon NPN Transistors. All Perfect. Coded Mixed. Types With Data And Eqvt. Sheet No Rejects. Fantasic Value. O/No. BP38 **£3.00**

100 Silicon PNP Transistors. All Perfect Coded. Mixed. Types With Data and Eqvt. Sheet. No Rejects. Real Value. O/No. BP39 **£3.00**

The best known Power Transmitter in the world 2N3055 NPN 115W. Our Bi-Pak Special Offer Price.

10 off	50 off	100 off
£3.50	£16.00	£30.00

BD312 COMPLIMENTARY PNP POWER TRANSISTORS TO 2N3055. Equivalent MJ2955 BD312 TO3. **Special Price £0.70 each. 10 off £6.50**

SEMICONDUCTORS FROM AROUND THE WORLD

100 A collection of Transistors, Diodes, Rectifiers & Bridges, SCRs, Triacs, I.C.s & Opto's all of which are current every day useable devices. Guaranteed Value Over £10 Normal Retail Price. Data etc. in every pack. Order No. VP56

Our Price £4.00

TRANSISTOR CLEARANCE

100 All Sorts Transistors. A mixed bag NPN-PNP Silicon & Germ. Mainly Uncoded You To Sort Pack includes instructions for making Simple Transistor Tester, Super Value.
Order No. VP60. **£1.00**

150 De-soldered Silicon Transistors from boards 10mm leads all good. O/No. VP173 **£1.00**

TECASBOTY

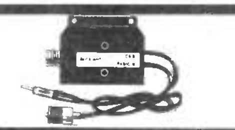
THE ELECTRONIC COMPONENTS AND SEMICONDUCTOR BARGAIN OF THE YEAR!

This collection of Components and Semiconductors for the hobbyist is probably the most value-packed selection ever offered, it consists of Resistors, carbon and wirewound of various values. Capacitors: All types, sorts and sizes including electrolytics. Potentiometers – single, dual, slider and preset. Switches, Fuses, Heatsinks, Wire, P.C.B. Board, Plugs, Sockets etc., PLUS a selection of Semiconductors for everyday use in popular Hobby Projects. These include: SCR's, Diodes, Rectifiers, Triacs & Bridges as well as a first class mix of Transistors and I.C.'s. In all, we estimate the value of this in current retail catalogues to be over £25! So, help yourself to a great surprise and order a Box TODAY – ONLY at BI-PAK. Remember, stocks are limited so hurry! You can call us on 0920 3182/3442 and order with your Barclaycard or Access Card – 24hr Answerphone Service NOW. Order No. VP 85.

just £7.00

ANTENNA COUPLER

Transceiver/car radio antenna coupler. With co-axial cables. One co-axial terminates in antenna plug and the other in PL259 plug. Dims: 67 × 46 × 30mm.
O/No. VP 117 **£2.00**



PRECISION MORSE KEYS

Well designed beginners key. Fully adjustable. Dims: Base 82mm × 45mm.
O/No. VP 122. **£1.85**

ELECTRONIC SIREN 12v DC

Red plastic case with adjustable fixing bracket. Emits high-pitched wailing note of varying pitch – 100 cycles per minute.
Dims: 90mm(dia)
60mm(depth)
Power: 12v DC
Our Price: £5.50

POWER SUPPLY

OUR PRICE £3.75

Power supply fits directly into 13 amp socket. Fused for safety. Polarity reversing socket. Voltage switch. Lead with multi plug input – 240v AC 50Hz Output –3 4.5 6 7.5 9 & 12v DC. Rating 300ma MW88.

TAPE RECORDER SWITCH

Unit to control motor of tape recorder. 1.8m cord and 2.5mm plug attached. On/Off switch. Dims: 55 × 20 × 20mm.
O/No. VP 127 **£1.00**

(LEARN A LINGO)

PILLOW SPEAKER

Slim under pillow unit. 80ohms 2" speaker. 1.5m lead with 3.5mm mono jack plug. Black. Dims: 65(dia) × 17mm. O/No. VP 88 **£1.25**

BI-PAK

Send your orders to Dept EE2 BI-PAK PO BOX 6 WARE, HERTS
SHOP AT 3 BALDOCK ST. WARE, HERTS
TERMS CASH WITH ORDER, SAME DAY DESPATCH, ACCESS, BARCLAYCARD ALSO ACCEPTED. TEL. (0920) 3182, GIRO 388 7006
ADD 15% VAT AND 75p PER ORDER POSTAGE AND PACKING

Use your credit card. Ring us on Ware 3182 NOW and get your order even faster. Goods normally sent 2nd Class Mail.
Remember you must add VAT at 15% to your order. Total Postage add £1.00 per Total order.

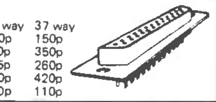
Rapid Electronics

MAIL ORDERS:
Unit 3, Hill Farm Industrial Estate, Boxted, Colchester, Essex CO4 5RD.
Tel. Orders: Colchester (0206) 36412.
Telex: 987756.

ACCESS AND BARCLAYCARD WELCOME

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
Plugs solder lugs	55p	66p	90p	150p
Right angle	90p	135p	200p	350p
Sockets solder lugs	80p	100p	135p	260p
Right angle	120p	180p	290p	420p
Covers	100p	90p	100p	110p



CONNECTORS

DIN	Plug	Skt	Jack	Plug	Skt
2 pin	9p	9p	2.5mm	10p	10p
3 pin	12p	10p	3.5mm	9p	9p
5 pin	13p	11p	Standard	16p	20p
Phono	10p	12p	Stereo	24p	25p
1mm	12p	13p	4mm	18p	17p

UHF (CB) Connectors:
PL259 Plug 40p. Reducer 14p.
SO239 square chassis skt 38p.
SD239S round chassis skt 40p.
IEC 3 pin 250V/6A.
Plug chassis mounting . . 38p
Socket free hanging . . . 60p
Socket with 2m lead . . 120p

SWITCHES

Submin toggle:
SPST 55p. SPDT 60p. DPDT 65p.
Miniature toggle:
SPDT 80p. SPDT centre off 90p.
DPDT 90p. DPDT centre off 100p.
Standard toggle:
SPST 35p. DPDT48p
Miniature DPDT slide 14p.
Push to make 15p.
Push to break 22p.
Rotary type adjustable stop.
1P12W, 2P6W, 3P4W all 55p each.
DIL switches:
4SPST 80p 6 SPST 80p. 8 SPST 100.
Min. DPDT slide 14p. Push-make 15.

SCRs

▶C106D	35
400V 8A	70
400V 12A	95

SOLDERING IRONS

Antex CS 17W Soldering iron	430
2.3 and 4.7mm bits to suit	85
Antex XS 25W soldering iron	530
3.3 and 4.7mm bits to suit	85
Solder pump desoldering tool	480
Spare nozzle for above	70
10 metres 22 swg solder	100
0.5kg 22 swg solder	750

TRANSFORMERS

3VA PCB Mounting
2x6V@0.25A;2x9V@0.15A
2x12V@0.12A;2x15V@0.1A 180p

6VA PCB Mounting
2x6V@0.5A;2x9V@0.4A
2x12V@0.3A;2x15V@0.25A 270p

Standard. Chassis Mounting
6VA: 2x6V@0.5A; 2x9V@0.4A
2x12V@0.3A;2x15V@0.25A 240p

12VA: 2x6V@1A; 2x9V@0.6A
2x15V@0.4A;2x20V@0.3A 350p

VERO

Verobloc	395
Veroboard Size 0.1 in matrix	
2.5 x 1	26
2.5 x 3.75	95
3.75 x 5	120
3.75 x 17	350
4.75 x 17	455
VQ board	190
Veropins per 100:	
Single sided	55
Double sided	65
Spot face cutter	145
Pin insertion tool	185
Wiring pen	375
Spare spool 75p Combs	6

MICRO

		27128-250	1225	6800	200	6522	330
		6116P3	480	6802	280	6532	520
		6264P15	2980	6809	600	6551	540
2716	310	4116P4	70	6810	140	8085A	320
2532	380	4164-15	480	6821	140	8156	380
2732 one time programmable	360	41256-15	2850	6840	360	8251	350
		Z80A CPU	290	6850	165	8253	370
		Z80A P10	320	6852	240	8255	320
2732	430	Z80A CTC	320	6875	500	8259	400
2764-250	495	Z80A S10	880	6880	100	MC1488	70
2764 BBC	495	Z80A DMA	880	6502	370	MC1489	70

SOCKETS

	Low profile	Wire-wrap
8 pin	7p	28p
14 pin	8p	45p
16 pin	10p	55p
18 pin	12p	60p
20 pin	13p	68p
22 pin	15p	75p
24 pin	17p	82p
28 pin	15p	95p
40 pin	25p	135p

Professional ZIF sockets
24 pin 430p 28 pin 480p
40 pin 595p

COMPONENT KITS

An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices. ¼W 5% Resistor kit. Contains 10 of each value from 4.7 ohms to 1M (total of 650 resistors) . . . 530
Ceramic Cap. kit. 5 of each value - 22p to 0.01u (135 caps) . . 370
Polyester Cap. kit. 5 of each value from 0.01 to 1uF (65 caps) . 575
Preset kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets . . . 425
Nut and Bolt kit (total 300 items): 180p

25 6BA ¼" bolts	50 6BA washers	50 6BA nuts
25 6BA ½" bolts	25 4BA ¼" bolts	50 6BA washers
50 6BA nuts	25 6BA ½" bolts	

CABLES

20 metre pack single core connecting cable ten different colours.	75p
Speaker cable	10p/m
Standard screened	16p/m
Twin screened	24p/m
2.5A 3 core mains	23p/m
10 way rainbow ribbon	26p/ft
20 way rainbow ribbon	47p/ft
10 way gery ribbon	14P/ft
20 way grey ribbon	28p/ft

REGULATORS

78L05	30	79L05	45
78L12	30	79L12	45
78L15	30	79L15	45
7805	40	7905	45
7812	40	7912	45
7815	45	7915	45
LM317K	270	LM723	40
LM317T	90	78H05	550
LM323K	420		

DIODES

		▶1N4001	3
BY127	12	1N4002	5
DA47	10	1N4006	7
DA90	8	1N4007	7
OA91	7	1N5401	12
OA200	8	1N5404	16
DA202	8	1N5406	17
1N914	4	400mWzen	6
▶1N4148	3	1.3W zeners	13

OPTO

3mm red	8	5mm red	8
3mm green	11	5mm green	11
3mm yellow	11	5mm yellow	11

Clips to suit - 3p each.

Rectangular:		TIL32	40
red	12	TIL111	60
green	17	TIL78	40
yellow	17	ORP12	85
ILD74	95	ILQ74	185
TIL38	35	TIL100	75
2NS777	45	Tri-color Led	35

Seven segment displays:
Com cathode. Com anode.
DL704 0.3" 95 DL707 0.3" 95
FND5000 5" 100 FND5070.5" 100
10 bar DIL LED display, red 180
5mm superbright LED 250mcd red 30

HARDWARE

PP3 battery clips	6
Red or black crocodile clips	6
Black pointer control knob	15
Pr Ultrasonic transducers	390
▶6V Electronic buzzer	65
▶12V Electronic buzzer	70
▶PB2720 Piezo transducer	75
▶64mm 64 ohm speaker	70
▶64mm 8 ohm speaker	70
20mm panel fuseholder	25
Red or black probe clip	35
4mm terminals	33
12 way 'chocolate' block	21
ultra-min. 6 or 12v rel. SPDT	130
ditto, but DPDT	195

EURO CONNECTORS

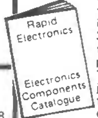
Gold flashed contacts:	Rt. angle plug	Wirewrap socket
64 wey A+B	195	230
64 way A+C	220	270
96 way A+B+C	320	330

TRIACS

		400V 8A	65
		400V 16A	95
400V 4A	50	BR100	25

* * * * * * * * * * * *

NEW 1985 CATALOGUE



Our new fully illustrated 50 page detailed information on over 3000 product lines at the most competitive prices in the market. The catalogue costs just 70p including postage or free with orders over £20 in value. Send for your copy today!

* * * * * * * * * * * *

COMPUTER CONNECTORS

ZX81 2 x 23 way edge connector wire wrap for ZX81 . . . 150
SPECTRUM 2 x 28 way edge connector wire wrap. . . 200
AMPHENOL PLUGS
24 way IEEE IDC . . . 450
36 way Centronix IDC . . . 490

RIBBON CABLE

Grey Ribbon cable. Price per foot

10 way	14	34 way	58
16 way	25	40 way	68
20 way	28	50 way	90
26 way	38	60 way	100

CAPACITORS

Polyester, radial leads. 250v. C280 type: 0.01, 0.015, 0.022, 0.033 - 6p; 0.047, 0.068, 0.1 - 7p; 0.15, 0.22 - 9p; 0.33, 0.47 - 13p; 0.68 - 20p; 1u - 23p.
Electrolytic, radial or axial leads: 0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V - 7p; 22/25V, 47/25V - 8p; 100/25V - 9p; 220/25V - 14p; 470/25V - 22p; 1000/25V - 30p; 2200/25V - 50p.
Tag end power supply electrolytics: 2200/40V - 110p; 4700/40V - 160p 2200/63V - 140p; 4700/63V - 230p
Polyester, miniature Siemens PCB: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p; 470n 26p; 680n, 29p; 1u 33p;

Tantalum bead:
0.1, 0.22, 0.33, 0.47, 1.0 @ 35V - 12p. 2.2, 4.7, 10 @ 25V - 20p; 15/16V - 30p; 22/16V - 27p; 33/16V - 45p, 47/6V - 27p; 47/16V - 70p; 68/6V - 40p; 100/10V - 90p.
Cer. disc. 22p-0.01u 50V, 3p each.
Mullard miniature ceramic plate: 1.8pF to 100pF 6p each.
Polystyrene, 5% tol: 10p-1000p, 6p; 1500-4700, 8p; 6800 0.012u, 10p.
Trimmers. Mullard 808 series: 2-10 pF, 22p; 2-22pF, 30p; 5.5-65pF, 35p

BRIDGE RECTIFIERS

		2A 200V	40
		2A 400V	45
		6A 100V	80
		6A 400V	95
1A 50V	20	VM18 DIL 0.9A	
1A 400V	35	200V	50

IDC CONNECTORS

	PCB Plug St.	PCB Plug Rt. ang.	Socket	Edge Conn.
10 way	70	70	70	–
16 way	75	80	80	–
20 way	90	90	95	130
26 way	105	110	115	155
34 way	115	130	130	180
40 way	140	140	145	210
50 way	165	165	170	240
60 way	195	195	200	–

LINEAR

		IC7611	98	LM358	50	LM3915	265	NE567	130	TDA1024	115
		ICL7621	190	LM377	210	LM1360C	110	NE570	370	TL061	40
555CMOS	80	ICL7622	200	LM380	80	MC1310	150	NE571	370	TL062	65
556CMOS	150	ICL8038	295	LM381	150	MC1496	70	NE5532	160	TL064	105
709	35	ICL8211A	220	LM382	130	MC3302	75	NE5534	105	TL071	38
741	16	ICM7224	785	LM384	140	MC3340	130	RC4136	65	TL072	60
748	35	ICM7555	80	LM386	90	MF10CN	330	RC4558	40	TL074	110
AY31270	720	ICM7556	150	LM387	120	ML922	390	SL486	195	TL081	30
AY38910	390	LF347	150	LM393	60	ML924	290	SL490	220	TL082	50
AY38912	430	LF351	40	LM710	48	ML925	290	SN76018	150	TL084	105
CA3046	65	LF353	75	LM711	60	ML926	210	SN76477	380	TL170	50
CA3080E	65	LF356	90	LM725	70	ML927	210	SP8629	250	UA2240	140
CA3089	200	LM10C	325	LM733	70	ML928	210	SP0256AL2	425	ULN2003	80
CA3090AQ	375	LM301A	30	LM741	16	ML929	210	Speech data	50	ULN2004	80
CA3130E	85	LM311	45	LM747	60	NE529	225	TBA800	70	XR2206	365
CA3140E	38	LM318	135	LM748	35	NE531	135	TBA810	90	ZN414	80
CA3160	95	LM324	45	LM1458	35	NE544	170	TBA820M	65	ZN423	135
CA3136	100	LM3342	85	LM2917N8	195	NE555	20	TBA950	220	ZN424P	130
CA3189	260	LM3352	125	LM3900	45	NE556	45	TCA940	165	ZN425E	350
CA3240E	100	LM339	40	LM3909	85	NE565	115	TDA1008	320	ZN426E	300
ICL7106	680	LM348	60	LM3914	265	NE566	140	TDA1022	490	ZN427E	600
										ZN428E	450
										ZN459	285
										ZN1034E	200

TRANSISTORS

				BC548	5	BFR40	23	2N1613	30	2N3906	10		
				BC549	10	BFR80	23	2N2218A	45	2N4037	45		
				BC557	10	BFR81	23	2N2219A	28	2N4058	10		
AC125	35	BC158	11	BC558	10	BFX29	30	2N2221A	25	2N4060	10	TIP35C	125
AC126	30	BC158	10	BCY70	16	BFX84	30	2N2222A	20	2N4061	10	TIP36A	115
AC127	30	BC159	10	BCY71	16	BFX85	30	2N2368	25	2N4062	10	TIP36C	130
AC128	30	BC160	40	BCY72	16	BFX86	30	2N2369	18	40360	40	TIP41A	45
AC176	25	BC168C	10	BD115	55	BFX87	30	2N2484	27	40361	50	TIP42A	45
AC187	25	BC169C	10	BD131	40	BFX88	30	2n2646	60	40362	50	TIP120	60
AC188	25	BC170	8	BD132	40	BFY50	27	2N2904	28	40408	50	TIP121	60
AD142	120	BC171	10	BD133	50	BFY51	27	2N2904A	28	2N5457	30	TIP122	60
AD161	42	BC172	8	BD135	35	BFY52	27	2N2905	28	2N5458	30	TIP141	110
AD162	42	BC177	16	BD136	35	BFY53	30	2N2905A	28	2N5459	30	TIP142	120
AF124	60	BC178	16	BD137	35	BFY55	30	2N2906	28	2n5485	35	TIP147	120
AF126	50	BC179	18	BD138	35	BFY56	30	2N2906A	28	2N5777	45	TIP2955	70
AF139	40	BC182	10	BD139	35	BRY39	50	2N2907	24	2N697	20	TIP3055	60
AF186	70	BC182L	10	BD140	35	BSX20	22	2N2907A	24	2N698	40	TIS43	40
AF239	55	BC183	10	BD204	110	BSX29	35	2N2926	10	2N706A	20	TIS43	40
BC107	10	BC183L	10	BD206	110	BSY95A	30	2N3053	28	2N708	25	TIS44	45
BC107B	12	BC184	10	BD222	85	BU205	160	2N3054	55	2N918	35	TIS45	45
BC108	10	BC184L	10	BF180	35	BU206	200	2N3055	50	TIP29	35	TI590	30
BC108B	12	BC212	10	BF182	35	BU208	170	2N3442	120	TIP29A	35	TI591	30
BC108C	12	BC212L	10	BF184	35	MJ2955	99	2N3702	9	TIP29B	35	VN10KM	65
BC109	10	BC213	10	BF185	25	MJE340	50	2N3703	10	TIP29C	35	VN46AF	94
BC109C	12	BC213L	10	BF194	12	MJE520	50	2N3704	9	TIP30	35	VN66AF	110
BC114	22	BC214	10	BF195	12	MJE521	90	2N3705	10	TIP30A	35	VN88AF	120
BC115	22	BC214L	10	BF196	12	MJE3055	70	2N3706	10	TIP30B	35	ZTX107	11
BC117	22	BC237	7	BF197	12	MPF102	40	2N3707	10	TIP30C	40	ZTX108	11
BC119	35	BC238	7	BF198	15	MPF104	40	2N3708	10	TIP31A	35	ZTX109	11
BC137	40	BC308	10	BF199	18	MPSA05	23	2N3709	10	TIP31B	35	ZTX300	14
BC139	38	BC327	8	BF200	35	MPSA06	25	2N3772	170	TIP31C	40	ZTX301	16
BC140	29	BC328	8	BF244B	35	MPSA12	29	2N3773	195	TIP32A	35	ZTX302	16
BC141	30	BC337	8	BF245	35	MPSA55	30	2N3819	32	TIP32B	38	ZTX304	20
BC142	28	8C338	12	BF256B	45	MPSA56	30	2N3820	50	TIP32C	40	ZTX341	20
BC143	30	BC477	22	BF257	32	MPSU05	55	2N3823	65	TIP33A	65	ZTX500	13
BC147	10	BC478	22	BF258	30	MPSU06	55	2N3866	90	TIP33C	75	ZTX501	18
BC148	10	BC479	22	BF259	30	MPSU55	55	2N3903	10	TIP34A	70	ZTX502	18
BC149	10	BC517	30	BF337	35	MPSU56	55	2N3904	10	TIP34C	80	ZTX503	18
BC157	11	BC547	5	BFR40	35	2N118L	22	2N3905	10	TIP35A	105	ZTX504	25

RESISTORS

Carbon film	1+	25+
¼W 5% 4.7ohm - 10M	2p	1p
½W 5% 4.7ohm - 4M7	3p	2p
Metal film		
¼W 1% 10ohm - 1M	4p	3p

25+ price applies to 25+ per value not mixed.

CRYSTALS

		4.194MHz	150
		4.43MHz	100
100KHz	235	5.008MHz	240
1MHz	275	6.0MHz	140
1.8432M	200	6.144MHz	150
2.0MHz	225	7.0MHz	150
2.4576M	200	8.0MHz	140
3.276M	150	10.0MHz	170
3.579M	95	12.0MHz	170
4.0MHz	140	16.0MHz	200

BOXES

		Aluminium	
		3 x 2 x 1"	65
Plastic with lid		4 x 2¾ x 1½"	95
& screws		4 x 2½ x 2"	95
71x46x22mm	50	6 x 4 x 2"	120
95x71x35mm	86	7 x 5 x 2½"	165
140x90x55mm	140	8 x 6 x 3"	205

TTL

		7412	25	7440	25	7476	40	74107	40	74157	80	74180	85
		7413	36	7442	74	7480	50	74109	60	74160	90	74181	230
		7414	60	7444	105	7483	65	74121	50	74161	90	74182	85
7400	25	7416	43	7446	130	7485	110	74122	50	74162	90	74190	120
7401	25	7417	43	7447	98	7486	38	74123	92	74163	90	74191	120
7402	25	7420	25	7448	98	7489	170	74125	50	74164	115	74192	120
7403	25	7421	30	7450	25	7490	55	74126	50	74165	90	74193	110
7404	25	7422	30	7451	25	7491	80	74132	60	74167	200	74194	80
7405	25	7427	30	7453	25	7492	55	74141	80	74170	170	74195	63
7406	45	7428	30	7454	25	7493	55	74145	85	74173	100	74196	120
7407	45	7430	25	7460	25	7494	90	74147	130	74174	100	74197	85
7408	25	7432	35	7472	35	7495	70	74148	105	74175	80	74198	195
7409	25	7433	35	7473	40	7496	80	74150	130	74176	80	74199	195
7410	25	7437	43	7474	36	7497	170	74153	70	74177	80		
7411	25	7438	45	7475	55	74100	125	74154	135	74179	90		

CMOS

		4016	26	4034	145	4054	70	4081	18	4502	50	4529	80
		4017	43	4036	270	4055	70	4082	20	4503	45	4532	65
		4018	55	4039	270	4059	400	4085	60	4507	45	4534	390
4000	18	4019	35	4040	46	4060	70	4086	60	4508	115	4538	70
4001	18	4020	48	4041	55	4063	80	4089	120	4510	48	4543	65
4002	18	4021	55	4042	45	4066	24	4093	26	4511	50	4549	390
4006	65	4022	60	4043	45	4067	230	4094	70	4512	50	4553	215
4007	18	4023	18	4044	50	4068	18	4095	70	4514	115	4555	50
4008	50	4024	35	4046	60	4069	18	4097	260	4515	115	4556	50
4009	40	4025	18	4047	52	4070	22	4098	70	4516	48	4559	390
4010	40	4026	120	4048	50	4071	18	40106	38	4518	48	4560	110
4011	18	4027	28	4049	26	4072	18	40109	100	4520	48	4584	38
4012	18	4028	40	4050	26	4073	18	40163	75	4521	110	4585	65
4013	26	4029	45	4051	48	4075	24	40173	100	4526	70	4724	140
4014	50	4030	18	4052	48	4076	60	40175	75	4527	60		
4015	42	4031	125	4053	60	4077	24	40193	90	4528	45		

LS TTL

		LS20	22	LS75	38	LS123	70	LS161	60	LS221	78	LS365	42
		LS21	22	LS76	28	LS125	37	LS162	60	LS240	105	LS366	42
		LS22	22	LS78	28	LS126	37	LS163	60	LS241	80	LS367	42
LS00	22	LS26	22	LS83	68	LS132	53	LS164	70	LS242	80	LS368	42
LS01	22	LS27	22	LS85	82	LS136	35	LS165	95	LS243	80	LS373	80
LS02	22	LS30	22	LS86	35	LS138	48	LS166	88	LS244	80	LS374	80
LS03	22	LS32	22	LS90	40	LS139	48	LS170	120	LS245	88	LS375	55
LS04	22	LS37	22	LS92	50	LS145	92	LS173	80	LS247	77	LS377	100
LS05	22	LS38	22	LS93	45	LS147	130	LS174	60	LS251	55	LS378	88
LS08	22	LS40	22	LS95	58	LS148	115	LS175	60	LS257	55	LS390	82
LS09	22	LS42	60	LS96	120	LS151	55	LS190	75	LS258	55	LS393	82
LS10	22	LS47	78	LS107	42	LS153	80	LS191	55	LS259	90	LS399	115
LS11	22	LS48	78	LS109	42	LS154	220	LS192	75	LS266	28	LS541	115
LS12	22	LS51	22	LS112	42	LS155	55	LS193	75	LS273	80	LS670	170
LS13	35	LS55	22	LS113	32	LS157	48	LS195	60	LS279	55		
LS14	45	LS73	28	LS114	32	LS158	48	LS196	75	LS283	70		
LS15	22	LS74	28	LS122	56	LS160	60	LS197	75	LS353	85		

The Rapid Guarantee

★ Same day despatch ★ Competitive prices
★ Top quality components ★ In-depth stocks

ORDERING INFO. All components brand new and to full spec. All prices exclude VAT. Please add to total order. Please add 50p carriage to all orders under £20 in value Minimum order £5 . Send cheque/P.O. or Access/Visa number with order. Our new 50 page catalogue is given free with all orders over £20. Available at 70p each. Telephone orders welcome with Access or Visa. Official orders accepted from colleges, schools etc. Export orders no VAT but please add for carriage. We are open Monday to Friday.

EVERYDAY ELECTRONICS and computer PROJECTS

VOL 14 Nº2 FEBRUARY '85

READERS' ENQUIRIES

We cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. All letters requiring a personal reply should be accompanied by a stamped self-addressed envelope or international reply coupons.

We cannot undertake to engage in lengthy discussions on the telephone.

COMPONENT SUPPLIES

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

All reasonable precautions are taken to ensure that the advice and data given to readers are 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 the indefinite availability of components used.

SUBSCRIPTIONS

Annual subscription for delivery direct to any address in the UK: £12.00. Overseas: £13.00. Cheques should be made payable to IPC Magazines Ltd., and sent to Room 2613, King's Reach Tower, Stamford Street, London SE1 9LS.

BACK ISSUES

Certain back issues of EVERYDAY ELECTRONICS are available world-wide price £1.00 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

Binders to hold one volume (12 issues) are available from the above address for £5.50 inclusive of postage and packing worldwide.

POSTBAG PUBLISHING

Our postbag is an important part of the magazine and while we do not publish many readers' letters we do receive plenty. Obviously it is not interesting reading material to publish letters asking about individual component buying or project queries, requests for photostats, back numbers or printed circuit boards; however, these letters all help to produce the magazine.

By scrutinising every letter that comes in we can see what features interest most people, by checking our p.c.b. orders we can see just what you are building and by carefully reading your queries regarding projects and features we can see what areas of theory and which techniques are giving you problems. Obviously we would be very rash to base any policy on an odd letter but over a period a picture is built up which often confirms our "gut feelings" about where the hobby is going and what you would like to see in your publication.

For instance we know that the majority of our readers own a computer and are now getting interested in building projects for them. *The Microcomputer Interfacing Techniques* series which was run in EE last year was one of the most popular project oriented series ever and items like the *Spectrum Amplifier* have inspired many to take up the soldering iron.

With such response in mind we have decided to introduce a special regular feature on the Spectrum. *On Spec* will start next month and will be edited by Mike Tooley BA, who is Principle Lecturer in Electronics at Brooklands Technical College. Mike will be well known to many readers as a regular contributor to our sister publication, *Practical Electronics*. He is involved with the Spectrum at various levels through the College and is therefore well qualified to edit the feature. We say edit rather than write as we hope most of the ideas and queries that will form *On Spec* will come from you! Incidentally a similar feature dealing with the BBC Micro will be run in *Practical Electronics*.

The March issue of EE will also carry a *Monitor Buyer's Guide* which will give computer users an introduction to the advantages and specifications of monitors in addition to showing a wide range of products.

We will continue to feature regular projects for computer users but we will not forget all the other applications for projects. For instance we have noted that the *Digital Multimeter* design has been well received, as test gear projects usually are, so we will be keeping to our policy of regular inclusion of test gear projects, along with a whole range of designs for a wide variety of uses.

Mike Kenward

Editorial Offices
EVERYDAY ELECTRONICS EDITORIAL, WESTOVER HOUSE,
WEST QUAY ROAD, POOLE, DORSET BH15 1JG Phone: Poole (0202) 671191
We regret that lengthy technical enquiries cannot be answered over the telephone

COMPUTERISED TRAIN CONTROLLER

R. A. PENFOLD

A computerised model train controller probably conjures up ideas of massive layouts and numerous flashing lights in most people's minds, but this need not be the case. Added interest can be given to the most modest of model train layouts by using a home computer to control the train. With a suitable program and track sensors the train can be made to do such things as perform a certain number of laps, stop at the station for the required period of time, complete a certain number of laps in the opposite direction, and so on. Another possibility is to run the train to a timetable using the timer facility which is available on most home computers. With a suitable program a computerised train controller can function as a sophisticated conventional device, with features such as simulated inertia and braking.

Obviously some form of interface between the computer and the engine is required, and in its most basic form this could consist of just one relay, to switch the power to the track on and off. This would give rather unrealistic results though, and give very limited control over the train. A better method, and the one adopted for this project, is to have a variable power controller so that the speed of the train can be accurately controlled. Furthermore, this unit uses a pulsed controller circuit which gives excellent starting and slow speed performance. Also, a relay at the output of the unit is controlled by the computer, and this enables the direction of the train to be controlled.

The unit is designed for use with the BBC model B, VIC-20, and Commodore 64 computers, and it connects to the user ports of these machines. It could probably be used with other computers, but it would almost certainly be necessary to resort to machine code programming in order to generate the main output signal for the controller.

PULSED CONTROL

The most basic of model train controllers consists of a high power variable resistor connected in series with the motor, so that, by varying the resistance, the power to the motor (and its speed) can be varied. This system does not give very accurate speed control since any increase in the load on the motor, such as when the train is going up a gradient, causes the motor to attempt to draw more current. This it will, in fact, do, but the variable resistor and the motor effectively form a potential divider, and when the motor tries to draw more current, its reduced resistance gives reduced voltage across the motor. As the power fed to the motor is equal to the applied voltage multiplied by the current flow, this increased current but reduced voltage gives little change in the power fed to the motor.

When the loading on the motor is reduced, the opposite occurs, with the resistance of the motor rising, giving reduced current flow but increased voltage, resulting in little change to the power of the motor. The practical result of all this is that the train tends to "stall" when climbing gradients, and run fast when running down one. Another allied effect is the poor starting performance. This occurs due to the low resistance of the motor when it is stationary. This gives very little voltage across the motor, or power, until the speed control is well advanced. When the train does start, the resistance of the motor becomes much greater, the voltage across the motor rises, and much more power is available. This gives the inevitable "jump" start that will be familiar to anyone who has used this type of train controller.

A common way around these starting and speed control problems is to use a constant voltage circuit. This is really just a stabilised power supply circuit, and by having a regulated voltage across the

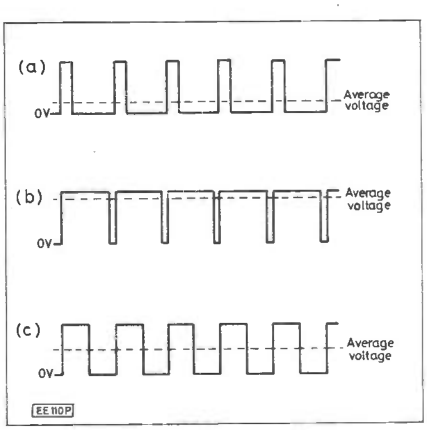
COMMODORE 64 BBC-B and VIC 20 compatible

motor it can draw more or less current and power when necessary, and to an extent the motor speed is regulated as well. In practice the variations in the power fed to the motor are not sufficient to give anything approaching perfect speed regulation, and the starting problem is not totally eliminated either, nevertheless quite good results are obtained using these methods.

For very high performance there are two standard methods of controlling a model train. One is to use what is effectively a stabilised supply, but one that over compensates for variations in loading by the motor. This can work very well indeed, but ideally the driver circuit must be properly matched to the motor it is controlling. The second method is to use pulses at full power to drive the motor, and for a computerised controller the use of a pulsed controller has obvious attractions. The power fed to the motor is varied by altering the mark-space ratio of the output signal. With a low mark-space ratio, as in Fig. 1(a), the average voltage (and power) supplied to the motor is low, and it operates at low speed. However, during the pulses the motor is driven at full power, and this gives good resistance to stalling. Also, these pulses at full power help to nudge the motor into action to give a good starting performance. To produce full speed a signal with a high mark-space ratio, as in Fig. 1(b) is used, so that the average output voltage is virtually equal to the full supply potential. Intermediate mark-space ratios give intermediate motor speeds, with a waveform of the type shown in Fig. 1(c) giving half power.

Various types of constant voltage controller were evaluated, but the circuit finally adopted is a pulsed type. This gives both simplicity and low cost, but nevertheless provides excellent performance. Also, only two lines of the user port are used (including one for direction control), which leaves some eight or nine input/output lines available for use with track sensors, points controllers, signals, etc.

Fig. 1. By varying the mark-space ratio of the signal, the average output voltage of a pulsed controller can be set at any desired level.



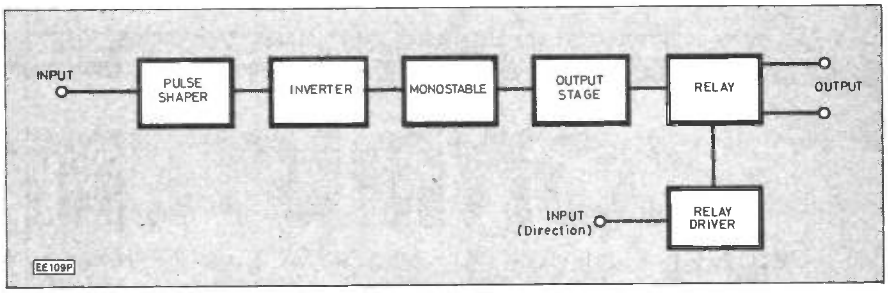
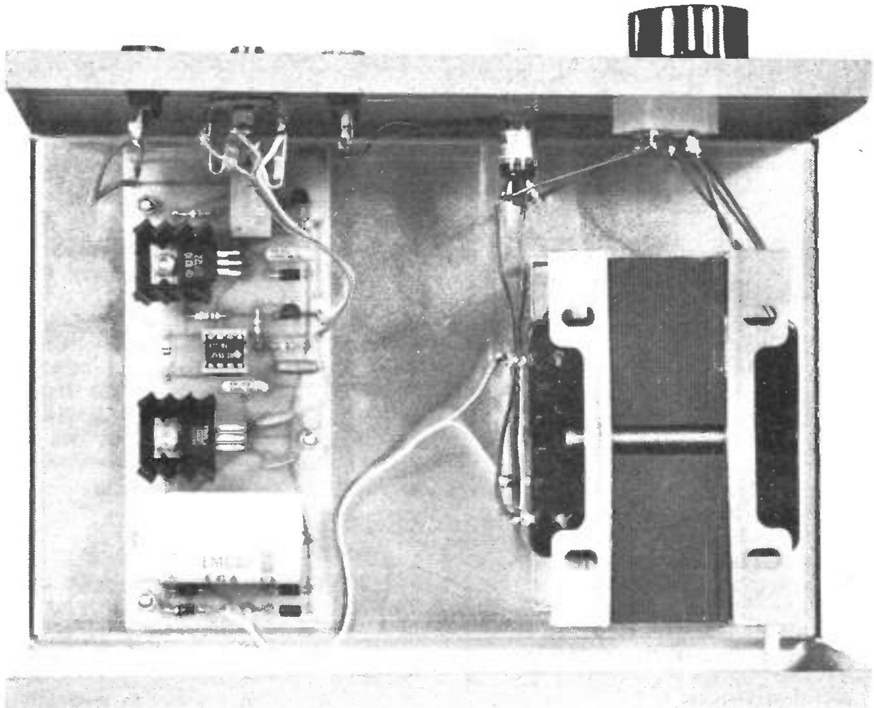


Fig. 2. Block diagram of the controller.



Details of the internal layout.

BLOCK DIAGRAM

There is more than one way in which a computer could be used to generate the pulse control signal for an electric motor. One way would be to use software to directly generate the signal on an output line, but this would probably require machine code programming, and would be a relatively complex way of doing things. Some computers incorporate a counter/timer circuit which can be used to generate a wide range of output frequencies, and the three machines mentioned earlier have this facility. This enables a very simple method of speed control to be used in conjunction with an equally simple interface. This is the system utilised in this controller, and Fig. 2 shows the interface in block diagram form.

The monostable is at the heart of the unit, and this produces an output pulse of fixed duration each time it receives a brief trigger pulse. With a low input frequency the output pulses are well spaced out, giving little power to the motor. As the input frequency is increased the average output power steadily increases until the point is reached where the gaps between the pulses are practically non-existent. This represents full power, and it is important not to increase the input frequency beyond this point or the monostable will only be triggered on alternate input pulses, causing the output power to drop to only about half maximum.

The output from the computer is a squarewave, and this is processed by a pulse shaper and an inverter to give the short negative trigger pulses required by the monostable. The output current available from the monostable is inadequate to drive a small electric motor, and an output stage is therefore needed to boost the output current capability. A maximum output of about 1 amp is available, and this is sufficient for normal (00 and smaller) model railway gauges. A relay having double pole changeover contacts is used at the output to control the polarity of the output, and the direction of

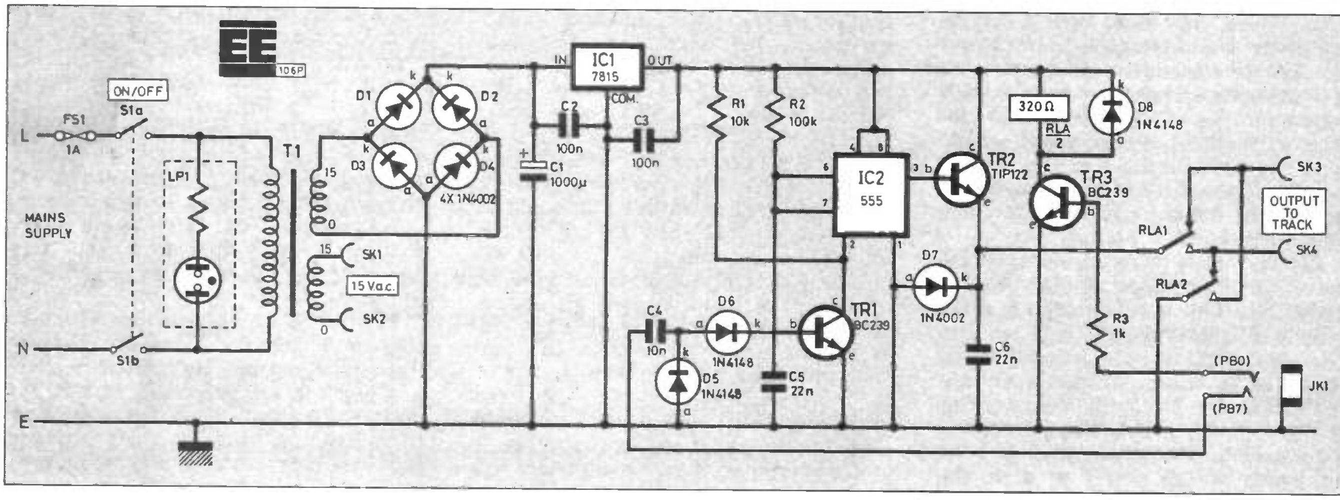


Fig. 3. Full circuit diagram of the Controller.

COMPONENTS

See Shop Talk page 84

Resistors

R1	10k
R2	100k
R3	1k

All ¼W 5% carbon

Capacitors

C1	1000u 25V axial elect
C2,3	100n ceramic (2 off)
C4	10n polyester
C5,6	22n polyester (2 off)

Semiconductors

IC1	uA7815
IC2	NE555
TR1,3	BC239 (2 off)
TR2	TIP122
D1,2,3,4,7	IN4002 (5 off)
D5,6,8	IN4148 (3 off)

Miscellaneous

T1	Mains primary, twin 15 volt 2 amp secondaries
LP1	Mains panel neon
S1	Rotary mains switch
SK1,2,4,5	4mm sockets (4 off)
JK1	Standard stereo jack socket
RLA	12V 320 coil, d.p.d.t. contacts, miniature p.c.m.
FSI	1A fuse and panel mounting holder

Metal instrument case about 200 × 150 × 100mm, printed circuit board, control knob, M3 or 6BA fixings, connecting cables, mains lead and plug, heatsinks plus fixings for (IC1) and (TR2).

Approx. cost Guidance only £18.50

the train. This is operated from a latching output of the computer's user port via a simple driver circuit.

Controlling the speed of the train is also very easy using this system. After a single command to set the interface device in the computer to the correct operating mode, the speed is controlled merely be writing numbers to two addresses. These two addresses effectively give *fine* and *coarse* speed control.

THE CIRCUIT

The circuit is based on the ubiquitous 555 timer device, as can be seen from the circuit diagram shown in Fig. 3.

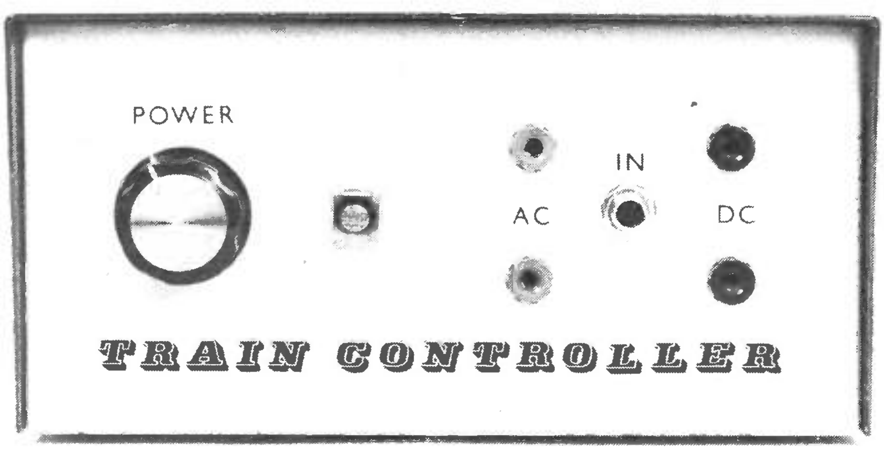
A supply potential of about 15 volts is required, and this is provided by a conventional fullwave bridge rectifier and smoothing circuit, plus a monolithic voltage regulator (IC1). The use of a well stabilised supply aids good performance, but the built-in current limiting facility of IC1 is a vital ingredient. Output short circuits are quite common with model railway layouts, and this current limiting protects the rectifiers, output transistor, and relay contacts against an excessive output current.

Mains transformer T1 has two secondary windings, one of which is used to power the controller while the other provides a 15 volt a.c. 2 amp output for use with a second controller, lighting circuit, etc.

Pin 2 of IC2 is the trigger input, and this must be briefly taken below one third of the supply voltage in order to trigger the device. It is important that the trigger pulses are short since they will otherwise lengthen the output pulses from IC2 and prevent the circuit from functioning properly. C4, D5 and D6 are used to shape the squarewave input signal to give short positive pulses. These are then inverted by TR1 to give the negative trigger pulses for IC2.

The output pulse duration of IC2 is set by R2 and C5, and is approximately 2·5 milliseconds. This corresponds to an input frequency of about 400Hz for maximum speed. The length of the output pulse is important since a slightly longer pulse duration would give rather jerky movement of the train at slow speeds. A significantly shorter pulse length would necessitate a high frequency in order to give maximum output power, and due to the highly inductive load presented by an electric motor this could result in a severe lack of power.

The Darlington power transistor (TR2)



is used in the emitter follower mode, as the output buffer stage. D7 suppresses any high reverse voltage spikes that are generated across the motor, and C6 helps to attenuate high frequencies on the output and minimises radio frequency radiation.

TR3 is used as a straightforward common emitter driver for the relay coil, and D8 is the usual protection diode. The relay's d.p.d.t. contacts are connected in series with the outputs of the unit and cross-coupled so that the polarity of the output signal is controlled.

CONSTRUCTION

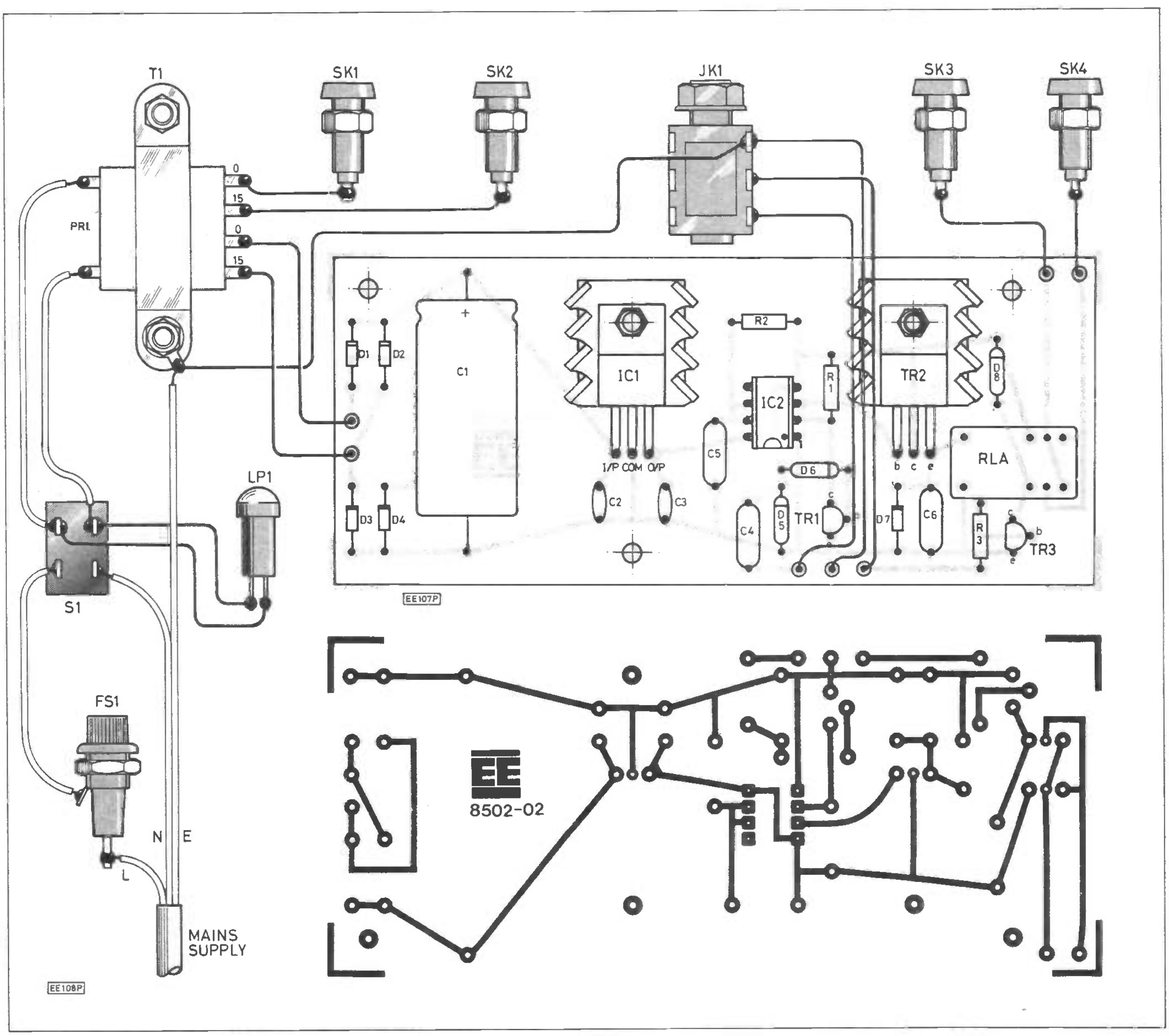
A metal instrument case having approximate outside dimensions of 200 by 150 by 100 millimetres makes a suitable housing for this project. This may seem to be somewhat larger than is absolutely necessary, but smaller cases would probably not have sufficient height to accommodate the mains transformer. For reasons of safety it is advisable to use a case of all metal construction, and to earth this to the mains earth lead. Also, use a case that has a screw fixing lid or cover, and not one which has a clip-on lid that would give easy access to the dangerous mains supply.

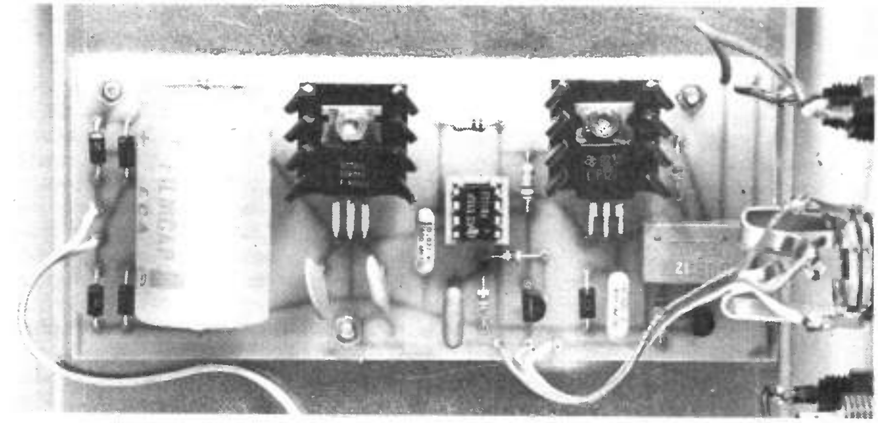
The general layout of the unit can be seen from the photographs. A soldertag is fitted to the chassis to provide a connection point for the mains earth lead, and this can conveniently be fitted on one of the mounting bolts of T1. The hole in the rear panel for the mains earth lead should be fitted with a grommet for protection.

Details of the printed circuit board and wiring are shown in Fig. 4. In most respects construction of the board is quite straightforward, but one point to bear in mind is that the relay will only fit direct onto the board if the specified component is used. If an alternative is used it will almost certainly be necessary to mount it off-board and hard-wire it to the printed circuit board. From the electrical point of view any relay having a 12 volt coil with a resistance of about 200 ohms or more, plus double pole changeover contacts rated at 1 amp or more at 15 volts d.c., is perfectly suitable.

IC1 and TR2 are mounted horizontally on the board and are bolted in position. Furthermore, they are both fitted with small finned heatsinks which fit between each device and the board. Neither component has to dissipate much power and this small amount of heatsinking seems to be quite adequate in practice.

Fig. 4. Component layout, p.c.b. design and wiring details. P.c.b. design available from the EE PCB Service, code 8502-02.





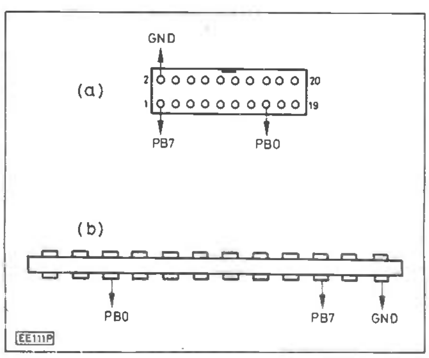
Veropins are fitted at points where connections to the off-board components will eventually be made. The completed board is then mounted on the chassis using 6BA or M3 fixings. These should include spacers about 6 to 12 millimetres long to keep the underside of the board well clear of the chassis. The remaining wiring is then added using ordinary PVC insulated multistrand connecting wire. Although there is little wiring in the unit, as the mains supply is involved be very careful to avoid any careless errors. When all aspects of assembly are complete, check the unit throughout for errors.

USING THE CONTROLLER

SK3 of the controller connects to the user port of the computer via a 3-way cable fitted with a standard stereo jack plug which connects to SK3. The other end of the cable is fitted with a 20-way IDC header socket if the unit is to be used with the BBC model B computer, or a 2 × 12-way 0·156 inch pitch edge connector if it is to be used with the VIC-20 or the Commodore 64. Connection details for all three machines are shown in Fig. 5.

The user ports of the BBC model B and VIC-20 computers both use port B of a 6522 VIA (versatile interface adaptor). Therefore, both machines are programmed in basically the same way when operating the controller. It is principally timer 1 that we are concerned with here,

Fig. 5. Connection details for (a) the BBC model B and (b) the VIC-20 Commodore 64.




```
10    REM *TRAIN CONTROLLER*
20    REM by John Penfold
30    REM for BBC model B w/o 2nd.
        Processor
40    *fx225,160
50    ?&FE62=129
60    ?&FE63=192
65    speed=6000
70    VDU 23,1,0,0,0,0
80    choice=0:oldchoice=0
90    PROCoptions
100   key=INKEY(1):IF key <>—1
        PROaccept
110   IF choice=160 PROCaccelerate
120   IF choice=161 PROCcruise
130   IF choice=162 PROCbrake
140   IF choice=163 PROCreverse
150   IF choice=164 PROCkick
160   IF choice=165 PROChandbrake
170   IF choice=167 PROChorn
180   IF choice=169 PROCemergency
190   IF choice=0 PROCdelay
200   GOTO 100
1000  DEF PROCoptions
1010  CLS
1020  PRINTTAB(10,3)CHR$141;
        “OPTIONS”
1030  PRINTTAB(10,4)CHR$141;
        “OPTIONS”
1040  PRINTTAB(3,10)“f0—Accelerate”
1050  PRINTTAB(3,11)“f1—Cruise
        Control”
1060  PRINTTAB(3,12)“f2—Brake”
1070  PRINTTAB(3,13)“f3—Change
        Direction”
1075  PRINTTAB(3,14)“f4—Power kick”
1076  PRINTTAB(3,15)“f5—Handbrake
        on”
1077  PRINTTAB(3,16)“f6—Handbrake
        off”
1078  PRINTTAB(3,17)“f7—Horn”
1080  PRINTTAB(3,19)“f9—CHR$(129);
        “EMERGENCY BRAKE”
1090  ENDPROC
2000  DEF PROCout(dbyte)
2010  ?&FE64=dbyte MOD 256
2020  ?&FE65=dbyte DIV 256
2030  ENDPROC
3000  DEF PROCaccelerate
3010  IF speed<1280 choice=0:
        PROCpointer: ENDPROC
3020  speed=speed—4
3025  IF speed>4000 speed=speed—4
3027  IF speed>5000 speed=speed—4
3030  PROCout(speed)
3040  ENDPROC
4000  DEF PROCbrake
4010  IF speed>6000 choice=0:
        PROCpointer:ENDPROC
4020  speed=speed+4
4024  IF speed>4000 speed=speed+4
4028  IF speed>5000 speed=speed+4
4030  PROCout(speed)
4040  ENDPROC
5000  DEF PROCcruise:ENDPROC
6000  DEF PROCemergency
6010  IF speed>6000 choice=0:
        PROCpointer:ENDPROC
6020  REPEAT
6030  speed=speed+16
6040  PROCout(speed)
6050  UNTIL speed>6000
6060  choice=0: PROCpointer
6070  ENDPROC
7000  DEF  PROCreverse
7010  oldspeed=speed
7020  REPEAT
7030  speed=speed+8
7035  PROCout(speed)
7040  UNTIL speed>6000
7050  ?&FE60=NOT ?&FE60
7060  REPEAT
7070  speed=speed—8
7075  PROCout(speed)
7080  UNTIL speed=oldspeed
7090  choice=reselect:PROCpointer
7100  ENDPROC
8000  DEF PROCdecay
8010  IF speed>6000 ENDPROC
8020  speed=speed+1
8030  PROCout(speed)
8040  ENDPROC
9000  DEF PROCkick
9010  PROCout(1280)
9015  FOR D=1 TO 50:NEXT D
9020  PROCout(speed)
9030  choice=160:PROCpointer
9040  ENDPROC
10000 DEF PROCpointer
10010 If choice<>0 PRINTTAB(1,
        choice—150)CHR$136
10020 If oldchoice<>choice PRINTTAB
        (1,oldchoice—150)CHR$32
10025 reselect=oldchoice
10030 oldchoice=choice
10040 ENDPROC
11000 DEF PROChandbrake
11005 IF speed<6000 PROCemergency:
        choice=165:PROCpointer
11010 ?&FE62=0:?&FE63=0
11020 REPEAT
11025 IF INKEY—23 PROChorn:
        choice=165:PROCpointer:
        *FX21,0
11027 UNTIL INKEY—118
11030 ?&FE62=129:?&FE6B=192
11040 choice=166:PROCpointer
11050 ENDPROC
12000 DEF PROChorn
12010 SOUND 1,—15,60,20
12020 SOUND 1,—15,80,20
12030 choice=reselect:PROCpointer
12040 FOR D=1 TO 200:NEXT D
12050 ENDPROC
13000 DEF PROaccept
13010 IF key<160 ENPROC
13020 IF key=166 ENDPROC
13030 choice=key
13040 PROCpointer
13050 ENDPROC
```

and we are using it in the mode where it divides the internal clock signal and provides an output on line PB7. PB7 must be set as an output, and as we are using PBO to control the direction relay, this line must also be set as an output. This is achieved by writing 129 to the data direction register which is at address &FE62 (BBC model B) and address 37138 (VIC-20).

Timer 1 is controlled by bits 6 and 7 of the auxiliary control register. In this case we require the free running mode with the output on PB7 enabled, and these bits are both set high to achieve this. Therefore, 192 is written to address &FE64 in the case of the BBC machine, and 37147 for the VIC-20.

Timer 1 occupies two bytes which together form a 16 bit number (the number by which the machine clock frequency is divided). In the BBC machine these are at addresses &FE64 (low byte) and &FE65 (high byte). The equivalent VIC-20 addresses are 37140 and 37141 respectively. Something approaching maximum speed will probably be produced with the low byte at zero and the high byte at 4, but a little experimentation will soon determine the particular values that are relevant for your set-up. The figures which result in the train just stopping depends on a number of factors, but the train will usually stop with about 12 loaded into the high byte.

In order to test the unit the following short program can be used:

BBC model B

```
POKE 37138,129
POKE 37147,192
POKE 37140,127
POKE 37141,6
```

VIC-20

```
?&FE62=129
?&FE63=192
?&FE64=127
?&FE65=6
```

This should result in the train going fairly fast, but at something less than maximum speed. The speed of the train can be altered by writing different numbers to the timer bytes. The direction can be changed using this command:

```
POKE 37136,1          ?&FE60=1
```

To change the direction back again, use:

```
POKE 37136,0          ?&FE60=0
```

The Commodore 64 has a slightly different interface device, the 6562, and this requires slightly different programming. The data direction register is at address 56579, and 1 is POKEd to this address to set PBO as an output. The port itself is at address 56577, and 1 is POKEd to this address to switch on the direction control relay—0 to switch it off again.

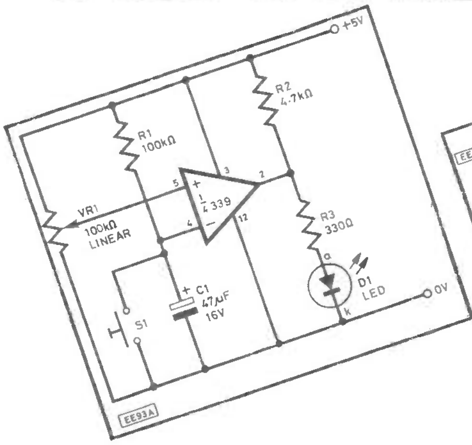
It is timer B that is used to divide the machine clock frequency and provide the squarewave output for the train controller. This has its low and high bytes at address 56582 and 56583 respectively. The control register for timer B is at address 56591. Bit 0 is set high to start the timer, while bit 1 is set low to enable output on PB7. This automatically sets PB7 as an output. Bit 2 is set high to give a squarewave output and bit 3 is set low to give continuous rather than one-shot operation. Bit 4 is set high to load the timer. Any data written to either byte will then be immediately loaded into the timer. Bits 5 and 6 are both set low to direct the timer to take its input from the system clock. Bit 7 is not relevant in this application. This gives a total of 23 to write to the control register. For the Commodore 64 the following routine can be used to test the unit.

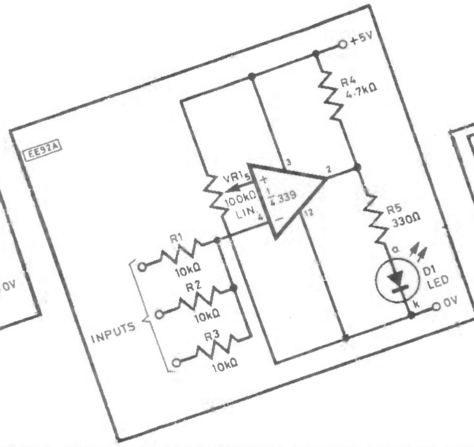
Commodore 64

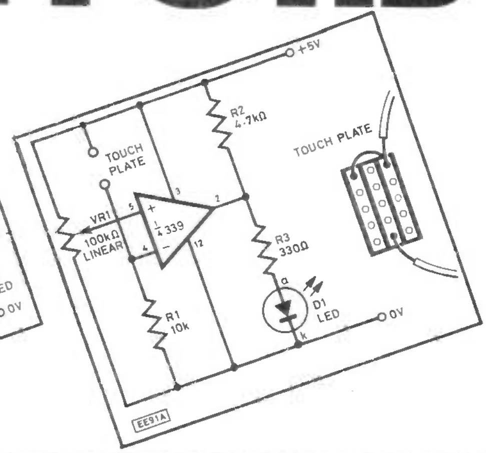
```
POKE 56579,1
POKE 56591,23
POKE 56582,127
POKE 56583,6
```

The accompanying listing (opposite) for the BBC computer enables the controller to be used as a conventional type having an accelerator, brake, reversing switch, emergency brake, cruising control, and a two-tone horn sound effect. The program is self-explanatory in use. It should be possible to include other features such as a "chuffer" sound effect, and there is plenty of scope for experimentation here. An alternative approach is to program the train to run completely automatically, but for best results this requires a small amount of additional hardware, with such things as sensors to detect the train, points controllers, and automatic signals. □

COMPARATORS







T. PRITCHARD

A COMPARATOR, often described as a voltage comparator, is an electronic circuit that gives an indication of which of two analogue input signals is the larger. In practice, we often use operational amplifiers (such as the popular 741) as comparators; even though integrated circuit packages exist that are dedicated comparators. In this article, I hope to describe these circuits and give some useful applications for them.

WHAT ARE THEY?

We can connect up an operational amplifier to act as a comparator as shown in Fig. 1.

As the voltage on V_{test} increases nothing happens until it exceeds the voltage V_{ref}, at which point the output of the operational amplifier changes state. This will be described in more detail later in the article. Thus we can detect when the test voltage exceeds the reference voltage or which, of the test voltage and reference voltage is the largest by examining the state of the output. Connecting the reference voltage to the inverting input of the operational amplifier gives the situation as shown in Fig. 3.

In both of these circuits, you have probably noticed the use of both a positive and negative power supply, and a ground. This is commonplace in operational amplifier circuits. We call Vs^+ and Vs^- saturation voltage levels, and they are the most positive and the most negative voltages that the output of the cirucit can attain, being within a couple of volts of the supply voltages. The operational amplifiers are connected in the circuit configuration known as an *open loop amplifier*. In this configuration, the op-amp will amplify the difference in voltage between the inverting and the non-inverting inputs of the amplifier in accordance with the equation below:

$$V_{OUT} = G\,(V^+ - V^-)$$

V^+ is the voltage applied to the non-inverting input of the op-amp- and V^- is the voltage applied to the inverting input. The constant, G, for a given operational amplifier is called the *open loop gain*. This parameter is a measure of the amount of amplification that can be provided by an op-amp circuit and is typically very large in the order of 10000 or more.

Thus, a small difference in the voltages applied to the inputs gives a very large change in the output voltage. Obviously, the output voltage cannot be more than Vs^+ in one direction and more than Vs^- in the other direction. Thus a small difference in the voltages at the input will result in the output achieving one of the two saturation levels. If the voltage applied to the non-inverting input is greater than the voltage applied to the inverting input then the output will swing to Vs^+.

If the situation is the other way round then the output will swing towards Vs^-. The difference in voltages applied to the inputs needed for the output to go from one saturation level to another is as small as 0·1 millivolts. By varying the voltage V_{ref} we can obviously alter the level of voltage at which the output transition will occur. The voltage V_{test} can be provided from a variety of sources, as we shall now see as we examine a practical comparator device and some applications.

QUAD COMPARATOR

The device chosen for examination is the LM339. This device is a quad comparator integrated circuit. This is an integrated circuit package containing four separate comparator circuits. I have several reasons for choosing this device. These are that it is fairly widely available, it is robust, it is powered from a single rail power supply instead of the dual rail ones we have seen in use with the operational amplifier comparators that we have already examined, and it will give an output capable of driving up to two TTL logic inputs. This means that the circuit could be used in conjunction with digital devices to provide a good digital input from various tranducers.

The circuit shown in Fig. 5 is a practical demonstration of the switching behaviour of a comparator circuit. The

HANDY CIRCUITS AND THEIR THEORY

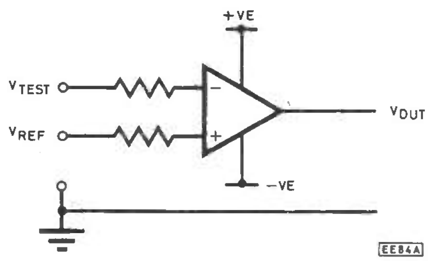


Fig. 1. An operational amplifier as a comparator. This will have a slower response transient than a dedicated comparator i.c, but is often a more convenient design solution. This circuit will give a 'low' output for a 'high' Vtest

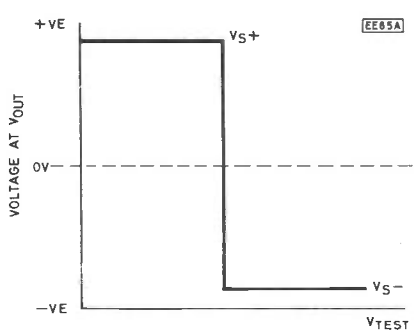


Fig. 2. The output voltage swing of the operational amplifier comparator. The comparator may be thought of as a single bit A-to-D converter

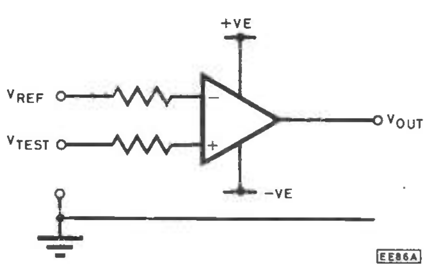


Fig. 3. The operational amplifier comparator wired so that a 'low' Vtest will give a 'low' output

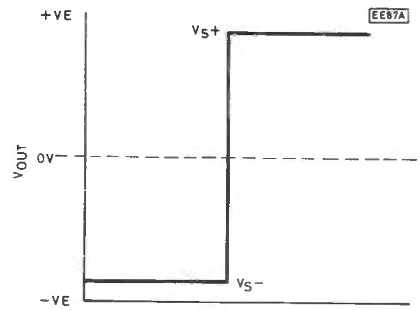


Fig. 4. The output voltage swing of the comparator

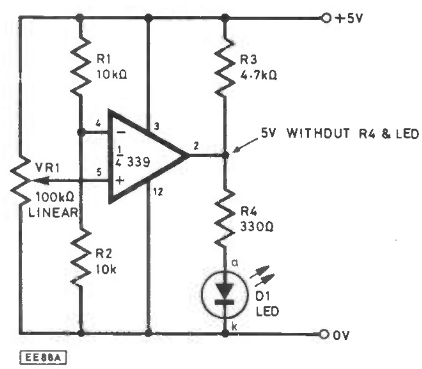


Fig. 5. A demonstrator circuit in which Vtest may be simulated using the potentiometer, and the output state of the comparator is indicated by a l.e.d.

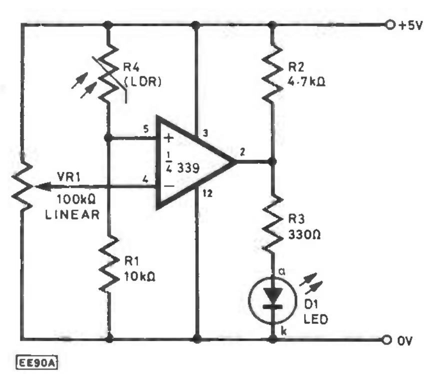


Fig. 6. The voltage to be tested is generated by a light dependent resistor, and the reference voltage by a potentiometer, in a circuit that will switch 'high' when the ambient light falls below a certain level

330 ohm resistor and l.e.d. provide a monitoring function. By altering the variable resistor, the l.e.d. will light up when the voltage applied to the non-inverting input equals or exceeds the voltage that is applied to the inverting input. By varying the values of R1 and R2 we can change the voltage applied to the inverting input, and hence the value at which the potentiometer is set for the l.e.d. to light must also be changed.

For this circuit, the output assumes a value of about 5V if we disconnect the l.e.d. resistor combination, when the two input voltages are equal.

COMPARATORS

NON INVERT

We do not have to put the reference voltage onto the inverting input of the device. In the following circuits we apply the reference voltage to the non-inverting input. The varying voltage, such as that provided in the above example by the potentiometer, is applied to the inverting input of the comparator. The voltage can come from a variety of sources, as I will show in the examples to be given. With this arrangement, the output will be at about 5 volts when the input voltages are such that the voltage applied to the inverting input is less than that applied to the non-inverting input. As soon as the voltage at the inverting input is equal to or greater than that at the non-inverting input then the output switches from 5V to 0V.

DARK SENSING

Fig. 6 shows how we can use a light dependant resistor to produce a circuit that switches its output in response to changes in the local light level. The light dependant resistor (l.d.r.) used is the common 0RP12 device, whose electrical resistance is high in darkness and low in light. We use this in one arm of a potential divider to provide a source of voltage to the inverting input of the comparator. In the configuration shown, as the l.d.r. receives less light, the voltage presented at the comparator will also fall. As soon as this falls below the voltage on the non-inverting input of the comparator, the output of the comparator will be at 5V. By varying the potentiometer, and hence the voltage applied to the non-inverting input of the comparator, we can adjust the threshold level below which the light has to fall before the output assumes a high value.

LIGHT SENSING

The circuit can easily be modified to give us a device that has its output high when the light level increases above the threshold. The circuit for this is shown in Fig. 7 and the theory behind its operation is similar to that for Fig. 6, but with the reference voltage generated by the potentiometer being applied to the inverting input of the comparator instead of the non-inverting input as in the previous case.

MOISTURE SWITCH

What about other devices in place of the l.d.r.? Well, Fig. 8 shows how the comparator can be used as a touch-plate or moisture switch. If the contacts are bridged by either water droplets or a finger, then the resistance across them will fall drastically and will hence cause the voltage applied to the inverting input to increase. As soon as this exceeds the voltage set by the potentiometer on the non-inverting input then the output will go from 5V to 0V. This circuit is easily set up to act as a touch-switch by turning the circuit on, touching the touch-plate and adjusting the potentiometer until the l.e.d. just goes out. On releasing the plate the l.e.d. will come on again, and touching the plate will turn it off again. If this does not occur, simply readjust the potentiometer until this switching action is seen. Varying the value of R1 will also change the behaviour of the circuit, forming as it does the other arm of the potential divider that provides the voltage to the inverting input. If we need the output to attain a high value when the plate is touched, then we could use the circuit of Fig. 7 but with the touch plate in place of the l.d.r.

THINKING COMPARATOR

Fig. 9 shows how we can use the comparator to make more complex decisions. Here we are taking three separate voltages in and getting a low output whenever two or more of them are taken to 5V. The circuit is set up by adjusting the potentiometer to mid-point through its range and then turning on. Then take two of the inputs to 5V and adjust the potentiometer until the l.e.d. goes out. Now disconnect both inputs from 5V and the l.e.d. will light again. Connecting one input to 5V will leave the l.e.d. on, but connecting a second input to 5V will turn the l.e.d. off. You can adjust the potentiometer so that any one input will cause the output to go low, or so that all three of the inputs need to be taken to 5V before the output will go low.

The theory behind this circuit is similar to those already examined. The voltage to the inverting input is provided by the potential divider formed by resistors R1, 2 and 3 in parallel and R4. Each of R1, 2 or 3 that is taken to 5V increases the voltage at the inverting input, until it is greater than that on the non-inverting input as set by the potentiometer. Again, if you want to get a high output when the two inputs are taken to 5V connect the potentiometer slider to the inverting input and the junction of the three input resistors and R4 to the non-inverting input of the comparator.

SIMPLE TIMER

The final demonstration circuit is shown in Fig. 10 and is a simple timer circuit. The practical timer integrated circuit, the 555, uses comparator circuitry in its internal construction. Here the output, on pressing the button S1 and releasing it will stay on for a period of time determined by the setting of the potentiometer. To get the l.e.d. to stay out and turn on after a certain length of time the potentiometer slider is connected to the inverting input and the junction of C1 and R1 is connected to the non-inverting input. The theory of operation of the circuit is as follows. On pressing and releasing the pushbutton we first discharge the capacitor and then allow the capacitor to recharge through the resistor, R1. As soon as the voltage at the inverting input exceeds that at the non-inverting input then the output will go low. The voltage at the inverting input will gradually increase as the capacitor charges via the resistor, and the rate of this voltage increase depends upon the value of both the resistor, R1 and the capacitor. Pressing down and holding down the pushbutton will prevent the capacitor from charging and so the l.e.d. will stay on for as long as the pushbutton is pressed. If it is released after being held down then a normal timing cycle will be initiated and the l.e.d. will stay on for a set time after the button is released. Varying the setting of the potentiometer will vary the time delay of the circuit.

CONCLUSION

It is hoped that this article has given the reader some insight into these useful circuits and that it will encourage some experimentation. The package containing the four comparators is shown in Fig. 11. The resistors used here are $\frac{1}{4}$W, 5% units and the capacitor used was 16 volts working. □

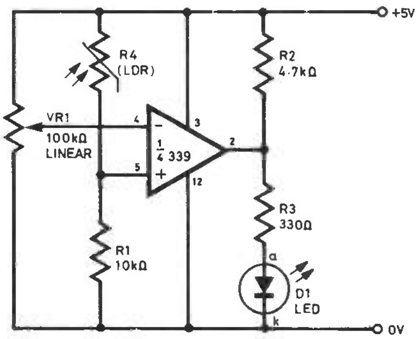


Fig. 7. A comparator used as a light sensor, as in Fig. 6, but arranged so that the comparator switches 'high' when the light level increases above a preset point

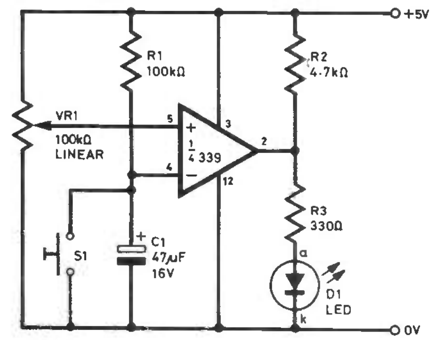


Fig. 10. Comparator as a monostable timer. A positive output pulse will result from pushing S1, the duration of which is proportional to R1 times C1, times a constant related to the setting of VR1

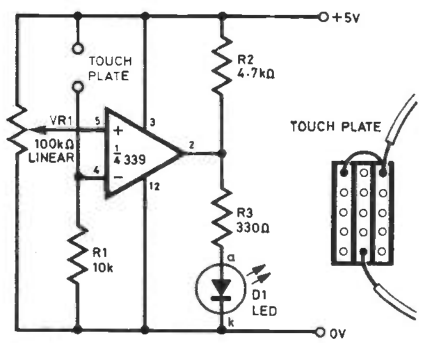


Fig. 8. The light sensing comparator easily becomes a moisture sensor, or touch switch for those with sweaty fingers. This circuit will detect condensation (water droplets on the interdigitated sensor pad), or the level of any electrically conductive liquid in a vessel

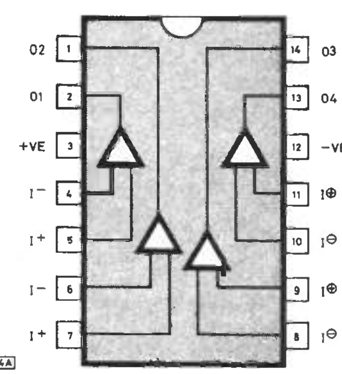


Fig. 11. Pin-out and internal architecture of the National LM339 quad Comparator

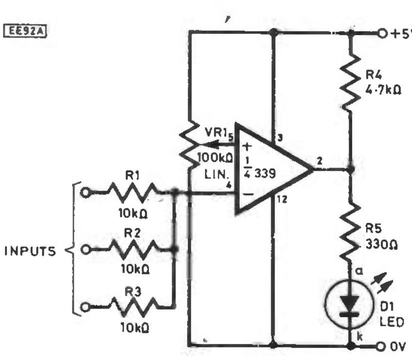


Fig. 9. This comparator circuit calls upon the principle applied to mixers or summing amplifiers. Its ability to add, or subtract input levels with each other, results in a novel function. A 'low' output will be generated if two or more inputs go 'high' (+5V)

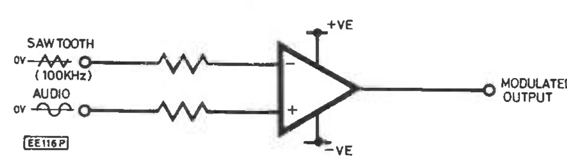
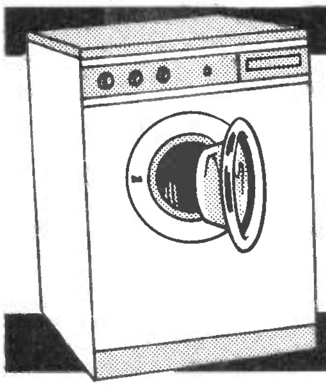


Fig. 12. Theoretical circuit for a pulse width modulator for turning audio signals into digital. A fast comparator must be used. Experimentally, if the output of this circuit is current amplified through a switching transistor to give an output between 0V and +5V the output could be listened to directly using an earpiece as the collector load



WASHING MACHINE ALERT

A. ROBSON

As domestic washing machines are thirsty for hot water, after a wash there is often little left for other purposes. This device alerts the machine user for the need to switch on the domestic heating boiler at the start of a wash.

The circuit is based on the LM3909 i.c. which consumes little power and requires the addition of only a few discrete components. A thermostat on the domestic boiler senses whether or not the water is being heated and a reed switch on the machine cycle switch ensures that the signal is given at the start of the wash. The alert is given by a red l.e.d. flashing at a rate of about one per second.

CIRCUIT DESCRIPTION

The circuit diagram is shown in Fig. 1. The thermostat (THT1) is of the type that opens the contacts when the temperature rises. A thermostat from a domestic space heater makes a satisfactory sensor.

The thermostat is ideally mounted on a thin metal bracket, close to and above a sloping section of the boiler chimney. Alternatively, it can be located as closely as possible to a vertical section of the chimney.

In series with the thermostat is a normally open reed switch (S1), and this is enclosed in a piece of plastic sleeving and attached at each end to terminal blocks. These terminal blocks are glued to the washing machine control panel (see photo) close to the rotary wash-cycle knob. The small bar magnet is glued to this knob so that the reed switch will close at the start of the wash-cycle.

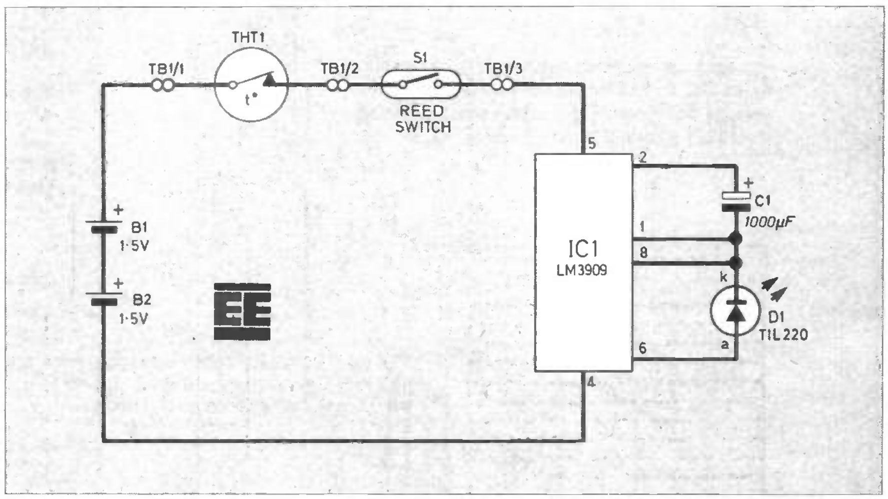


Fig. 1. Circuit diagram of the Washing Machine Alert.

COMPONENTS

Capacitor
C1 1000µF 15V elect.

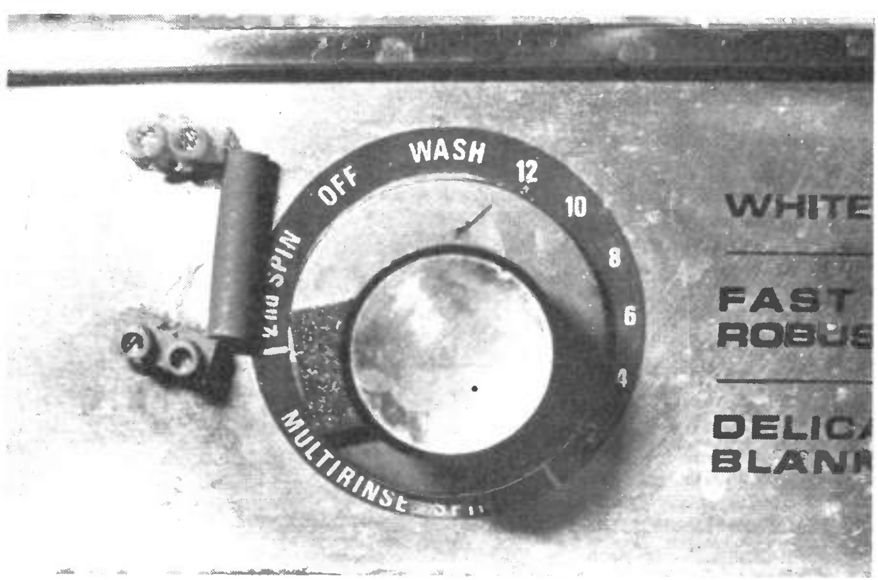
Semiconductors
D1 TIL220 5mm red l.e.d.
IC1 LM3909 l.e.d. flasher

Miscellaneous
B1,2 HP7 1·5V battery (2 off)
S1 normally open reed switch
THT1 normally closed thermostat that switches off with temp. rise (see text)
TB1 3-way terminal block
0·1 inch matrix stripboard, 15 holes by 10 strips; metal container, approx. 64mm (dia.) × 44mm (deep); small bar magnet; hand-torch reflector; grommet; 7/0·2mm connecting wire; twin-core cable.

Approx. cost guidance only £4.00

See Shoptalk page 84

The bar magnet glued to the wash-cycle control so that when the cycle is started, it closes reed switch S1. This switch is shown enclosed in a plastic sleeve and secured to terminal blocks.



In this way, power is supplied to the l.e.d. flasher i.c. (IC1) when the wash is started if the boiler is not turned on and therefore will not open the thermostat. When the boiler is fired, THT1 will open and the l.e.d. will stop flashing. Similarly, as the wash-cycle knob rotates, the magnet moves away from the reed switch and interrupts the power.

CONSTRUCTION

CIRCUIT BOARD

The LM3909 i.c. and the capacitor are soldered onto the stripboard as shown in Fig. 2 and housed together with the HP7 batteries in a cylindrical metal container approximately 64mm diameter and 44mm deep.

To enhance the effect of the flashing l.e.d., the leads are pushed through a small cork which is inserted into the centre hole of a small hand-torch reflector. The body of the reflector is fixed to the lid of the container with epoxy adhesive.

The leads from the thermostat and reed switch to the stripboard are secured at terminal block TB1, housed within the metal container. The leads pass through a hole in the side of the can via a grommet.

OPERATION

With the washing machine programme switch at the start position and the domestic boiler off, turn the adjusting screw of the thermostat until it is just on. The l.e.d. should now flash. Then turn on the boiler and after waiting for a few minutes, note if the thermostat has switched off, when the l.e.d. will have stopped flashing.

If the thermostat does not turn off, make further adjustments to the screw. As the wash progresses, the permanent magnet will cease to influence the reed switch and the l.e.d. will not operate again until the programme switch is turned to "start". □

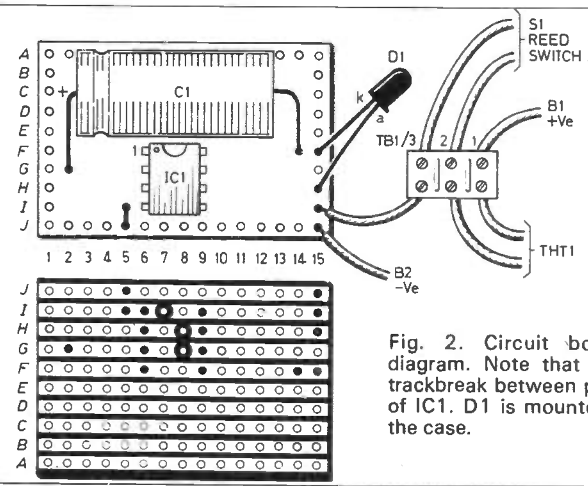


Fig. 2. Circuit board layout diagram. Note that there is no trackbreak between pins 1 and 8 of IC1. D1 is mounted on top of the case.

The finished prototype unit assembled into a cylindrical metal container. The l.e.d. in the torch reflector can also be seen.

DATA BANKS

Latest of the breed of Casio Pocket Computers incorporate a Data Bank—an arrangement for simply building up and reading back a personal electronic file of related facts and figures.

At its simplest it could be a telephone directory, or a train timetable. For professional use it could become a surveyor's notebook or an advertising agent's table of magazines and space rates, and so on.

Couple with that a BASIC language computer capability and you are beginning to command real power for scheduling, organising, optimising or whatever earns your profit.

For less than £49.95 you can now buy a Casio PB110 pocket Data Bank BASIC computer with 1k RAM. Expand it with an extra 1k RAM extension; connect to a cassette recorder for program and data storage through FA3 interface; add an FP12 printer.

Go a stage better with interchangeable (as opposed to extendible) RAM modules on the PB410 model. Still with Data Bank, the FA3 and FP12S options, and 2k or 4k memory on plug-in RAM cards. It is also possible to build up a collection of RAM cards, each coded with separate programs and data, to make a comprehensive library of handy computer routines, all portable in pocket or handbag.

Another almost identical model is the FX720P, perhaps more useful to scientists, technologists and engineers by virtue of single-key activation of common maths and statistical functions.

All Data Bank functions can be protected (to preserve confidentiality or prevent corruption of data) by password. Invent your own, which can be a string of up to eight letters, figures or symbols. Since that represents something in excess of one million billion possibilities, you should be able to select a unique password.

Good news too is that these pocket computers come with some prepared software. All are supplied with "example" programs in the Instruction Books, which list routines for the user to key in. The FX720P also has a program library of more than 70 professionally oriented programs. PB410 and FX720P are supplied additionally with a scheduling program already loaded on a RAM card. More software support is on the way.

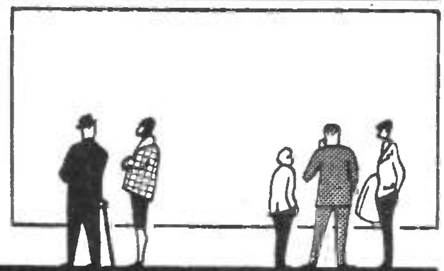
The suggested retail prices (including VAT) for the pocket computers and ancillaries are: PB110 £49.95; PB410 £59.95; FX720P £59.95. The OR1 1k RAM extension for PB110 is £13.95; the RC2 2k RAM card for PB410 and FX720P cost £24.95; and the RC4 4k RAM card £35.95.

The cassette interface FA3, suitable for all three machines, is listed at £25.95; the FP12 printer (PB110 only) £25.95; and the FP12S printer, for both the PB410 and FX720P, £25.95.

Details of nearest stockists may be obtained from:

Casio Electronics Co. Ltd.,
Dept EE, Unit 6,
100 North Circular Road,
London NW2 7JD.

SHOP TALK



BY DAVE BARRINGTON

Catalogue Received

It's always a pleasure to receive new component catalogues in the office and this month has been no exception with the arrival of the latest offering from **Maplin Electronics Supplies** and a very special offer from a new component supplier from North Wales which should interest all electronics' constructors.

The Maplin catalogue, which has become a firm favourite with constructors over the years, is another massive effort containing 448 pages packed with everything from aerials to Zener diodes and many new ranges to complement their existing stock.

One interesting feature is the introduction of the 74HC and 74HCT digital i.c. series which is recommended for use in all new designs as they are pin for pin compatible with respective types in the other ranges, such as the 74, 74LS and 4000 series. The new CMOS 74HC series has a similar operating speed to low power Schottky TTL (LS TTL) but with between 5 to 7 times lower power consumption.

The only point to note is that if you want to drive the new HC series from the old 74 series the transition levels are different so the output of the TTL requires a 4k7 pull up resistor. To overcome this problem the 74HCT range can be used. This range has identical input characteristics to TTL. However, to obtain this compatibility the noise immunity found in the 74HC series is much reduced along with the upper operating frequency in the 74HCT devices.

Remember though because these devices are CMOS the same handling precautions still apply: Always make sure your wrist or hand is grounded before you handle the device.

The price of the catalogue is £1.35 and is available from newsagents or direct from **Maplin Electronics Supplies Ltd., PO Box 3, Rayleigh, Essex.**

Now for that special offer, but be warned, like all good things it may not last forever. So if you would like a *FREE* sample pack of components containing a transistor, diodes, an l.e.d., capacitors, resistors as well as sleeving, and a potentiometer you had better post your letter quickly.

The company, **Systems Electronique (UK)**, is a new component supplier from Deeside, North Wales, and they have developed a new system for keeping their customers up to date. The idea is that information cards (A4 size) are supplied free of charge and they contain information on components, kits and special offers which are automatically updated by post.

There are six cards currently available covering; connectors, passive components, opto-electronics, semiconductors (two cards) and hardware. Orders can be processed by return of post or via a telephone order service using Barclaycard or Access. For further information along with your free gift and cards contact **Systems Electronique (UK) Ltd., Unit 26, Engineer Park, Sandycroft, Deeside, Clwyd (0244 536699).**

Finally this month before we look at the constructional projects here is a very useful magnifier which only weighs 35 grams ($1\frac{1}{4}$ ounces) and yet has an A4 magnifying area. It is made from a flexible sheet of acetate which is embossed with a series of concentric rings which form a Fresnel lens. The advantage of this type of lens is that the rings are telescoped together in the surface of the material and form a virtually flat magnifier which would otherwise be both expensive and heavy using conventional solid lens techniques.

The magnifier which is also extremely flexible offers a magnification of between 1.5 and 2 times and is ideal for use on printed circuit boards, checking wiring or for visually handicapped people as a reading aid.

Priced at £2.60 plus VAT the magnifier is supplied sealed inside a clear acetate envelope which protects the unit against any abrasions or scratches. It is available from **Magnifiers & Microscopes, 3 Approach Road, Taplow, Maidenhead, Berks SL6 0NP.**

CONSTRUCTIONAL PROJECTS

Reverb Unit

The *Reverb Unit* is available as a complete kit from Magenta Electronics or they will supply components separately.

The JFET op amps LF351 are widely available and it is worth noting that because they are not MOS FET devices no special handling precautions are necessary. The charge transfer device (MN3011) used in the delay line is of the type which is usually referred to as a "bucket brigade" and this particular device along with its companion i.c., the MN3101, are available from Magenta. The MN 3011 is £19.25 and the MN3101 is £1.98 both prices include VAT. P&P is 60p extra.

Load Simplifier

There are a few points worth mentioning on the *Load Simplifier.* The speaker is available from Maplin (order code WB04E) and the CMOS 4011 should be the buffered type with the BE suffix. The meter can be any 0 to 1mA type as advertised by M. Dziubas, Maplin and other advertisers. The ABS case type 2005 should be used as it will make mounting the stripboards easier as they will just slide into position overcoming the need for fixing screws or holes.

Computerised Train Controller

The only difficult component on the *Train Controller* could be the relay which is available from Maplin (YX95D) or Cirkit.

Washing Machine Alert

The thermostat used in the author's model of the *Washing Machine Alert* was the type used in a domestic space heater. The thermostat is of the type that opens the contacts when the temperature rises.

We see that one of our advertisers, J. Bull (Electrical) Ltd., is offering an assortment of 10 thermostats for the princely sum of £2.50 the lot! It is quite possible that one of these may be suitable, but we would point out that they have not been tried in this circuit.

The l.e.d. flasher/oscillator LM3909 is available from: Maplin, Magenta, Rapid and TK Electronics.

Mains Monitor

The recommended audible warning device, WD1, used in the *Mains Monitor* is the Maplin "6V Buzzer". This should be ordered as: FL39N (Buzzer 6V).

The wire-ended neon indicator lamp was also purchased from Maplin: stock no. X70M (Wire Neon).

The case used in the prototype model is a "Bim" case manufactured by Boss Industrial Mouldings. This case, type BIM 2003, is available from **Bimsales, Dept EE3, 48a Station Road, Cheadle Hulme, Cheadle, Cheshire, SK8 7AB.**

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Fly Pass

Japanese electronics companies are getting worried. Every weekend on a Friday evening, they can see some of their research engineers and production line managers flying off into the blue. The trippers come back on Sunday night ready for work Monday morning.

These trips are unofficial and they aren't innocent weekend holidays. The weekly exodus is to Korea, and Taiwan, where local electronics firms are desperately trying to learn all they can about Japanese engineering and technology.

Both countries have their sights set on becoming "the next Japan". It is cheap at the price to pay an engineer from NEC, Sony, Matsushita or any of the other major Japanese company, a few hundred pounds, all-found, to spend the weekend in Seoul or Taipei, spilling a few technical beans and offering a few production hints.

This ties in with the story I heard recently about a Japanese video company which was worried about the large number of spare video head drums being ordered by service stations. They started a crash programme to find if there was something wrong with the drums they had been selling over recent years, for instance to make the heads wear out earlier than expected.

Finally they discovered that the spare drums were being bought by a Korean company which was building them into its VHS machines. The Korean company could make the electronics, and some of the mechanics, but not the high technology head drum. So they just bought a bulk batch of spares from Japanese manufacturers!

French Connection

This story puts another piece into the jigsaw of the French connection. With sales of video recorders in Britain now dipping, the Japanese see France as their next big market.

So far high prices and trade embargos have kept French sales of Japanese video recorders relatively low, especially outside the major cities. Also, by character, the French are slow to latch onto any new craze.

When the French Government lifted some trade anti-Japanese restrictions (which included routing all video recorders round through a cowshed custom point at Poitiers) they struck a face-saving deal with the video manufacturers in Japan. Nationalized French firm Thomson would produce the high technology mechanical parts for video recorders, and sell them to Japanese assembly factories around Europe.

Very swiftly Thomson started producing VHS video drums at a factory in Longwy for use by the J2T (JVC-Thorn-Telefunken) factories in Berlin and Newhaven. "They are as good as we get from Japan" J2T told me.

I'll bet they are. My information is that no journalist, even French, has seen inside the Longwy plant. As the Koreans found out, making video head drums is not something you pick up over night. The clear inference is Thomson at Longwy has at least started off simply by re-packaging Japanese head drums, while pretending to make them.

Access to IDA

The news is expected any day now of a new phone system called IDA. This stands for Integrated Digital Access and it is British Telecom's first step towards System X and an Integrated Services Digital Network (ISDN). IDA is just one service that System X will be able to offer and the plan was to start pilot operation, at least in London, in July 1984. But System X, and ISDN, are running late. So IDA is late too. The current plan is for a trial to start "at the turn of 1984/85".

The IDA system comes in several forms. The simplest "single line IDA", relies on a serial stream of data along a pair of conventional copper phone wires into the home. In this stream there is a 64 kilobit per second channel which can carry speech or data.

The mathematics are simple. Telephone speech bandwidth is 3·1kHz (from 300Hz to 3·4kHz) so the speech is digitally sampled at 8kHz to give a notional bandwidth of 4kHz. This is then coded into 8 bit words or bytes, to give a 64 kilobit stream. But this stream can also carry data, like text, or slow scan TV still pictures.

To give users a chance to talk and use data at the same time, there is also an 8 kilobit per second data-only channel. A third 8 kilobit per second channel, to which the user has no access, carries the control signals or "housekeeping".

There already exist ways of digitizing speech in less than 64 kilobits. The sampling rate can be reduced and the word length shortened, by a similar technique to that used by the BBC for its PCM links.

Essentially, some of the data carries ranging information. For instance some data codes large jumps in the signal, while other data codes more precise information on smaller jumps. Already BT is working with a 32 kilobit speech stream which means that the scope of access can widen.

Slow Scan TV

Slow scan television will initially be expensive. It relies on a memory store in the receiver which can build up a full TV picture slowly and then display it in its entirety. I spoke recently with engineers at ITT's integrated circuit factory in Freiberg, West Germany. They know all about digital TV pictures and memory stores, because ITT leads the world in research into an all-digital domestic TV.

The ideal way to store a TV picture, is to convert it to digital code and store the code in a RAM. You need five million bits of information for a full TV frame, that is two interlaced fields.

With tricks, like the ranging technique used to compress speech data into a slower stream, you can get away with 4 megabits. Currently the largest chips available are one megabit. So a 4 megabit single chip is two generations away, which at the current rate of progress is between 6 and 8 years.

Professionals, of course, use a memory store built up from many rows of lower capacity RAMS. But these are bulky and expensive. Cheap stores rely on a CCD (Change Coupled Delay) device, like a bucket brigade delay, where packets of analogue signal continually pass down a delay line.

The problem is that the signal is continually losing strength, which makes it noisy. The same thing happens with a glass delay line. Behind the scenes Philips engineers are working on a CCD shift register which works with digital signals, rather than analogue waves.

The delay lines still can't store a signal permanently like a solid state memory chip, but they can keep on cycling a signal to simulate a store. Because the signal is digital, the effect of noise is less important. So long as the bits are recognisable over the noise, the stored picture frame stays clean.

The snag of course is that with a shift register of this type you can only read out at the speed you write in, which makes it harder to juggle with the picture content. The long term answer to frame storage has to be with RAMS.

In The Picture

Every winter the BBC gets a deluge of queries about poor reception in the London area for BBC 2 television. Mine was so bad recently that I called in some aerial contractors to check the signal strength with an electronic meter.

All channels except BBC 2 were fine. "What you need sir" they told me with assurance "is a whole new aerial system". I resigned myself to the fact that my carefully installed v.h.f./f.m. and u.h.f. TV system had corroded on the roof beyond repair.

Fortunately, just before giving the go-ahead for its even more expensive replacement, I phoned the BBC. That was when I learned that every winter they get a deluge of complaints and queries about BBC 2 reception.

In London this station goes out from Crystal Palace on channel 33, which is right at the opposite end of the band to ITV's Channel 23. Any problem with the aerial cable, like water in the junction box or coaxial cable, will pull all signal strengths down. This pulls channel 33, or 23, or both, down to below the level needed for clear, snow-free pictures. There is even some evidence that the state of leaves on the trees in the Autumn may affect the signal as well.

The real surprise for me was that when the BBC has tests and maintenance to do, it is usually the BBC 2 transmitter that is cranked down to low power. Information on this is available every day on page 195 of Ceefax teletext, on BBC 1.

So if you are having trouble receiving BBC 2, switch to page 195 before paying someone to switch aerials. It's *much* cheaper, because the fault may not be in your system.

NEW · NEW · NEW · NEW PRODUCTS NEW · NEW · NEW · NEW

PRINT DIRECTOR

A NEW data switch which allows one Centronics-type printer to be switched between two computers or one computer between two printers has been introduced by **GSC**.

Known as the Model 236 Centronics Director, the switch supports the 36-pin Centronics parallel interface used by many leading printer manufacturers. It is equipped with three 26-contact female ribbon-type connectors with cable connection locks, and is operated via a single front-panel switch.

Global Specialities Corporation,
Dept EE, Shire Hill Industrial Estate,
Saffron Walden,
Essex CB11 3AQ.

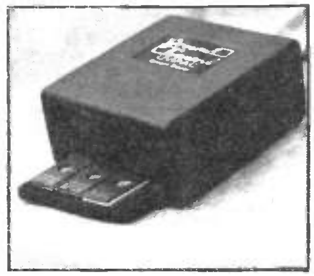
BURN-UP

THE latest EPROM eraser from the **Ground Control** range is specially aimed at the home microcomputer enthusiast and constructor.

A special type of UV discharge tube is used to achieve the compact dimensions of the UVIPAC (TS), which is housed in a 90mm × 80mm ×40mm plastics case. Powered from 230V a.c. or 110V a.c. mains, it is possible to erase up to three EPROMS or one CPU, with on-board EPROM, in 15 minutes.

The EPROMs are simply loaded into the conductive foam pad supplied and inserted into the unit. After the "shutter" or door has been closed the unit is switched on, an optical fibre indicator showing that the unit is in operation.

When the fixed 15 minutes period has elapsed the sounder will beep, indicating that the "oven" should be switched off



and the EPROMs removed. The eraser is available without built-in timer (UVIPAC).

Spare tubes and conductive foam pads are available if required. For details of prices readers should write to:

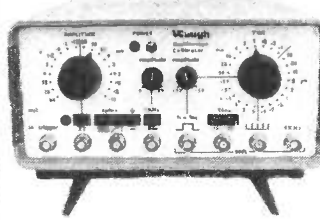
Ground Control,
Dept EE, Alfreda Avenue,
Hullbridge, Essex, SS5 6LT.

SCOPE CHECK

ONE of the first products launched under the new company trade name of **Waugh Instruments** (previously Otter Electronics) is an oscilloscope calibrator.

Ideal for small to medium sized companies, colleges, schools and universities, the Waugh Oscilloscope Calibrator provides all the signals necessary for checking performance and recalibrating scopes up to 150MHz bandwidth.

A calibrated amplitude square wave generator checks correct adjustment and accuracy of input attenuators. A wide range of timing signals from an internal crystal controlled oscillator provides pulses with periods from



10ns to 5 secs. Vertical amplifier risetime can be checked with a clean fast rise <1ns square pulse.

Two sine wave outputs of 1KHz and mains supply frequency can be used for checking correct level selecting of trigger circuits and locking the sweep circuits to the mains supply when checking vertical amplifiers and EHT supplies for mains hum. Oscilloscope sync separators used for television measurements can be checked using the fully interlaced composite video output, both positive and negative going video being provided.

Further details and prices may be obtained from:

Waugh Instruments Ltd.,
Dept EE, Otter House,
Weston Underwood, Olney,
Bucks, MK46 5JS.

REGULATING THE CHARGE

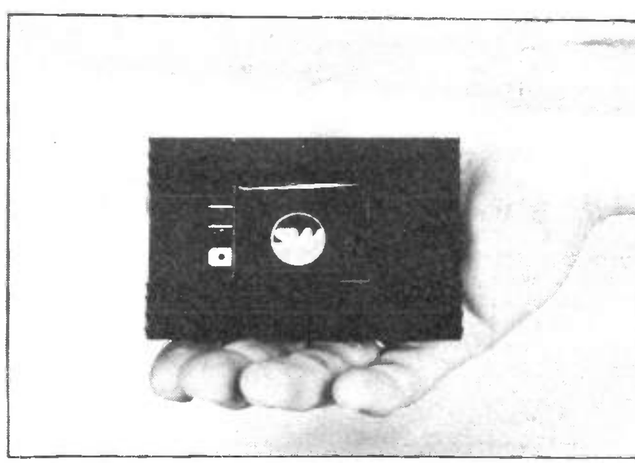
BATTERIES need never fail as a result of overcharging. A plug-in module that may be fitted to any battery charger in order to adjust the output according to battery need has been developed by **S & W Battery Charging Systems.**

The controller will allow full charge to be delivered into a flat battery but when voltage rises current will reduce to a safe level. The battery may therefore be left on without fear of overcharge. This type of unit is ideal when using new re-combination sealed lead acid cells.

The new 10A version is totally encapsulated and claimed to be tamper proof. It is available in fixed or adjustable voltage mode for use on various types of cells.

Although designed for OEM use, whenever batteries are required to form an essential and reliable source of standby power, the controller can also be fitted to any existing uncontrolled charging system.

S & W Battery Charging
Systems Ltd., Dept EE,
Nailsea Trading Estate,
Southfield Road, Nailsea,
Bristol BS19 1JL.



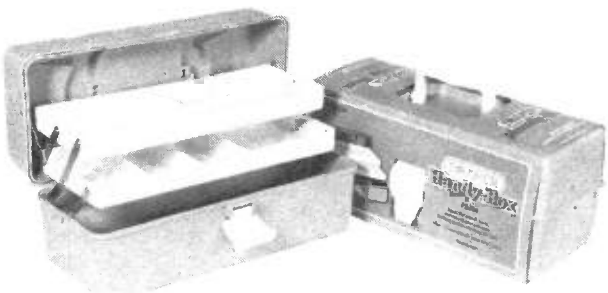
HANDY BOX

A PLACE for everything and everything in its place is a maxim which can be economically achieved by using **Draper's** new Handy Box. Designed to retail at around £3.50 including VAT, the box contains two pop-up trays sub-divided into useful sections.

Manufactured in blue and white plastic, it features a secure catch, fold flat handle and is intended to house bits and pieces for a variety of hobbies and D-I-Y activities. It is particularly useful for storing components, hand tools, connecting wire and soldering equipment.

For further details of local stockists write to:

Draper Tools Ltd.,
Dept EE, Hursley Road,
Chandler's Ford, Eastleigh,
Hants, SO5 5YF.



POWER PACK

A NEW type of sealed lead acid rechargeable battery from **Panasonic** offers a compact solution to the power requirements of portable equipment.

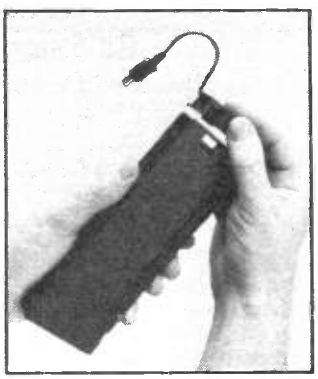
Known as the S–2012A, the "flat" battery is a sealed pack which has a capacity of 2.0Ah at 12V. With a weight of only 635g, this represents a considerable advance for the lead-acid battery, not only in terms of dramatically increased energy density but in the 1 hour rate offered, bringing it in line with the most advanced currently available Ni Cad types.

A feature of the "battery pack" is the special "one touch" slide terminal connection system, making installation into equipment easy, but unintentional connection almost impossible. A simple slide-on connector provides a standard termination for recharging.

The S–2012A is aimed at the more professional end of the market for portable equipment, such as lap-held computers and portable instruments. Nevertheless, it is claimed that cost-savings can still be made compared to the complete assembly and installation of batteries consisting of several discrete Ni Cad cells.

For further details contact:

Panasonic Industrial UK Ltd.,
Dept EE, 280/290 Bath Road,
Slough, Berks SL1 6JG.



ILLUMINATING

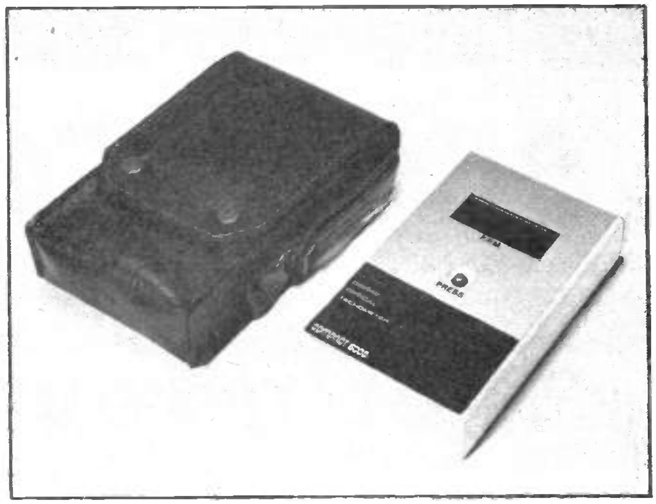
A SMALL high quality rechargeable torch has just been introduced by **Superswitch.** It is only 178mm (7in) long, so takes up very little wall space when hung on its recharging bracket.

It has an indicator light on the front of the torch, so it is easy to find in the dark—ideal for emergencies. The strong bright light gives 1·5 hours continuous use on a full charge and is available in the shops at under £16, inclusive.

There is a special lead available so that the torch can be recharged from a car's cigarette lighter.

For further information and addresses of nearest stockists contact:

Superswitch Electric Appliances Ltd.,
Dept EE, 7 Station Trading Estate,
Camberley, Surrey GU17 9AH.



DIGITAL TACHOMETER

USING large-scale integrated CMOS circuitry, the Compact 6000 now being stocked by **Toolrange** is designed for quick, easy, on-the-spot speed measurement of engines, fans, turbines, couplings, shafts, pulleys, faceplates, in fact, almost any rotating machinery.

The instrument is supplied in a simulated leather carrying case with wrist strap, and comes complete with alkaline batteries, a supply of reflective tape and operating instructions. No calibration is needed at any time after the instrument leaves the factory.

The speed of rotation directly in revolutions per minute is shown on a front panel digital display. To facilitate writing down results, a built-in memory system holds the last reading for 10 seconds after the button is released.

An on-target indicator illuminates when aligned correctly and the unit gives over-range indication. Speed coverage on two ranges is 50 to 19,999 rpm (with over range), 50 to 199,990 rpm (with over range), accuracy ±1 rpm low range (±10 rpm high range).

For more details and prices of the Compact 600 Digital Tachometer contact:

Toolrange Ltd., Dept EE,
Upton Road, Reading,
Berkshire RG3 4JA.

SOLID STATE REVERB

MARK STUART

HOLLOW OUT YOUR NOTES

THIS module uses a low multi-tapped 'bucket brigade' delay line to provide a high quality reverberation effect. It has a high 100kohm input impedance and a low output impedance, and so can be connected between most audio sources and PA systems.

The circuit is designed to work at line level and will handle up to three volts peak to peak. An ideal configuration is to use the unit in conjunction with a mixer that has send and receive effects sockets. With such an arrangement a fully variable amount of reverb can be introduced to any selected combination of input channels.

The module contains its own mains power supply unit and is very compact measuring only 155 × 135 × 50mm overall

DELAY LINE

The delay line used is the MN3011. This is a particularly suitable chip for reverberation generation because it has a large number of stages (3328) with five additional outputs available at intermediate tapping points. Fig. 1 shows a block diagram of the i.c. The number of stages between each tap has been selected by the manufacturer to be optimum for reverberation applications. As with all 'bucket brigade' delay line i.c.s. the delay circuits require two clocking signals running at the same frequency but 180 degrees apart. A companion i.c., the MN3101, provides these pulses and also supplies a gate bias voltage of approximately plus one volt to the MN3011.

CIRCUIT DESCRIPTION

A full circuit diagram is shown in Fig. 2. The clock frequency for the delay line is set by R20,R21 and C11 which control the oscillation frequency of IC4 to 15–20kHz. This sets the delay to the final output as approximately 100ms. The input signal from SK1 passes to the delay line input via IC1 and IC2 which are connected as low pass filter stages. The resistors R1,R2 and R3 along with capacitors C1 and C3 are configured around IC1 to provide a standard 2 pole low pass filter. Components R5,R6,R7, R8,C5,C7,C8 & IC2 provide a further three poles of filtering. The purpose of all this filtering is to ensure that frequencies above half of the clock frequency do not reach IC3. This is very important because of a phenomenon called aliasing. When aliasing occurs the incoming signal and the clock signal interfere in a complicated way producing low frequency interference components which mix with the wanted signals.

The outputs from IC3 are all used to provide a composite output signal. Resistors R10–R14 and R31 provide bias for the outputs of IC3. The six output signals pass via R15–R19 and R22, and are combined at the input to IC5. The values of the six resistors are chosen so that the signal levels from the outputs fall progressively as the delay increases. This corresponds to a natural reverberation effect where the shortest echo has the least distance to travel and so is strongest.

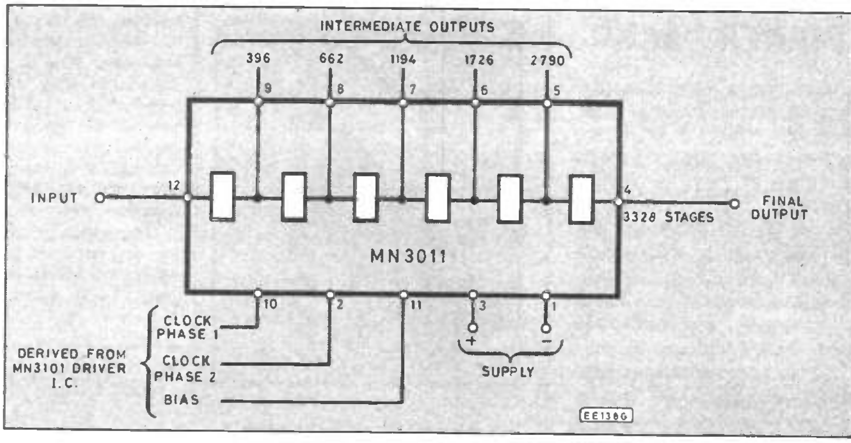


Fig. 1. Block diagram for the MN3011 "bucket brigade" delay line integrated circuit.

Some of the combined output signal is passed back to the input via R9 and C6. This signal will undergo a further pass through IC3 emerging with twice the original delay. The recirculation of the signal through the delay line in this way enhances the reverberation effect by producing multiple echoes which gradually die away. The value of R9 controls the rate of decay of the recirculating signal. Its value can be adjusted if required to alter the reverberation time.

The final composite signal is fed to the output via IC5 and IC6 which are connected as low pass filters exactly as IC1 and IC2. The purpose of the output filters is to eliminate the components of the clock frequency which are present in the output signals from IC3. They also remove high frequency noise from the output of IC3. The final filtered output passes via C17 to the output socket SK2.

POWER SUPPLY

Fig. 3 shows the power supply circuit which is quite conventional. A centre tapped mains transformer T1 provides 15–0–15 volts which is full wave rectified by D2 and D3 to produce 20V across the smoothing capacitor C18. IC7 is a 15V 100mA voltage regulator which provides a stable ripple free output. C19 ensures stability of the regulator and reduces the high frequency impedance of the supply rail. Power on indication is provided by light emitting diode D4 via R29.

CONSTRUCTION starts here

PRINTED CIRCUIT BOARD

The actual-size p.c.b. master pattern is shown in Fig. 4 and the component layout in Fig. 5. Insert the low profile components such as resistors and diodes first.

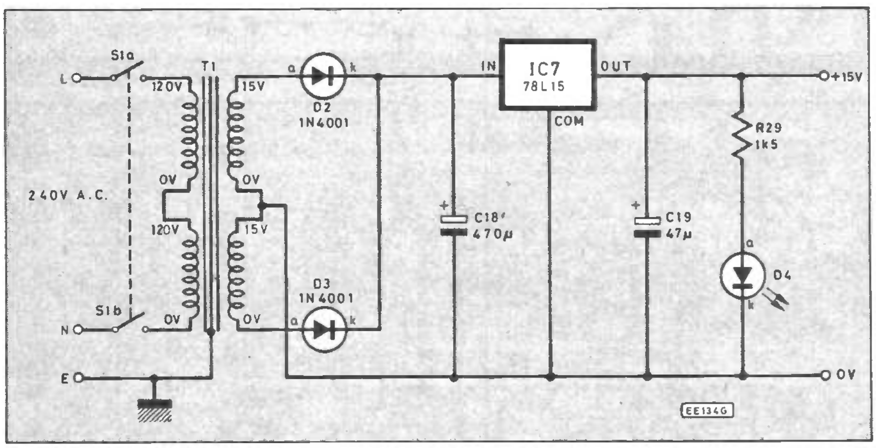
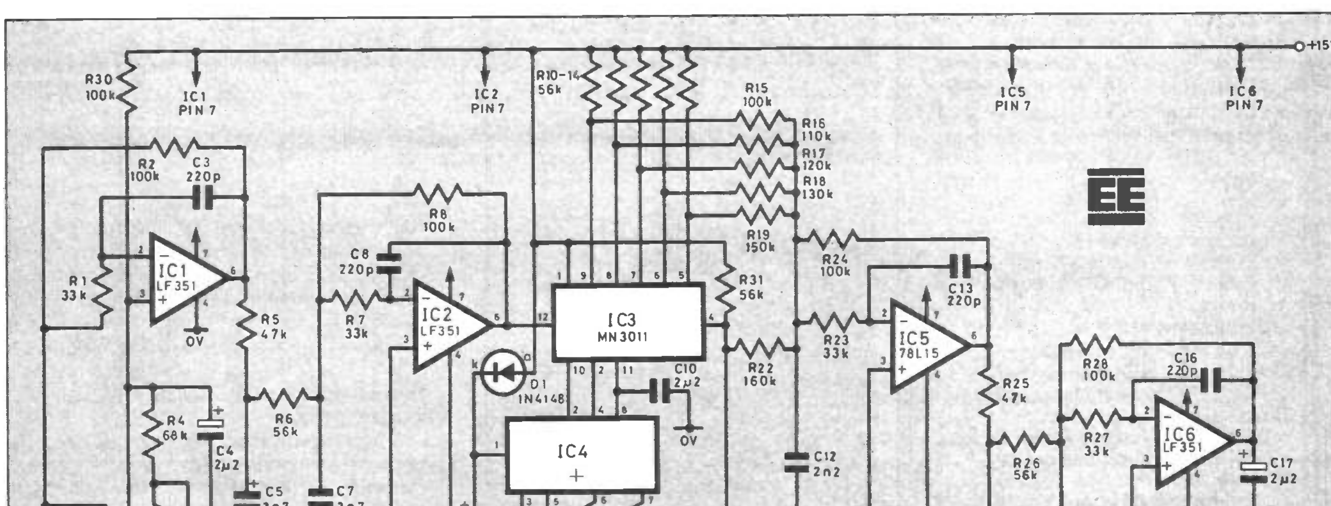
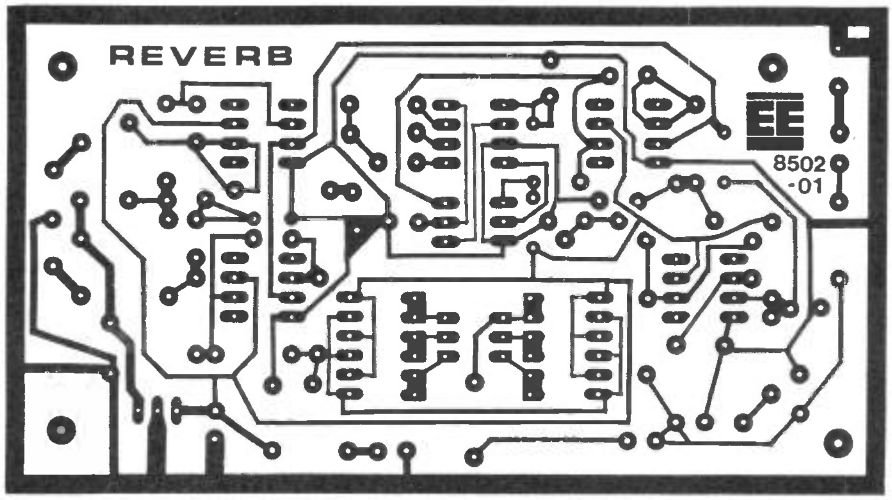


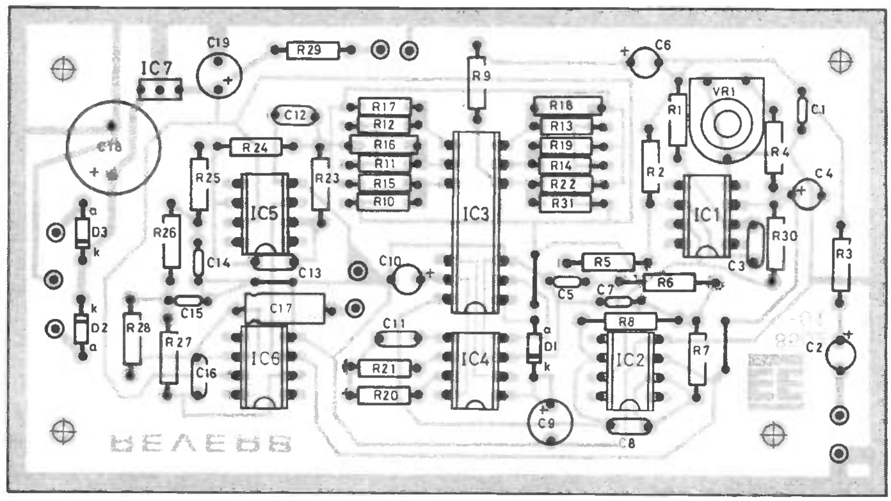
Fig. 3. Circuit diagram of the power supply for the Reverb unit.

Fig. 2. Complete circuit diagram for the Solid State Reverb.

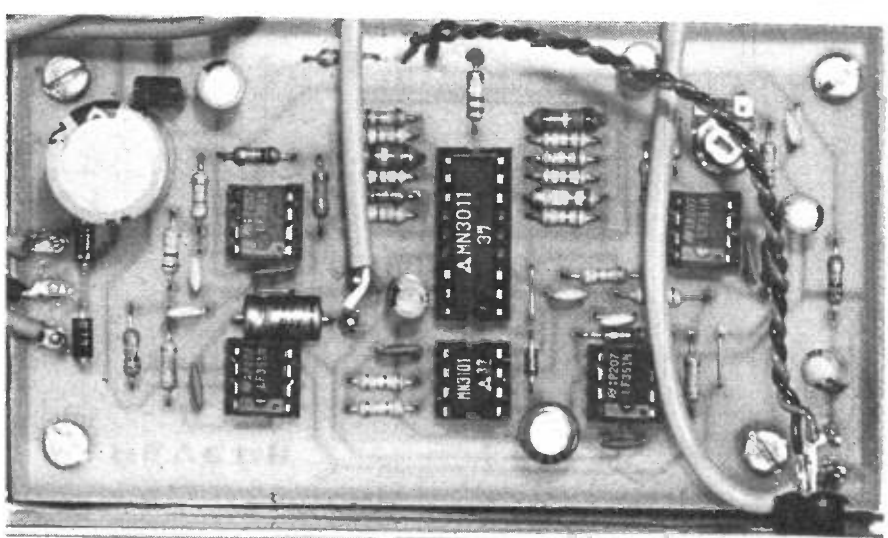


SOLID STATE REVERB





EE137G



COMPONENTS

Resistors

R1,7,23, 27	33k (4 off)
R2,3,8, 15,24,28, 30	100k (7 off)
R4	68k
R5,20,25	47k (3 off)
R6,10,11, 12,13,14, 21,26,31	56k (9 off)
R9	220k
R16	110k
R17	120k
R18	130k
R19	150k
R22	160k
R29	1k5

Resistors ¼W 5% carbon film

See Shop Talk page 84

Potentiometers

VR1	Min horizontal preset 47k

Capacitors

C1,5,7, 14,15	2n7 ceramic 10% (5 off)
C2,4,6,10	2µ2/16V radial elect. (4 off)
C3,8,11, 13,16	220pF ceramic 5% (5 off)
C9	100µF/16V radial elect.
C12	2n2 ceramic 10%
C17	2µ2 axial elect.
C18	470µF/25V radial elect.
C19	47µF/16V radial elect.

Semiconductors

IC1,2,5,6	LF351 (4 off)
IC3	MN3011
IC4	MN3101
IC7	78L15
D1	1N4148
D2,3	1N4001 (2 off)
D4	5mm l.e.d. & clip

Miscellaneous

T1	15–0–15 6VA transformer
S1	on/off mains rotary switch
SK1,2	¼in. mono jack sockets (2 off)—plastics

Printed circuit board: single-sided, size 115 × 64mm; EE PCB Service, Order code 8502-01. Small cable clamp; case—metal 155 × 135 × 50mm (approx.); wire, screened cable, mains cable; i.c. sockets; feet; knob; pillars; screws etc.

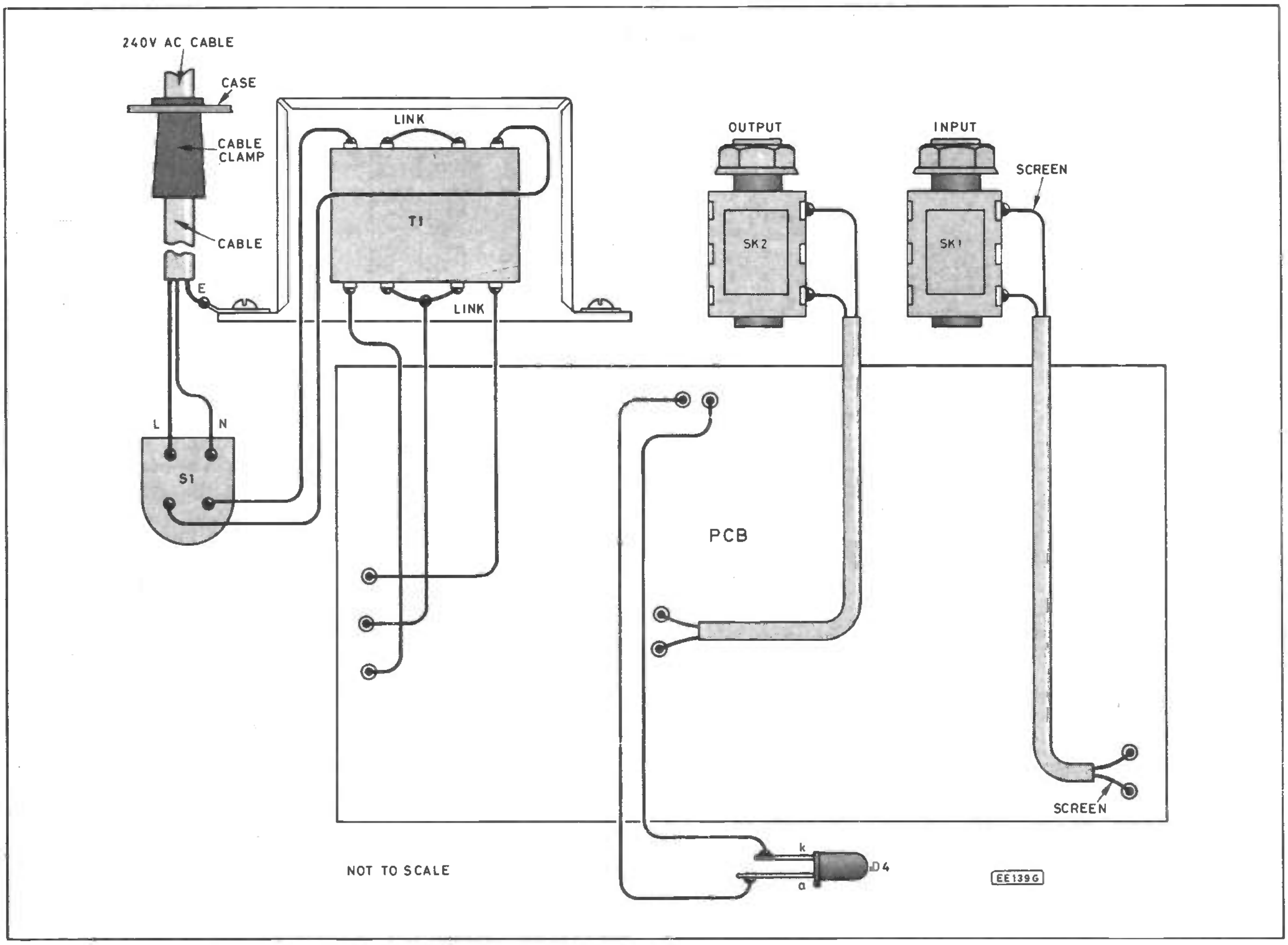
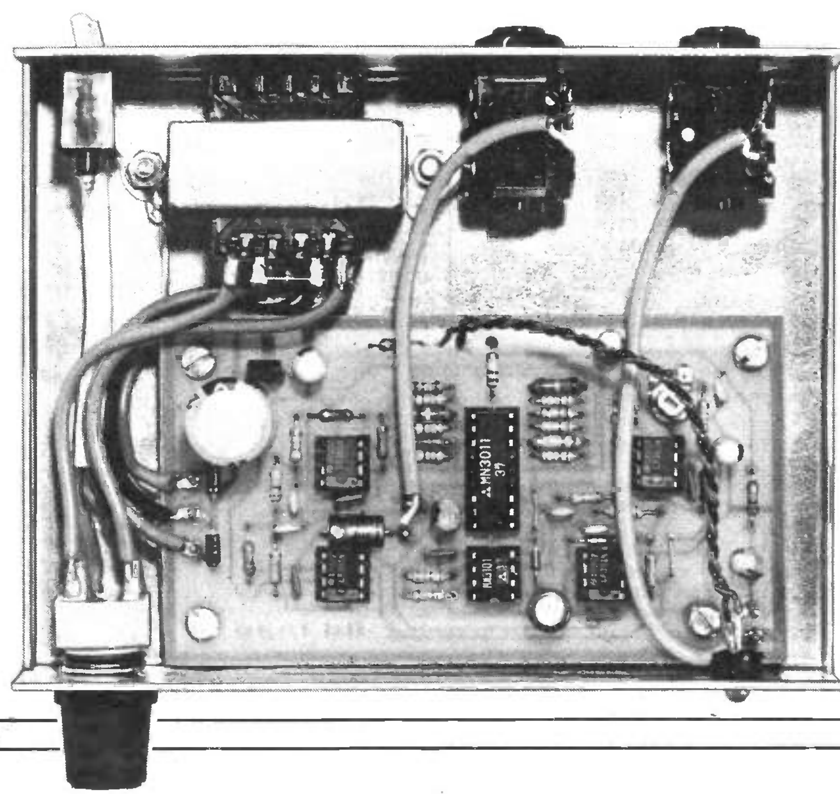


Fig. 4 (top left). Actual-size master pattern for the Solid State Reverb. This board is available from the EE PCB Service, Order code: 8502-01.

Fig. 5 (above left). Layout of components on the topside of the circuit board.

Fig. 6 (above). Interwiring details to the off-board components.
(left) Completed circuit board.
(right) Finished reverb unit showing positioning of the mains transformer and "screened" wiring to the two plastics jack sockets.



COMPONENTS approximate cost £39·00

It is recommended that i.c sockets are used for all i.c.s because this can greatly aid fault finding and reduces the chances of overheating or static damage. IC3 has an unusual pin out. It is necessary to use an 18 pin socket with the centre pins removed or cut off. Take care to get all components the right way round. Fit wiring pins to the board for the input and output connections, the power supply connections, and the connections to D4.

INTERWIRING

When the board is completed begin the mechanical assembly by fitting T1, SK1, SK2, S1 and D4 to the case. The layout of the case is shown in Fig. 6. Take care to keep the mains wiring run direct and neat. Use cable ties if necessary to ensure that should a mains wire come adrift it will not fly over and contact the low voltage circuits. A suitable mains cable clamp should be fitted where the mains lead enters the case.

The mains earth wire should be securely twisted round a solder tag on one of the transformer bolts before soldering. Be sure to correctly identify the primary and secondary windings of the mains transformer. Some transformers may have two separate secondary windings of 15 volts each. To obtain the 15–0–15 required, the two should be linked as shown in Fig. 6. The p.c.b. should be mounted to the bottom of the case using four insulating pillars and self-tapping screws.

TESTING

Before inserting ICs 1 to 6 check that the power supply section is working correctly. There should be 20–24 volts across C18 and 15 volts across C19. If all is well, disconnect the mains and allow a few seconds for C18 to discharge. Set VR1 to mid position and insert the i.c.s.

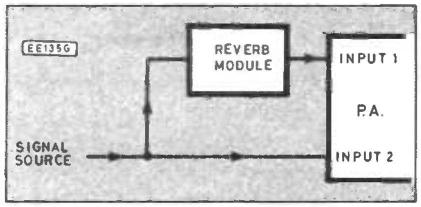


Fig. 7. Mixing the reverb signal in a 2-input amplifier.

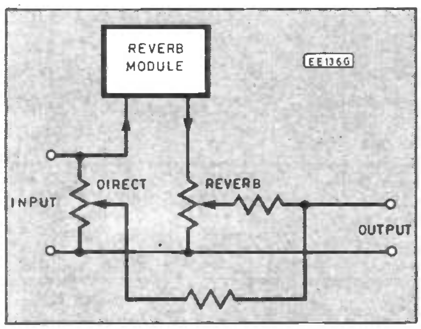
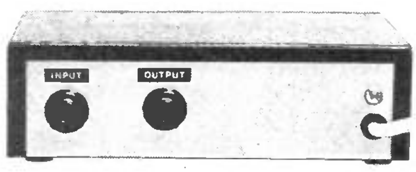


Fig. 8. Simple passive mixing.



Rear of the case showing the plastic input and output sockets.

connect a suitable input and connect an amplifier to the output. Switch on and check for correct operation. The reverberation effect is very strong and has an overall decay time of well over one second. The setting of VR1 is not critical, its purpose is to minimise distortion at high output levels by setting the d.c. bias on IC3 for even clipping. If you have an oscilloscope then it is simply a matter of observing the distortion under high input conditions. The setting can be done quite well by ear, preferably with a pure tone as the input. Gradually increase the input level until distortion is heard and adjust VR1 for the purest sound.

USE

The module has been designed to produce a heavy reverb effect which on its own is rather overpowering. It is intended that the reverb output should be mixed in small quantities with the direct signal so that the ideal amount of reverberation can be obtained. Most mixers have effects send/receive facilities which are ideal for this arrangement. It is possible to arrange the mixing of the effect by using two inputs of a P.A. system as shown in Fig. 7. The signal source is split into two and fed to the reverb module, and to one input of the amplifier. The output from the reverb module, is connected to the other amplifier input. The relative levels of direct and reverberated signal can be adjusted using the volume controls associated with each input.

Where two amplifier channels are not available the signals can be mixed using the simple passive mixer shown in Fig. 8. Two 100k log pots and two 47k resistors permit a full range of adjustment of direct and reverberated signal. □

EVERYDAY news

Edinburgh University, with the financial backing of Lothian Regional Council and now the Scottish Development Agency, has established a specialist centre to promote the application of Artificial Intelligence (AI) to industrial and commercial processes.

RCA Corporation and Sharp Corporation have reached agreement in principle to establish a join venture to engage in the design, development and fabrication of CMOS VLSI integrated circuits in the USA.

Metrotel Picks Apricot

An agreement for the joint production of a new videotex electronic mail system has been signed between viewdata software specialists, Metrotel Viewdata Systems and ACT, manufacturers of the Apricot micro.

The agreement means that an Apricot Computer can be used to provide Prestel-style internal mail systems which, in addition, can be accessed by anyone with a Prestel set.

A multiplexer to allow the advance hard disk Apricot Computer to communicate at this level has been developed by ACT. Metrotel has developed the software that allows one machine to talk to up to 16 other Prestel sets or suitably adapted micros.

The new system is an important breakthrough, according to John Straw, Metrotel's UK Sales Manager. The ACT Apricot is very advanced and highly successful and is currently in use with a number of major companies, he says and added: *"Now anyone with such a machine can have a private viewdata system and electronic mail network which can also be accessed by any Prestel user."*

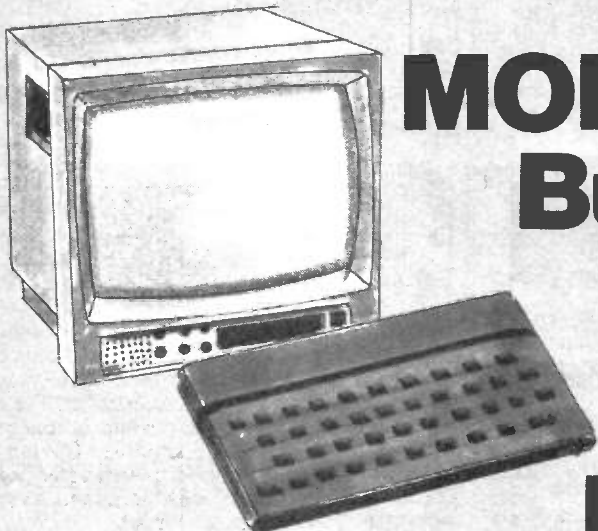
SHOPPING AROUND

Of special interest to readers in the Dartford, Kent, area comes the news that Mail Order company Skybridge Ltd., have just opened a shop at 441 Princes Road, Dartford, Kent.

As well as the usual discrete components, the product range is divided into various categories such as computer, ham radio, audio and electronics, radio control, servicing and test equipment. Being aware of the many problems facing the beginner, they are quite happy to offer free advice whenever possible.

Particularly interesting is the formation of a technical library available for customers' use covering component data by product and manufacturer. Constructional literature is also provided for those wishing to design their own projects using proven "building blocks".

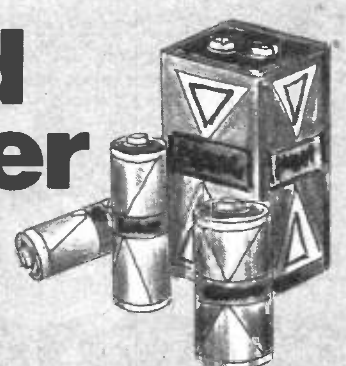
MARCH FEATURES...



MONITORS... Buyer's Guide

If you are becoming dissatisfied with the display quality of your computer system when used with a TV set then this article will help you choose the correct monitor to suit both your pocket and computer.

Nicad Charger



Will charge either a single PP3 or up to ten single-cell types such as AA (HP7), AAA (HP16), C (HP11) and D (U2).

On Spec...

This new regular feature will be of particular interest to Spectrum owners. Each month, a different aspect of the machine will be examined, including software, interfacing, and hardware add-ons.

HEADLIGHT ACTIVATED SWITCH

Light up your house on dark nights automatically as your car enters the drive. This very useful project offers security at low cost, and is sensitive and flexible enough to be activated by a hand-held torch, or simply by the action of a person entering the driveway.

EVERYDAY ELECTRONICS and computer PROJECTS

MARCH 1985 ISSUE ON SALE FRIDAY, FEBRUARY 15

A COMPUTER CLUB GAME — 'Culuplex'

A 2-PLAYER game

OBJECTIVE TO WIN POINTS BY COLOURING BLANK SQUARES WITH YOUR OWN COLOUR.

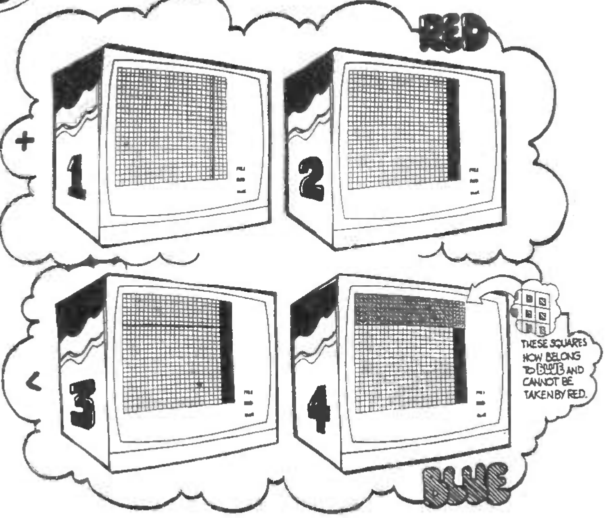
RULES.. PLAYERS ARE RED & BLUE... LET RED START

RED MOVES ACROSS TOP -"+" SIGN USING ← & → KEYS
BLUE MOVES UP & DOWN ONE SIDE -"<" SIGN USING ↑ & ↓ KEYS

1. WHEN RED HAS CHOSEN A POSITION 'RETURN' KEY IS PRESSED AND A VERTICAL LINE IS DRAWN
2. PRESS 'L' OR 'R' THEN 'RETURN' KEY AND THE SQUARES TO THE 'LEFT' OR 'RIGHT' WILL BE COLOURED RED
3. WHEN BLUE HAS CHOSEN A POSITION 'RETURN' KEY IS PRESSED AND A HORIZONTAL LINE IS DRAWN
4. PRESS A OR B THEN 'RETURN' KEY AND THE SQUARES 'ABOVE' OR 'BELOW' WILL BE COLOURED BLUE

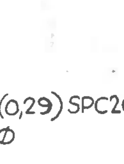
... CONTINUE UNTIL ALL SQUARES LOOK LIKE ■ (BLUE OR RED)

IF NO POINTS RESULT THEN THIS MESSAGE WILL APPEAR: NIL MOVE TRY AGAIN (Y/N). THIS CHOICE IS MADE BY THE APPONENT . IN SOME SITUATIONS THERE WILL BE NO SCORING AVAILABLE AND "TRY AGAIN" WILL HAVE TO BE "NO"



NOT[E]

THIS PROGRAM WOR[KS ON THE]
BBC'B' BUT IT DEL[IBERATELY]
DOESN'T USE SUCH [FEAT-]
URES AS PROC[EDURES]
INSTEAD -"GOSU[B"]
TO MAKE IT MOR[E EASILY]
CONVERTED TO O[THER]
MACHINES



START

```
10  CLEAR: MODE 1 : GOSUB 170 : p = 1
20  COLOUR p : GCOL0,p
30  IF p = 1 GOSUB 260 ELSE GOSUB 320
40  nc = C * 32+16 : nr = 1008-r * 32
50  PRINT TAB(c,0)" " TAB(27,r)" " TAB(0,29) SPC26:FX15,1
60  IF p = 1 GOSUB 380 ELSE GOSUB 470
70  IF S<>0 THEN 120
80  PRINT CHR$7 TAB(1,27)"NIL MOVE TRY AGAIN (Y/N)
90  INPUT TAB(25,29) SPC3 TAB(25,29), D$
100 IF D$<>"N" AND D$<>"Y" THEN 90
110 IF D$= "Y" GOSUB 690 : GOTO 30
120 S(p)=S(p)+S : GOTO 210
130 p=P EOR 3: IF FR<>0 GOTO
140 INPUT TAB(19,9) SPC6 TAB(2,29) "ANOTHER GAME Y/N", D$
150 IF D$="Y" THEN 10 ELSE IF D$="N" THEN END ELSE GOTO 140
160 *****
170 VDU 19,2,6,0;0;23,1,0;0;0;0;
180 FOR W = 176 TO 976 STEP 32 : MOVE 48,W ; DRAW 848,W: NEXT
190 FOR W = 48 TO 848 STEP 32 : MOVE W,176: DRAW W,976: NEXT
200 DIM S(2): S(1)=0 : S(2)=0 : FR=625
210 COLOUR 1: PRINT TAB(30,29) "RED=" ; S(1)
220 COLOUR 2: PRINT TAB(29,31) "BLUE= "; S(2)
230 COLOUR 3: PRINT TAB(29,27) "FREE="; FR
240 RETURN
250 *****
```

NOTES

FR = Free = number of unclaimed squares left
p = Player (1 or 2) S = score for this go.
c and nc are column values
r and nr are row values.
SQ = colour number of square on board
0 = Black = background : 1 = Red = Player 1
2 = "Cyan" = Player 2 : 3 = White = Grid.

```
260 C=12 : nC=13 : C=1
270 IF INKEY(-26) AND c>2 nc=C-1
280 IF INKEY(-122) AND C<25 nC= C+1
290 IF nc<>C PRINT TAB(C,0)" " TAB(nc,0)"+":
    C=nc : GOSUB 690
300 IF NOT INKEY(-74) THEN 270 ELSE RETURN
310 *****
320 r=13: nr = 14 : C=26
330 IF INKEY(-58) AND r >2 n2=C-1
340 IF INKEY(-42) AND r<25 nr=r+1
350 IF nr<>r PRINT TAB(27,r)" "TAB(27,nr)"<":
    r=nr : GOSUB 690
360 IF NOT INKEY(-74) THEN 330 ELSE RETURN.
370 *****
380 FOR r=nr TO 176 STEP-4: PLOT 69,nc,r : NEXT
390 INPUT TAB(19,29) SPC6 TAB(2,29) "L(EFT) OR R(IGHT)",D
400 IF D$<>"L" AND D$<>"R" THEN 390
410 C=nc : IN=4 : IF D$ = "L" IN = -4
420 C=C+IN : SQ=POINT(c,nr) : IF SQ=3 THEN SQ=3
```

by Thakery

```
430 IF SQ<>0 C=C-4 : IF IN=4 C=C+32
440 LE=C+8 : RI=nc-28 : IF IN=4 LE=nc+4 : RI=C-32
450 LO=180 : UP=972 : GOSUB 560 : RETURN
460 *****
```

E!

...KS ON THE
...IBERATELY
...BBC FEAT-
...EDURE
...3. THIS IS
...E EASILY
...HER

NOTES

Lines	Purpose
10	Sets up game
20-130	main playing loop
140-150	Another game?
170-200	Initialises colours, grid and score
210-240	writes score to screen
260-300	Player 1 picks a column
310-360	Player 2 picks a row.
380-450	Player 1 picks left or right

```
470 FOR c=nc TO 48 STEP-4 : PLOT69,c,nr : NEXT
480 INPUT TAB(19,29) SPC6 TAB(2,29) "A(BOVE) OR B(ELOW)",D$
490 IF D$<>"A" AND D$<>"B" THEN 480
500 r=nr : IN=4 : IF D$="B" IN=-4
510 r=r+IN : SQ=POINT(nc,r) : IF SQ=3 THEN 510
520 IF SQ<>0 : r=r-4 : IF IN=4 r=r+32
530 LO=r+8 : UP=nr-28 : IF IN=4 LO=nr+4 : UP=r-32
540 LE=52 : RI=844 : GOSUB 560 : RETURN
550 *****
560 PRINT TAB(2,29) SPC23 : S=0
570 FOR C=LE TO RI STEP 32
580 FOR r=LO TO UP STEP 32
590 SQ=POINT(C,r) : IF SQ=0 SQ=p : S=S+1 : GOTO 620
600 IF SQ=p OR SQ=3 THEN 670
610 SQ=3 : S=S+2 : FR=FR-1
620 GCOL0,SQ : FOR W=r TO r+24 STEP4
630 MOVE C,W : DRAW C+24,W : NEXT
640 IF SQ=p THEN 670
650 GCOL0,p : FOR W=r+8 TO r+16 STEP4
660 MOVE C+8,W : DRAW C+16,W : NEXT
670 NEXT : NEXT : RETURN
680 *****
690 FOR p=1 TO 120 : NEXT : RETURN
```

NOTES

Lines	Purpose
470-540	Player 2 picks ABOVE or BELOW
560-670	Make the move
690	A "DELAY" loop.

FURTHER games

WHEN A GAME IS FINISHED A CHOICE IS GIVEN WHETHER TO PLAY AGAIN OR NOT

)$

Computer LINK-UP

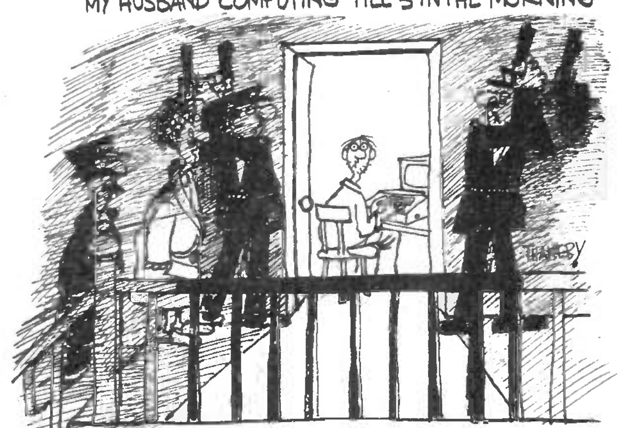
Start at [R] and form a chain of well known BASIC terms.

I	C	H	C	B	M	E	R	R	E	L	E
N	S	R	R	E	U	N	M	E	T	E	D
K	A	$	■	R	E	P	T	A	U	T	O
E	Y	U	N	T	■	E	A	A	L	R	N
E	C	U	S	I	L	T	R	F	S	O	E
D	O	B	O	T	O		U	E	E	F	X
U	R	P	G	O	G	T	N	I	R	P	T
R	E	S	I	F	T	H	E	N	H	E	N
■	S	E	A	T	O	L	D	V	I	M	L
■	T	R	R	A	T	P	U	N	E	M	O
G	R	O	E	D	G	C	O	L	T	O	P
N	I	T	S	D	A	E	R	E	G	A	P

...THE FIRST TERM IS 'REPEAT'

Solutions on page 118

"SORRY, OFFICERS! I JUST HAVEN'T GOT USED TO MY HUSBAND COMPUTING TILL 3 IN THE MORNING"



NEXT COMPUTER CLUB

STARTS A COURSE ON WRITING IN BASIC BY STUDYING A STEP-BY-STEP APPROACH TO WRITING A PROGRAM FOR A GAME CALLED...

SEEKERS of the GOLD SEAL

LOAD SIMPLIFIER

A. FLIND

INSTANT VERIFICATION OF CORRECT CASSETTE LOAD SIGNALS

ALL HOME computer owners, it seems, quickly discover a common problem; difficulty in persuading their computer to accept programs from a cassette recorder. I was no exception, though it must be said that the use of a very old recorder may not have helped. After much experimenting in the workshop this simple little monitoring instrument proved to be the ideal answer. Since it's construction, load errors have become a thing of the past and most cassette problems can now be quickly identified and cured.

NEEDLE AND BUZZ

The monitor simply connects across the cassette recorder's output and checks signals going from it to the computer. Indication of output is provided in two ways. A meter indicates the signal voltage, enabling accurate adjustment of the recorder's volume control, and a small loudspeaker allows the program to be heard. The 'blocks' of program can be easily distinguished and in most cases corresponding indication will appear on the TV screen.

AUTO TURN-OFF

Very simple operation of the monitor was required, so that my young children could use it. To start with, the meter's range is internally preset so that the correct volume results in a half-scale reading. A most useful feature is the special battery switching circuit. The only control is a pushbutton. Pressing this once turns the unit on. A further press at any time will turn it off again, but should the user forget, it will turn off automatically. It 'times out' after about twenty seconds, unless a program signal is present when the timing is delayed until this has ended. So, all the user has to do is press the button, adjust the recorder's volume control until the needle is central and check that program sounds correspond with happenings on-screen.

BATTERY CONDITION?

Even the l.e.d. ON indicator has an extra function. It's current fed, so the brightness remains constant so long as the battery is good. However, the current generator is in turn controlled by a voltage sensing circuit so that the lamp extinguishes rapidly when the battery voltage has dropped to about two-thirds of its full value. This is a much more positive indication than a simple, gradually dimming l.e.d.

HOW IT WORKS

The full circuit is shown in Fig. 1. Its action is more easily described if it is considered in three parts. Starting with the signal monitoring circuit, this is built around the four operational amplifiers of IC1, an LM324 device. IC1a and associated components form a simple audio millivoltmeter. R1 and VR1 set the sensitivity. With the values given this can be adjusted anywhere between about 250mV and several volts full-scale. My unit is set to 500mV r.m.s. to suit a BBC model B which appears to prefer its input at around 250mV r.m.s. Coarse range adjustments may be made if necessary by altering the value of R1. R3 and D1 provide meter protection.

IC1b provides the audible indication. Its basic gain is set at about fifty but diodes D6 and D7 clamp the output to about one volt peak to peak. For any reasonable input signal level, therefore, IC1b provides a constant amplitude output. This is fed to a small speaker, with R7 setting the volume. It is recommended that this is kept low, as amplified computer programs are not very pleasing to the ear.

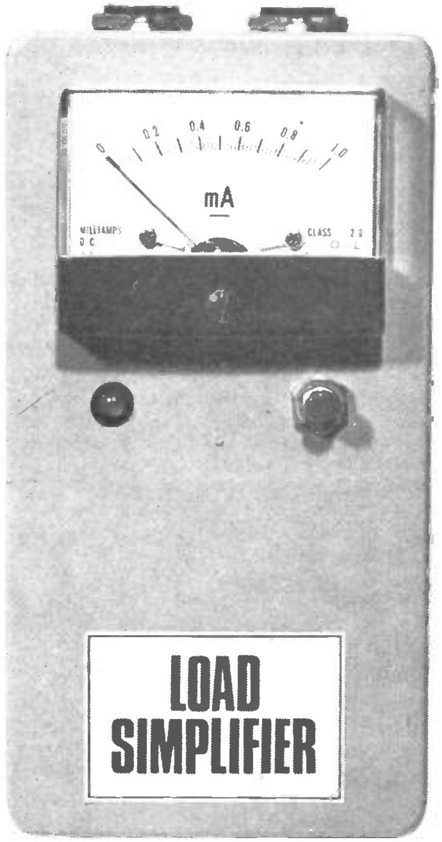
Both these parts of the circuit require a reference of half the supply voltage; this is provided by IC1c. The job could have been done with a few more resistors but the operational amplifier was available and this puts it to good use.

The inputs of IC1d are arranged so that in the absence of an input signal, the inverting input is held about 100mV negative of the non-inverting one. This causes its output to swing close to the positive supply rail and remain there. Processed signals from IC1b output are high enough to take the non-inverting output both above and below the level on the inverting one, so the output swings between its normal high state and zero, at signal frequency. This is used to prevent the unit 'timing out' whilst a signal is present, as will be seen shortly.

The battery supply is switched on and off by the circuitry around IC2. This is a CMOS device, so it can be continuously energised without placing any drain on the battery. The action of this part of the circuit can perhaps be more easily understood if it is simplified a little. Fig. 2. shows the basic CMOS alternate-action pushbutton switch. Assume the output is high, then the input to gate 'a' is also high, so the output of 'a' (and the input to 'b') must be low. This is a stable state, and any charge on C1 is lost via R2 until this capacitor is completely discharged. When the button is pressed, it pulls the

CASSETTE SOFTWARE

SEE NO EVIL!
HEAR NO EVIL!
THEN LOAD WITH NO EVIL!



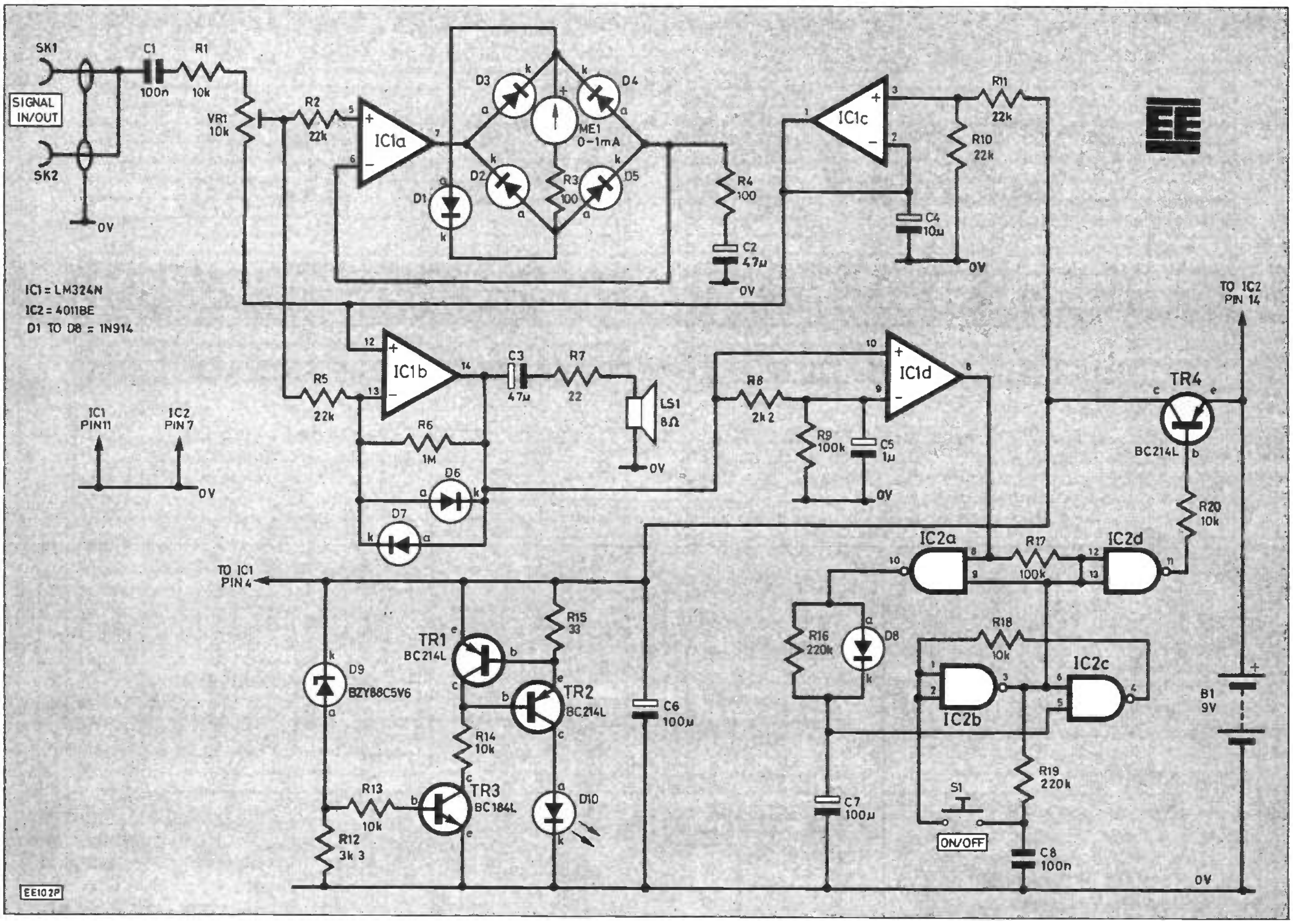


Fig. 1. Circuit diagram of the Load Simplifier.

input of 'a' low via C1 and the circuit changes state. The value of R2 is much higher than that of R1 so C1 cannot charge through R2 until the button is released. Once it has been allowed to do so however, the next press of the button will cause the circuit to revert to its former state.

This is a useful little circuit that can be built with any of the CMOS inverting gates. Since it consumes no quiescent current it has obvious applications in battery-powered equipment.

In the full circuit IC2b and 'c' take the place of gates 'a' and 'b' of the above example. Now, if the 'c' output is high, the 'b' output must be low, so the 'a' and 'd' outputs must also be high. This is the *off* state, as TR4 needs a negative bias to make it conduct. Meanwhile, C7 is charged to the high state. Pressing the button changes state as before and so turns on TR4, which supplies power to the rest of the circuit. However, gate 'a' output is now low, so C7 commences discharging through R16. When the voltage on this, and hence on one input of gate 'c', gets low enough it causes the circuit to revert to the off state. C7 then recharges rapidly through D8, ready for re-use. This assumes that the vox output from IC1d to gate 'a' is continually high; if at any time it goes low, as it will when a signal is present, gate 'a' output will go high and recharge the capacitor, effectively restarting the timer. As the circuit is actually constructed on two boards, R17 is included to prevent the input gate 'a' being operated with one input open-circuit, if the vox input is not connected.

Finally, the l.e.d. 'on' indicator is fed by TR1 and TR2, which are connected to form a constant-current generator. This prevents gradual dimming of the l.e.d as the battery voltage falls. Bias for the generator comes from TR3, fed in turn by Zener D9. When the supply falls to about six volts this arrangement cuts off the current to the l.e.d. quite sharply. It thus operates at full brilliance so long as the battery is good but fails rapidly when replacement is due.

CONSTRUCTION

Construction is on two small pieces of 0·1in. pitch stripboard. The monitor circuit occupies one board, the on-off switch and l.e.d. driver is on the other. This not only assists in fitting it all into the case; it allows the use of the switch circuit in other designs (Fig. 3).

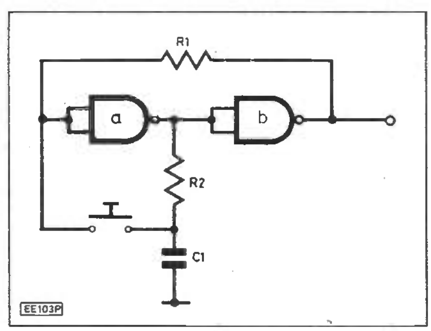


Fig. 2. Simplified alternate action pushbutton switch circuit.

The first step is to cut the two pieces of board to size and ensure they fit into the moulded slots in the case. Small nicks in the top corners of the boards allow the lid to fit over them. The breaks in the strips can then be made. Check these with a magnifying glass; sometimes an almost invisible strip of copper remains around the edge of a break. Then fit the components in 'height order', i.e. links, then diodes, then resistors etc., but leave the i.c.s until last. It is preferable to use sockets for these, especially IC2. External connections to the boards can be made more easily if solder pins are fitted.

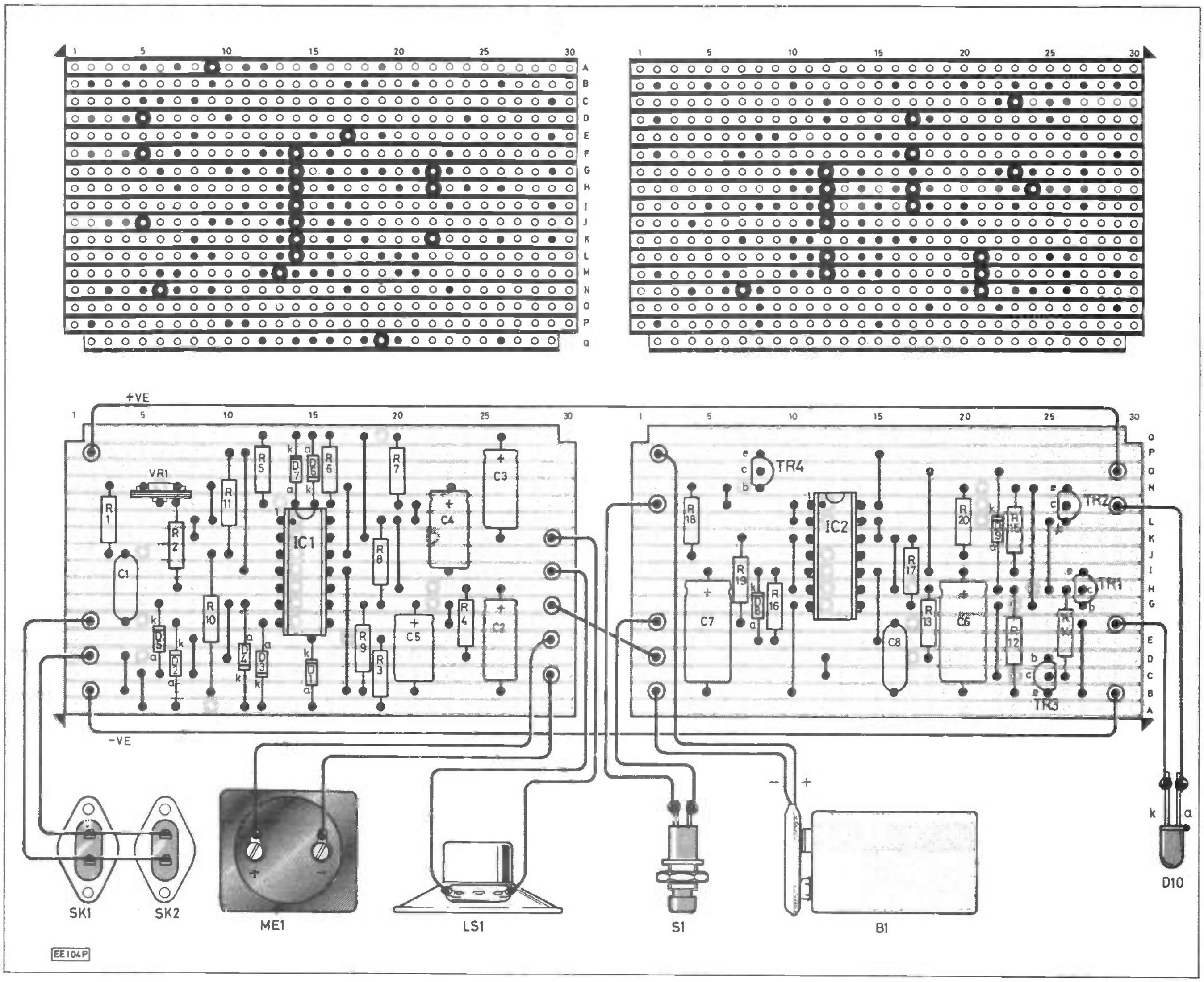


Fig. 3. Component layout and wiring diagram.

COMPONENTS

Resistors

R1,13,14, 18,20	10k (5 off)
R2,5,10, 11	22k (4 off)
R3,4	100 (2 off)
R6	1M
R7	22
R8	2k2
R9,17	100k (2 off)
R12	3k3
R15	33
R16,19	220k (2 off)

all miniature types, 5% or better

See Shop Talk page 84

Potentiometers

VR1	10k vertical sub-min preset

Capacitors

C1,8	100n polyester (2 off)
C2,3	47µ 10V axial lead (2 off) electrolytic
C4	10µ 25V axial lead electrolytic
C5	1µ 63V axial lead electrolytic
C6,7	100µ axial lead (2 off) electrolytic

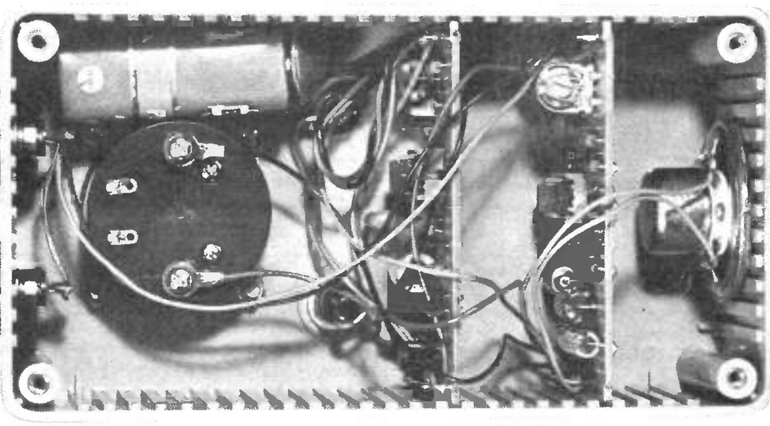
Semiconductors

D1–8	1N914 or 1N4148 (8 off)
D10	Standard l.e.d., yellow
D9	BZY88C5V6, 5·6V 400mW Zener
TR1,2,4	BC214L (3 off)
TR3	BC184L
IC1	LM324N quad op-amp
IC2	CMOS 4011BE

Miscellaneous

Veroboard: 2 pieces 0·1" pitch 17 strips of 30 holes; Veropins; 2 off i.c. sockets, 14-pin d.i.l.; S1, push-to-make switch; speaker, 8ohm, 38mm dia.; battery connector for PP3; input/output sockets, 2 off, see text for type; meter: 0–1mA; case, grey ABS box 150 x 80 x 50mm.

COMPONENTS approximate cost £17.50



TESTING

Test the switch and l.e.d. board first. If you connect the battery, l.e.d. and switch temporarily to the correct points, one press of the switch should cause the l.e.d. to light for fifteen to twenty seconds and then extinguish again quite abruptly. If it doesn't light, check first that you have its polarity right, after that you will have to work through the circuit in stages, ensuring that the various gates are in the appropriate high and low states.

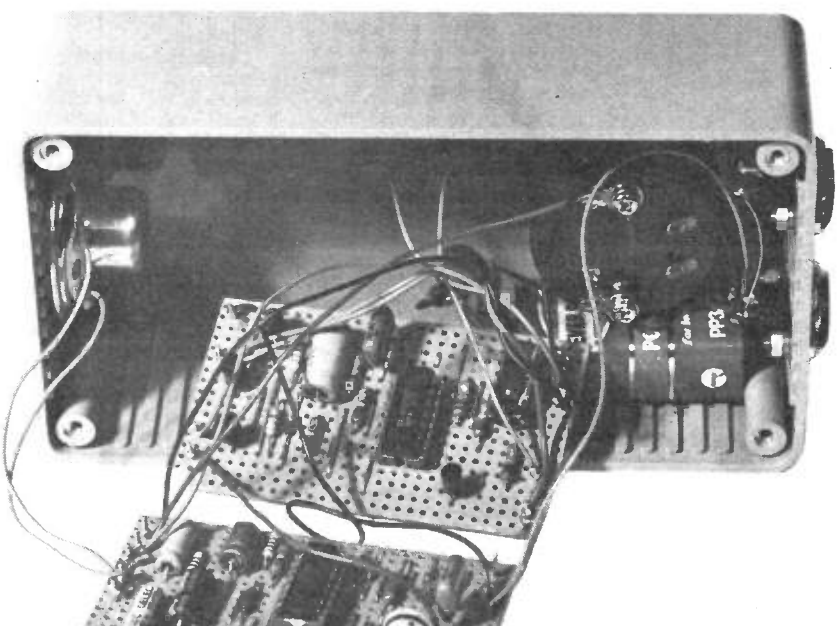
Testing of the signal monitoring board is much easier if you have an audio signal generator to hand, with an output of, say, 0 to 1 volt r.m.s. at 1kHz. The battery may be connected for testing directly to the +V and −V supply points. The speaker and meter should be temporarily connected. Of course an actual cassette output can be used for testing if a generator is not available. The prototype was calibrated by supplying an input from a signal generator with a DVM connected to it. The output of the generator was set for 500mV r.m.s. displayed on the DVM, then VR1 was adjusted for full scale on the monitor's meter.

Your computer may require a different level to this. If you have no information, try initially setting the monitor for, say, one or two volts full scale, then experiment until you find the level that ensures reliable program loading. You can then recalibrate the monitor to suit, or simply adjust VR1 for half-scale on the meter when the optimum level is present. You can then easily and accurately readjust your recorder to this level at any time.

The vox output should be within a couple of volts of the positive supply rail in the absence of a signal. If you check it with an analogue meter, it should fall to less than half the supply voltage when a signal is present, indicating that it is actually alternating rapidly between the high and low states.

The layout for final assembly is shown in the photographs as the various parts are packed quite tightly into the case. The speaker is simply glued into place after a pattern of holes has been drilled to form a grille. Choose sockets for the input and output that match those on your recorder; if you then make up a short lead with a plug on each end it is a very simple matter to insert or remove the unit from your set-up. The drawing for the interconnections is shown in Fig. 3. The battery connector goes directly to the appropriate points on the switching board, as do the connections from the push-button and the l.e.d. Vox-In goes to vox-Out on the monitor board. '+V Out' and '−V Out' go to '+V' and '−V' respectively on the monitor. The speaker and meter connect directly to their appropriate points, and the signal input comes from the input/output sockets which are, of course, connected in parallel. The signal lead that should go to the chassis side is indicated, but it probably will not make any difference if they are reversed.

The battery fits beside the meter and is held in place with a piece of foam plastic.



OTHER POWERS

Although the main function of this monitor is to enable correct level setting and indicate the presence of signals, it can help in other ways. For instance, the needle will normally remain fairly steady at the reading for either pilot tone or program signals. A lot of erratic movement has been found to indicate a need for head-cleaning.

At the frequencies involved in program storage correct head *azimuth* adjustment is important; a small amount of error can soon degrade the signal to the point where the computer will not accept it. The azimuth can be adjusted with the pilot tone on a commercial software tape, by ear if necessary, but it is easier to adjust it for maximum deflection of the monitor's meter needle.

A couple of other possible sources of trouble may be of interest to computer users. Most enthusiasts will have heard the term 'drop-out'. This is where small faults in the oxide layer on the tape cause the loss of vital data. The best defence against this is the use of good quality tape, and the making of more than one recording of valuable programs.

One final problem which caught me out is that the output from the computer when *saving* programs may be too high for the recorder's input. In my case, turning the Record Level control right down produced the correct level indication, but the single amplifier stage ahead of the control was being severely overloaded. The resulting distortion caused subsequent problems when attempting to reload. If you have to turn your control down a long way, you might consider using a couple of resistors to attenuate the signal before it goes into the recorder. □

Dedicated Times For Schools

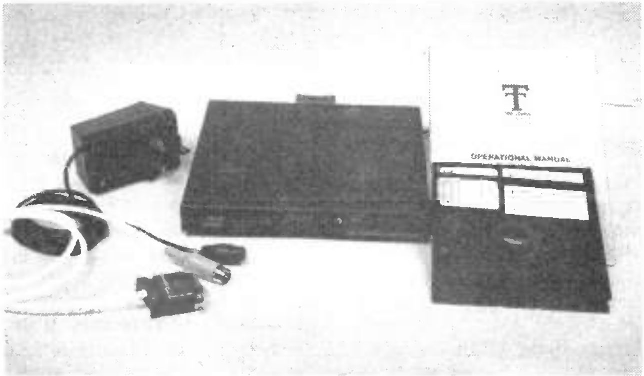
SCHOOL children will be able to use their microcomputers for a much wider range of activities with the launch of the first national electronic mail and information service dedicated exclusively to education.

Claimed as a major breakthrough in the use of computers in education, The Times Network Systems Ltd., have announced The Times Network for Schools (TTNS) communications system.

Based on the public electronic mail and noticeboard service offered by Telecom Gold, TTNS is a communications system with a central "database" or store of information built up from educational and outside resources. Schools' usage is subsidised by sponsors selected from commercial companies and trade, professional and industrial associations capable of contributing worthwhile information of relevance to education.

Two companies who have so far made this commitment are Memorex International, the tape people, and the newly-formed National Computer Club. Negotiations are well advanced with many other large organizations.

Until now, schools have tended to confine the use of microcomputer equipment, acquired under the Department of Industry's grant scheme, to the mathematics or computer studies departments. Many have been deterred from entering the communications field by the prohibitive entry and running costs of public or commerical network services. With TTNS, however, it is claimed that schools throughout the country will be able to exchange information at a fraction of the commercial price.



The Times Network Starter Pack consisting: a BABT approved modem; a TTNS connection program; a tutor program; operating manual and cabling to connect the modem to the micro's serial port.

Database

The database, currently being set up under the supervision of educational advisors, will contain a variety of information relating to both curricular and extra-curricular activities. Children will be able to initiate research projects, enter competitions, send and receive software programs, pool technical expertise and equipment, and find out about national and local events from the noticeboards.

Older students will be able to find out about different careers and apply for jobs directly through the system. It is also hoped that the network will provide links between education, industry, commerce, and the professions by helping young people understand the requirements of their future employers and, at the same time, making them familiar with new technology.

Pupils from the Garth Hill Comprehensive School, Bracknell show their delight with the new system.

As well as having rapid access to topical data, such as lectures, exhibitions or articles in the press, teachers will be able to pool schools equipment to maximise resources. Sports fixtures and other inter-school activities can also be arranged more economically than at present.

Administrative material can also be exchanged at high speed between schools and their Local Education Authorities, with confidentiality safeguarded by passwords on individual messages as well as on mailboxes.

Cost

The Times Network Systems will supply a combined hardware and software package to adapt the micro for linking to the Network, at the subsidised price of £152. This is a one-off charge, with a further nominal subscription of £69 payable termly (usually three periods) on each mailbox (£52 in Scotland—four periods) to cover unlimited access to TTNS.

This represents a considerable saving on the normal Telecom Gold charges of £100 registration, plus £10 per month minimum billing in advance, with peak rate access charged at 10·5 pence per minute and data storage at 20 pence per 2048 characters per month. The Times Network Systems has also made every effort to help schools minimise telephone bills by incorporating the preparation and reading of data off-line into the access software, and negotiating with British Telecom's Packet Switch Services and Multistream for group discounts on charges above local call rates.

The System

The first public demonstration of the network was given at the Garth Hill Comprehensive School, Bracknell. It has 1,140 pupils aged between 11 and 19, its own computer centre (built with funds raised by parents and children) and is equipped with 20 BBC Micros.

During the pilot project, which commenced operation at the beginning of November '84, TTNS users are sharing Telecom's PRIME 850 and 750 minicomputers but will move over to the TTNS dedicated machines in April this year.

Technical requirements for accessing the service are the same as for any other Telecom Gold user, namely a microcomputer with a RS323 port, a modem and software to convert the micro into a "dumb terminal".

Users can decide how much to build into their program, with the ability to alter and store alternative telephone numbers on-line as one of the menu options offered. The mailbox number and password can also be stored on the software if required, so that the entire logging on process is automatic, or left out for security reasons.

Starter Pack

Schools signing up for the TTNS service will be sent a Starter Pack suitable for use with most micros currently being used by schools.

MEETINGS . . . & . . . COURSES

The 1985 Offshore Computers Conference and Exhibition is to be held from 8 to 10 October 1985 at the Aberdeen Exhibition & Conference, Bridge of Don, Aberdeen, Scotland.

The Apricot and Sirius Show '85 is being held on 5 to 7 February — 10a.m. to 6p.m. (5p.m. last day) — at The Kensington and Chelsea Town Hall, London.

The Institution of Electrical and Electronics Incorporated Engineers is to hold a lecture entitled "Electric Road Vehicles" by A. F. Aldous, Director, Electric Vehicle Development Group, at the IEE Lecture Theatre, Savoy Place, London WC2 on March 25 at 6p.m.

The Kingston Polytechnic is to hold a one day course entitled "Choosing a Micro."

The University of Glasgow is to run a 5 week, one evening per week, course entitled "Introduction to Programming in Basic."

Tandata Marketing, who claim to be the British videotex hardware market leader, is searching for overseas distributors for its British-made terminals and modems.

The full range has been approved by the relevant authorities in the UK, Eire and the Netherlands. Australia, Denmark, Hong Kong, New Zealand, South Africa and Sweden are amongst the countries in which individual products have been approved.

HOT CAGE

No bird is held captive in this "wireless cage". What looks like a bird cage is, in fact, the screen grid of a 100kW vapour-condensation-cooled tetrode for medium and shortwave radio transmitters.

The photograph was taken at Siemens' electronic tube plant in Berlin and shows the delicate pattern of a graphite grid made from a cylindrical hollow body using a laser as a precision cutting tool.

Also known as pyrographite, the material is loaded with as much as 24W per square centimetre, with temperatures just below 2000K.

TRADE MARK

The Minister for Information Technology, Mr Geoffrey Pattie, has confirmed that the Government would be prepared to give financial support, with Parliamentary approval, to the siting of the European Community Trade Marks Office in London.

He indicated that efforts are already in hand to find suitable premises for the Office.

David Maroni, well-known to the trade press as Director of External Relations for British Olivetti, is one of four new public members of the Press Council.

INFRA RED LINK

The Department of Trade and Industry has given Datapoint (UK) permission to sell its LightLink infra red data transmitter in the UK.

Using modulated non-coherent infra red light, LightLink transmits and receives digitised data at up to four million bits-per-second over distances of up to one mile. It operates over a line-of-sight path between rooftops or windows of separate buildings.

Datapoint has already received an order for a pair of LinkLights from the UK company International Management Ltd who want to connect the ARCNET system in its offices on both sides of Shaftesbury Avenue, London.

IN-ROOM MOVIES

A 90 channel microprocessor selector for their in-room hotel movie system is being marketed in the UK by Spectradyne UK Ltd. Developed by the parent company in the USA, and so far installed in some 40 US leading hotels and also in Brussels and Antwerp, the selector provides such facilities as: a selection of video movies, TV programmes, hotel facilities, tourist information, Reuter reports and other news bulletins.

Installed in guest bedrooms, Spectravision is connected to the TV set and controls all the sets channels. The TV set in turn is connected via a multi antennae system to central video players and a billing computer. If required it can also be interfaced to the hotel main frame computer and to any type of central information reception which converts to TV format.

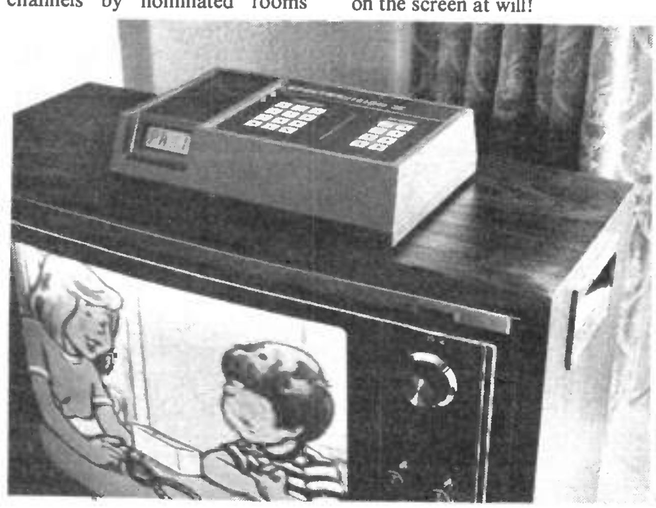
It allows for up to eight pay view channels, and distinguishes between a pay and a free channel, enabling pay channel viewing to be charged via the billing computer. It also converts existing TV sets into 90 channel receivers, catering for any foreseeable number of free TV or cable channels.

Services

In a typical UK hotel bedroom installation, guests can select from four pay per view movies at a time or view any TV channel free of charge. The spare channels are available to advertise hotel facilities, provide tourist information, and feature news bulletins and Reuter reports.

Other possible functions include an inhibit facility which restricts access to particular channels by nominated rooms only. This is useful for tour operators and conference organisers who want to contact their members or for parents who wish to restrict their children's viewing.

It is hoped that with further development of the selector's two-way communication function it will enable hotels to relay telephone messages onto room TV sets and for guests to order up their bill or the restaurant menu on the screen at will!



FAULT FINDING

E.A.Rule Part 4

LAST month we dealt with the types of faults that are found in newly constructed equipment. Faults can, of course, develop at any time but in general it is true to say that the longer a piece of equipment stays working, the longer it is likely to continue working. The graph in Fig. 1 shows a typical component failure curve plotted against time and it can be seen that the first few hours of operation are where most failures occur. This is why many manufacturers leave new equipment on 'soak test' for 48 hours or so before despatching it to the consumer.

The methods used to locate faults in equipment will largely depend on the personal experience of the engineer and the type of test equipment available. Some types of equipment manufactured for the consumer market seem to develop faults that are particular to a given model and the experienced engineer will look for these first. However we shall assume that you have no experience of the equipment under test and also that our test equipment is limited to a multimeter and a signal generator. We shall also look at tests that can be made using an oscilloscope because these days the price of simple scopes makes them available to most constructors. Without doubt, the oscilloscope is the engineer's most valuable tool, and in experienced hands can do most jobs.

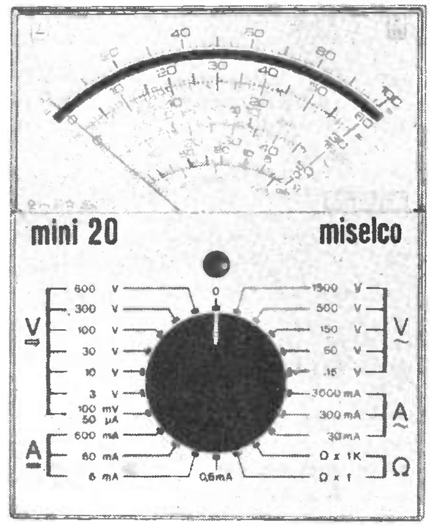
CHECK THE OBVIOUS

The procedure now given can be used for most linear signal handling equipment, but for our example we shall assume that we have a simple radio receiver which has failed after a reasonable period of time.

Always start by checking the obvious things. Are the pilot lamps still alight? Is the tuning meter still working? Are fuses OK, speakers connected etc? In the authors experience many faults come into this simple category. Having checked the obvious and decided that more detailed investigation is required we can remove any covers to expose the internals, always *switch off* before removing any covers and watch out for exposed mains or high voltage connections once covers are removed. Best of all, *remove* the mains plug from the socket until you are sure the equipment is safe to work on. Having removed covers etc, reconnect speakers, aerials and any other external items that are relevant to the tests.

The first thing to do now is to reduce the area of search and this is done by means of a few simple tests which should tell us which section of the receiver is faulty. It is always a good plan to start by measuring voltages throughout the item under test as often this will reveal the faulty area. If as mentioned in part two of this series you made a 'table of voltages', measured when the equipment was working correctly, you will now see if there are any changes and this may directly reveal the fault.

Keep a watchful eye open for clues, burnt components, dry joints etc. Also note whether or not the operating of various switches changes the voltage readings, is this normal? If as a result of these measurements you have found a suspect voltage reading, then a more detailed examination of the circuit around that area can be carried out.



A typical general-purpose low-cost multimeter. Courtesy of Alcon Instruments.

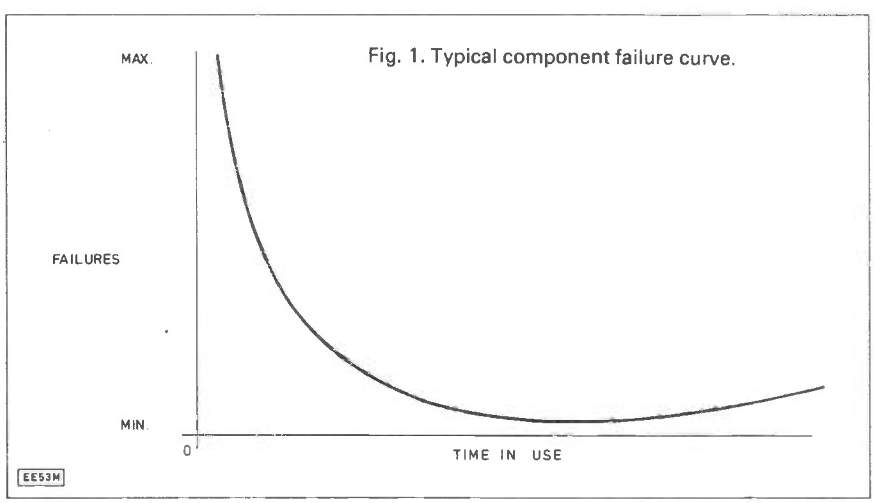


Fig. 1. Typical component failure curve.

SIGNAL TRACING

Assuming that all the voltages measured are correct and that no other clue was found, the next step is to try to isolate the faulty section by some means of signal tracing. This can range from simply touching the input of each stage to see if anything is heard from the loudspeaker to injecting a signal from a signal generator into each stage, or by 'looking' with an oscilloscope. Each method is different but all can be successful. What we are looking for is where the signal 'disappears'. These procedures can start from the output stage working towards the RF section or from the aerial input working towards the output stage. The one used will depend on what test equipment is available.

The signal generator can be a simple squarewave oscillator (rich in harmonics) fed into each stage in turn. Starting at the input of the output stage we should hear something from the loudspeaker. If we do not then we need look no further. However if a signal is heard, transfer the signal back one stage and repeat this until the signal disappears. Between the point where the signal was last heard and where it disappeared is the area most likely to have the fault and a detailed check of this area can begin. The advantage of a simple squarewave signal generator is that because it is rich in harmonics it will work in both audio and RF sections of the receiver. However it will only indicate a 'go-no-go' situation, it will not tell you if the gain is low or a circuit is off-tune for example, so a degree of commonsense is required when using such simple test equipment.

An RF modulated signal generator will be far more useful. The audio tone used to modulate the RF signal is normally available at a terminal and can be used to inject a signal at audio frequency into each audio stage in turn. The procedure is the same as above. The RF output can be used to inject a signal into the IF stages or RF stages in turn (with the generator tuned to the correct frequency of course). It could also be used to take the place of the local oscillator in the receiver if it is suspected that this is not operating (in this case tuning the generator across a band of frequencies should result in signals being tuned).

If an oscilloscope is available the signal could be traced from the aerial through the receiver towards the output stage.

ASSUME NOTHING SUSPECT EVERYTHING

With any of these methods, as I have already said, the idea is to find the point where the signal 'disappears', and to carry out a more detailed check around that stage. Having found the faulty stage, recheck the voltages around that area very carefully, look now for slight errors and try to decide if there is a clue that can be obtained from these slight differences. Be careful as there are traps for the unwary.

For instance in Fig. 2 when the meter is connected across R1 a voltage will be seen to be present, even if R1 is open circuit; this is because the internal resistance of the meter will complete the circuit. The clue here is to switch the meter to another range, this will change the voltage seemingly present. In a circuit of this type the emitter should always be about 0·7 to 0·2 volts less than the base, depending on the type of transistor used.

The circuit shown in Fig. 3 can give misleading information in that the voltages may seem to be correct, even if C1 is short circuited and prevents signals from passing. This type of fault can be revealed by tracing the signal through.

Do not assume anything, suspect everything, and bear in mind that one cannot always see the wood for the trees.

INTEGRATED CIRCUITS

Another problem area is when an integrated circuit is used. Often all the voltages will be correct but tests fail to get a signal past that stage. In this situation the only way is to change the i.c.

However if the voltages measured are not correct, check carefully, the measurements could show incorrect voltages caused by the i.c. itself being faulty, or incorrect voltages may have damaged the i.c. Sometimes no information is available regarding the voltages to be expected around an i.c., in this case it is worth looking at the manufacturers data as often it will include a voltage table for that particular i.c. and a circuit for its application given. Most i.c.s are used as specified so this source of information can be of considerable help. If the device is an LSI be careful to take precautions regarding static (more about this in a later part).

OSCILLOSCOPE DETECTION

To end this months section we will look at an actual fault on a receiver, found by using an oscilloscope, a fault that would be difficult to find by any other method.

The symptoms were, a high noise level in the form of "crackles" when tuned to a station. The first test carried out was to inject a signal into the IF amplifier stages with the generator tuned to the correct frequency. This test revealed a "clean" signal. Checking through the aerial input revealed a noisy signal. So the fault seemed to be in the RF section. A signal directly into the mixer showed the noise to be present. From this it was suspected that the fault was in the mixer stage.

The next test was to use the generator as the local oscillator and this revealed that the noise had gone. This seemed to indicate quite clearly an oscillator fault. Note the words "suspect" and "seemed", the truth was quite different.

The set in question had varicap tuning and from past experience it was known that any "noises" on the varicap tuning voltage could cause noise at the output. The reason for this is that small variations in tuning voltage cause variations in tuning, as the set was an FM receiver these small variations in tuning acted in the same way as an FM input signal and would be detected as "audio". Measurements of the varicap tuning voltage using a meter did not reveal any variations but connecting an oscilloscope across the varicap supply line showed noise to be superimposed on the steady direct voltage present.

Moving the oscilloscope probe along the varicap supply line (Fig. 4) to various points showed that the noise was 'visable' at the oscillator varicap and at two points before this. Each point was decoupled with a capacitor. Now we know that a capacitor/resistor network will filter out the higher frequencies, so looking more closely at the oscilloscope screen we found the point of maximum high frequency noise. This turned out to be at each end of the resistor R2, used in the supply line; changing this resistor effected a cure. The fault had turned out to be not directly connected with the oscillator circuit but in a supply line.

Without an oscilloscope this type of fault could only be found by substituting each component in turn, a long and expensive procedure.

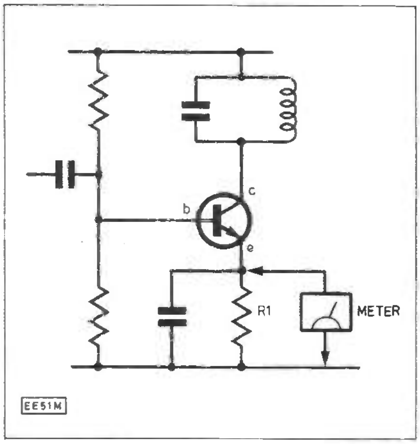


Fig. 2. Because of its internal resistance the meter will still indicate a voltage, even when R1 is open circuit.

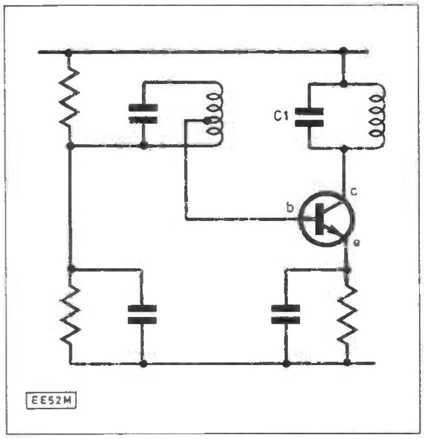


Fig. 3. The voltages measured in this circuit may seem to be correct, even if C1 is short circuited.

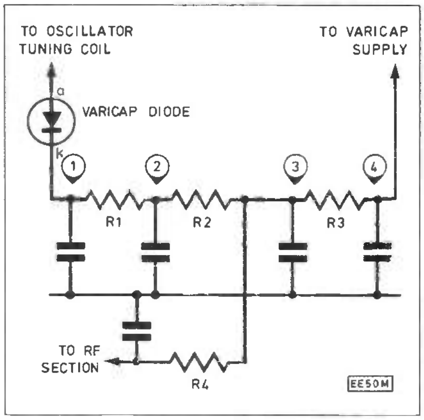


Fig. 4. The highest amounts of high frequency noise were equally present at points 2 and 3, and the lowest at points 1 and 4. This showed R2 to be the problem.

Next month we shall take a look at methods used to locate intermittent faults.

RADIO WORLD

BY PAT HAWKER G3VA

Radio Amateurs' Examination

During recent years there has been an upsurge in the number of licensed radio amateurs in the UK, the majority of whom now hold the Class B licences for v.h.f. operation that do not require the passing of a Morse Test. Both the Class B and Class A licenses, which permits operation on all amateur bands including those below 144MHz, require the passing of the City & Guilds of London Radio Amateurs' Examination, which is held two or three times a year and can be taken at some 400 centres throughout the UK.

The next examinations are due to be held on Monday, March 18 and Monday, May 13 although even to sit the May examination applications have to be in by February 15 at the latest (and possibly even earlier at some local centres). The RAE takes the form of two "multichoice" papers, the first covering licence conditions and transmitter interference and the second covering operating practices, procedures and theory.

The first part lasts one hour and the second $1\frac{3}{4}$ hours. Each question normally provides four "answers" and the candidate simply has to indicate which answer he considers to be correct.

This sounds easier than the old form of written examination paper but in fact is not as simple as it sounds. It seems to be the usual practice to provide two "answers" that are clearly incorrect to any candidate who has studied the subjects listed in the syllabus with reasonable care. However, the other two answers seem to be designed to be much more testing, and it may be by no means obvious which of the two will be deemed "correct" when viewed in the light of modern practice.

The papers are drawn from a large bank of questions, most recently with the aid of a computer program. C&GI issue a block of 40 "sample" questions but are not prepared to disclose the complete bank of questions for fear that "cramming" publications would be issued, enabling candidates simply to know the correct answers in advance without any real study of the subjects.

Occasionally copies of particular papers "leak" out and those I have seen, dating from a few years ago, have not inspired great confidence in the standard of the question-setting.

The Institute is advised by a committee including educationalists and radio amateurs. Some papers have included printing errors and at least some of the questions have not appeared to have any really "correct" answer!

However, one hopes that these have now all been weeded out of the "bank"! There was also the curious decision to remove all questions relating to thermionic valves at a time when the majority of amateur radio equipment used them for power amplification (even today this is true of most high-power equipment).

Similarly, CGI do not make known any fixed "pass" mark and the impression is that this is varied so that roughly two-thirds of all candidates are deemed to have passed, and one-third to fail—a curious practice for what is supposedly a "qualifying" examination. Some 10 per cent of candidates usually obtain a "distinction", and around 30 per cent a "credit" mark. While it must be satisfying to achieve a "distinction" it carries no privileges, since a "pass" certificate is all that is required to obtain a licence.

Fewer Candidates

The number of candidates for RAE reached a peak in 1982 when 8176 completed the examination, falling back to 7542 in 1983 and 5922 in 1984. It is possible that numbers in 1982 were boosted by the surge of interest in two-way radio communication brought about by the controversies surrounding the introduction of Citizen's Band.

It is also possible that the subsequent reduction may be partly due to the shift of interest to home computing, though it should be emphasised that the number of people taking out new licences, particularly Class B licences, is still at a vastly greater rate than in earlier decades.

Forward Planning

As a result, a major problem faces the hobby in spreading out activity more evenly between the different bands. In many areas, 144-146MHz is now so crowded as to inhibit weak-signal operation in favour of local repeaters that can be assessed with hand-held low-power transceivers that give little real scope for the type of experimental work that still retains the interest of many amateurs.

The possibility, with the closure of British v.h.f. television on January 6 this year, of a UK allocation at 50MHz open to all amateurs (at present about 100 UK amateurs hold experimental permits for 50MHz "outside broadcasting hours") may bring about some improvement, though it will need restraint and some forward planning to prevent this rapidly becoming a "chatter" band.

Although the opportunities for really long-distance working on 50MHz are likely to be few during the next few "sunspot minimum" years, it is a band that has much potential for interesting experimental working via Sporadic E propagation, and is particularly suitable for meteor scatter and possibly ionospheric scatter at lower power levels than used in the military systems.

Frequency Upheavals

It is not always recognized that many of the changes to frequency allocations agreed at the 1979 World Administrative Radio Conference have still to work their way through the system. For example the expansion in Europe of the v.h.f./f.m. broadcasting band up to 108MHz may not finally be implemented until after 1995, another ten years away, although the sector 102.5 to 104.5MHz is already in use for local radio (and by some of the land-based radio "pirates"). Of this the sector 104.1 to 1.45MHz is available only to local radio north of the Midlands.

The sector 97.7 to 102.1MHz is due to be cleared of police and fire service two-way communications by 1989—an expensive business involving already large scale destruction of much relatively new equipment by bulldozer. There appears to be a reluctance to release equipment by the emergency services or the Defence services on to the "surplus" market where, in days past, such equipment was a much-valued source of components for home-constructed equipment.

Of particular interest is the sector 105 to 107.9MHz (currently used for communications by the nationalised industries) but expected to become available in the UK for a new tier of "community radio services" to cater for the need for small local areas and "community of interest" specialised-format stations, though much remains to be determined as to how these will operate. It is not always recognised how much the "pirate" stations gain in programme appeal simply from the fact that they do not have to observe any of the "needle-time" restrictions on the amount of recorded music they play, that apply to BBC and ILR stations.

In the Americas (ITU Region 2), preparations are still being made to expand the medium-wave a.m. broadcasting band to 1705kHz (176 metres). Since few existing broadcast receivers cover the portion 1605 to 1705kHz this sector will hardly prove popular at first with American broadcasters. This is particularly so as the ground-wave signals will be attenuated more rapidly than in lower frequency sections of the medium-wave band.

With receiver manufacture so firmly "international" it seems likely that sets on sale in UK in a few years time will normally cover 1605 to 1705kHz although this part of the spectrum will not be available to any official broadcasters. It could prove an enormous temptation for "pirates" unless the Department of Trade & Industry, assuming that the Radio Regulatory Department continues under their aegis, discovers how to regain more effective control of the frequencies and improve its spectrum management.

As these notes are being written, the outcome of the attempt by the official Radio Mercury to obtain an injunction against pirate *Radio Jackie* has still to be determined. The reluctance of the DTI to enforce the Wireless Telegraphy Acts in recent months against the openly-operating Jackie seems a curious reflection on a Government dedicated to "law and order".

Woodpecker Hammers On

Since 1976 listeners and other users of the Short-Wave (h.f.) band have been plagued by the series of Russian "over-the-horizon" radars, popularly known as "Woodpeckers" from the constant loud tapping nature of the noise they produce. With effective radiated powers of between 10 to 50 *megawatts*, they are often the most powerful signals on the bands and cause interference throughout the world.

They use frequencies related to the changing maximum usable frequency but are particularly prone to park within the amateur bands where the competing signals are relatively so much less powerful. The pulsed signals are spread over quite broad sectors of the spectrum and it has been calculated that even at 50kHz away from the nominal frequency they still radiate about 5kW e.r.p.

Currently there appear to be three main target areas for these ballistic-missile early warning systems: two directed towards the USA and one towards China, but they affect listeners in all parts of the world.

Although some far-fetched theories have been advanced, including the suggestion that the powerful radiation is intended to result in behavioural biological changes, there is no reason to doubt that they are over-the-horizon radars and part of the elaborate Russian radar defence network.

While many complaints have been made to the USSR about these powerful sources of interference operating on frequencies allotted to other services under the ITU Radio Regulations, the Russians can simply shrug these off since the ITU agreements, although they have the status of a formal international treaty, have an escape clause that gives any country the right to ignore the treaty where this is deemed to be in the interests of its national defence.

The Americans also operate very powerful over-the-horizon h.f. radars (CONUS OTH–B) but these work on the Doppler principle from narrow-bandwidth continuous-wave signals, not involving pulses.

There seems little or no chance that the Woodpeckers will stop their tapping in the foreseeable future, unless the Russians develop a more elegant system. Only the h.f. band can give the necessary continuous long-distance coverage from fixed sites, although the radars carried in satellites form a back-up system.

The long pulses of Woodpecker can however be much reduced by means of noise-blanker techniques which cut the signal path in the receiver for the necessary periods. Similarly the commercial fixed-station radioteletype transmissions can usually cope with Woodpecker since they use automatic request for repetition (ARQ) and other error protection techniques. Worst sufferers are the listeners and amateurs with receivers having no suitable noise blanking circuits.

Coded Travel

Although only a minority of British amateurs now regularly use manual telegraphy, the amount of Morse that can be heard at the low-frequency ends of the bands is still remarkably high. The East European countries have always encouraged Morse operation, and it remains an effective way of overcoming the different-language problems of speech.

The present low sunspot levels encourage the use of the 1.8 and 3.5MHz bands for inter-European working and it is easy to bump into some interesting stations on Morse. Recently I found myself exchanging comments with Hel near Essen, a West German using a fishing-rod vertical antenna; then down to Frank near Paris with his home-made equipment; then Herman on a gas-rig near Ameland, Holland in the foggy North Sea. Then I made contact with Art on the Isle of Man who was using a home-made, all-band all-solidstate 80-watt transceiver and later with Stanley a retired Englishman in Ibiza in the Ballearic Islands.

These days with computer-type Morse trainers it is easier than ever to learn the code well enough to pass the test for the Class A licence. Yet in a recent RAE most candidates thought the Q code (first devised in 1912) was intended primarily for telephony operation!

QUALITY COMPONENTS...FAST!

SEMICONDUCTORS

AC127	35p	BU208	280p	W01	34p	4012BE	28p	4066BE	26p
AC128	35p	CA3046	99p	W02	38p	4013BE	38p	4067BE	250p
AD161	58p	CA3080E	135p	W04	44p	4014BE	68p	4068BE	28p
AD162	60p	CA3140	90p	W005	30p	4015BE	65p	4069UBE	28p
BC107B	17p	CA3189	240p	ZN414	120p	4016BE	35p	4070BE	30p
BC108C	18p	CA3240	145p	ZTX500	22p	4017BE	55p	4071BE	21p
BC109C	17p	LF347	175p	ZTX502	18p	4018BE	65p	4072BE	90p
BC140	37p	LF351	75p	ZTX504	32p	4019BE	41p	4073BE	28p
BC141	36p	LF353	96p			4020BE	65p	4075BE	35p
BC168C	12p	LM301A	33p	1N4001	7p	4021BE	68p	4076BE	74p
BC169C	12p	LM311	99p	1N4002	5p	4022BE	72p	4077BE	32p
BC182L	12p	LM380	165p	1N4005	6p	4023BE	28p	4078BE	32p
BC183L	15p	LM381	180p	1N4007	7p	4024BE	48p	4081BE	28p
BC184L	16p	LM382	150p	1N4148	4p	4025BE	28p	4082BE	28p
BC212	14p	LM384	170p	1N914	5p	4026BE	110p	4085BE	59p
BC214	12p	LM387	175p	2N2219	37p	4027BE	38p	4089BE	140p
BC327	14p	LM389	150p	2N2369A	28p	4028BE	55p	4093BE	40p
BC328	14p	LM3914	380p	2N2646	90p	4029BE	60p	4094BE	110p
BC337	14p	MJ2955	115p	2N2904	32p	4031BE	130p	4098BE	85p
BC547	9p	ML922	505p	2N2907	26p	4032BE	65p	4099BC	96p
BC548	12p	MPF102	85p	2N3054	79p	4033BE	94p	40106	44p
BC549	12p	NE555	37p	2N3055H	105p	4035BE	65p	40109	86p
BCY70	23p	NE556	65p	2N3703	14p	4038BE	85p	40162	68p
BCY71	22p	NE565	155p	2N3704	12p	4040BE	60p	40174	72p
BD131	49p	NE566	160p	2N3705	12p	4041BE	69p	40194	79p
BD132	50p	OA200	9p	2N3706	14p	4042BE	56p	4502BE	60p
BD135	37p	OA47	21p	2N3708	12p	4043BE	60p	4503BE	55p
BD139	40p	OA90	9p	2N3711	11p	4044BE	63p	4508BE	150p
BD140	40p	OA91	10p	2N3772	195p	4045BE	115p	4510	65p
BD180	45p	SL490	320p	2N3903	16p	4046BE	75p	4511	70p
BF258	37p	TDA1022	640p	2N3904	18p	4047BE	75p	4520BE	65p
BF259	37p	TDA1024	179p	2N3905	14p	4048BE	50p	4568BE	310p
BFX29	34p	TIP122	95p	2N5458	59p	4049UBE	56p	7106	810p
BFX84	34p	TIP127	75p			4050BE	38p	7107	810p
BFX85	37p	TIP2955	95p	4000BE	23p	4051BE	60p	741	28p
BFX87	38p	TIP3055	87p	4001BE	28p	4052BE	60p	748C	59p
BFX88	35p	TIP31A	39p	4002BE	28p	4053BE	72p		
BFY50	31p	TIP41A	45p	4006BE	75p	4054BE	88p		
BFY51	38p	TIP42	45p	4007UBE	28p	4056BE	95p		
BFY52	31p	VNK10KM	92p	4008BE	75p	4060BE	82p		
BU205	200p	VN66AF	188p	4011BE	28p	4063BE	90p		

SEE THE 1985 CATALOGUE FOR A HUGE RANGE OF COMPONENTS

PLEASE REMEMBER OUR PRICES INCLUDE 15% VAT!

CONNECTORS

4mm PLUGS - Black and red **15p EACH.** Green, White, Yellow, Brown and Blue - **16p EACH.**

4mm CHASSIS SOCKETS
Above colours - **15p EACH.**

4mm TERMINAL POSTS
Above colours - **44p EACH.**

PLASTIC PHONO PLUGS - Black, Red, White, Blue, Yellow - All **12p EACH.**

BNC CONNECTORS
Line Plug - **99p**
Line Socket - **£1.15**
Chassis Socket - **48p**

D-RANGE PLUGS
9 WAY - **£1.32**
15 WAY - **£1.42**
25 WAY - **£1.46**

D-RANGE SOCKETS
9 WAY - **£1.32**
15 WAY - **£1.96**
25 WAY - **£1.30**

BT CONNECTORS
Line cord & plug - **£1.92**
Wall Socket - **£2.94**

DIN PLUGS - 2pin - **12p**; 3pin - **15p**; 4pin - **33p**; 5pin 180 - **17p**; 6 pin - **42p**; 7pin - **24p**; 8pin - **62p**

SEE CATALOGUE FOR FULL DETAILS OF CONNECTORS

CAPACITORS

ELECTROLYTIC AXIAL TYPE
25V:10uF **8p**; 22uF **10p**; 47uF **12p**; 100uF **15p**; 150uF **15p**; 220uF **17p**; 330uF **20p**; 470uF **22p**; 1000uF **36p**; 2200uF **61p**; 3300uF **91p**

63V:1uF **9p**; 1.5uF **11p**; 2.2uF **8p**; 3.3uF **8p**; 4.7uF **8p**; 6.8uF **18p**; 10uF **12p**; 15uF **16p**; 22uF **17p**; 47uF **17p**; 100uF **21p**; 150uF **31p**; 220uF **29p**; 330uF **32p**; 470uF **46p**; 1000uF **78p**; 2200uF **£1.50**

TANTALUM BEAD (uF/Volts)
0.1/35 **12p**; 0.22/35 **17p**; 0.47/35 **18p**; 1/35 **19p**; 2.2/35 **21p**; 4.7/16 **17p**; 10/16 **26p**; 22/25 **63p**; 100/3 **37p**; 100/10 **£1.28**

DISC CERAMIC TYPE
0.01uF **6p**; 0.022uF **6p**; 0.047uF **8p**; 0.1uF **8p**

1% POLYSTYRENE TYPE (pF)
100 **25p**; 150 **25p**; 220 **25p**; 270 **25p**; 330 **26p**; 390 **27p**; 470 **27p**; 1000 **28p**

SEE CATALOGUE FOR A FULL LIST OF CAPACITORS

RESISTORS

1% 0.4 WATT METAL FILM

These high quality resistors are supplied singly or in bargain packs. All E24 values 1R - 1M are available:

ONLY 2p EACH! . . . OR

PACK 1: 10 of each value
= 1210 resistors
£21.95

PACK 2: 5 of each value
= 605 resistors
£10.99

1985 CATALOGUE

PACKED WITH THOUSANDS OF TOP QUALITY COMPONENTS AT COMPETITIVE PRICES AND ALL COVERED BY OUR SUPERB DISPATCH SERVICE!

INCLUDES 3 £1 VOUCHERS AND DETAILS OF OUR DISCOUNT SCHEME FOR REGULAR CUSTOMERS.

SEND 50p CHEQUE/P.O. TODAY FOR YOUR COPY BY RETURN OF POST!

AB MICROSYSTEMS

P.O. BOX 12, SWINTON, MANCHESTER M27 3WS.

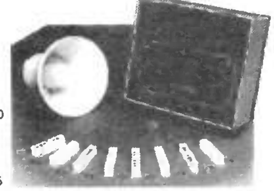
PRICES INCLUDE VAT @ 15%. POSTAGE: PLEASE ADD 30p TO ORDERS UNDER £5. OFFICIAL ORDERS WELCOME. DESPATCH NORMALLY 24 HRS. E.&O.E.

Don't put it off any longer!

Protect your family and property with your know how and our security modules. Complete systems start from as little as £39.95

A COMPLETE SECURITY SYSTEM FOR ONLY £39.95 + V.A.T.

Control Unit	CA 1250
Enclosure	HW 1250
Key Switch & 2 keys	KS 3901
L.E.D.'s	LED 1
5½" Horn Speaker	HS 588
4 quality surface Magnetic Switches	MS 1025



With only a few hours of your time it is possible to assemble and install an effective security system to protect your family and property, at the amazingly low cost of £39.95 + V.A.T. No compromises have been made and no corners have been cut. The outstanding value results from volume production and direct supply. Assembly is straight forward with the detailed instructions provided. When installed you can enjoy the peace of mind that results from a secure home. Should you wish to increase the level of security, the system may be extended at any time with additional magnetic switches, pressure pads or ultrasonic sensors. Don't wait until it's too late - order today.
Order code CS 1370

CA 1250 – 2 zone alarm control unit with built in alarm & power supply **£19.95 + V.A.T.**
HW 1250 Enclosure & Hardware Kit for above **£9.50 + V.A.T.**
LED 1 – Set of 4 l.e.d.'s in chrome bezels + Push Switch to fit HW 1250 **£2.15 + V.A.T.**
KS 3901 – 3 position Key Switch **£3.43 + V.A.T.**
HS 588 – 5½" Horn Speaker, output of 11-dbs with CA 1250 or SL 157 **£6.25 + V.A.T.**
US 5063 – advanced Digital Ultrasonic Detector, high sensitivity, with false alarm suppression **£13.95 + V.A.T.**
SC 5063 – Enclosure for US 5063 **£2.95 + V.A.T.**
IR 1470 – Infra-red system to provide 50' invisible beam, includes both transmitter and receiver **£25.61 + V.A.T.**
SL 157 – Siren Module 12V **£2.95 + V.A.T.**

Wide range of modules and accessories, etc. Send S.A.E. for details.

SELF-CONTAINED ULTRASONIC UNIT CK 5063

Requires no installation. Easily assembled using our professionally built and tested modules.

- Adjustable range up to 25 ft.
- Built-in entrance and exit delay
- Built-in timed alarm
- Key operated switch - Off, Test and Operate
- Provision for an extension speaker
- Fully self-contained
- Uses US 5063, PSL 1865 Key Switch 3901, 3" Speaker 3515

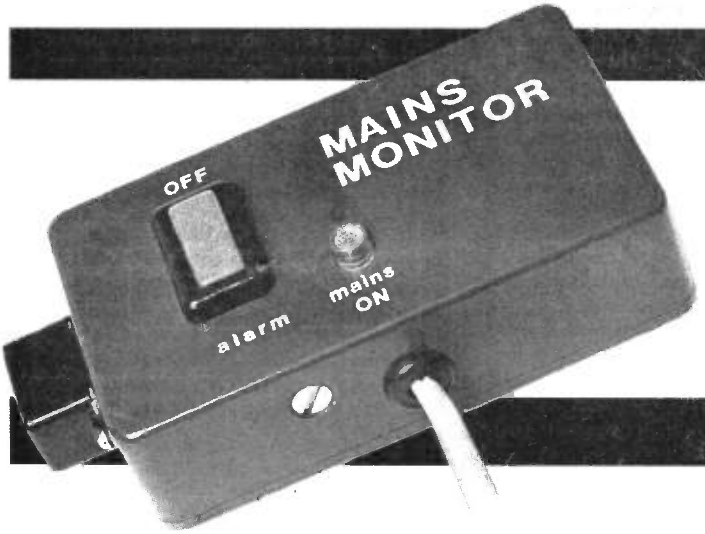
only **£37.00 + V.A.T.**

Now you can assemble a really effective intruder alarm at this low price using tried and tested Riscomp modules. Supplied with full instructions, the kit contains everything necessary to provide an effective warning system for your house or flat. With a built-in LED indicator and test position the unit is easily set-up requiring no installation. It may simply be placed on a cupboard or desk. Movement within its range will then cause the built-in siren to produce a penetrating 900dbs of sound, or even 110dbs with an additional speaker. All parts included and supplied with full instructions for ease of assembly.
Size 200 x 180 x 70mm   Order as CK 5063

Add 15% VAT to all prices
Add 70p post and packing to all orders
Units on demonstration
Shop hours 9.00 to 5.30 p.m.
Closed Wednesday

Saturday 9.00 to 1.00 p.m.
SAE with all enquiries
Order by telephone or post using your credit card

RISCOMP LIMITED
Dept EE26.
21 Duke Street.
Princes Risborough.
Bucks. HP17 0AT.
Princes Risborough (084 44) 6326



MAINS MONITOR

A. R. WINSTANLEY

Owners of deep freezers or tropical aquaria will appreciate the need to know immediately when the mains supply has failed; although under these circumstances there is little that can be done to rectify the situation. Unless you are lucky enough to own a standby generator, you can at least take steps to reduce the risk of consequential damage caused by disconnection of the mains.

The unit takes the form of a battery-operated pulsed alarm, the operation of which is disabled when the mains is connected. Failure of the electricity supply will cause the alarm to bleep until the supply is restored. In the meantime, the alarm can be switched off if you wish.

The circuit diagram of the Mains Monitor is shown in Fig. 1. IC1 is a CMOS 7555 timer i.c. connected as an astable multivibrator. The CMOS version of the popular 555 chip is used to reduce the quiescent or standby current drawn by the i.c. and this helps to increase battery life.

CIRCUIT DESCRIPTION

When S1 is closed d.c. power is applied to the astable and IC1 is triggered because the trigger terminal (pin 2) is initially at 0V. Then capacitor C1 starts to charge up through R4 and R5 as the output (pin 3) goes high to roughly the supply rail voltage. C1 continues charging until the voltage at the "threshold" terminal (pin 6) exceeds precisely two-thirds of the supply rail.

At this point an internal comparator switches over (also causing pin 3 to go low to about 0V) and starts to discharge C1 through R5 and into pin 7, the discharge terminal. Eventually the potential across C1 will drop back to one-third the supply voltage and this is detected by the trigger pin and once more the chip switches over, permitting C1 to charge up again to two-thirds the supply rail with the output going high.

Basically what happens then is that C1 charges and discharges between one-third and two-thirds the supply potential and the output switches high and low accordingly.

The three components R4, R5 and C1 control the frequency of operation and with the values indicated, the output high time (or mark) will be roughly one second. The low period (or space) is about 0·7 of a second and this equates to a frequency of 0·6Hz.

CURRENT AMPLIFIERS

The integrated circuit, IC1, drives a current amplifier TR1 which completes a circuit to WD1. This is an audible warning device consuming 15mA or so and the warning device will sound when the output of IC1 goes high. Note that ordinary electromechanical buzzers must not be used in place of WD1 on account of the much greater current that they consume.

Operation of the astable may be inhibited by taking the reset terminal pin 4 to 0V. R2 and the light-dependent resistor PCC1 form a potential divider network, the output of which is wired to the astable reset pin.

The resistance of the l.d.r. according to its data, may vary from less than 100 ohms when brightly illuminated, to several megohms in darkness. Consequently the reset signal to IC1 is light-dependent and relies upon the amount of light falling upon PCC1.

FAILURE DETECTION

Now we turn to the method by which the Mains Monitor detects when the mains electricity has failed. *Live* and *neutral* feeds (no earth is required) are connected to a neon bulb, LP1, and its associated voltage-dropping resistor R1. Thus LP1 is illuminated when the mains is switched on.

The bulb is placed directly over PCC1 so that its illumination determines the resistance of the photo-resistor. This assembly forms a home-made "opto-isolator."

Thus when the mains is connected, LP1 lights up and causes the l.d.r. resistance to be quite low, approximately 200 ohms, or so. By potential divider action this means that the voltage at IC1 pin 4 will be at a fraction of a volt and so the oscillator is inhibited.

Disconnection of the mains will extinguish LP1 and as a consequence the resistance of PCC1 will rise dramatically. This pushes pin 4 towards the positive d.c. supply rail and enables the astable, permitting the audible warning device to operate in a pulsed manner. This will continue until the mains is restored.

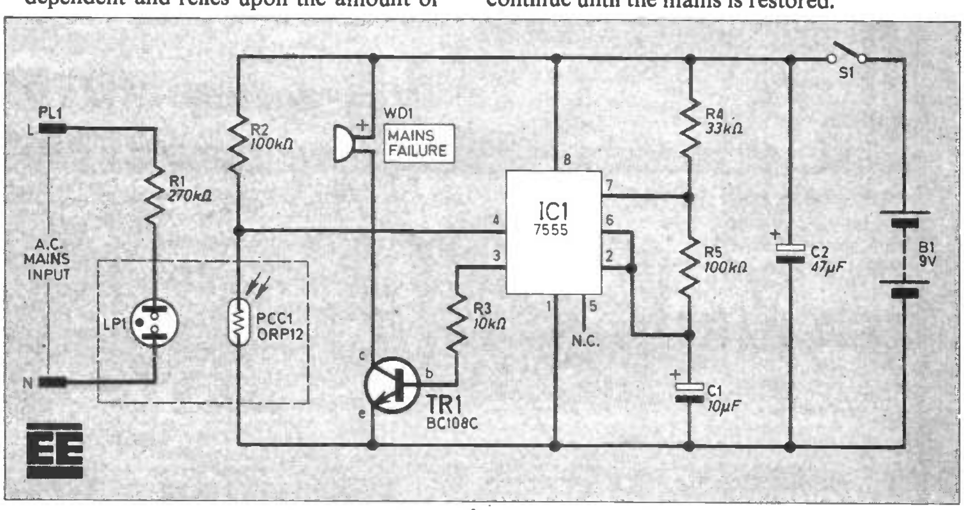


Fig. 1. Circuit diagram of the mains monitor.

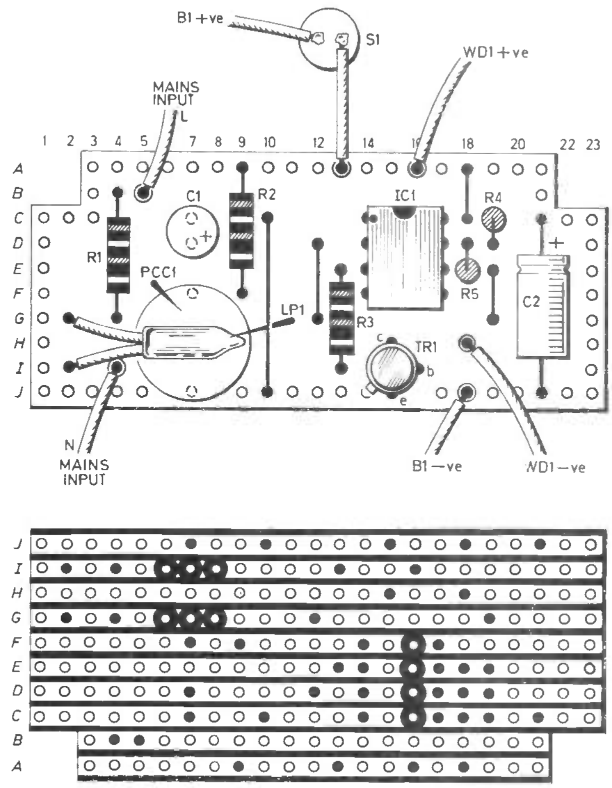


Fig. 2. Drilling details and component layout for the mains monitor.

COMPONENTS

See Shop Talk page 84

Resistors
- R1 270k
- R2,5 100k (2 off)
- R3 10k
- R4 33k
- All ¼W carbon ±5%

Capacitors
- C1 10µ 25V radial elect.
- C2 47µ 25V radial elect.

Semiconductors
- TR1 BC108C silicon *npn*
- IC1 ICM7555 CMOS timer i.c.
- PCC1 ORP12 light-dependent resistor

Miscellaneous
- LP1 wire ended neon
- WD1 6V, 15mA audible warning device
- S1 s.p.s.t. rocker switch

Case, 113 × 63 × 31mm (BIM2003); 0·1in matrix stripboard, 10 strips by 23 holes; 8-pin d.i.l. i.c. socket; battery clip; transparent l.e.d. cover; connecting wire; rubber grommet; "P" clip.

COMPONENTS approximate cost £5·50

Finally the function of capacitor C2 is to decouple the d.c. power supply and it compensates for low-frequency ripple which will eventually appear on the rails due to increased internal resistance of the battery as it begins to age.

CONSTRUCTION starts here

CASE

The prototype was constructed in an all-plastic box type BIM2003 measuring 113 × 63 × 31mm. Of course, a light-proof box must be used so that the resistance of PCC1 is not affected by external light sources. Also the lack of any metal panel on the box obviates the requirement that the box be earthed.

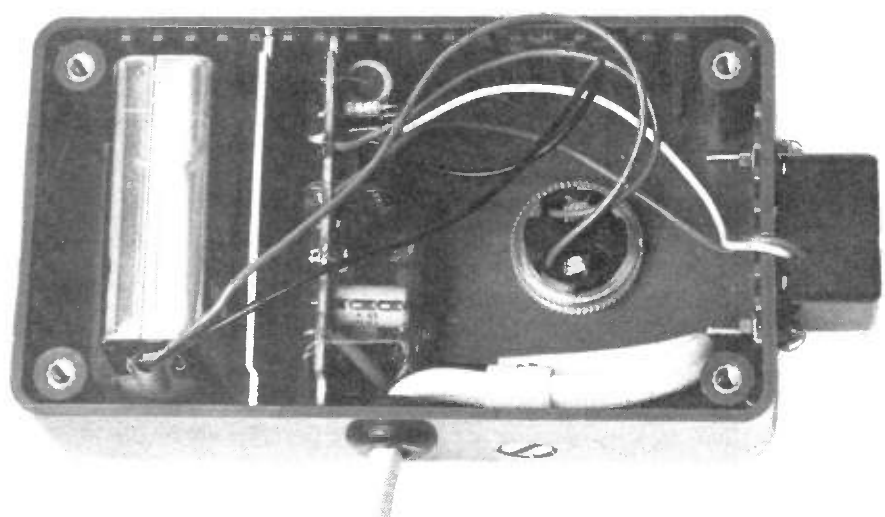
The complete circuit is assembled on 0·1in pitch stripboard, 10 strips × 23 holes (see Fig. 2). These dimensions permit the stripboard to be held by the p.c.b. guides moulded into the case interior.

Commence construction by cutting and filing the stripboard to size and then make the breaks in the copper strips in the locations shown. Notice in two locations that three track breaks are made adjacent to each other. This is a *safety precaution* designed to ensure complete isolation of mains circuitry from the rest of the components.

Continue by soldering in the i.c. socket which acts as a good reference when soldering in the rest of the components. Do not insert IC1 into its socket yet but keep it in its protective anti-static package for the moment.

Solder into place the rest of the components as shown in Fig. 2. Take care not to overheat the transistor during soldering and you would be advised to employ a heatshunt on the leads being soldered. Also it is important to observe correct polarisation of the electrolytic capacitors.

The neon bulb should be soldered into its location last of all to prevent it being damaged when assembling the stripboard; it is also necessary to insulate both leads of the bulb with about 20mm of 1mm p.v.c. sleeving prior to soldering, in order to prevent short circuiting. Then gently bend the bulb over so that it lies on top of PCC1.



Now push the i.c. quickly into its socket, making sure of course that it is correctly polarised, otherwise you may finish up with a "disintegrated" circuit!

The plastic box needs to be drilled to accept the on/off switch and audible warning device. The latter is mounted on the outside of the box and the two leads pass through an adjacent hole to the circuit panel within the case.

MAINS LEAD

The twin-core mains input lead passes through a hole in the middle of one side of the box, this hole should be fitted with a grommet. In any case it is quite essential that the cable is properly secured to ensure that it can never be pulled out of the box. In this respect, employ either a cable gland or a nylon "P" clip of appropriate size.

A further hole can be made on the front panel so that when the component panel is slotted into place the neon bulb (which is directly behind the front panel, not next to the removable lid) may be observed once illuminated. This acts as the "mains on" indicator. By drilling a $\frac{1}{4}$in hole you can then fit a transparent l.e.d. cover of the type intended for use with light-emitting diodes.

With assembly completed, check the unit most thoroughly. Since mains and low d.c. voltages are both present on the component board, it is of course essential that there are no errors in assembly. Note that it is necessary to secure the battery inside the case, so that it does not make contact with the component board.

Before connecting the mains, clip on a battery (PP3) and then close up the box. It is preferable that the mains is connected through a 1A or 3A fused plug.

TESTING

With the mains off, closing S1 should cause the alarm to sound. Switching on the mains supply should inhibit the alarm and the neon bulb should be seen to be illuminated through the front panel l.e.d. cover.

Very bright direct light (sunlight, possibly) can diffuse through the l.e.d. cover and affect correct operation of the circuit by reducing the resistance of PCC1 irrespective of whether the neon bulb is illuminated or not. Take this into consideration when placing the unit in its position.

Of course, it is wise to occasionally check the condition of the battery and this can be achieved by simply unplugging the Mains Monitor to see that the buzzer operates effectively. A battery life of several months can be expected. □

COUNTER INTELLIGENCE

BY PAUL YOUNG

Fifth Generation

Time and time again I find myself drawn back to the question of the Fifth Generation of Computers. This is not surprising, because we are assured by those who have spent many years studying computers, that the impact when it arrives could be even greater than that caused by the invention of the printing press!! Having delved fairly deeply into the subject, I am able at last to get a clear overall picture and shed one or two misconceptions.

It is unfortunate, that rumours have spread around, that engineers and scientists were on the brink of inventing machines that had intelligence and could think and reason. This even reached a stage where sales were being lost because would-be purchasers were frightened off buying them. The manufacturers were forced to counter this, by telling their customers that a computer is nothing more than a dumb machine, without a trace of intelligence in its make up.

As usual the truth lies somewhere in between. At one end of the spectrum we have the hypothesis that it is only a matter of time before they not only think, but will be able to reproduce themselves, will proceed to outsmart us and take over the human race.

To me, this is pure "Clarkes Country" and should be regarded as such. We know pretty well what they are capable of at the lower end of the scale and pretty impressive it is. They can play chess up to championship standard and do very accurate medical diagnosis, but none of this is original thinking.

One example that the experts quote is this:

"The interdisciplinary team from computer science, genetics, and chemistry laboured for years, and produced an expert system so knowledgeable and effective, that its ability to explicate the details of molecular structure from chemical data, now exceeds human capability, including that of its designers."

While I admit this is getting very close to it, what I would wish to know is this, did the system add anything original that hadn't been programmed into it? In the end it comes down to this, that before you start to examine the possibilities, you must define your premises, such terms as human intelligence, reasoning and thinking and this alone would be an awe inspiring task.

Knowledge Banks

The fifth generation of computer engineers can't stop to worry about such trifles, and at present will not go beyond saying that the fifth generation of computers having been programmed with several different sets of knowledge, will be in a position to draw inferences from them. What in fact they aim to do, is to build systems that will be able to store vast quantities of knowledge covering every subject under the sun.

To this end the Japanese are already designing chips that will contain 10 million transistors!! Experts will be called in from all fields to give their knowledge and other experts will translate it into terms that can be assimilated by the computer.

Just think what this alone entails. It means that the translator must reach a very high standard in the subject himself (or herself) and then go through the subject with the expert, while comparing his answers with the text books.

Take a small group of surgeons, specialists in cancer and at the top of their profession. Between them they might possess 75 per cent of the world's knowledge of this dreaded disease. In the fullness of time they will die and most of this knowledge will be lost, but feed it into these new computers, and it is ready for use whenever it should be required and gives the donors a new immortallity. This aspect deals with medicine, but the same treatment could be applied to every form of human endeavour, and without much reflection it is easy to see how vast the scale of these projects will be.

In The Future

Now what are the various Nations doing about it? The Japanese realise it is too large for private firms to tackle alone and they are prepared to put into it whatever amount of money that is required. They are also enlisting all the big electronics firms to take part. They know it is a huge gamble, though they are confident that even if only part of it is successful, it will pay off.

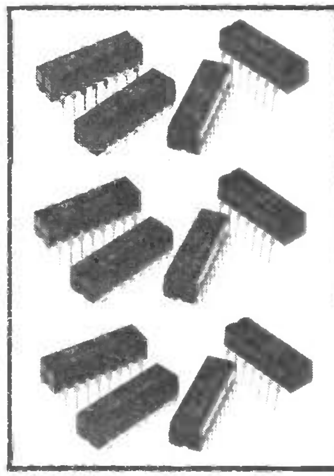
The Americans are undecided and tend to say "Leave it to IBM . . ." The British, with the exception of Sir Clive Sinclair, have shown little interest so far. However, you never can tell with us British, when you consider that Oliver Cromwell was buried at Westminster Abbey with full honours and two years later the Government changed its mind and condemmed him as a traitor. They dug up his remains, hanged him at Tyburn and then proceeded to remove his head with eight blows of the executioner's axe!!

Nothing like ending on a joyous note.

DIGITAL ELECTRONICS

D.W. CRABTREE B Sc Tech Eng (CEI)

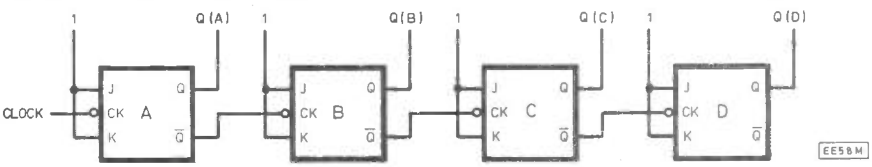
PART FIVE



IN the previous article in this series we described different types of bistables in use in digital electronics. We shall now show how they can be used to provide counting circuits, which have many applications today.

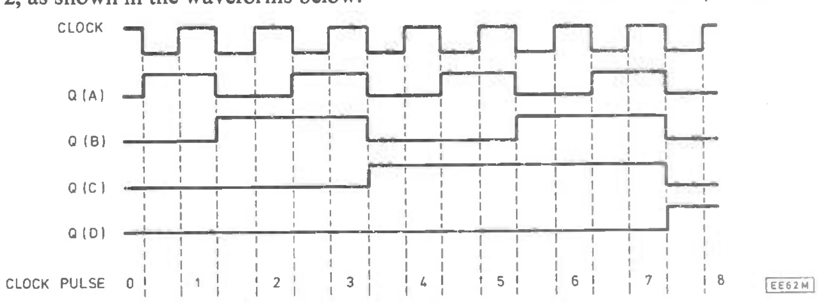
BASIC COUNTING CIRCUIT USING J-K BISTABLES

Let us consider the circuit shown below, which utilises 4 J-K bistables.



Basic counter using J-K bistables.

It should be noted that, since each of the J and K inputs are tied to logic '1', all the four flip-flops are designed to toggle their respective Q outputs when the clock pulse goes low. (Note the symbol shown on the CK inputs, denoting clock "active low"). Assume that initially, all the Q outputs have '0' as their output states. Then, when the first clock pulse goes low, 'A' flip-flop will toggle, giving a '1' at Q(A). With the next clock pulse going low, 'A' flip-flop will again toggle, reverting Q(A) output to '0' again. However, as this output changes to a low, it is also, since it is the input to Q(B) clock input, going to toggle 'B' flip-flop, thus changing Q(B) output to a '1'. Now, since the circuit has similar connections throughout, a similar chain of operations will be carried out, and it will be seen that each flip-flop is dividing the previous clock input function by 2, as shown in the waveforms below.



Timing diagram of the 4-Stage Counter.

TRUTH TABLE

It will be seen that, looking at the voltage levels of Q(A), Q(B), Q(C) and Q(D) at each period of the clock, a binary count is being produced, and the pattern is best seen in the truth table shown below. The system is, effectively, counting the clock pulses.

The truth table identifies the usual binary count, with Q(A) being the least significant bit. It is noticed that the 16th clock pulse resets all the Q outputs to '0' again. Hence the count is said to be "modulo-16". There are 4 stages of flip-flops: A,B,C,D and each Q output can have only 1 of 2 states, either '0' or '1'. Hence, there are $2^4 = 16$ states possible for this particular counter. Therefore 5 stages would allow $2^5 = 32$ possible states.

Clock Pulse	Q(D)	Q(C)	Q(B)	Q(A)	Decimal Equivalent
0	0	0	0	0	0
1	0	0	0	1	1
2	0	0	1	0	2
3	0	0	1	1	3
4	0	1	0	0	4
5	0	1	0	1	5
6	0	1	1	0	6
7	0	1	1	1	7
8	1	0	0	0	8
9	1	0	0	1	9
10	1	0	1	0	10
11	1	0	1	1	11
12	1	1	0	0	12
13	1	1	0	1	13
14	1	1	1	0	14
15	1	1	1	1	15
16	0	0	0	0	0

Truth table of the Binary Counter.

Exercise 1.

Using the principles laid out above, design a binary counting system with eight possible output states (ie: the system counts from 0 through to 7), using J-K flip-flops.

ASYNCHRONOUS COUNTERS

Now, it is important to make one or two points regarding the above "basic" counting circuit. Firstly, the system is said to be "Asynchronous", since only the first stage (A) is switched by the clock, each subsequent stage is switched by the previous stage's output, hence there exists a time delay that expands throughout the system, this delay being due to the propagation delay of each J-K flip-flop stage.

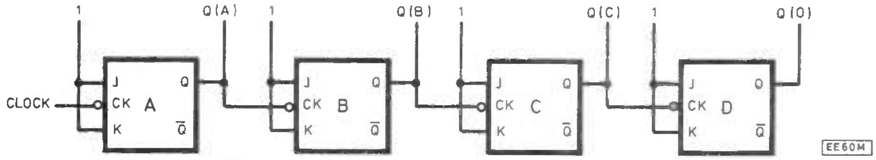
Secondly, the system shown is a binary-up counter. Ie: the system counts from 0 through to 15 and then resets to 0. Now, if a binary-down count is required, ie: counting from 15 through to 0 and then resetting to 15, then the second, third and fourth stages should be fed from the previous stage's $\overline{Q}$ output, as shown in the diagram.

The truth table for this circuit is shown opposite.

Alternatively, if reference is again made to the previous circuit and truth table, it should be noted that the same result would be obtained as shown above, for the down-counter, if $\overline{Q}$(A), $\overline{Q}$(B), $\overline{Q}$(C) and $\overline{Q}$(D) were used as direct outputs.

Exercise 2.

Design, using J-K flip-flops, a counting circuit that gives a binary-down count of eight, taking the outputs from the $\overline{Q}$ connections. Draw the truth table also to show the first eight clock pulses.



Circuit diagram of the Binary-Down Counter.

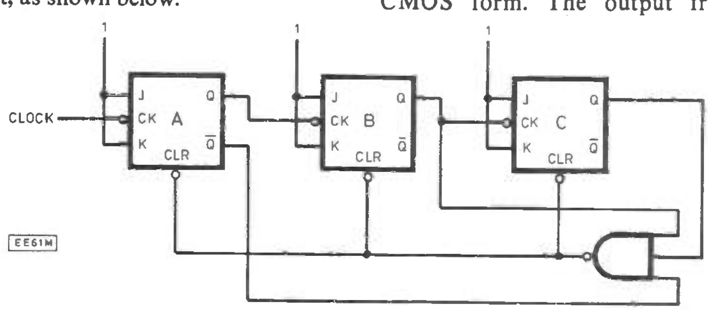
Clock Pulse No	Q(D)	Q(C)	Q(B)	Q(A)	Decimal Equivalent
0	1	1	1	1	15
1	1	1	1	0	14
2	1	1	0	1	13
3	1	1	0	0	12
4	1	0	1	1	11
5	1	0	1	0	10
6	1	0	0	1	9
7	1	0	0	0	8
8	0	1	1	1	7
9	0	1	1	0	6
10	0	1	0	1	5
11	0	1	0	0	4
12	0	0	1	1	3
13	0	0	1	0	2
14	0	0	0	1	1
15	0	0	0	0	0
16	1	1	1	1	15

Truth table of the Binary-Down Counter.

DIVIDERS

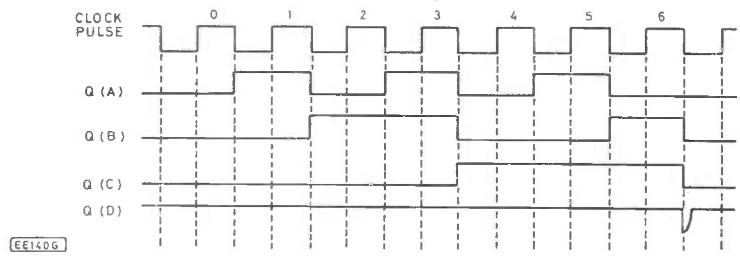
Now, as stated above, each clock input function is being divided by 2 to give an output. That is, only 1 output pulse will be produced for every 2 clock input pulses. This highlights one of the principle applications of the J-K flip-flop in the mode shown, as a frequency divider. Looking again at the basic counter which is a four stage counter, the outputs at Q(A), Q(B), Q(C) and Q(D) are $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$ and $\frac{1}{16}$th of the original clock pulse frequency. In other words, Q(A) divides the clock input by 2, Q(B) effectively divides the clock input by 4, Q(C) effectively divides it by 8 and Q(D) effectively divides it by 16.

It can be seen from this that any subsequent stages added on will give a further division by another power of 2. How can we obtain a count of other than to a power of 2? This is done quite simply by adding gating circuitry to detect the required highest count and then reset the circuit, using the "clear" inputs usually available on most bistables. Suppose we want to divide by, say, 7 then this would involve a count from 0 through to 6 and then reset, as shown below.



Circuit diagram of the Mod-7 Counter.

Now, we require to detect binary 6 and then reset all the J-K flip-flops to '0'. Binary 6 is equivalent to 110 where the '0' is the least significant bit. We can, therefore, directly connect to A, B and C on the Q(A), Q̄(B) and Q(C) outputs respectively to obtain binary 6. If these outputs are then fed into a 3-input NAND gate, the output can be connected to the active low CLR input of the J-K flip-flops. Thus, when binary 6 is detected, the circuit will reset to 0. The waveforms are shown below.



Timing diagram of the Binary-Down Counter.

Now, as can be seen from the waveforms, the circuit has the desired result in resetting after 6, to give an overall count of 7. However, there is a nasty spike produced on the reset line which may become noticeable on the power supply. This spike is produced because the condition set up on the inputs to the NAND gate (ie: binary 6) allows the reset line to become low to reset the J-K flip-flops to zero, which immediately sets up all the zeroes on the inputs to the NAND and thus sends the reset line high again. Thus a sharp spike is obtained, which is not really desirable in digital electronic circuitry.

The asynchronous type of counter described above usually would not be used, because of the "ripple through" effect described, where propagation delays add up. However, some frequency division applications do use such techniques. One way of obtaining an accurate 1 second period clock source is to allow a 2·097152MHz crystal oscillator, which is readily available, to be divided by a 21-stage counter, which is available in CMOS form. The output from the counter is then 1 second pulses. (Note that $2^{21} = 2{\cdot}097152$M).

SYNCHRONOUS COUNTERS

The advantage of the synchronous counter is that there is only 1 propagation delay for the counter, that of the longest delay for any particular stage, since all the stages are clocked simultaneously. The disadvantage is that additional gating is required in between stages to detect certain conditions and provide the interstage switching mechanism. Let us consider the binary counting data in the truth table shown below, for a 4-stage binary-UP counter.

Now, for a circuit to count the clock pulses, as before, we require certain characteristics from the truth table to be incorporated in the circuit design, namely:—

D	C	B	A	Decimal
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	10
1	0	1	1	11
1	1	0	0	12
1	1	0	1	13
1	1	1	0	14
1	1	1	1	15

Truth table of the Binary-Up Counter.

'A' output changes with the clock (toggle).

'B' output changes when A = 1 only.

'C' output changes when A.B = 1 only.

'D' output changes when A.B.C = 1 only.

Any subsequent stages would have a similar pattern as that shown.

The data given is for a 4-stage counter which counts to maximum, 15, and then resets to 0 giving a total count of $2^4 = 16$. If a count of other than a total binary count is required, then the necessary reset circuitry must be applied as shown for the asynchronous counter.

Therefore, with the characteristics derived from the truth table we can add the switching circuits required to switch the subsequent stage, as shown opposite.

We have seen how additional gating can be added to give the switching mechanism required for an orderly binary count. It would be just as simple to add gating that would give a different sequence of outputs on Q(A), Q(B), Q(C) and Q(D), not necessarily a logical sequence, but any preset sequence. However, this does involve a certain amount of mapping functions.

As an example, let us design a BCD (binary coded decimal) counter using J-K flip-flops, in the synchronous mode. (Remember that BCD is a count from 0 to 9 and then a reset, with the output given in binary form.)

First of all, let us draw the truth table for the functions required by a BCD counter, and then write down the list of changes at each stage.

D	C	B	A
0	0	0	0
0	0	0	1
0	0	1	0
0	0	1	1
0	1	0	0
0	1	0	1
0	1	1	0
0	1	1	1
1	0	0	0
1	0	0	1

Note that:
A stage changes with the clock.
B stage changes with 1, 3, 5 or 7.
C stage changes with 3 or 7.
D stage changes with 7 or 9.

Let us also draw a J-K Transition map. Ie: a map of the levels required at J and K in order to give certain required outputs at Q. Note that Q– and Q+ represent the state of Q output before and after the clock pulse.

Q–→Q+	J	K
0→0	0	X
0→1	1	X
1→0	X	1
1→1	X	0

+ = Don't care

We can now look at the truth table and the listed output changes and plot a Karnaugh Map for each J and K input of the second, third and fourth stages.

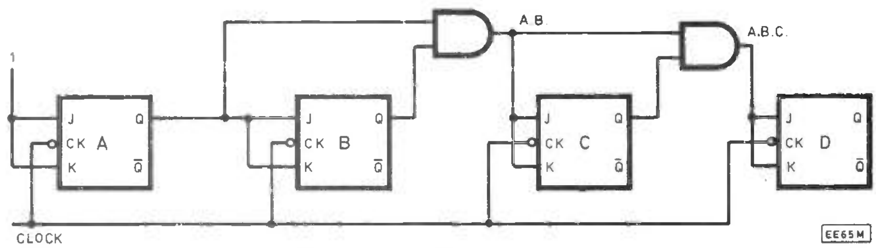
(Remember that 'A' stage purely toggles with the clock input.)

As stated, 'A' is merely toggling with the clock, so J(A) = K(B) = 1. Now, from above, we can derive that:

$$J(B) = K(B) = A.D$$
$$J(C) = K(D) = A.B$$
$$J(D) = A.B.C$$
$$K(D) = A.D$$

Now let us check the sequence of operation with the equations above.

From the truth tables and Karnaugh maps it is seen that the sequence works as required using the equations which will be used as inter-stage gates. There is, however, something else still to check. It is possible, on initial switch-on of system, when working, that some conditions exist on ABCD other than those within the main sequence. We must, therefore, check that the system will be driven into the main sequence if this situation occurs.



Circuit diagram of the Binary-UP Counter.

D	C	B	A	J(A)	J(B)	J(C)	J(D)	K(D)
0	0	0	0	1	0	0	0	0
0	0	0	1	1	1	0	0	0
0	0	1	0	1	0	0	0	0
0	0	1	1	1	1	1	0	0
0	1	0	0	1	0	0	0	0
0	1	0	1	1	1	0	0	0
0	1	1	1	0	0	0	0	0
0	1	1	1	1	1	1	1	0
1	0	0	0	1	0	0	0	0
1	0	0	1	1	0	0	0	1
0	0	0	0	1	0	0	0	0

(cycle repeats)

Truth table for the BCD Counter.

(A) Assume 1010 occurs on switch-on.

D	C	B	A	J(A)	J(B)	J(C)	J(D)	K(D)	
1	0	1	0	1	0	0	0	0	10_2
1	0	1	1	1	0	1	0	1	11_2
0	1	1	0	OK, since main sequence.					

(B) Assume 1100 occurs on switch-on.

D	C	B	A	J(A)	J(B)	J(C)	J(D)	K(D)	
1	1	0	0	1	0	0	0	0	12_2
1	1	0	1	1	0	0	0	1	13_2
0	1	0	0	OK, since main sequence.					

(C) Assume 1110 occurs on switch-on.

D	C	B	A	J(A)	J(B)	J(C)	J(D)	K(D)	
1	1	1	0	1	0	0	0	0	14_2
1	1	1	1	1	0	1	1	1	15_2
0	0	1	0	OK, since main sequence.					

The above is known as "self-starting". Hence the circuit becomes that shown below:

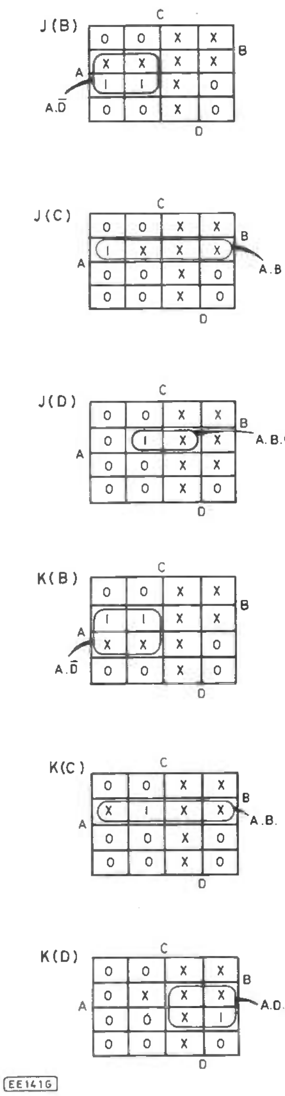
Hence to summarise:—

(1) Decide on the binary sequence required.

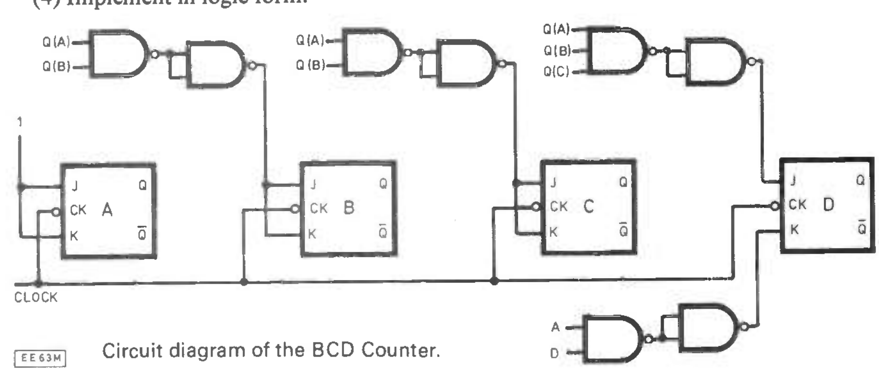
(2) Map each J and K parameter from the "changes" required.

(3) Check for main sequence and self-starting.

(4) Implement in logic form.



Karnaugh maps showing the J and K input stages.



Circuit diagram of the BCD Counter.

SHIFT REGISTERS

Shift registers are very important devices in modern digital electronics systems, forming the basics of most data communication systems. The basic system is shown opposite.

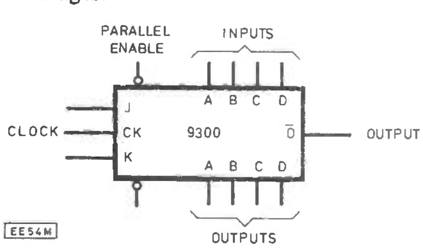
Now, a shift register is a circuit or device that is capable of taking in information, in either serial or parallel form, and storing that information until required to be output, with the output being taken, again, in either serial or parallel form. The serial inputs are taken in at J and K inputs. Similarly, the serial data outputs are taken from the Q and $\overline{Q}$ outputs. To put parallel data into the circuit the clear and preset inputs are used, to either set Q to '0' or '1' respectively. Parallel outputs are taken directly from Q(A), Q(B), Q(C) and Q(D) as before.

Referring to the circuit, suppose we have some serial information to be stored in the device. The first bit (most significant bit) is input at J(A) and the first clock pulse allows the bit to be entered and that bit of information is then shifted so that it appears at Q(A). The next bit of information is then input to J(A) in the same way, with the clock pulse entering this new bit into Q(A) whilst the first bit is shifted along to appear at Q(B). Subsequent bits are entered in exactly the same way. Note, however, that if, in the example above, where we have only four stages of shift available, more than four bits will result in the first shifted bits being "lost" out of the Q(D) end of the system. Now let us suppose that we have entered four bits into the system and those four bits have been shifted so that they now appear at Q(A), Q(B) Q(C) and Q(D), where Q(A) holds the least significant bit. We are now in a position to "read" the four bits in parallel form by looking directly at the Q outputs.

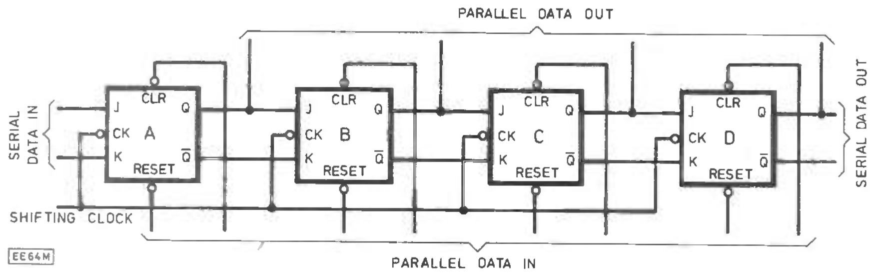
Alternatively, suppose we wish to enter a particular word, say 1001 into the system. We would then apply "preset" signals to A and D stages and "clear" signals to B and C stages, noting that these functions are active low. The required word, 1001, would then appear at Q(A), Q(B), Q(C) and Q(D) without any clock pulse.

APPLICATIONS OF SHIFT REGISTERS

Let us look at a medium scale integration device, the 9300 TTL MSI shift register. The circuit symbol is shown below and this is the overall symbol for four stages.



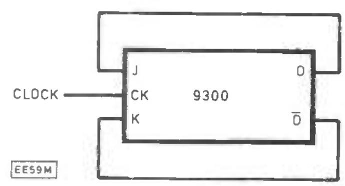
Logic symbol of the 9300 Shift Register.



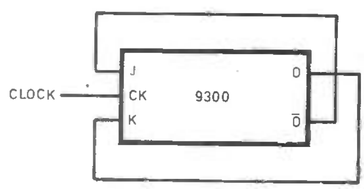
Circuit diagram of the Serial/Parallel Shift Register.

The 9300, which is a Fairchild device, is virtually the same as the typical shift register described, with slight alterations to the connections. Serial data is fed in at J or K as before and a serial data is taken out at either D or $\overline{D}$ outputs. Parallel information is entered directly at ABCD inputs, using the active low "parallel enable" function, and parallel information is retrieved at ABCD outputs. A Master reset facility (active low) is available for resetting ABCD inputs to '0'.

One application of the shift register is as a counter. Here, there are two types available. One uses the "ring" principle where output D is fed into input J and output $\overline{D}$ is fed into K, thus providing a ring of information being passed round the chip, the other uses the "twisted ring" or Johnson counter principle where the $\overline{D}$ and D outputs are transposed, feeding to J and K respectively. These circuits are shown below.



Wiring the Ring Counter.



Wiring the Twisted Ring Counter (Johnson Counter).

The disadvantage with the ring counter is that if, say, '0000' appears on the ABCD outputs, there is no way of ever getting any 1's to appear since these 0's will be passed round the ring creating more 0's. The twisted ring works differently and the truth table for this system is shown below.

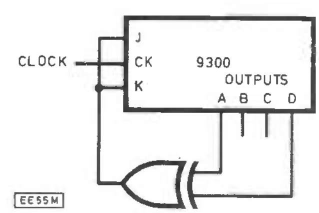
A	B	C	D
0	0	0	0
1	0	0	0
1	1	0	0
1	1	1	0
1	1	1	1
0	1	1	1
0	0	1	1
0	0	0	1
0	0	0	0

(Outputs)

It is seen that each '0' that appears at 'D' allows a '1' to be generated at 'A' after the clock pulse. Conversely a '1' is "converted" to a '0' after each clock pulse. It should be noticed that the twisted ring counter, even though there are effectively 4 stages, only allows a modulo-8 count (ie: there are 8 states), the output states possibly being equivalent to decimal 0, 1, 3, 7, 15, 14, 12 and 8 only. Other points to note are that (a) the system works in a cyclic sequence (only one bit changes at each step) leading to (b) any state can be decoded by a two-input gate. (For example, decimal 7 can be decoded by the function C.$\overline{D}$).

For this, as with any other type of counter, a check must be made for "self-starting" upon switch on. As an exercise, check all possible non-valid states for the system and prove that self-starting does occur. (Ie: try decimal 2, 4, 5, 6, 9, 10, 11, 13.)

Another application of the shift register is that of the "pseudo-random" sequence generator where, for example, A and D outputs are fed into an exclusive-OR gate, the output of which is fed into J and K inputs. See below.



'Pseudo Random' Sequence Generator.

Here, numbers are seen to be (apparently) random. They are in fact, obviously in a set sequence but they do appear to be random. The truth table shows the system outputs for the circuit shown. Note that '0000' appearing on the ABCD outputs provides a "non-start" condition, sometimes known as an "all-zero latch-up" and, quite simply, subsequent clocking will not change the output at all. This is a maximum length sequence given by 2^N-1 where N is the number of stages. By connecting three 9300's in series, we get 12 stages, hence the sequence length becomes:

$$2^{12}-1=4095$$

Hence it can be seen that a fairly random-like set of outputs would be available.

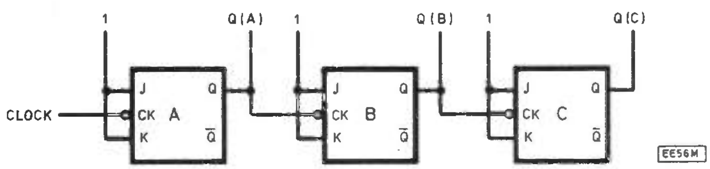
A	B	C	D	Decimal Equivalent
0	0	0	1	8
1	0	0	0	1
1	1	0	0	3
1	1	1	0	7
1	1	1	1	15
0	1	1	1	14
1	0	1	1	13
0	1	0	1	10
1	0	1	0	5
1	1	0	1	11
0	1	1	0	6
0	0	1	1	12
1	0	0	1	9
0	1	0	0	2
0	0	1	0	4
0	0	0	1	(cycle repeats)

Truth table of the Random Sequence Generator.

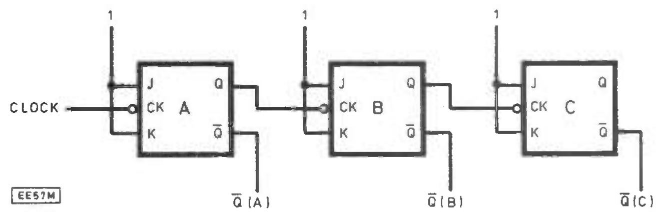
Answers to Exercises.

Exercise 1.

Outputs taken from Q(A), Q(B) and Q(C), where Q(A) is the least significant bit.



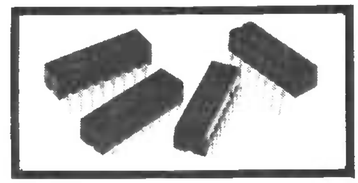
Exercise 2.



Mod-8 Counter Circuit diagram.

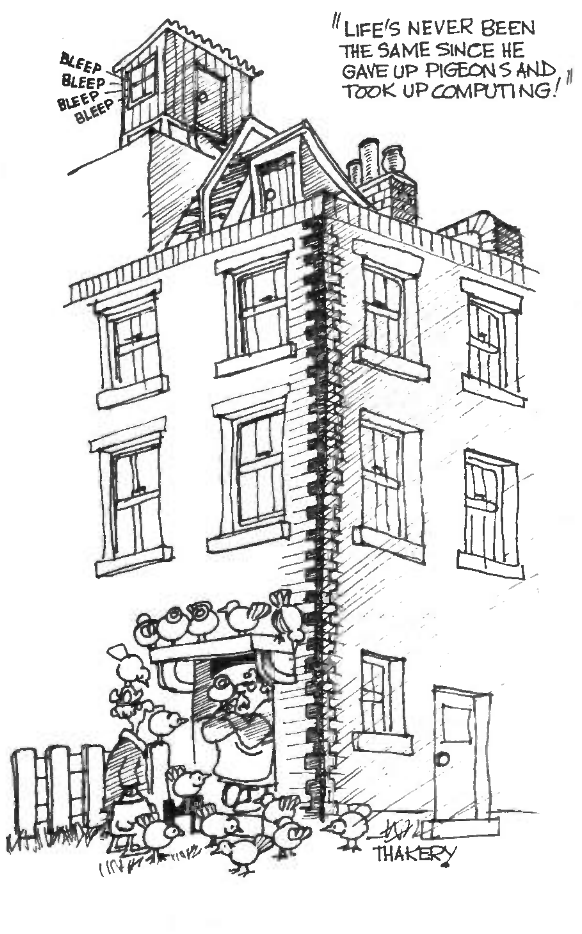
Clock Pulse	$\overline{Q}$(C)	$\overline{Q}$(B)	$\overline{Q}$(A)	Decimal Equivalent
0	1	1	1	7
1	1	1	0	6
2	1	0	1	5
3	1	0	0	4
4	0	1	1	3
5	0	1	0	2
6	0	0	1	1
7	0	0	0	0
8	1	1	1	7

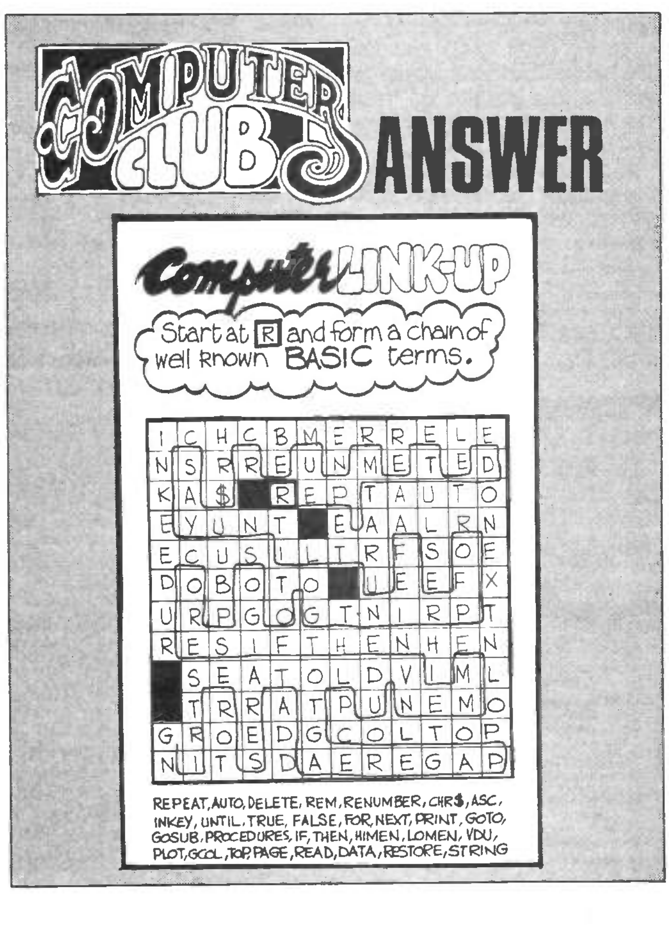
Truth table for the Mod-7 Counter.



Shift registers and counters have many applications in modern electronics and an article of this kind cannot really do them justice with regards to all their advantages. However, I have tried to show the basic uses and further information may be sought from the many fine text books available.

The next article in this series will include descriptions of the many types of memory devices available, with an outline of their uses in combinational logic and in computer design.





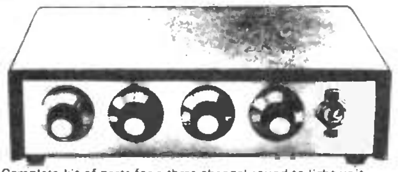
BAKERS DOZEN PARCELS

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

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 x 1 metre lengths colour-coded connecting wires
35 – 4 battery operated model motors
36 – 2 air spaced 2 gang tuning condensors
37 – 2 solid diaelectric 2 gang tuning condensors
38 – 10 compression trimmers
39 – Long and Medium wave tuner kit
40 – 4 x 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 SP DT Centre Off
44 – 4 Rocker Switches 10 amp DPDT
45 – 1 24 hour time switch mains operated
46 – 1 6 hour clockwork timeswitch
47 – 2 lever switches 4 pole changeoverup and ditto down
48 – 2 6v operated reed switch relays
49 – 10 neon valves – make good night lights
50 – 2 x 12v DC or 24V AC 4C0 relays
51 – 1 x 12v 2C 0 very sensitive relay
52 – 1 x 12v 4C 0 relay
53 – 2 mains operated relays 3 x 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' House switches
58 – 2 telephone hand sets incorporating ear piece and mike (p)
59 – 2 flat solenoids – ideal to make current transformer etc.
60 – 5 ferrite rods 4" x 5/16" diameter aerials
61 – 4 ferrite slab aerials with L & M wave coils
62 – 4 200 earpieces
63 – 1 Mullard Thyristor trigger and modules
64 – 10 assorted knobs ¼ spindles

With most items quantity buyers get good discounts and save on postage costs.

SOUND TO LIGHT UNIT



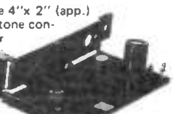
Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio 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 or £25.00 assembled and tested.

WANT A PART OF HISTORY? During the last war, cars and army lorries were able to travel without lights. The drivers looked through binoculars which contained infra red Converter Cells (a British invention). We have these infra red binoculars and you can obtain this bit of history for only £3.50 + £2.50 pp (Cases are a bit rusty through long storage and although unused, we cannot guarantee the cells are in working order, but working cells available.

THERMOSTAT ASSORTMENT

10 different thermostats. 7 bi-metal types and 3 liquid types. There are the current stats which will open the switch to protect devices against overload, short circuits, etc., or when fitted say in front of the element of a blow heater, the heat would trip the stat if the blower fuses; appliance stats, one for high temperatures, others adjustable over a range of temperatures which could include 0 – 100 C. There is also a thermostatic pod which can be immersed, an oven stat, a calibrated boiler stat, finally an ice stat which, fitted to our waterproof heater element, up in the loft could protect your pipes from freezing. Separately, these thermostats could cost around £15.00 – however, you can have the parcel for **£2.50.**

MINI MONO AMP on p.c.b., size 4"x 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 10 for £10.00.**

– BARGAIN OF THE YEAR –

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 as 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 – 270 KHz, medium wave band 525 – 1650KHz. FM band 87 – 108MHz, 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 £6.00** + £1.50 post + insurance.

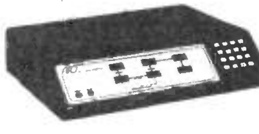
25w SPEAKER SYSTEMS By Amstrad

25 watt RMS loading 8" woofer, 4" tweeter with crossover. £12.00 per pair + £4 post. New and unused but cabinets slightly damaged hence this low price, carry our normal guarantee.

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 post paid.

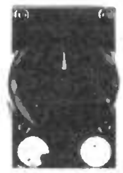
PRESTEL UNITS



These are brand new and we understand tested, came with manufacturer's guarantee now void as the manufacturer no longer trades. These originally sold for over £150. We offer them complete, except for 7 plug in i.c.'s and price is only £14.95 (less than the value of the modem included).

STABILISED POWER SUPPLY (Mains Input) By LAMDA (USA) – Ideal for computer add-ons, d.c. output. Regulated for line volts and load current. Voltage regulation .1% with input variations up to 20% – load regulation 1% from no load to full load – or full load to no load. Complete in heavy duty case – Models available 5v - 9A £23. 12v - 1.5A £13.25. 15v - 1.2A £13.25. 24v - 2A £23.

25A ELECTRICAL PROGRAMMER

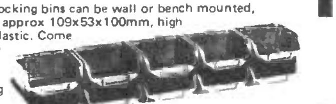


Learn in your sleep: Have radio playing and kettle boiling as you wake – switch on lights to ward off intruders – have a warm house to come home to. You can do all these and more. By a famous maker with 25 amp on/off switch. Independent 60 minute memory jogger. A beautiful unit at £2.50.

THIS MONTH'S SNIP

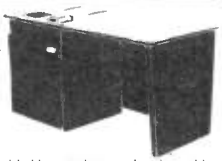
MULTI PURPOSE BINS

10 interlocking bins can be wall or bench mounted, each size approx 109x53x100mm, high impact plastic. Come complete with 2 wall mounting bars



3 lots £10 post paid — **Snip price £2.95 + £1.50 post.**

COMPUTER DESKS



Again available · Computer desks – size approx 4' x 2' x 2'6" high formica covered, cost over £100 each. Our price only from £9.50 – you must collect – hundreds supplied to schools.

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

FLEXIBLE EXTENSION LEAD twin rubber 5mm ideal grass cutter etc. 250 mtre £25.50 metre coil £6.75.

50 THINGS YOU CAN MAKE

Things you can make include Multi range meter, Low ohms tester, A.C. amps meter, Alarm clock, Soldering iron minder, Two way telephone, Memory jogger, Live line tester, Continuity checker, etc. etc., and you will still have hundreds of parts for future projects. Our 10Kg parcel contains not less than 1,000 items - panel meters, timers, thermal trips, relays, switches, motors, drills, taps, and dies, tools, thermostats, coils, condensers, resistors, neons, earphone/microphones, nicad charger, power unit, 90% are unused componants.

YOURS FOR ONLY £11.50 plus £3.00 post.

REVERSIBLE MOTOR WITH CONTROL GEAR

Made by the famous Framco Company this is a very robust motor size approximately 7½" long, 3½" dia. 3/8" shaft Tremendously powerful motor, almost impossible to stop. Ideal for operating stage curtains, sliding doors, ventilators etc., even garage doors if adequately counter-balanced. We offer the motor complete with control gear as follows:

1 Framco motor with gear box
1 manual reversing & on/off switch
1 push to start switch
2 limit stop switches
1 circuit diag. of connections

£19.50 plus postage £2.50

J. BULL (Electrical) Ltd.

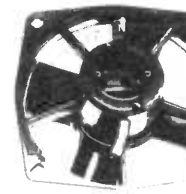
(Dept. EE), 34 - 36 AMERICA LANE, HAYWARDS HEATH, SUSSEX RH16 3QU. Established 30 YEARS

MAIL ORDER TERMS: Cash, P.O. or cheque with order. Orders under £12 add 60p 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.

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 24 hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is **£2.30.** **Ex-Electricity Board. Guaranteed 12 months.**

EXTRACTOR FANS – MAINS OPERATED



Woods extractor.
5" – £5.75, Post £1.25.
6" – £6.95, Post £1.25.
5" Plannair extractor £6.50. Post £1.25.
4"x 4" Muffin 115v. £4.50. 230v. £5.75. Post 75p.
All the above ex-computer, those below are unused.
4" x 4" £8.50. Post 75p.
9" American made £11.50. post £2.00.
Tangential Blower 10x3 air outlet, dual speed £4.60. Post £1.50.

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

ROCKER SWITCHES Standard size fit 11.5 x 28 mm cut out. Single pole on/off – 15p each 1000 for £75. Single pole changeover 20p each – 1000 for £100. Single pole changeover with centre off – 25p each – 1000 for £125. Single pole on/off with neon – 36p – 1000 for £180.

ROCKER SWITCH DP/DT 15 amp 250 volts suitable for motor reversing etc. – 46p – 100 for £34.50, 1000 for £230.

MICRO SWITCHES V3 type all 250 10 amp SpST 20p 1000 – £100 Spdt 30p 1000 – £150, very low tongue Spdt 40p 1000 for £200.

TOP OF THE POPS LIGHTING if you use our disco switch These have 9 x 10 amp changeover switches 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 etc. 230 volts mains operation, £5.75 each or 10 for £50. VAT included.

WALL MOUNTING ROOM THERMOSTAT By Danfoss has a really pretty two tone grey case with circular white scale and dial. Setting temperature from 0 – 30 c – 13 amp 250v contacts. Price £4.60. – 10 for £40.

BLEEPERS 6 or 12v battery or transformer operated, ideal for using in alarm circuits but particularly suitable for can and motor cycle alarms. These give a loud shrill note. Price 69p. 1000 for £345. Jap made.

MINIATURE WAFER SWITCHES

2 pole, 2 way – 4 pole, 2 way – 3 pole, 3 way – 4 pole, 3 way – 2 pole, 4 way – 3 pole, 4 way – 2 pole, 6 way – 1 pole; 12 way.
All at 25p each or 10 for £2.00

12 volt MOTOR BY SMITHS

Made for use in cars, etc. these are very powerful and easily reversible. Size 3½" long by 3" dia. They have a good length of ¼" spindle – **Price £3.45.** Ditto, but double ended £4.25.

MAINS MOTORS

We have very large stocks of motors from 2 watts to ¼ hp. Most at a price well below cost, let us know your requirements.

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.

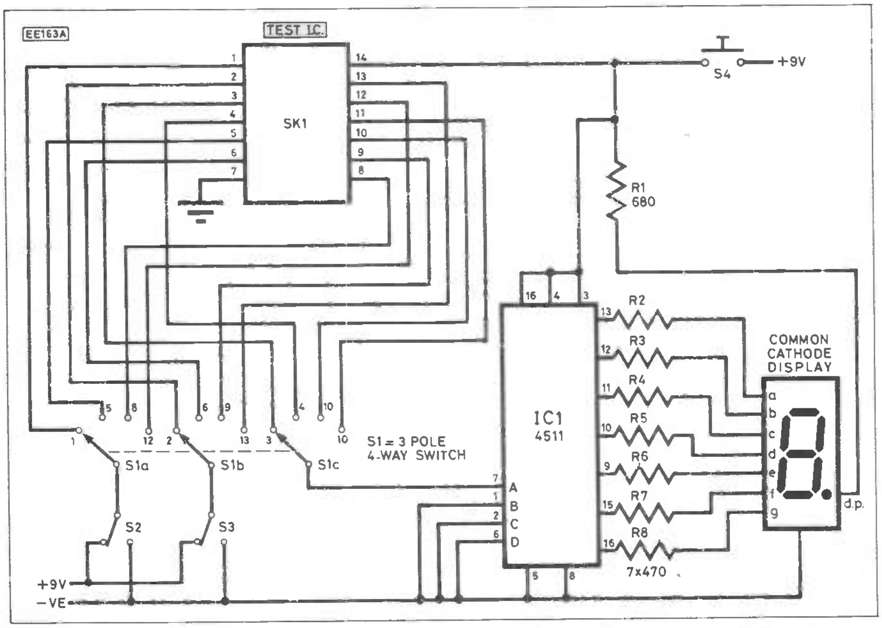
OTHER POPULAR PROJECTS

R C Bridge Kit	£9.95
3 Channel Sound to Light – with fully prepared metal case	£14.95
Big Ear, listen through walls	£9.50
Silent sentinel Ultra Sonic Transmitter and receiver	£9.50
Car Light 'left on' alarm	£3.50
Secret switch – fools friends and enemies alike	£1.95
3 – 30v Variable Power Supply	£13.80
2 Short & Medium wave Crystal Radio	£3.99
3v to 16v Mains Power Supply Kit	£1.95
Radio stethoscope – fault finding aid	£4.80
Mug stop – emits piercing squark	£2.50
Morse Trainer – complete with key	£2.99
Drill control kit	£3.95
Interrupted beam kit	£2.50
Transmitter surveillance kit	£2.30
Radio Mike	£6.90
F M receiver kit – for surveillance or normal F M	£3.50
Insulation Tester – electronic megger	£7.95
Battery shaver or fluorescent from 12v	£6.90
Matchbox Radio – receives Medium Wave	£2.95
40 watt amp – hifi 20hz – 20kHz	£9.50
115 Watt Amplifier 5Hz 25kHz	£13.50
Power supply for 115 watt amps	£8.50

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.

CMOS TESTER



IF you are often short of money, like me, and have to use one i.c. for several projects, transferring the i.c. from project to project can bend the pins. Many of the projects I construct use the 4011 and 4001 CMOS 'chips', so I felt it necessary to construct a low cost piece of test equipment to see if the gates still carried out the correct functions. The project is easy to use and all that is necessary is to compare the results from the test instrument with the truth table of the device under test. Although its primary function was to test the 4001 and 4011, it will also test the 4081, 4071, 4093, 4077 and 4070.

One of the seven i.c.s mentioned above is plugged into the 14-pin d.i.l. socket. The gate to be tested is selected using S1. This connects its output to the 4511 BCD—Seven Segment Decoder integrated circuit. The inputs are chosen using S2 and S3. Depending on the inputs, the ouputs are in the low or high state. Pins 1, 2 and 6 of the 4511 are connected to ground giving two possible inputs (0000 and 0001). Whichever one of these are entered '0' or '1' will be displayed on the seven segment display.

Altogether, this makes a low cost and effective piece of test equipment. The circuit could also be easily modified to test devices with three or more inputs.

T. Ratcliffe,
Shirley,
W. Midlands.

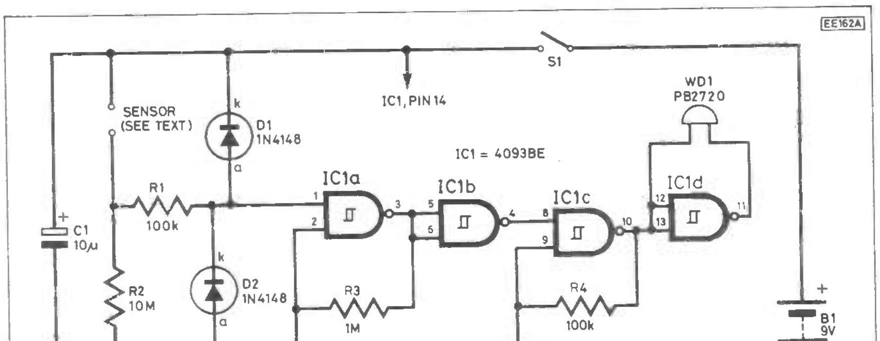
SIMPLE RAIN ALARM

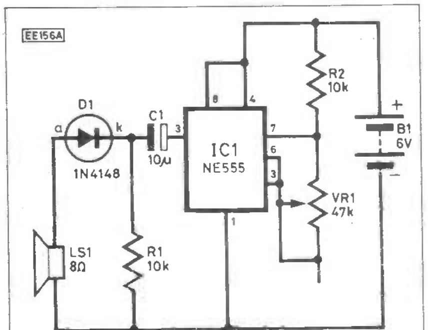
THIS simple little circuit is very effective as a rain detector and alarm. It is basically a single quad 2-input NAND gate wired as an oscillator.

In the absence of rain the resistance between the sensors is far greater than that of R2. This causes the input to IC1a to remain low until water is detected between the sensors. This will cause the resistance to fall, forcing the input high. With this the circuit will oscillate thus sounding the buzzer, WD1.

The whole circuit is cheap and simple to build and may be assembled on a small piece of stripboard.

H. J. Karmazyn,
Handsworth, Birmingham.



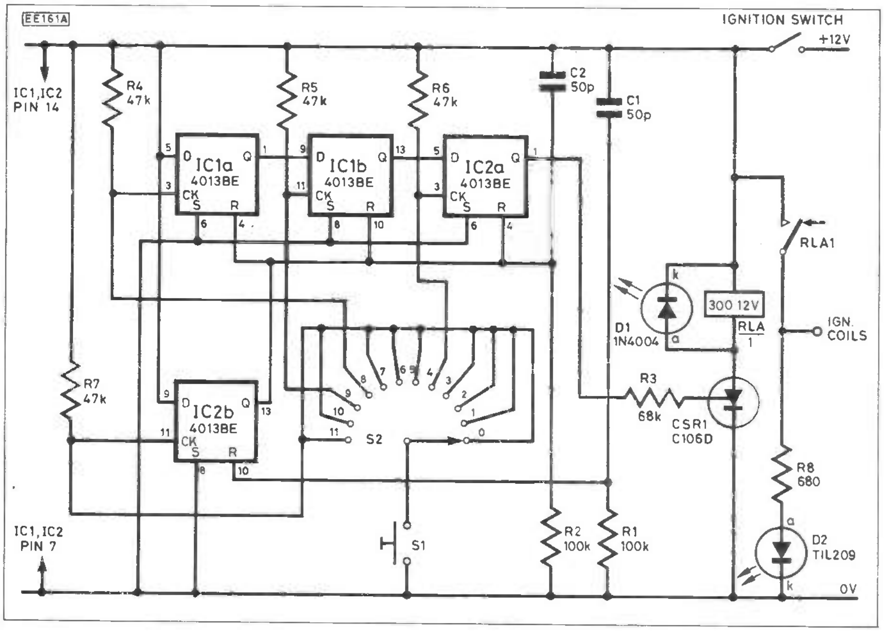


TYPING TIMER

TYPING is becoming an evermore essential skill as the age of the computer progresses, and increasingly more people are learning to type. After the keyboard layout has been mastered, speed is the ultimate aim, a steady rhythm being most important. The circuit described here is an aid to attaining that speed, regulating the timing of each typing stroke.

The NE555 is wired as an astable, the frequency of which is controlled by the potentiometer VR1. The output is coupled to the loudspeaker by C1 and the diode-resistor circuit ensures one steady pulse at regular intervals. To increase the frequency as improvements are made, the potentiometer resistance should be decreased.

M. P. Horwood,
Watford,
Herts.



MOTORCYCLE CODELOCK

ALTHOUGH there are codelock i.c.s. readily available, these tend to be rather expensive. The codelock shown uses two CMOS 'D' type flip-flops which are much cheaper and just as reliable.

When the ignition switch is turned on all flip-flops receive a positive pulse via the R1-C1 and R2-C2 networks. This sets all the 'Q' outputs to logic '0'. With the rotary switch turned to position eight and S1 pressed, the positive 'D' input is passed through IC1a to the output. A logic '1' is now available at IC1b awaiting to be passed through when position nine is selected and S1 is pressed, similarly when position four is selected.

This time, however, the output from IC1c is used to turn on CSR1 via R3. CSR1 drives the relay RLA, which supplies power to the ignition coils. If, however, a wrong number is selected IC1d comes into operation and its output goes positive. This resets and holds IC1a, IC1b and IC1d 'Q' outputs at logic '0' and hence CSR1 can no longer be activated.

D. J. Gillery,
Acomb,
Yorks.

SIMPLE BCD KEYBOARD ENCODER

THE circuit presented here is a very simple BCD Keyboard Encoder that is very easy and economical to build. Many circuits require only one decade of decimal entry (0 through 9). The circuit shown implements this function with only three readily available CMOS chips, therefore its power consumption is considerably low, so it is possible to use a battery for operation of the circuit.

In operation, an astable oscillator made from two cross-coupled inverters (IC1a and IC1b) supplies clock pulses to IC2, a 4017 decade counter/decoder, and to IC3, a 4518 dual BCD counter. Initially, both counters are disabled by the application of appropriate logic levels to their respective 'enable inputs' (a logic '1' at pin 13 of IC2 and a logic '0' at pin 10 of IC3). The l.e.d. readout, therefore, displays the status of the outputs of IC3 immediately after power is applied.

The keyboard is activated by closing any of the ten input switches S0 through S9 and then toggling RESET, S10, from ground to $+V_{DD}$ and back to ground again. If desired, the BCD output can be cleared to 0000 (all l.e.d.s glowing) by toggling S10 prior to selecting a data input switch.

Assume S3 is closed. All inactive outputs of the 4017 are low so the keyboard (S0 through S9) bus goes low and enables both IC2 and IC3 via IC1c. Both counters then begin a synchronized count of the pulses, applied to their CLOCK inputs. When the fourth clock pulse has been counted, pin 7 of IC2 goes to logic '1' and disables both counters via S3. The l.e.d.s then display the BCD equivalent of the selected switch: 0100.

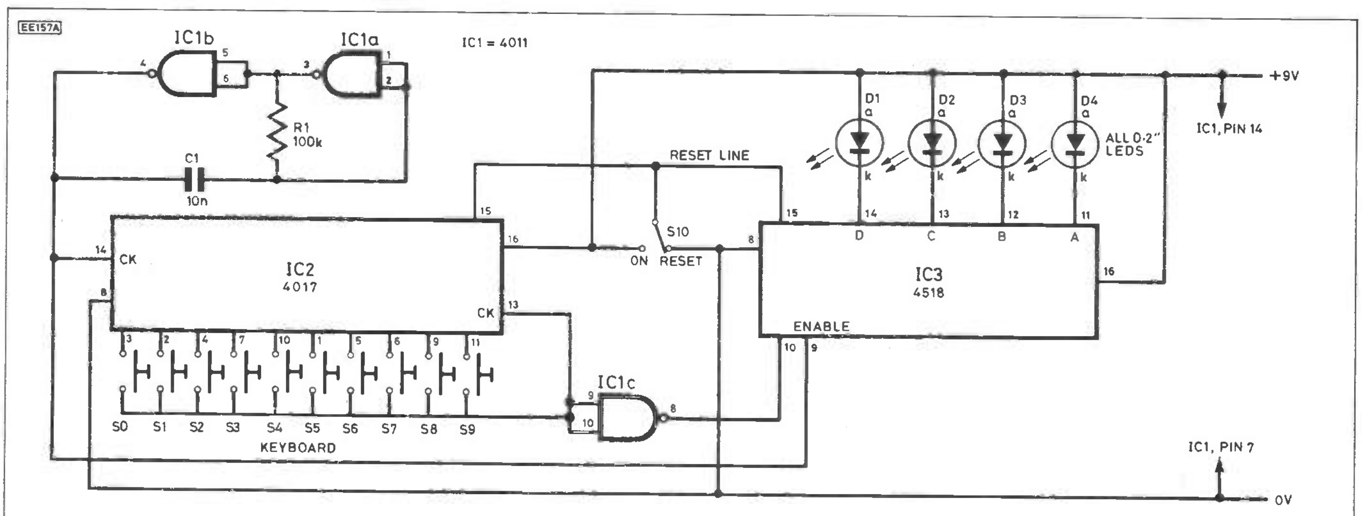
Counter IC3 stores and presents at its output the BCD equivalent of the selected switch, even if the selected switch is opened and another is closed. Only after S10 has been momentarily toggled will a new switch closure be detected and indicated by the output l.e.d.s.

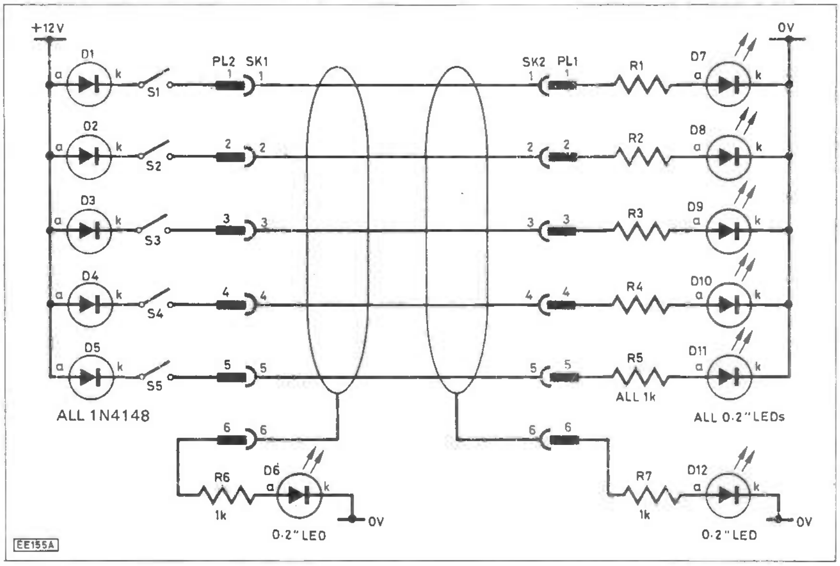
If two or more input switches are closed when S10 is toggled, then the first closed switch to be scanned by the 4017 is selected. This is a form of Priority Encoding.

The output l.e.d.s shown on the diagram are optional. They permit the operation of the circuit to be verified but are unnecessary in many practical applications. Of course, they can be retained. Alternatively, the outputs can be decoded by a BCD to seven segment decoder/driver such as the 4511 or 4543.

The basic circuit which is shown can also be used or modified for different applications. For example, recall that the 4518 contains two BCD counters, only one of which is used. The second counter can be clocked in parallel with the first (and the 4017) to provide a storage register which can remember a previous keystroke. Other modifications may require the addition of one or more chips. For example, a 4066 quad bilateral switch can be connected to the outputs of the second counter to provide a 3-state output. The circuit is very flexible and the user can apply suitable modification for the special uses.

Hamid-Reza Tajzadeh,
Tehran,
Iran.





DIN LEAD TEST UNIT

AT work one day we had to test some transmitter leads, which means taking the covers off and checking the wiring. When you have twenty or so leads to check this becomes a very tedious task, and so I sat down and tried to design a unit which would enable the plugs and leads to be tested without removing the covers.

The principle is very simple. With the lead to be tested plugged into the DIN sockets a switch is pushed and the l.e.d. for that line should light. If another l.e.d. lights then the wires in the plugs are on the wrong pins. This process is repeated for each switch and thus each line in the lead.

The l.e.d.s connected to the shield are to check for short circuits and will light immediately upon plugging in if there is a short. I thought that this unit may help anyone who experiences problems with DIN leads or as a useful checking tool for anyone who makes DIN leads in any quantity.

D. Robins,
Hyde,
Cheshire.

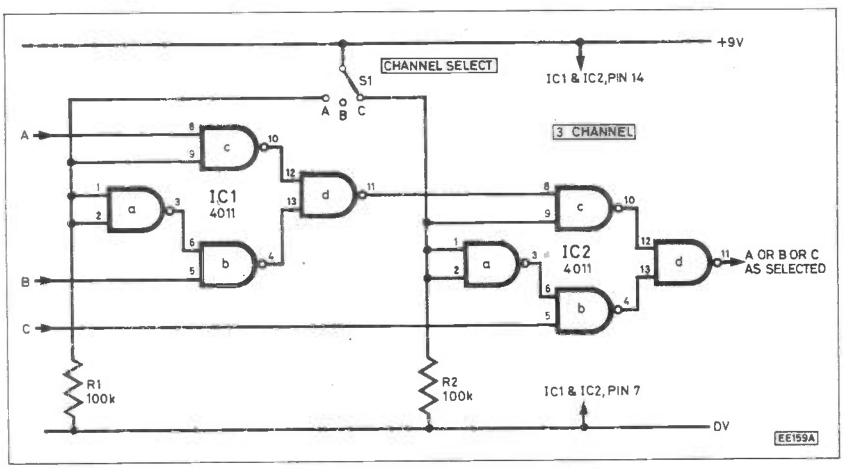
SELF RESETTING LATCH

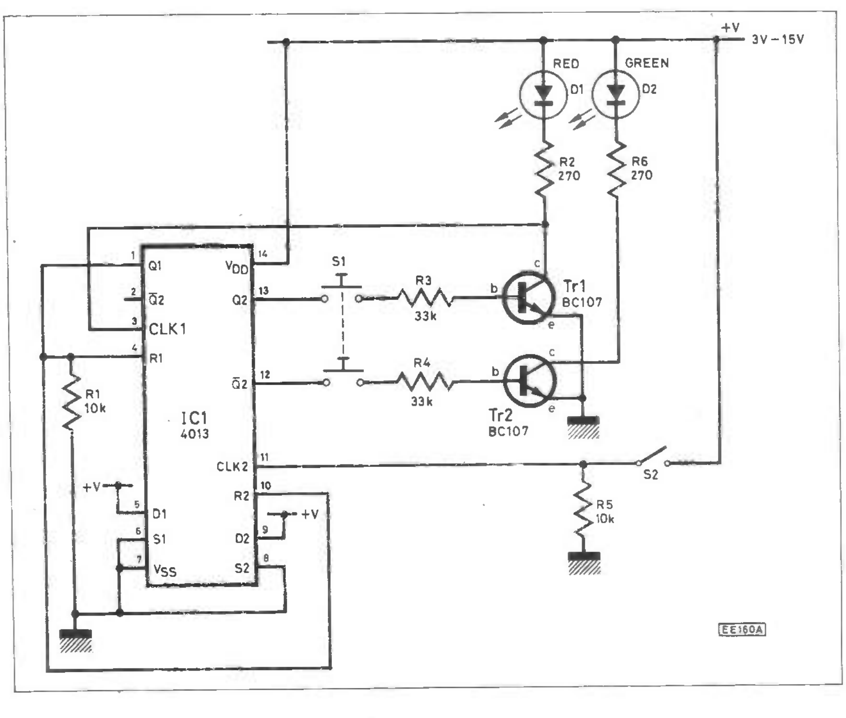
THIS circuit is a low current latch which will reset after its status has been examined. When S2 is closed, CLK_2 is pulled high and the latch is set. To examine the status, depress S1 and the appropriate l.e.d. will light. If the latch is set, when S1 is released there is a rising edge at CLK_1. Q1 will go high and thus both latches are reset.

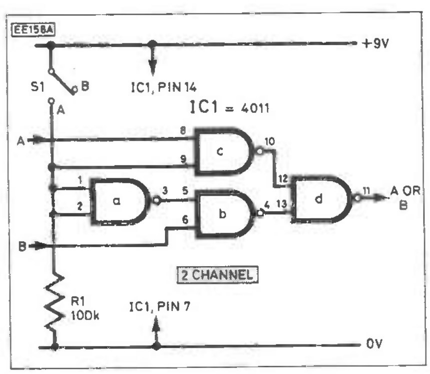
The supply may be 3V–15V, although R2 may be lowered to 100 ohms to increase l.e.d. brightness at low voltage operation. Current consumption is $<1\mu A$, giving battery life of over a year.

S2 may be operated by a door, or can be a mercury switch to become a tamper indicator. The circuit may also be used to show if a phone has rung, or a doorbell used.

N. Holden,
Tewkesbury,
Glos.







DIGITAL DATA SWITCH

THIS circuit is capable of switching and buffering data from various channels without the need for multi-pole switches. It also means that the signal does not have to pass through any switch. Operation is achieved by merely a d.c. control voltage.

The circuit uses a simple gating arrangement which can be cascaded as shown to provide further channels.

W. G. Adam,
Kettering,
Northants.

SQUARE one FOR BEGINNERS

LAST MONTH, *Square One* was concerned with the basic chemical processes that cause electrons to move through a conductor. The action of the basic "wet" cell, first developed at the end of the eighteenth century, was used to explain the production and flow of electricity, and the modern "dry" cell was also mentioned.

This month two other common ways of producing small d.c. voltages are briefly examined, before moving on to the characteristics and properties of conductors, insulators, and—especially—semiconductors.

THE ACCUMULATOR

The lead-acid accumulator (or car-battery) has the great advantage of being rechargeable. It makes use of a lead negative plate and a positive plate of lead oxide. Between them is dilute sulphuric acid. When discharged, both plates are coated with lead sulphate. However, by passing a current backwards through the accumulator for some time, the chemical action is reversed, and the accumulator will supply current again.

NICADS

Nickel-cadmium batteries ("NiCads") are becoming increasingly popular because they, too, can be recharged, and they are the same size, or smaller, than comparable zinc-carbon dry cells. Although they supply a smaller voltage than zinc-carbon cells—around 1·2V compared with 1·5V—they can sustain this level for up to 20 hours' continuous use, compared with only 3 or 4 hours for a standard cell.

The particular attraction of NiCads, of course, is the ability to recharge them hundreds of times. With conventional battery costs soaring, the once-off purchase cost of a charger can be recouped many times over. It is also possible, of course, for the home constructor to build a charger, and just such a project will be published in the March '85 issue of *EE*.

CURRENT FLOW

Having considered the most common ways of producing small voltages—that is, electron flow—we now come to the uses of electricity. Current will flow easily through a conductor such as copper, but not through an insulator, such as plastic or wood. This is because the negatively-charged electrons produced by a cell travel towards the positive electrode by "shunting" electrons along in the material between the electrodes. The electrons in the atoms of which copper and other conductors are made are not tightly-bound to the nucleus and so are free to move easily, and current flows. In insulators, the electrons are very tightly-bound to the nuclei and so virtually no current flows.

But what about semi-conductors, the material that has initiated the second industrial revolution?

Semiconductors are a kind of in-between case which can be visualised as having just a few electrons able to move easily. Such materials include selenium, germanium, and silicon, though much research is being done at present into the use of gallium arsenide.

At present, silicon is almost universally used in the manufacture of transistors and integrated circuits, partly because it is cheap. However, the first transistors were made with germanium (by Bell Laboratories, in 1948), and a few are still in use today.

CRYSTAL STRUCTURE

Pure silicon has a crystal lattice atomic structure, as shown in Fig. 1. Each atom has four orbiting outer electrons, and each "shares" space with electrons from neighbouring atoms to form a rigid, stable, lattice.

In order to conduct electricity, the silicon is "doped": that is, very small, carefully controlled amounts of a different element with either one extra, or one fewer, outer electron, are added. As Fig. 2 shows, the addition of phosphorous, which has five outer electrons, allows a free electron to move when a potential difference is applied.

The addition of boron, which has three outer electrons, has a somewhat different effect: there is a "gap" or *hole* where an electron should be. When an electron from a neighbouring atom fills this gap, the "hole" has moved. And when an electron replaces this new hole, it moves again. Hence this type of semiconductor action can be considered as passing positive charge-carriers which travel in the opposite direction to electrons. Semiconductor material which has extra electrons because of doping is called *n-type*, and that with fewer, *p-type*.

THE DIODE

The function of a diode is to allow current to flow in one direction, but not the other. The device is made by bonding together a piece of p-type and a piece of n-type silicon, so that a continuous silicon structure is formed. Although both semiconductor materials have been "doped", they possess no electric charge, as the excess (or shortage) of electrons within the material belong to the dopants: so that the bonded crystal structure is electrically neutral, like any other mixture or compound.

At the junction of the p-type and n-type materials some electrons drift across to fill holes in the p-type material, and some holes diffuse into the n-type, as in Fig. 3. Thus, at the junction, the p-type becomes negatively charged, and the n-type postively charged; this phenomenon is local to the barrier region, and inhibits further movements of charge-carriers, as the p-type repels electrons at the junction, and the n-type repels holes. This *potential barrier*, or *depletion layer*, is the key to diode action.

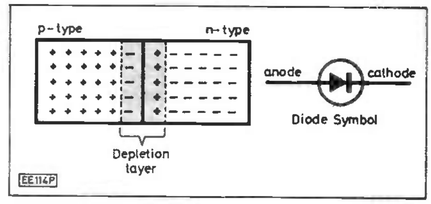


Fig. 3. p-n junction diode structure.

When a cell is connected to the diode, with the positive terminal connected to the n-type silicon (the cathode) and the negative terminal connected to the p-type silicon (the anode), the "holes" are attracted to the negative terminal, while electrons are attracted to the positive terminal. Thus the potential barrier is increased, and there is virtually no current flow.

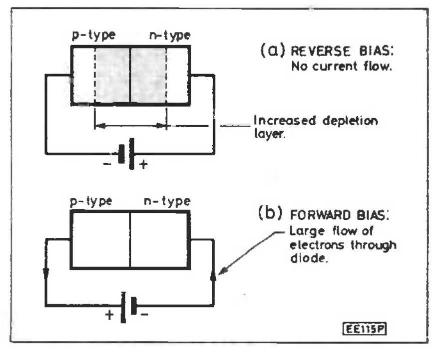


Fig. 4. (a) reverse-biased diode; (b) forward-biased diode.

When the battery connections are reversed, there is a large current flow, as holes travel to the negative electrode and electrons to the positive one. Fig. 4 illustrates this. When the *reverse* bias voltage is increased beyond the level that the device is designed for, "breakdown" occurs. The current flow increases drastically for a very short period of time, and the device is permanently destroyed.

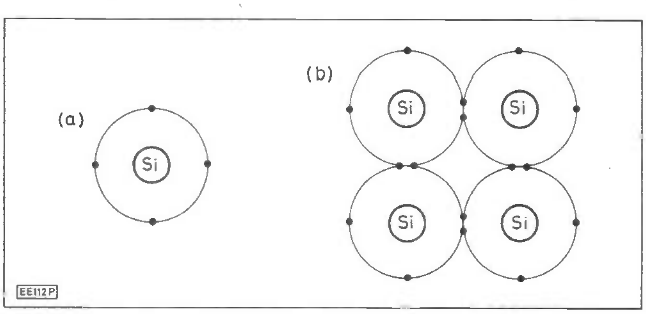


Fig. 1. (a) model of silicon atom; (b) atoms "sharing" electrons.

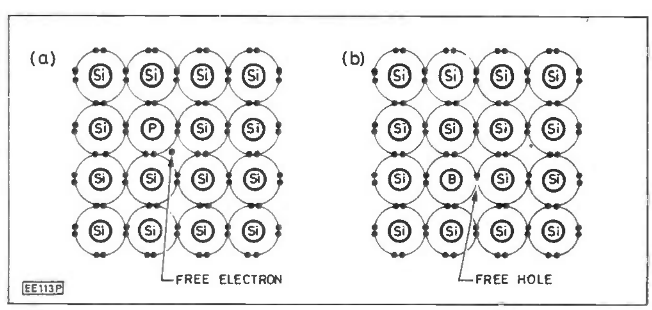


Fig. 2. (a) n-type silicon; (b) p-type silicon.

EVERYDAY ELECTRONICS PRINTED CIRCUIT BOARD SERVICE

Printed circuit boards for certain EE constructional projects are now available from the EE 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: EE PCB Service, Everyday Electronics 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 ordering both p.c.b.s *and* software cassettes may send a single cheque/PO for the combined amounts listed.

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 here.

PROJECT TITLE	Order Code	Cost
— JUNE '83 —		
Eprom Programmer, TRS-80	8306-01	£9.31
Eprom Programmer, Genie	8306-02	£9.31
Eprom Programmer, TRS-80 & Genie	8306-03	£1.98
— JULY '83 —		
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
— AUGUST '83 —		
Storage 'Scope Interface, BBC Micro	8308-01	£3.20
Car Intruder Alarm	8308-02	£5.15
High Power Interface *M.I.T. Part 2*	8308-03	£5.08
Pedestrian Crossing Simulation *M.I.T. Part 2*	8308-04	£3.56
Electronic Die	8308-05	£4.56
— SEPTEMBER '83 —		
High Speed A-to-D Converter *M.I.T. Part 3*	8309-01	£4.53
Signal Conditioning Amplifier *M.I.T. Part 3*	8309-02	£4.48
Stylus Organ	8309-03	£6.84
Distress Beacon	*8309-04	£5.36
Distress Beacon Pocket Version	8309-05	£3.98
— OCTOBER '83 —		
D-to-A Converter *M.I.T. Part 4*	8310-01	£5.77
High Power DAC Driver *M.I.T. Part 4*	8310-02	£5.13
Electronic Pendulum	8310-03	£5.43
— NOVEMBER '83 —		
TTL/Power Interface for Stepper Motor *M.I.T. Part 5*	8311-01	£5.46
Stepper Motor Manual Controller *M.I.T. Part 5*	8311-02	£5.70
Digital Gauss Meter	8311-03	£4.45
Speech Synthesiser for BBC Micro	8311-04	£3.93
Car On/Off Touch Switch	8311-05	£3.11
— DECEMBER '83 —		
4-Channel High Speed ADC (Analogue) *M.I.T. Part 6*	8312-01	£5.72
4-Channel High Speed ADC (Digital) *M.I.T. Part 6*	8312-02	£5.29
TRS-80 Twin Cassette Interface	8312-03/09	£7.43
Environmental Data Recorder	8312-04	£7.24
Touch Operated Die (Dot matrix)	8312-05/06	£4.34
Touch Operated Die (7-segment)	8312-05/07	£4.34
Continuity Tester	8312-08	£3.41
— JANUARY '84 —		
Central Heating Pump Delay	8401-01	£3.33
Biological Amplifier *M.I.T. Part 7*	8401-02	£6.27
Temp. Measure & Control for ZX Comprs		
Analogue Thermometer Unit	8401-03	£2.35
Analogue-to-Digital Unit	8401-04	£2.56
Games Scoreboard	8401-06/07	£9.60
— FEBRUARY '84 —		
Eprom Programmer/ROM Card for ZX81	**8402-01	£7.84
Oric Port Board *M.I.T. Part 8*	8402-02	£9.56
Negative Ion Generator	*8402-03	£8.95
Temp. Measure & Control for ZX Comprs		
Relay Driver	8402-04	£3.52
— MARCH '84 —		
Latched Output Port *M.I.T. Part 9*	8403-01	£5.30
Buffered Input Port *M.I.T. Part 9*	8403-02	£4.80
VIC-20 Extension Port Connector *M.I.T. Part 9*	8403-03	£4.42
Commodore 64 Extension Port Connector *M.I.T. Part 9*	8403-04	£4.71
Digital Multimeter Add-On for BBC Micro	8403-05	£4.63
— APRIL '84 —		
Multipurpose Interface for Computers	8404–01	£5.72
Data Acquisition "Input" *M.I.T. Part 10*	8404-02	£5.20
Data Acquisition "Output" *M.I.T. Part 10*	8404-03	£5.20
Data Acquisition "PSU" *M.I.T. Part 10*	8404-04	£3.09
Timer Module	8404-05	£3.58
A.F. Sweep Generator	8404-06	£3.55
Quasi Stereo Adaptor	8404-07	£3.56
— MAY '84 —		
Simple Loop Burglar Alarm	8405-01	£3.07
Computer Controlled Buggy *M.I.T. Part 11*		
Interface/Motor Drive	8405-02	£5.17
Collision Sensing	8405-03	£3.20
Power Supply	8405-04	£4.93
— JUNE '84 —		
Infra-Red Alarm System	8406-01	£2.55
Spectrum Bench PSU	8406-02	£3.99
Speech Synthesiser *M.I.T. Part 12*	8406-03	£4.85
Train Wait	8406-04	£3.42
— JULY '84 —		
Ultrasonic Alarm System	8407-01	£4.72
Atom EPROM Simulator	8407-02	£3.08
Electronic Code Lock		
Main board	8407-03	£2.70
Keyboard	8407-04	£3.24
— AUGUST '84 —		
Microwave Alarm System	8408–01	£4.36
Temperature Interface–BBC Micro	8408–02	£2.24
— SEPTEMBER '84 —		
Op-Amp Power Supply	8409-01	£3.45
— OCTOBER '84 —		
Micro Memory Synthesiser	*8410-01	£8.20
Drill Speed Controller	8410-04	£1.60
— NOVEMBER '84 —		
BBC Audio Storage Scope Interface	8411-01	£2.90
Proximity Alarm	8411-02	£2.65
— DECEMBER '84 —		
TV Aerial Pre-Amp	*8412-01	£1.60
Digital Multimeter	*8412-02/03	£5.20
Mini Workshop Power Supply	8412-04	£2.78
— JANUARY '85 —		
Power Lighting Interface	8501–01	£8.23
Games Timer	8501–02	£1.86
Spectrum Amplifier	8501–03	£1.70
— FEBRUARY '85 —		
Solid State Reverb	8502–01	£3.68
Computerised Train Controller	8502–02	£3.38

*Complete set of boards. **Calibrated with C1, VR1 and IC3 fitted.

M.I.T.—Microcomputer Interfacing Techniques, 12-Part Series.

EVERYDAY ELECTRONICS and computer PROJECTS AT YOUR

Reach effectively and economically to-days enthusiasts anxious to know of your through our semi-display and classified pages. Semi-display spaces may be booked at timetre (minimum 2·5cm). The prepaid rate for classified advertisements is 33 pence per word number 60p extra. All cheques, postal orders, etc., to be made payable to Everyday Electronics crossed "Lloyds Bank Ltd." Treasury notes should always be sent registered post. Advertise-tance, should be sent to the Classified Advertisement Department, Everyday Electronics and 2612, IPC Magazines Limited, King's Reach Tower, Stamford St., London SE1 9LS. (Telephone

Security

WHO CAN PUT A PRICE ON PEACE OF MIND

PROFESSIONAL EQUIPMENT AT LOW! LOW! PRICES.

HOME SECURITY IS NOW AVAILABLE AT TRADE PRICES

ADVANCED SECURITY PRODUCTS LTD
2 Ealing Road, Aintree,
Liverpool L9 0HU, Merseyside.
Tel: 051-525 3440

FREE CATALOGUE PHONE OR S.A.E.

SECURITY Alarm Systems

FREE COMPREHENSIVE CATALOGUE!

- LOWEST DISCOUNT PRICES
- HIGHEST QUALITY EQUIPMENT
- FREE DIY DESIGN GUIDE
- FULLY ILLUSTRATED
- MICROCHIP CIRCUITRY
- QUICK DESPATCH SERVICE
- FULL INSTRUCTIONS

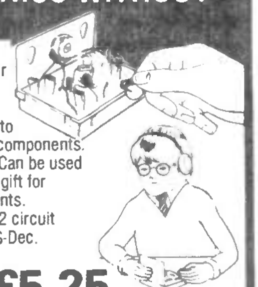
SEND SAE OR PHONE

C-TEC SECURITY. Dept EE.
Unit 1. Stephensway Ind. Estate Goose Green
Wigan WN3 6PH Telephone (0942) 42444

Trade Enquiries Welcome

Miscellaneous

LEARN ELECTRONICS WITHOUT SOLDER



Build electronic circuits without solder on a Roden S-Dec. This has built-in contacts and holes into which you plug your components. Suitable for all ages. Can be used time after time. Ideal gift for students or experiments. Full instructions and 2 circuit diagrams with each S-Dec.

Send Cheque or P.O. to:- Roden Products, Dep EE High March, Daventry, Northants, NN11 4QE.

£5.25 including p & p

ORDER FORM PLEASE WRITE IN BLOCK CAPITALS

Please insert the advertisement below in the next availble issue of **Everyday Electronics** for .... Insertions. I enclose Cheque/P.O. for £ ....

(Cheques and Postal Orders should be crossed Lloyds Bank Ltd. and made payable to Everyday Electronics)

HEADING REQUIRED:

NAME ....

ADDRESS ....

....

....

EVERYDAY ELECTRONICS and COMPUTER PROJECTS

Classified Advertisement Dept., Room 2612, King's Reach Tower, Stamford Street, London SE1 9LS
Telephone 01-261 5942

Rate:
33p per word, minimum 12 words. Box No. 60p extra.

Company registered in England. Registered No. 53626. Registered Office: King's Reach Tower, Stamford Street, London SE1 9LS.

2/85

Learn to make your own Printed Circuit Boards

EXPERIMENTER'S PRINTED CIRCUIT KIT

Laminate Boards, Chemicals, Instruction Book, also, Plans & Circuits for 50 Interesting Projects you can build with own parts and transistors £2.50 p&p 50p.

Protect your premises with an efficient BURGLAR ALARM. PHOTOELECTRIC KIT £5.50 p&p 50p; INVISIBLE BEAM OPTICAL KIT £4.50 p&p 50p. Send SAE for details of all Kits & Circuits, and FREE GIFT 5 transistors & 5 diodes.

EXPERIMENTAL ELECTRONICS 145 Stonhouse Street, London SW4 6BQ Tel: 01-720 2683

"PROJECT BUILDERS!" Our cased transistorised breakdown units will save £££'s. S.A.E. for lists, 5 St Josephs Park, Ballycruttle, DownPatrick, BT30 7EN.

FREE! PARCEL OF COMPONENTS worth £10. Send only 80p postage! D. HORSLEY, 113 Clare Road, Braintree, Essex.

Receivers & Components

RESISTORS 1,000 mixed ⅛w, ¼w, ½w, 2%, 5%, 10%, C. film £3.45 inc p&p. D. J. Hooker, Romney Marsh Electronics, Pennywood Park Road, Greatstone, Romney Marsh, Kent TN28 8PB.

TURN YOUR SURPLUS capacitors, transistors, etc., into cash. Contact Coles Harding & Co., 103 South Brink, Wisbech, Cambs. 0945-584188. Immediate settlement.

Service Sheets

FULL SIZE TOP QUALITY Service Sheets £2.50 + l.s.a.e. CTV/Music centres £3.50 + l.s.a.e. Repair data almost any named TV/video £10.50 in circuits. L.s.a.e. brings any quite-free magazine/pricelists. TI-SEE, 76 Churches, Larkhall, Lanarkshire. Tel. 0698 883334.

BELL'S TELEVISION SERVICE for service sheets on Radio, TV etc. £1.50 plus S.A.E. Service Manuals on Colour TV and Video Recorders, prices on request. S.A.E. with enquiries to: BTS, 190 King's Road, Harrogate, N. Yorkshire. Tel: 0423 55885.

For Sale

CYCLISTS ADD The rear lamp with electronic control to your dynamo lighting. Be seen when you stop. £4.95 Requires batteries. E.D.E. Box 11, Marple, Stockport SK6 6JS.

IMMERSION TIN PLATE your D.I.Y. P.C.Bs. Half gallon kit. £6.00 post paid. EE Box No. 5.

SERVICE

products and services £7·80 per single column cen- (minimum 12 words), box and Computer Projects and ments, together with remit- Computer Projects, Room 01-261 5942).

Tuition

IMPROVE YOUR PROSPECTS

with skills that employers want – learn the easy way with modern home study courses from Ideal Schools.

MODERN ELECTRONICS
Train for success in the fastest ever growing industrial sector.

COMPUTER PROGRAMMING
The demand for Programmers is increasing constantly – don't miss out!

For free booklet write today to

IDEAL

IDEAL SCHOOLS (Ref. EE2) 60 St. Enoch Sq. Glasgow G1 UK. Tel: 041-248 5200

Software

MOST ADVANCED SOFTWARE for 48K Spectrum. 1. Dialogue tape two way writing quite advanced artificial intelligence. 2. Fail safe circuitry to quite high levels. All components available from MAPLIN. All you have to do is provide a few basic facts describing the wanted result. Full price £10.00 each to: N. J. Edwards, 68 Woodhill Rise, Norwich NR5 0DW.

Services

INVENTORS

Think of something new? Write it down!

American industry offers potential royalties for you innovations and new products. We offer free confidential disclosure registration and initial consultation in London regarding your idea's potential value. Write without delay for your free information package.

American Inventors Corporation
82 Broad Street, Dept. EV, Westfield, Massachusetts 01086, United States of America
A fee based marketing company

Wanted

WANTED Supplier of Burgular Alarm p.c.b.'s or modules in quantities. Send to S. Lawton, 2 Aldbury Close, Smithies, Barnsley, S. Yorks 294898.

WANTED BI-PAK S450 Stereo Push Button Tuner. Ayres, 31 Barr Common Road, Walsall. 0922 51591.

★ BAKER ★
GROUP P.A. DISCO AMPLIFIERS post £2

150 watt Output, 4 input Mixer pre-amp. Illustrated **£99**
150 watt Output, Slave 500 mv. Input 3 Speaker Outputs **£80**
150+150 watt Stereo, 300 watt Mono Slave 500 mv. Inputs **£125**
150 watt P.A. Vocal, 8 inputs. High/Low Mixer Echo Socket **£129**
100 watt Valve Model, 4 inputs, 5 Outputs. Heavy duty **£125**
60 watt Valve Model, 4 inputs. Low imp and 100v line output .. **£69**
60 watt Mobile 240v AC and 12v DC. 4-8-16 ohm+100v line **£89**

MIKES Dual Imp **£20**, Floor Stand **£13**, Boom Stand **£22**, PP £2.

Reverb Unit for Microphone or Guitar **£35** PP £1.
Electronic Echo Machine for mic/guitar **£85** PP £1.

BAKER LOUDSPEAKERS Post £2 each

Type	Model	Size	Watts	Ohms	Price
P.A./Disco/Group	DG50/10	10	50	8/16	£18.00
Midrange	Mid 100/10	10	100	8	£25.00
Hi-Fi	Major	12in	30	4/8/16	£16.00
Hi-Fi	Superb	12in	30	8/16	£26.00
P.A./Disco/Group	DG45	12in	45	4/8/16	£16.00
Hi-Fi	Woofer	12in	80	8	£25.00
Hi-Fi	Auditorium	15in	60	8/16	£37.00
P.A./Disco/Group	DG75	12in	75	4/8/16	£20.00
P.A./Disco/Group	DG100	12in	100	8/16	£26.00
P.A./Disco/Group	DG100/15	15in	100	8/16	£35.00

DISCO CONSOLE Twin Decks, mixer pre amp **£145.** Carr £10. **Ditto** Powered 120 watt **£199**; or Complete Disco **£300.** 150 watt **£360**; 360 watt **£410.** Carr £30.

DISCO MIXER. 240V, 4 stereo channels, 2 magnetic, 2 ceramic/tape, 1 mono mic channel, twin v.u. meters, headphone monitor outlet, slider controls, panel or desk mounting, grained aluminium facia. **Tape output facility.** **£54. Post £1.**
DELUXE STEREO DISCO MIXER/EQUALISER as above plus L.E.D. V.U. displays 5 band graphic equaliser, left/right fader, switchable inputs for phone/line, mike/line.
Headphone Monitor, Mike Talkover Switch **£124** PP £2
As above with 7 Band Graphic £138.

P.A. CABINETS (empty) Single 12 **£32**; Double 12 **£38.** carr £10.
WITH SPEAKERS 60W **£27**; 75W **£54**; 90W **£73**; 150W **£82.**
HORNBOXES 200 Watt **£32**, 300 Watt **£38.** Post £4.

WATERPROOF HORNS 8 ohms. 25 watt **£20.** 30 watt **£23.** 40 watt **£29.** 20W plus 100 volt line **£38.** Post £2.
MOTOROLA PIEZO ELECTRONIC HORN TWEETER, 3⅜in. square **£6**
100 watts. No crossover required. 4-8-16 ohm, 7⅜×3⅛in. **£10**

CROSSOVERS. TWO-WAY 3000 c/s 30 watt **£3.** 60 watt **£5.** 100 watt **£6.**
3 way 950 cps/3000 cps. 40 watt rating. **£4**, 60 watt **£6.50**, 100 watt **£10.**
LOUDSPEAKER BARGAINS Please enquire, many others in stock.
4 ohm, 5in. 7×4in. **£2.50**; 6½in, 8×5in. **£3.** 8in. **£3.50.** 6½in. 25W **£7.50.**
8 ohm, 2⅝in. 3in. **£2**; 5×3in, 6×4in, 7×4in, 5in. **£2.50**; 6½in, 8×5in **£3**; 8in. **£4.50**; 10in. **£5**; 12in. **£6.** 8in. 25W **£6.50.** 8 in Hi-Fi 60w **£12.50.**
15 ohm, 2¼in, 3½in, 5×3in, 6×4in. **£2.50.** 6½in 10W **£5.** 8in. **£4.** 10in. **£7.**
25 ohm, 3in. **£2**; 5×3in, 6×4in, 7×4in. **£2.50.** 120 ohm, 3¼in dia. **£1.**

Make	Model	Size	Watts	Ohms	Price	Post
AUDAX	WOOFER	5½in.	25	8	£10.50	£1
GOODMANS	HIFAX	7½×4¼in.	100	8	£30	£2
GOODMANS	HB WOOFER	8in.	60	8	£13.50	£1
WHARFEDALE	WOOFER	8in.	30	8	£9.50	£2
CELESTION	DISCO/Group	10in.	50	8/16	£21	£2
AKAI	WOOFER	12in.	80	8	£16	£2
GOODMANS	HPG/GROUP	12in.	120	8/15	£30	£2
GOODMANS	HPO/DISCO	12in.	120	8/15	£30	£2
GOODMANS	HP/BASS	15in.	250	8	£72	£4
GOODMANS	HPO/BASS	18in.	230	8	£84	£4

METAL GRILLES 8in **£3**, 10in **£3.50**, 12in **£4.50**, 15in **£5.50**, 18in **£7.50.**

RCS SOUND TO LIGHT CONTROLLER KIT. Printed Circuit. Cabinet. 3 channels. 1,000 watts each. Will operate from Hi-Fi or Disco. **£19.** Post £1.
READY BUILT DELUXE 4 CHANNEL 4,000 WATT sound chaser + speed + programme controls **£69.** Mk2 16 programs, **£89** PP £2.

MAINS TRANSFORMERS	Price	Post
250-0-250V 80mA. 6.3V 3.5A. 6.3V 1A.	£7.00	£2
350-0-350V 250mA. 6.3V 6A CT £12.00 Shrouded	£14.00	£2
250V 60mA. 6.3V 2A.	£4.75	£1
220V 25mA. 6V 1 Amp £3.00 220V 45mA. 6V 2 Amp	£4.00	£1
Low voltage tapped outputs available		
1 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£6.00	£2
ditto 2 amp £10.50 3 amp £12.50 5 amp	£16.00	£2
31-26-0-26-31 volt 6 amp	£14.00	£2

LOW VOLTAGE MAINS TRANSFORMERS £5.50 each post paid
9V, 3A; 12V, 3A; 16V, 2A; 20V, 1A; 30V, 1½A; 30V, 5A+ 17-0-17V, 2A; 35V, 2A; 20-40-60V, 1A; 12-0-12V, 2A; 20-0-20V, 1A; 50V, 2A.

£8.50 post 50p MINI-MULTI TESTER
Pocket size instrument, o.p.v. DC volts 5, 25, 250, 500. AC volts 10, 50, 500, 1000. DC 0-250Ma; 0-250ma. Resistance 0 to 600K.
De-Luxe Range Doubler Meter, 50,000 o.p.v. 7 × 5 × 2in. Resistance 0/20 meg in 5 ranges. Current 50MA to 10A. Volts 0.25/1000v DC, 10v/1000v AC. **£25.00** post £1

PANEL METERS 50MA, 100MA, 500MA, 1mA, 5mA, 100mA, 500mA, 1 amp, 2 amp, 5 amp, 25 volt, VU 2¼×2×1¼in. **£5.50** post 50p

ALUMINIUM PANELS 18 s.w.g. 12 × 12in. **£1.80**; 14 × 9in. **£1.75**; 6 × 4in. **55p**; 12 × 8in. **£1.30**; 10 × 7in. **96p**; 8 × 6in. **90p**; 14 × 3in. **72p**; 12 × 5in. **90p**; 16 × 10in. **£2.10**; 16 × 6in. **£1.30.**
ALUMINIUM BOXES. MANY OTHER SIZES IN STOCK.
4 × 2½ × 2in. **£1.20**; 3 × 2 × 1in. **£1**; 6 × 4 × 2in. **£1.90**; 8 × 6 × 3 in. **£3**; 12 × 5 × 3in. **£3.60**; 6 × 4 × 3in. **£2.20**; 10 × 7 × 3in. **£3.60**

HIGH VOLTAGE ELECTROLYTICS

16/450V	50p	220/400V	£2	20+20/350V	75p
20/500V	75p	8+8/500V	£1	32+32/500V	£2
32/350V	45p	8+16/450V	75p	32+32/350V	50p
32/500V	95p	16+16/350V	75p	32+32+32/450V	£1.50
				16+32+32/500V	£2

SINGLE PLAY DECKS. Post £2.

Make	Drive	Model	Cartridge	Price
GARRARD	Rim	6200	Ceramic	£22
BSR	Rim	P182	Ceramic	£26
BSR	Belt	P232	Magnetic	£28
BSR	Rim	P207	Ceramic	£20
AUTOCHANGER	BSR		Ceramic	£20
AUTOCHANGER	GARRARD		Ceramic	£24

DECCA TEAK VENEERED PLINTH space for small amplifier. Board cut for BSR or Garrard 18¾in. × 14¼in. × 4in. **£5.** Post £1

TINTED PLASTIC COVERS for Decks. **£5 each.** Post £1
17⅞ × 13⅓ × 3¼in. 18¼ × 12½ × 3in. 21½ × 14¼ × 2½in.
17 × 12⅞ × 3½in. 14⅛ × 13 × 3¼ 14½ × 13⅓ × 2¾in.
22⅝ × 13⅞ × 3in. 16⅝ × 13 × 4in. 21 × 13⅜ × 4⅓in.

RADIO COMPONENT SPECIALISTS

Dept 4, 337, WHITEHORSE ROAD, CROYDON SURREY, U.K. TEL: 01-684 1665

ACCESS VISA

Post 65p Minimum. Callers Welcome.
Lists 34p. Same day despatch. Closed Wed.

leader of the Packs

AC/DC COMPONENT PACKS

Pack No.	Qty	Description	Price
TF 11	12	RED 5mm LED	£1.00
TF 12	30	500mz ZENERS 5%	£1.00
TF 15	50	1 amp Rect. Diodes in 4000 series	£1.00
TF 16	6	1 amp Bridge Rect.	£1.00
TF 17	100	Transistor pads	£1.00
TF 18	20	A/S Fuses 20mm	£1.00
TF 19	10	3A Rect. Diodes	£1.00
TF 110	2	ORP 12	£1.00
TF 111	5	BR 100 DIAC	£1.00
TF 112	10	BC109B	£1.00
TF 113	10	LC's all different	£1.00
TF 114	50	BFR 86	£1.00
TF 115	12	8 pin DIL sockets	£1.00
TF 116	20	10mm Horiz. Pre set (10 values)	£1.00
TF 117	10	Slide Pots – 3K all the same	£1.00
TF 118	10	Mixed Pots	£1.00
TF 119	10	Feed throughs	£1.00
TF 120	25	Electrolytic Caps	£1.00
TF 121	50	Polyester Caps	£1.00
TF 122	100	Mixed Resistors – Incl. Wire Wound	£1.00
TF 123	100	Mixed Transistor Hardware	£1.00
TF 124	25	5mm LED clips and rings	£1.00
TF 125	10	BC 107	£1.00
TF 126	10	BC 108	£1.00
TF 127	6	Green 5mm LED	£1.00
TF 128	6	Yellow 5mm LED	£1.00
TF 129	150 approx.	Mixed nuts/bolts/washers/ self tapper	£1.00
TF 130	25	Mixed Electrolytics Axial	£1.00
TF 131	25	Mixed Electrolytics Radial	£1.00
TF 132	50	Mixed Polyester Axial	£1.00
TF 133	50	Mixed Polyester Radial	£1.00
TF 134	15	BC 337	£1.00
TF 135	20	500MA A/S 20mm Fuse	£1.00
TF 136	50	Mixed Ceramic Discs	£1.00
TF 137	50	Mixed Ceramic Plates	£1.00
TF 21	200	47 pf 160V Polystone Cap	£2.00
TF 22	10	LM 3900 N	£2.00
TF 23	10	Mixed DTL	£2.00
TF 24	5	4700 mf 25V Tag Elect 2" × 1"	£2.00
TF 25	10	1000 mf 63V Ax Elect	£2.00
TF 26	50	.022 mf 400V RAD POLY	£2.00
TF 27	10	100 mf 250V Ax	£2.00
TF 28	10	2.2 mf 160V Polyester RAD	£2.00
TF 29	10	VDR's	£2.00
TF 210	10	Mixed TTL (74 series)	£2.00
TF 211	4	2N 3055 H(RCA)	£2.00
TF 213	200	IN 4151 Diodes	£2.00
TF 214	200	IN 4148 Diodes	£2.00
TF 51	100	White/Red 5mm LED	£5.00
TF 52	50	BC 108C	£5.00
TF 54	½KG	Reel 22g ersin multicore	£5.00
TF 55	10	2N3055 H(RCA)	£5.00
TF 56	5	OCP71	£5.00
TF 57	3	10,000 mf 40V Comp. grade elect	£5.00
TF 58	720	¼W Carbon film 1w–10Mw ten values	£5.00
TF 59	25	1,000 mf 25V Axial	£5.00
TF 510	25	1,000 mf 25V Radial	£5.00

ALL PRICES INCLUDE VAT – ALL GOODS BRAND NEW & NORMALLY DESPATCHED BY RETURN POST. TERMS: Cash with order. POST & PACKING: Please add 75p to total order.

AC/DC ELECTRONICS COMPONENTS
DEPT E.E., 45 CHURCH STREET, ENFIELD, MIDDLESEX.

INDEX TO ADVERTISERS

AB Microsystems ... 109
AC/DC Electronics ... 127
AD Electronics ... 126
American Inventors ... 127

Benning Cross ... 128
Bib Audio ... 85
Bi-Pak ... 66-67
BK Electronics ... Cover III
BNRES ... 113
Bull J. ... 119

Cardigan Electronics ... 128
C-Tec Securities ... 126

Dziubas M ... 86

Electrovalue ... 113
Experimental Electronics ... 126

Grandata Ltd ... 113
Greenweld Electronics ... 68

ICS Intertext ... 86
Ideal Schools ... 127

London Electronics College ... 128

Magenta Electronics ... 70
Maplin Electronics ... Cover IV
Marco Trading ... 85

Radio Component Specialists ... 127
Rapid Electronics ... 69
Riscomp Ltd ... 109
Rodean Products ... 126
RTVC ... 86

Skybridge Ltd ... 68
Software Index ... 125
Systems Electronique ... 128

TK Electronics ... Cover II

Published approximately the third Friday of each month by IPC Magazines Ltd., Kings Reach Tower, Stamford St., London SE1 9LS. Printed in England by Chapel River Press, Andover, Hants. Sole Agents for Australia and New Zealand—Gordon and Gotch (A/Sia) Ltd. South Africa—Central News Agency Ltd. Subscriptions: Inland £12.00, Overseas £13.00 per annum payable to IPC Services, Oakfield House, Perrymount Road, Haywards Heath, Sussex. Everyday Electronics is sold subject to the following conditions namely that it shall not, without the written consent of the Publishers first given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on cover, and that it shall not be lent, resold, or hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade, or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

All new in the 1985 Catalogue

From a gentle purr to a mighty roar, the tightly controlled power of the beast is yours to command!

PROFESSIONAL QUALITY HIGH POWER LOUDSPEAKERS

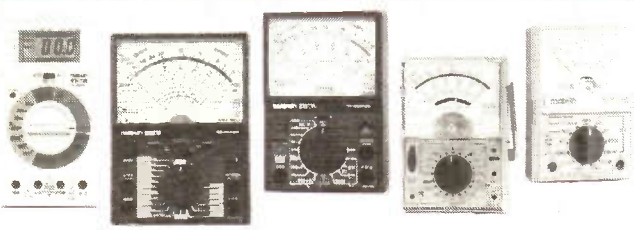
A new range of superb quality loudspeakers.

- ★ *Virtually indestructible high temperature voice-coil reinforced with glass-fibre*
- ★ *100% heat overload tolerance*
- ★ *Advanced technology magnet system*
- ★ *Rigid cast alloy chassis*
- ★ *Linen or Plastiflex elastomer surrounds*
- ★ *5-year guarantee (in addition to statutory rights)*

Available in 5, 8, 10, 12, 15 and 18 inch models with 8Ω and some 16Ω impedances and with input powers ranging from 50W to 300W e.g.

5in. 50W 95dB 8Ω: XG39N / 16Ω: XG40T £17.95§
8in. 100W 98dB 8Ω: XG43W £29.95§
10in. 100W 100dB 8Ω: XG46A £29.95§
12in. 100W 101dB 8Ω: XG49D £29.95§
12in. Twin Cone 100W 100dB 8Ω: XG50E / 16Ω: XG51F £31.95§
Note - the output power doubles for each 3dB increase (ref 1W @ 1m).

PRECISION GOLD MULTIMETERS



A new range of very high quality multimeters offering truly amazing quality at the price.

Pocket Multimeter, 16 ranges, 2000Ω/V DC/AC £6.95§ (YJ06G)
M-102BZ with Continuity buzzer, battery tester and 10A DC range, 23 ranges, 20,000Ω/V DC £14.95§ (YJ07H)
M-2020S with Transistor, Diode & LED tester and 10A DC range, 27 ranges 20,000Ω/V DC £19.95§ (YJ08J)
M-5050E Electronic Multimeter with very high impedance, FET input, 53 ranges including peak-to-peak AC, centre-zero and 12A AC/DC ranges £34.95§ (YJ09K)
M-5010 Digital Multimeter with 31 ranges including 20Ω and 20μA DC/AC FSD ranges, continuity buzzer, diode test, and gold-plated PCB for long-term reliability and consistent high accuracy (0.25% +1 digit DCV) £42.50§ (YJ10L)

N.B. All our prices include VAT and Carriage. A 50p handling charge must be added if your total order is less than £5 on mail order (except catalogue).

MAPLIN ELECTRONIC SUPPLIES LTD.

Mail Order: P.O. Box 3, Rayleigh, Essex SS6 8LR. Tel: Southend (0702) 552911
SHOPS
- BIRMINGHAM Lynton Square, Perry Barr, Tel: 021-356 7292.
- LONDON 159-161 King Street, Hammersmith, W6. Tel: 01-748 0926.
- MANCHESTER 8 Oxford Road, Tel: 061-236 0281.
- SOUTHAMPTON 46-48 Bevois Valley Road, Tel: 0703 25831.
- SOUTHEND 282-284 London Rd, Westcliff-on-Sea, Essex. Tel: 0702-554000

Shops closed all day Monday.

Our huge range of top quality electronic components at very competitive prices are all detailed in our catalogue, and with well over 600 new lines in our 1985 edition and many design improvements, it's well worth getting a copy. Here are just a few examples from the catalogue. (The items below are NOT kits).

★ Most phono and jack plugs now with integral strain relief sleeve - gold-plated types also available from 14p (gold from 70p)
★ Stereo Disco Mixer with cross-fade, talk-over, cue monitoring, aux input, slide controls. Only £58.95 (AF99H)

★ 10-Channel Stereo Graphic Equalisers - 3 models - basic; with peak level meter; and with spectrum analyser - from £77.95

★ Digital Delay Line permits Slap-back, Doubling, Flanging, Chorus and Echo. 11 controls. Only £195.00 (AF98G)
★ Video Enhancer improves picture quality when recording from one VTR to another, and with TV's with monitor input. Only 28.95 (XG59P)
★ Detailed descriptions of the exciting new 74HC range of IC's which combine the advantages of CMOS and TTL. From 46p
★ Keyboards: sloping keys, two-tone grey, mounted in steel frame, very smart cases (extra) available. 61 keys, only £33.95 (YJ12N)
79 keys, only £37.95 (YJ13P)
★ 1% Resistors now 50ppm/°C, 0.4W, only 2p each!
★ Auto transformers 120/240V 50VA, £10.75§ (YJ56L). 100VA £14.95§ (YJ57M). 150VA £16.95§ (YJ58N). 250VA £21.95§ (YJ59P).
★ Digital Clinical Thermometer. Only £13.95 (FK51F)

Check our 1985 Catalogue for all our other fascinating new lines.

☎ ***Phone before 2pm for same day despatch.***

1985 CATALOGUE

Pick up a copy now at any branch of W.H. Smith or in one of our shops. The price is still just £1.35, or £1.75 by post from our Rayleigh address (quote CA02C).

Post this coupon now for your copy of the 1985 catalogue. Price £1.35 + 40p post and packing. If you live outside the U.K. send £2.40 or 11 International Reply Coupons. I enclose £1.75.

Name ....
Address ....
....
....

EE 2/85

§ Indicates that a lower price is available in our shops. *All offers subject to availability.* *Prices firm until Feb 9th 1985.*