EVERYDAY
ELECTRONICS
and computer PROJECTS

MARCH 1985 £1·00

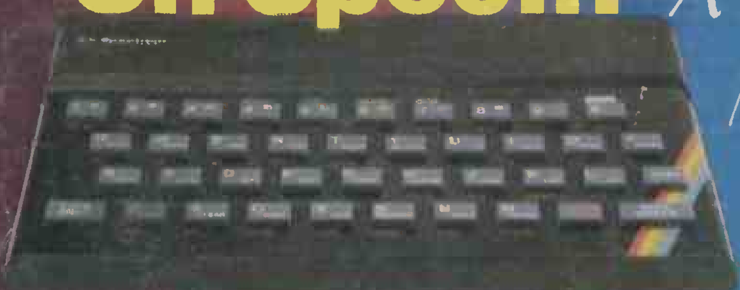
Special!

MONITOR

Buyer's Guide

NiCad Battery Charger

On Spec... A NEW Feature for Spectrum Owners!



Australia $1.75 New Zealand $1.95 Malaysia $4.95

BI-PAK BARGAINS

HIGH QUALITY MODULES FOR STEREO, MONO & OTHER AUDIO EQUIPMENT

Audio Amplifiers

O/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

O/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

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

Magnetic Cartridge Pre-Amplifier
O/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

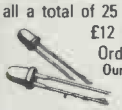
Red 0.3" Common Anode Display 0-9 with right hand decimal point. TTL compatible. 5v DC Supply. Data supplied.

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

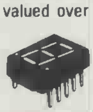
THE MORE YOU BUY THE LESS YOU PAY

BI-PAK'S OPTO SPECIAL

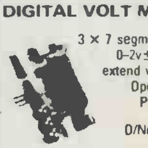
A selection of large and small sized LED's in various shapes, sizes & colours, together with 7 Segment Displays both anode & cathode plus photo transistors emitters and detectors. Cadmium Cell ORP12 and Germ. photo transistor OCP71 included. In all a total of 25 Opto pieces valued over £12 Normal Price



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

Order No	Pieces	Size	Sq. Ins.	Price
FB4	2	14 × 4"	110	£2.00

EDGE CONNECTORS

2 × 5 way .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	2in. high bright RED LEDs 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. Ideal Alarm projects etc. O/No. VP147.

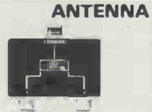
BI-PAK Price ONLY £0.60 pr.

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" 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). O/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. O/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.
O/No. VP 116 **£2.75**

IC BARGAINS

40 Assorted TTL CMOS 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. 8P39 **£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**

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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**

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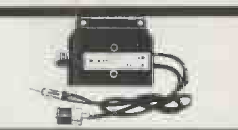
THE ELECTRONIC COMPONENTS AND SEMICONDUCTOR BARGAIN OF THE YEAR!

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.

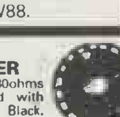
TAPE RECORDER SWITCH

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

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EVERYDAY ELECTRONICS and computer PROJECTS

VOL. 14 No. 3 MARCH 1985

ISSN 0262-3617

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

See Page 155

PROJECTS

SERIES

FEATURES

Our April 1985 issue will be published on Friday, March 15. See page 165 for details.

Heathkit - *IT'S A PLEASURE TO BUILD*

Bring the enjoyment back into your hobby with a kit from Heathkit. The beautifully illustrated documentation and step-by-step instructions make building a Heathkit a relaxing, absorbing pleasure! Every kit includes a constructors' guide covering soldering and component identification which makes construction straightforward even for a beginner.

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All the most popular kits and educational products are fully detailed in the 1984 Maplin catalogue (see outside back cover of this magazine for details) or for the full list of Heathkit products send 50p for the Heathkit International Catalogue complete with a UK price list of all items.

All Heathkit products available in the UK from:

Maplin Electronic Supplies Ltd.
P.O. Box 3, Rayleigh,
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(For shop addresses see back cover.)

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		

PLEASE REMEMBER OUR PRICES INCLUDE 15% VAT!

SEE THE 1985 CATALOGUE FOR A HUGE RANGE OF COMPONENTS

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.

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 solderlugs	80p	100p	135p	260p
Right angle	120p	180p	290p	420p
Covers	100p	90p	100p	110p

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

2718-250 £12.25

Brand new Hitachi product. Ideal for use with the BBC Micro. Please note this price is not a misprint!!

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.
SO239S round chassis skt 40p.
IEC 3 pin 250V/6A.
Plug chassis mounting . . 38p
Socket free hanging . . 60p
Socket with 2m lead . . 120p

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

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		

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 way 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

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

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.

MICRO

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

DIODES

		▶1N4001	3
8Y127	12	1N4002	5
OA47	10	1N4006	7
OA90	8	1N4007	7
OA91	7	1N5401	12
OA200	8	1N5404	16
OA202	8	1N5406	17
1N914	4	400mW zen	8
▶1N4148	3	1.3W zeners	13

NEW 1985 CATALOGUE

Rapid Electronics — Electronics Components 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!

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
2N5777	45	Tri-color Led	35
Seven segment displays:			
Com cathode.		Com anode.	
DL704 0.3"	95	DL707 0.3"	95
FND500 0.5"	100	FND507 0.5"	100
10 bar DIL LED display, red			180
5mm superbright LED 250mcd red	30		

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

0.25W Resistor Kit. Contains 1000 0.25W 5% resistors from 4.7 ohms thru to 10M. Quantities depend upon popularity i.e. 10x10R, 30x470R, 30x10K, 25x470K. Just £7.90
Ceramic capacitor Kit. Total of 250 miniature ceramic capacitors from 22p to 0.1u. Just £6.90
Polyester capacitor Kit. Total of 110 miniature polyester capacitors from 0.01u to 0.47u. Just £6.90
Preset Kit. Total of 110 miniature preset resistors from 100R to 1M. Horizontal mounting type. Just £6.90
Radial Electrolytic Capacitor Kit. A pack containing a total of 93 miniature caps from 1u to 2200u Just £7.50
Nut and Bolt Kit. Contains 800 assorted items. 100 each 6BA ¼in, ½in, nuts and wshrs, 4BA ¼in, ½in, nuts and wshrs. Just £3.20

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

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	LM13600	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	30	BFY52	27	2N2905	28	2N5458	30	TIP141	110
AD162	42	BC177	16	BD136	30	BFY53	30	2N2905A	28	2N5459	30	TIP142	120
AF124	60	BC178	16	BD137	30	BFY55	30	2N2906	28	2n5485	35	TIP147	120
AF126	50	BC179	18	BD138	30	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	TIP298	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
BC116	22	BC214L	10	BF196	12	MJE3055	70	2N3706	10	TIP308	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	TIP318	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	BC338	12	BF266B	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

Plastic with lid & screws		Aluminium	
		3 x 2 x 1"	65
		4 x 2¾ x 1½"	95
		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	55
		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	60	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
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SNUG HOBBY

AT THE time of writing the country is in the grip of what will no doubt go down as one of the worst winters in living memory; '85 will be remembered for it. While much of the sport grinds to a halt, various social events are cancelled and few people wish to venture out in pursuit of their pastimes, EE readers have been having a heyday snug at home with their hobby to keep them amused and some useful projects as a result. Provided you ordered items for one or two of our designs a few weeks before the freeze there was no need to go out at all. You could simply stay at home, let the postman deliver the components and build your next project.

Not only is our hobby excellent for this time of year, electronics can be of assistance when the elements do their worst and therefore it has a double attraction.

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HEADLIGHT ACTIVATED SWITCH

T. R. de Vaux Balbirnie

A DARK APPROACH to the house is not very inviting and can be dangerous. This project switches on a driveway light for a preset time when the car headlights are flashed onto a distant sensor. The system is designed for dusk-to-dawn use and has a range of at least 20 metres.

Although described as *headlight* activated, the unit may be operated by a hand held torch (although perhaps over a shorter range). It may thus be of interest to the non-motoring reader.

In the present design, the headlights must be flashed 3 times within approximately 5 seconds. This makes the circuit practically immune from false triggering providing the sensor is correctly located. Once *on*, the driveway light switches off automatically about two minutes later.

All the circuitry, apart from the sensor, is built into a plastic box which may be accommodated wherever a mains supply exists—inside the garage, for example. The sensor is housed in a waterproofed plastic box which may be placed any reasonable distance from the main unit and connected to it by light-duty twin wire. Lights of up to 5A rating (1200 watts or 240V mains) may be used. Since there are mains connections to make, this part should be left to a qualified electrician if the constructor is unsure of his or her ability to make a safe job.

FALSE TRIGGERING

Before beginning the project, it would be wise to check that a suitable position for the sensor exists. Note that people or pets walking in front of it sometimes causes false triggering. A car with its headlights on being driven along a bumpy path may also trigger the system—but, this may be thought an advantage rather than the reverse. Since the driveway light goes off automatically, any occasional false triggering is of no concern. Fig. 1 is a block diagram of the Headlight Operated Switch while Fig. 2 shows the entire circuit.

When light-dependent resistor, R13, together with component network VR1, R1 and C1 detect a flash of light, a voltage pulse is passed to the operational amplifier, IC1. This causes its output to go momentarily low and trigger IC2. This is a dual monostable with time periods of approximately 0·5 and 5 seconds respectively. With each flash of light, IC2, pin 9, sends a clock pulse to the decade counter IC3. Meanwhile, the output from IC2, pin 5, is inverted by TR1 and connected to the reset input of IC3. Thus, IC3 is enabled to count pulses while IC2 is *on*, but when it goes *off* IC3 resets. If 3 pulses are registered before this happens, the output corresponding to digit "3" (pin 7) goes high and, after inversion by TR2, triggers IC4. This is a further monostable with a time period of about 2 minutes—its purpose is to operate the relay, RLA, and hence the mains light through its "make" contacts. IC4 remains on for its full time despite resetting of IC3. The relay provides complete isolation between the mains and low voltage sections of the circuit.

Light-emitting diodes D1, D2 and D3 (different colours were used in the prototype) indicate the *on* states of each monostable. These are observed through holes in the lid of the case and will be found very useful at the testing stage. Further holes in the lid provide screwdriver access for VR1, VR2 and VR3. In this way, the setting-up procedure is followed with the lid in position—an important safety point since there are mains connections inside.

The unit receives power from a standard arrangement of mains transformer, bridge rectifer and smoothing capacitor. This last component has a high value to prevent false triggering due to fluctuations in the supply voltage.

SENSOR

The sensor operates in the following way. The non-inverting input of IC1 is set to approximately one-half supply voltage by the potential divider R2 and R3. The inverting input is held just below this voltage by means of VR2—thus, IC1 is normally *on*. When R13 detects a flash of light, its resistance falls sharply and so does the voltage at point A (Fig. 2). This change is passed on through C1 and upsets the action of R2/R3. The voltage at the non-inverting input falls momentarily below that at the inverting point and the op-amp switches *off*. This triggers IC2 in the manner previously described. The value of C1 gave good results in the prototype but changing its value could be the subject of experiment.

CONSTRUCTION

Note that since IC3 is a CMOS device, it should not be unpacked until needed. Refer to Fig. 3 and construct the main circuit panel. This is based on 0·1 in. matrix stripboard size 14 strips by 51 holes. Drill the mounting holes, make the breaks in the copper tracks and solder the

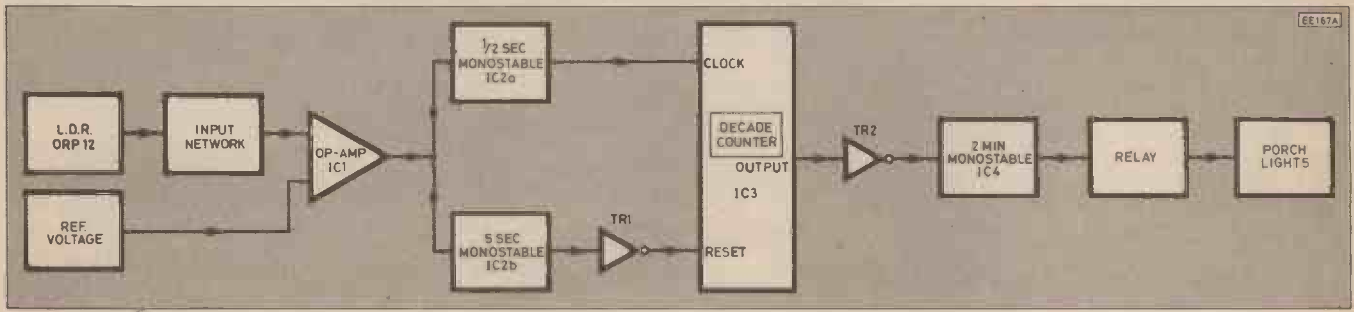


Fig. 1. Block diagram of the headlight-activated switch.

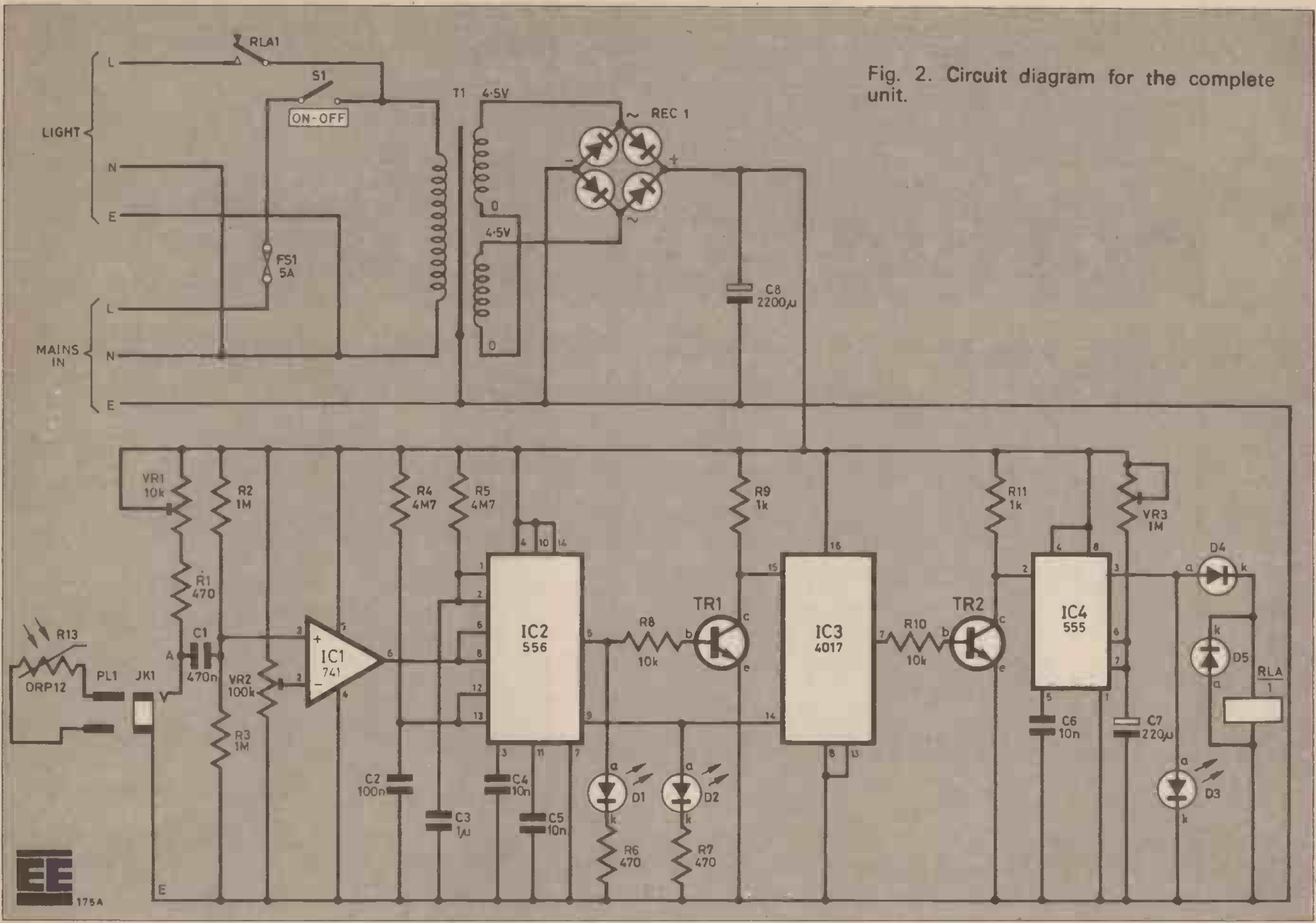


Fig. 2. Circuit diagram for the complete unit.

inter-strip link wires in position. Follow with the on-board components noting especially the polarities of all diodes and of C7 and C8. C8 is mounted alongside the panel as shown in the photographic illustration. Mount R4 and R5 clear of the panel—this will facilitate changing them in the unlikely event of the IC2 timings proving unsatisfactory. Solder connecting wires to copper strips B (3 off), N (2 off) and H as indicated in Fig. 3.

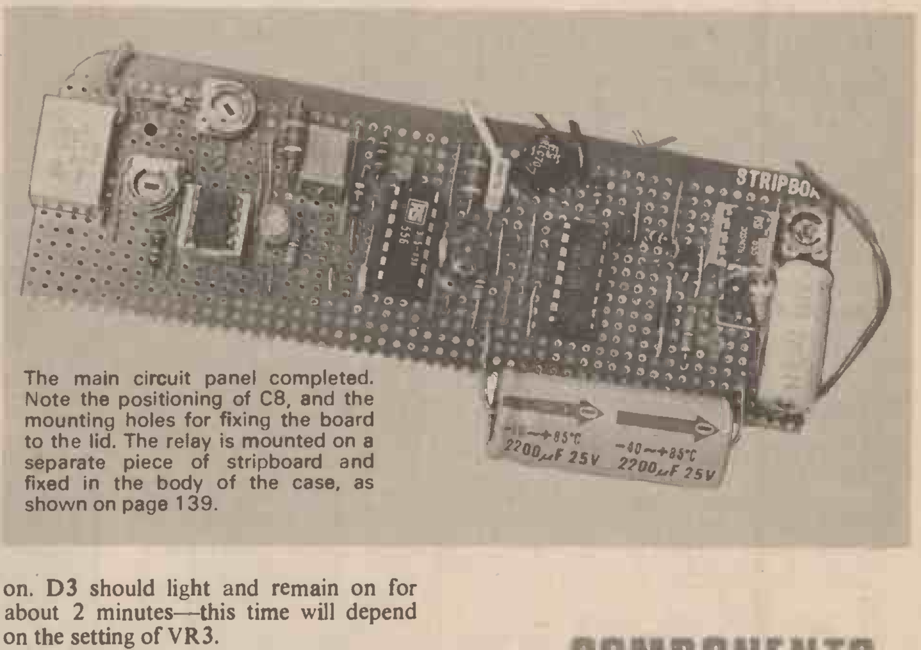
TESTING

It is wise to test the completed circuit panel using a 9V battery so that any faults may be corrected before making the mains connections. Start by inserting all the i.c.'s, apart from IC3, into their sockets. *Without touching the pins*, remove IC3 from its special packing and insert it into its socket noting that it is upside-down compared with the others. Leave VR1, VR2 and VR3 adjusted to approximately mid-track position.

Connect the wires labelled "a.c. in" (Fig. 3) either way to the battery. Adjust VR2 *gently* so that D1 and D2 just remain off—remember that D1, once on, takes a few seconds to go off. Touch the wires labelled "R13 (ORP 12)" together for an instant. D1 and D2 should both come on with D2 going off again after about 0·5 sec. and D1 after about 5 sec.

Now make D2 flash *3 times* with D1 on. D3 should light and remain on for about 2 minutes—this time will depend on the setting of VR3.

Mount RLA1 on its separate stripboard panel size 9 strips by 29 holes. Make sure it fits the runners of the case *tightly*—for safety reasons it must not break free or slide about in operation. Note that RLA1 must be of the fully-enclosed type with mains rated contacts as specified in the components list.



The main circuit panel completed. Note the positioning of C8, and the mounting holes for fixing the board to the lid. The relay is mounted on a separate piece of stripboard and fixed in the body of the case, as shown on page 139.

COMPONENTS approximate cost £21.00

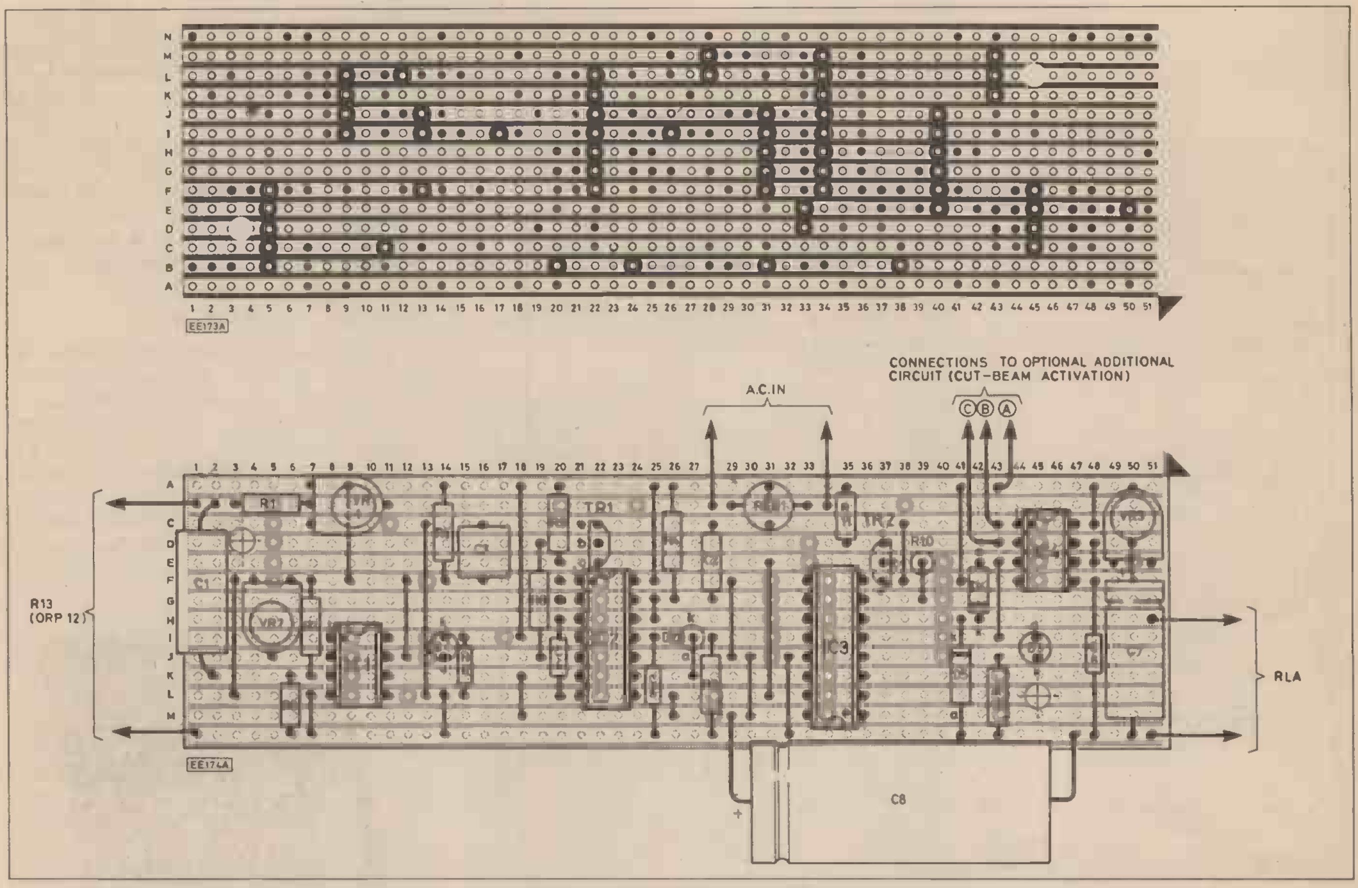


Fig. 3. Drilling details and component layout for the headlight-activated switch. Note that IC3 is in position the opposite way round to the other i.c.s. The connections off the board to the positions labelled A, B and C are for the optional add-on cut-beam triggering circuit.

ASSEMBLY

Prepare the case by making holes for S1, JK1 (sensor connector), mains leads and for attaching the terminal block, transformer and fuseholder. Mount all the offboard components.

Carefully measure the positions of the l.e.d's and preset potentiometers and drill 5mm diameter holes in the lid to correspond. Attach the circuit panel to the lid using suitable small fixings and stand-off insulators. Check that a small screwdriver will engage the preset potentiometers for adjustment.

Refer to Fig. 5 and complete all internal wiring. 3A mains-rated wire must be used for relay contact and terminal block connections. Slide the relay panel in position and "lock" it securely with a little glue in the runners of the case. The photograph opposite shows the relay panel glued in place, and also the internal wiring and layout of the off-board components. Insert the fuse in its holder.

Offer the lid to the rest of the case and check *very carefully* that no short-circuits are caused between the main circuit panel and the relay connections—for this reason, the main panel securing bolts should be cut short.

Switch off the mains supply at the fusebox and remove the fuse. Make the external mains connections using 1·5mm^2 twin and earth p.v.c. cable. Use similar cable to connect the light—do not use flexible wire.

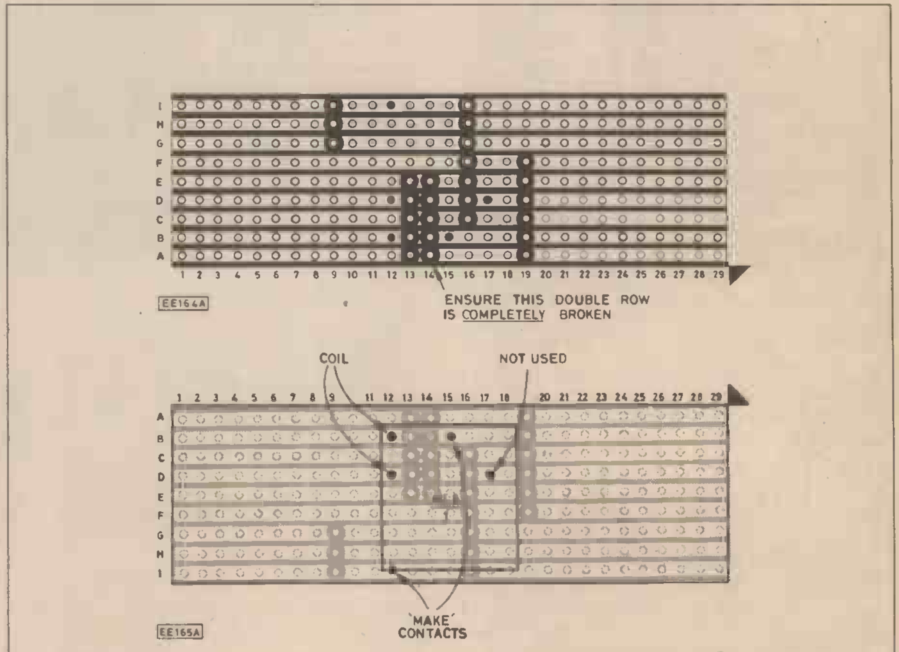


Fig. 4. Drilling details and positioning for the relay. Note that mains voltages will be present on this board.

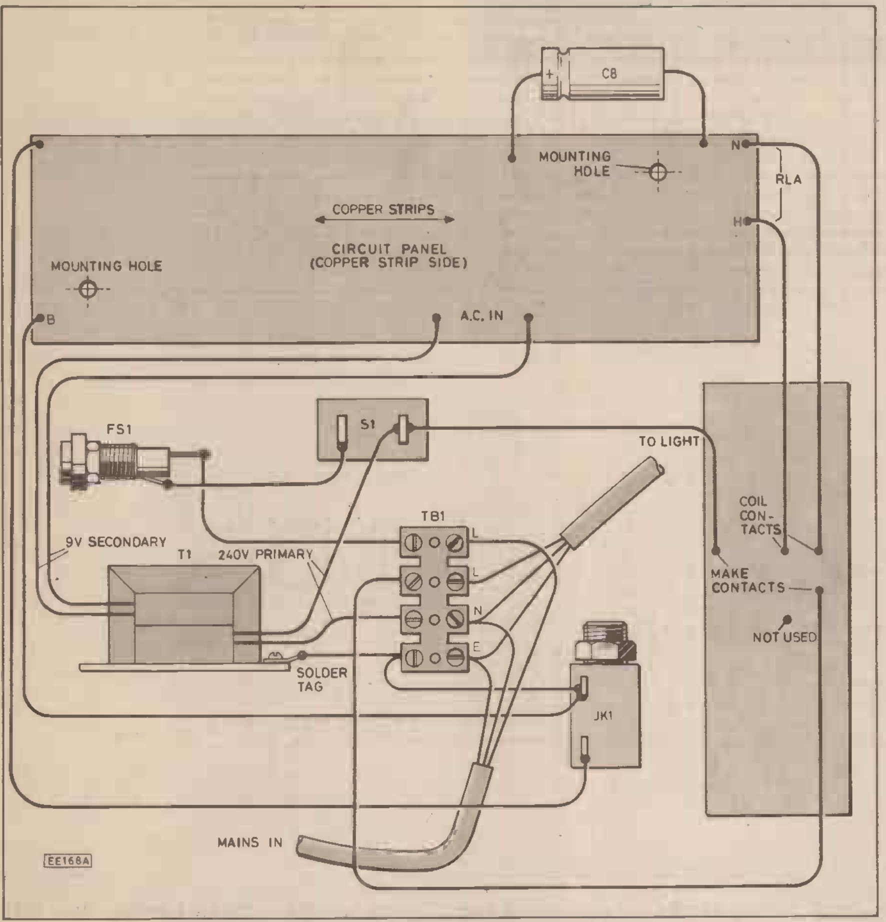
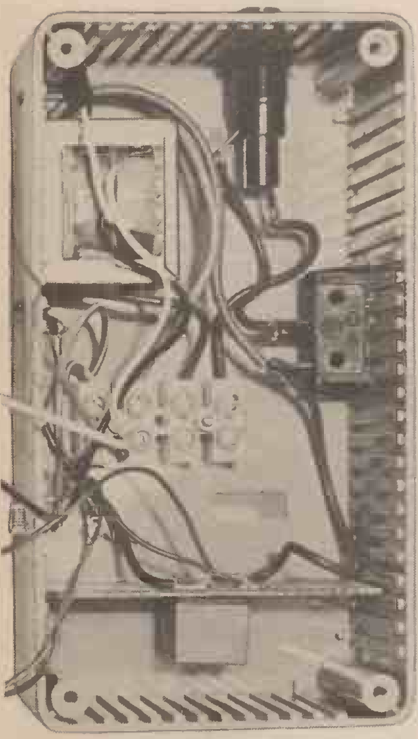


Fig. 5. Interconnecting wiring for the complete circuit.



Photograph showing the positioning of the relay board, the off-board components and the interconnecting wiring.

SENSOR

Refer to Fig. 6 for mounting details of PCC1. If the sensor is to be exposed to the weather it will be necessary to make a plastic seal for the lid. Connect up the sensor using light-duty twin wire. Test and adjust the system at dusk.

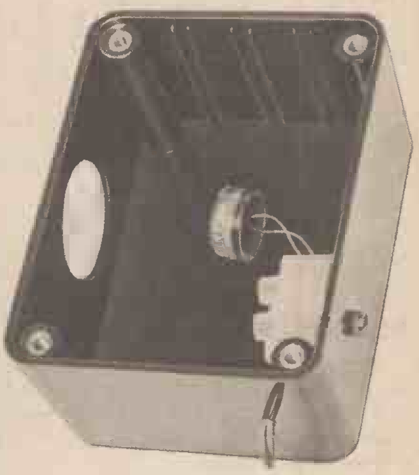
Adjust VR2 so that D1 and D2 remain off and adjust VR1 for best operation. Adjust VR3 for a suitable operating time—2 minutes in the prototype. Note that all adjustments are made with the lid in position.

If there is any tendency for the unit to operate randomly or when fluorescent lights are switched on nearby, this means that VR2 has been adjusted too critically. The light may be cancelled at any time by switching S1 off for a few seconds.

TRANSFORMER

Certain cheap mains transformers fail to develop their nominal secondary voltage and this can cause intermittent operation or failure of the relay to work at all. This can be avoided by using a good quality component. In marginal cases, try short-circuiting D4.

With the Headlight Activated Switch, you will always have a cheerful welcome home on dark evenings.



The light-dependent resistor mounted in its box. The diagram below shows the wiring details.

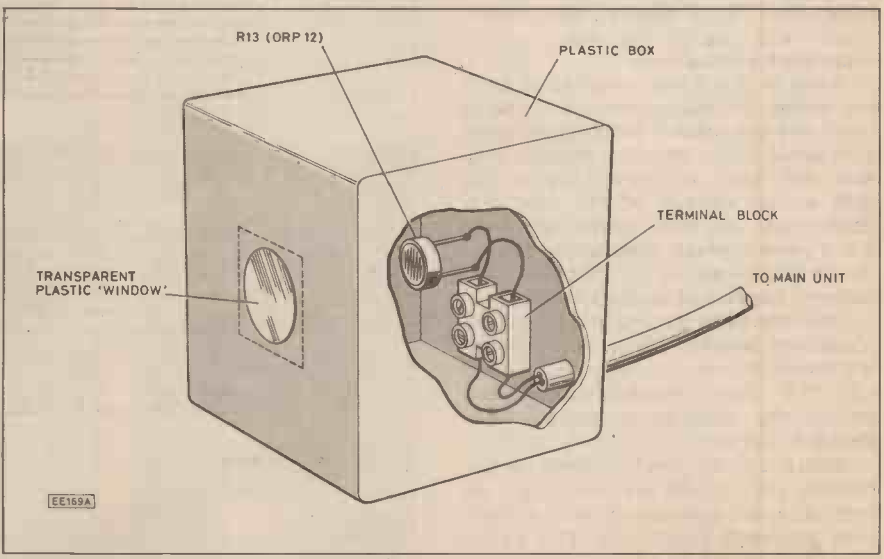


Fig. 6. Sensor mounted in its case.

COMPONENTS

Semiconductors

D1,2,3	5mm red, yellow, green l.e.d's (3 off)
D4,5	1N4001 silicon diodes (2 off)
D6–9	W005 bridge rectifier
TR1,2	ZTX300 *npn* silicon (2 off)

See **Shop Talk** page 146

Integrated circuits

IC1	741 operational amplifier
IC2	556 timer
IC3	4017 decade counter
IC4	555 timer

Resistors

R13	ORP12 light dependent resistor
R1,6,7,12	470 (4 off)
R2,3	1M (2 off)
R4,5	4M7 (2 off)
R8,10	10k (2 off)
R9,11	1k (2 off)
VR1	10k miniature horizontal preset potentiometer
VR2	100k miniature horizontal preset potentiometer
VR3	1M miniature horizontal preset potentiometer

Capacitors

C1	0·47µ
C2	0·1µ
C3	1µ
C4,5,6	0·01µ (3 off)
C7	220µ 16V electrolytic
C8	2200µ 16V electrolytic

Miscellaneous

Miniature mains transformer with 240V primary and 2 off 4·5V secondary windings (or single 9V secondary) at 100mA.

RLA	Fully enclosed miniature relay 400 ohm 12V coil, 10A mains-rated "make" contacts
PL1/JK1	3·5mm miniature jack plug and chassis socket
Stripboard	0·1in. matrix 14 strips by 51 holes (main circuit panel)
	0·1in. matrix 9 strips by 29 holes (relay panel)
FS1	Panel mounting mains fuseholder with 5A fuse
TB1	5A terminal block—8 sections required
S1	s.p.s.t. rocker switch rated at 240V 5A minimum

A.B.S. plastic boxes: 150×80×50mm (external) for main unit (2005 box)
80×61×41mm (external) for sensor (MB1 box)

Cut-Beam Triggering

By using a small add-on unit, the circuit may be triggered by cutting a light beam. With a suitably placed light source and sensor, a person walking between them will activate the driveway light. This could be useful to light the way for visitors or to deter prowlers. This extra facility in no way affects "normal" operation of the circuit using headlight flashes. Fig. 7 shows the circuit of the additional part and it will be noted that this receives power from the main section. IC5 is an operational amplifier used as a voltage comparator.

The non-inverting input is set to one-half supply voltage by the potential divider R20 and R21. The inverting input receives a voltage which depends on the adjustment of VR20 and the level of illumination of the sensor, R24. With R24 illuminated, its resistance is *low* and the voltage at the inverting input less than that at the non-inverting input. Thus, the op-amp will be *on* with its output, pin 6, high. D20 "blocks" this output which therefore has no effect on the main circuit. When illumination to R24 is reduced, its resistance rises and the op-amp switches *off* with pin 6 going low. This triggers IC4, pin 2, in the main section and the driveway light operates in the manner described previously.

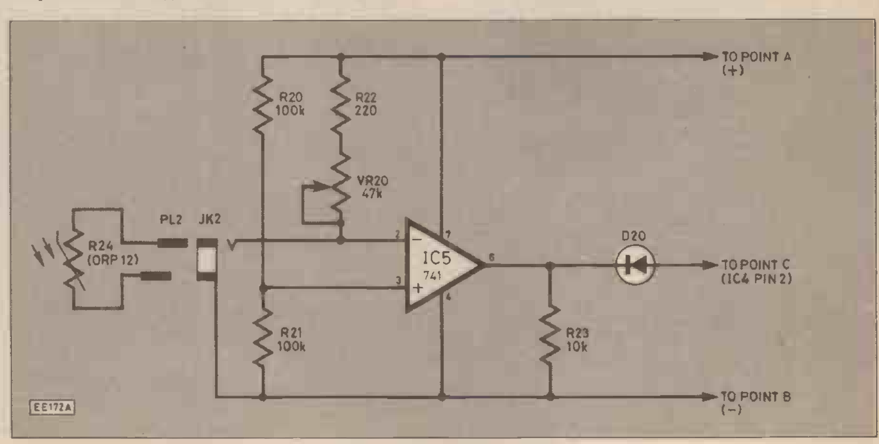


Fig. 7. Circuit diagram for cut-beam triggering operation.

CONSTRUCTION

The additional circuit is constructed on 0·1 in. matrix stripboard size 6 strips by 13 holes (Fig. 8). This is accommodated alongside the main circuit panel as shown in the photograph. A single hole is used for mounting and connections are made to Points A, B and C on the copper strip side of the main circuit panel (see Fig. 3). Points A and B are supply + and − respectively while Point C is the trigger connection. VR20 is a *vertical* preset potentiometer which allows for adjustment through a small hole drilled in the case. The sensor is connected by means of a 3·5mm jack socket mounted next to the existing one.

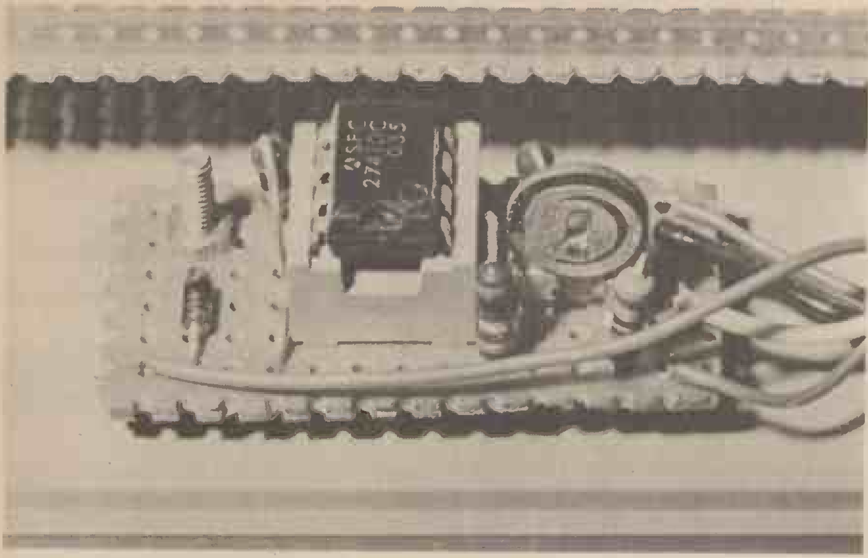
SENSOR UNIT AND LIGHT SOURCE

The sensor unit may be the same as the one already described for headlight triggering.

The light source used in the prototype is shown in Fig. 9. This is merely a suggestion and there is plenty of scope for experiment, especially if a long range of operation is required.

The bulb—which should not exceed 2·2W rating—must be powered by its own transformer placed inside the building. This is connected to the light source using light-duty twin wire. A cheap plastic lens (magnifying glass) focuses the light onto R24. The box used should be of plastic—suitably waterproofed—and of a length rather more than the focal length of the lens used.

Adjustment must be provided so that the lampholder may be moved to its optimum position. The prototype operates over a distance of more than 5 metres and this is thought to be sufficient for most



Photograph showing the optional add-on circuit, the cut-beam triggering unit which will activate the driveway light automatically when a light-beam is broken. The circuit layout is shown below, actual size, and the unit can be fixed to the lid of the case next to the main circuit, using a single screw as shown.

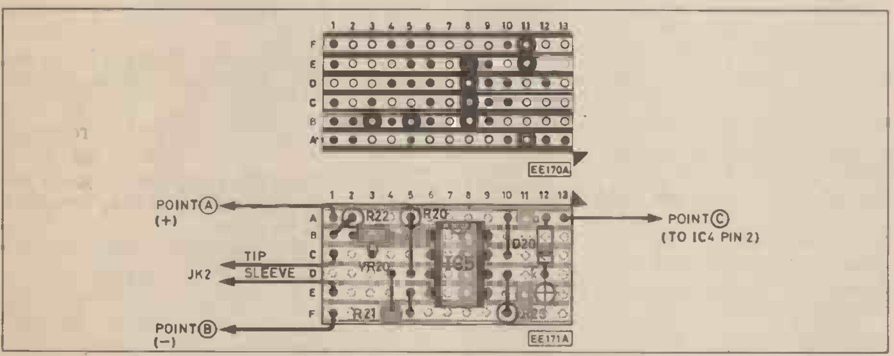


Fig. 8. Drilling details and component layout for the cut-beam triggering optional add-on circuit.

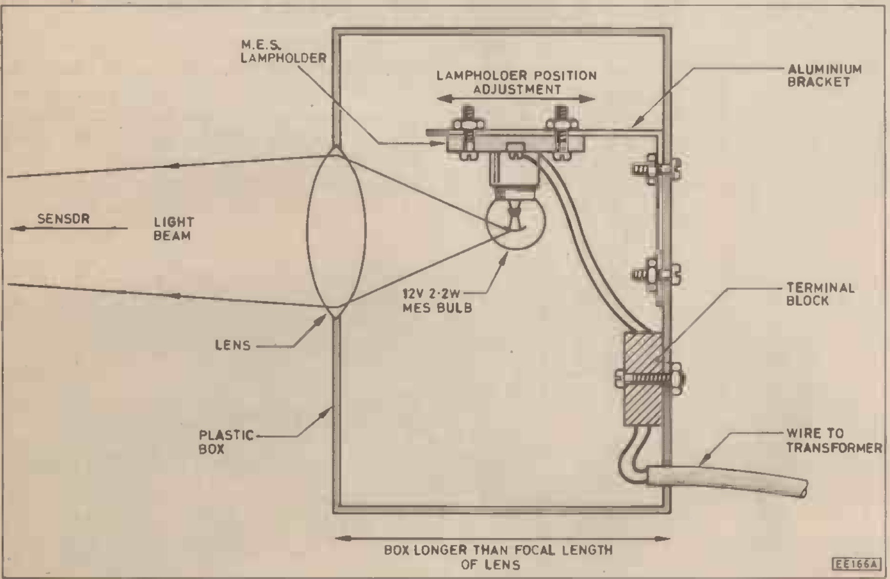


Fig. 9. Prototype light source for cut-beam triggering activation.

COMPONENTS

See Shop Talk page 146

Semiconductors

IC5	741 operational amplifier
D20	1N4148 diode

Resistors

R20,21	100k (2 off)
R22	220
R23	10k
All 0·4W ±1%	
VR20	47k miniature preset potentiometer—vertical mounting
R24	ORP12 light-dependent resistor

Miscellaneous

0·1 inch matrix stripboard size 6 strips by 11 holes; Mains transformer with 240V primary and 12V 250mA secondary with suitable housing; PL2/JK2 3·5mm jack plug and socket; Plastic boxes for sensor and light source; plastic lens; M.E.S. lampholder; 12V 2·2W M.E.S. lamp. Aluminium for lampholder bracket. Terminal block; fixings; connecting wire.

Approx. cost Guidance only **£9.50**

purposes. For a greater range, a similar lens could be used at the sensor unit to focus a beam of parallel light onto R24. This would increase the range. It is wise to under-run the lamp, using about 10 volts instead of 12 as this will greatly increase its life.

Check the voltage *at the lampholder terminals* using an a.c. voltmeter. Some voltage drop may be expected due to the connecting wire.

ADJUSTMENT

Once it is established that the light-source and the sensor are working correctly, they can be fixed permanently in position. After these initial experiments, which must be performed after dusk, it will be necessary to mount the lamp and sensor units rigidly in correct alignment. The best setting for VR20 is found over a period of trial. Shield the sensor as necessary from other sources of light—street lights and the driveway light itself, for example. During daylight hours the circuit is de-activated since sufficient light reaches the sensor to keep the op-amp *on*.

If the sensor is unplugged from the unit for any reason, it will be necessary to insert a dummy jack plug with short-circuited terminals to prevent the unit from operating. □

MODEL RAILWAY POINTS CONTROLLER

R. A. PENFOLD

THIS ARTICLE is primarily concerned with a simple project that enables a digital output of a computer to control an electric point reliably, and with no risk of burning out the solenoids in the point. However, track sensors to detect the position of the train and automatic signals will also be considered.

POINT OPERATION

An electric point is an extremely simple item of equipment, and it is basically just an ordinary (manually operated) point with the addition of two solenoids that give optional automatic operation. A short pulse of current to one solenoid sets the point to one position, and a current pulse through the other solenoid sets it back to the original position again. A manual points controller can therefore consist of nothing more than a single-pole-double-throw (SPDT) switch connected as shown in Fig. 1. Note though, that the switch must be a type having a central "Off" position. By operating the switch power can be applied to one or other of the solenoids, and the position of the point can be altered. The power source is the usual nominal 12 volt d.c. type which is in fact usually a rectified 15V a.c. signal.

It would be quite easy to produce a computerised controller of this type, and the most simple way of doing this would be to drive two relays from digital outputs of the computer, and then use one relay to control each solenoid. This might not work well in practice since there is a slight flaw in the basic form of points controller outlined in Fig. 1. The problem is brought about by the tendency of many points to stick when power is applied. With a manual points controller this can result in power being applied to one of the solenoids for an excessive amount of time in an attempt to force it to change positions, and this can in turn lead to a solenoid burning out. With a computerised version the software could be used to limit the maximum amount of time power would be supplied to the solenoid so that overloading and damage would be impossible, but this would still result in the point being left in the wrong position.

CAPACITOR DISCHARGE

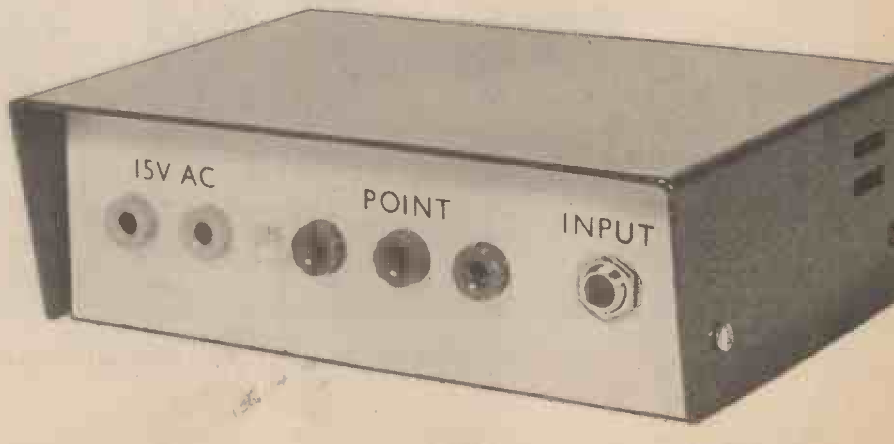
More reliable operation can be obtained using a capacitor discharge circuit. With this type of controller a high value capacitor is charged to around 24 volts via a current limiting resistor. The points controller switch then uses the capacitor as its power source. This arrangement is shown in the circuit diagram of Fig. 2.

The advantages of this type of controller are that it gives a stronger pulse of current and therefore better reliability, and that the solenoids can not be burned out if the switch is operated for an excessive period of time. The higher pulse of current is produced due to the higher voltage utilized, and the very low source impedance of the capacitor also helps in this respect. The solenoid can not be burned out even if the switch is operated continuously due to the inclusion of the current limiting resistor. Once the capacitor has discharged this resistor ensures that the current flow from the power source and through the resistor is inadequate to damage the solenoid. This is less important in a computerised controller than in a manual circuit, but it does protect the points in the event of a software error or if the computer is crashed.

This type of controller could again be computerised simply by replacing the switch with two relays driven from digital outputs of the computer. The circuit finally devised is a little more sophisticated than this though, as it uses semiconductor switching devices and is driven from a single digital output of the computer. The block diagram which appears in Fig. 3 helps to explain the way in which the controller operates.

The 15 volt a.c. input from the auxiliary output of a train controller is rectified to give a pulsating d.c. signal having a peak potential of typically about 24 to 25 volts. This supply is used for the charge circuit, and the capacitor charges to virtually the peak input voltage in only about one second. The control signal from the computer connects to the inputs of two monostable multivibrators. These are of the non-retriggerable type, and when triggered each monostable provides an output pulse of a certain duration,

THE JUNCTION BETWEEN MODEL AND MICRO THAT PUTS BRAINS IN YOUR BRANCHLINE



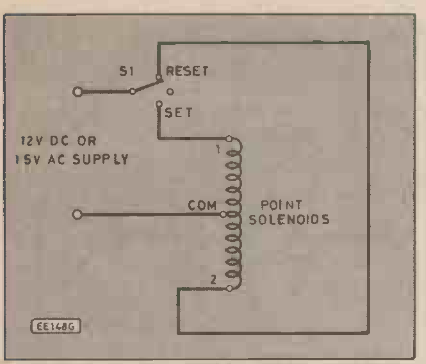


Fig. 1. A simple manual points controller.

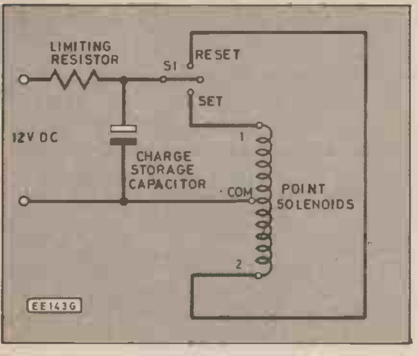


Fig. 2. An improved points controller circuit.

regardless of how long or short the trigger pulse happens to be. One of the monostables is a negative-edge triggered type, and it therefore generates an output pulse when the input is taken from high to low. The other monostable is a positive-edge triggered type, and it produces an output pulse when the input signal goes from low to high.

If we assume that the input is initially low, by setting it high the positive triggered monostable can be made to give an output pulse. This pulse is used to activate an electronic switch, and this switch connects one of the point's solenoids to the discharge circuit. The pulse duration is long enough to permit the capacitor to discharge through the solenoid and operate the point. If the input is now taken low again the negative triggered monostable generates an output pulse, activating the other electronic switch and connecting the charge circuit through to the other solenoid of the point. Provided the charge circuit has been given a second or so to recharge, this results in the point being switched back to its original position. This makes the software to control the unit very straightforward, with a high output level corresponding to one position, and a low output level giving the opposite position.

THE CIRCUIT

The full circuit diagram of the Model Railway Points Controller appears in Fig. 4.

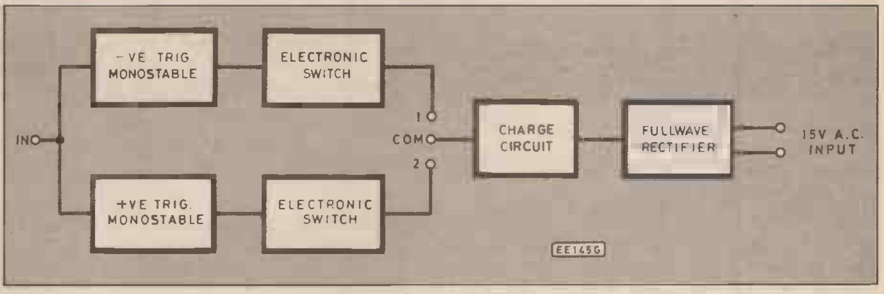


Fig. 3. Block diagram of the points controller.

Diodes D1 to D4 form a bridge rectifier which fullwave rectifies the 15 volt a.c. input. C1 is the charge storage capacitor and R1 is the current limiting resistor.

Both monostable multivibrators are based on a CMOS 4098BE (or the 4528BE which is an exact equivalent). It is possible to produce most types of monostable using CMOS gates, but the 4098BE is actually a dual monostable, and is more convenient in this application. Each section of the device can be used as a positive or negative edge triggered circuit, and in the retriggerable or non-retriggerable mode. In this case both sections are used in the non-retriggerable mode. C2 and R4 are the timing components for the first section, and these give an output pulse duration of approximately 250 milliseconds. This may seem rather short, but in practice is more than adequate to give the point time to switch over. This section is wired to operate in the positive-edge triggered mode, and it therefore generates the output pulse when the input goes from low to high. This pulse appears at pin 6 of IC1, and it is used to activate switching transistor TR1 via current limiting resistor R3. Although the drive current to TR1 is not very high (about 3 milliamps), TR1 is a Darlington device which consequently has an extremely high current gain (about 5000 times). When switched on TR1 connects one of the solenoids across C1, and due to the high gain of TR1 it allows a suitably large pulse of current to flow. TR1 must be a power device as the peak current flow can easily reach 2 or 3 amps.

Resistor R5, and C3 are the timing components for the other monostable which is, of course, wired to operate in the negative-edge triggered mode. It provides an output pulse at pins 10 and 12 of IC1, and this is used to drive TR2 via current limiting resistor R2. TR2 controls the second solenoid of the points.

As IC1 is a CMOS device none of its inputs must be left open circuit and vulnerable to damage by static charges. R6 is therefore used to tie the two inputs to the negative supply rail when the unit is not connected to the computer. The input can be driven from any CMOS compatible logic output, and the MOS devices often used in computer ports (the 6522 and 8255A for example) are perfectly suitable. The unit also seems to function satisfactorily when driven from an LS TTL output. If the unit is used with the previously published *Computerised Train Controller* in conjunction with a VIC-20, Commodore 64, or BBC model B computer, line PB1 of the user is probably the most convenient one to use. A +5 volt output supply is needed for the monostable circuit, and most computers (including the three mentioned above) have a +15 volt output on the user port that is suitable. As IC1 is a CMOS device the current consumption is negligible.

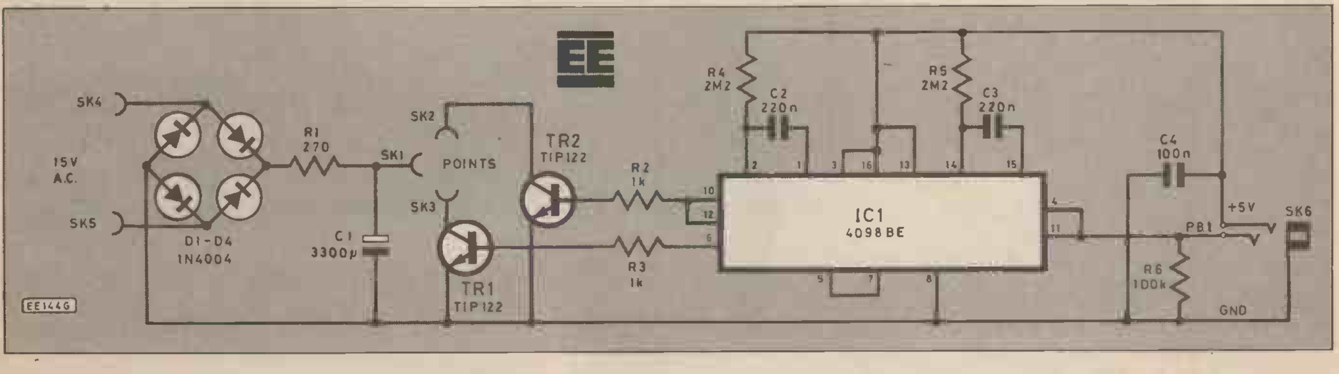


Fig. 4. Circuit diagram of the Model Railway Points Controller.

CONSTRUCTION

A metal case measuring about 150 by 100 by 50 millimetres is used for the prototype controller, but any case about this size should be suitable and it does not have to be a metal type. Although a 6·35mm stereo jack is specified for SK6, and 4mm sockets are specified for SK1 to SK5, these can, of course, be changed for alternative types if these would be more convenient in your particular set-up. SK6 is mounted at the right hand end of the front panel, SK4 and SK5 are mounted at the opposite end, with SK1 to SK3 grouped in the middle of the panel. It is advisable not to alter this layout as it would make the wiring of the unit a little less straightforward.

The other components are fitted onto a printed circuit board, as detailed in Fig. 5. TR1 and TR2 are power devices, but as they do not have to dissipate much power in this application they do not require heatsinks. They are fitted horizontally onto the board and are each fixed in place using an M3 6mm screw plus fixing nut. Their leadout wires are then trimmed to length and soldered to the board. IC1 is a CMOS device and requires the normal antistatic handling precautions. Use a 16 pin d.i.l. i.c. socket for this component, and do not plug it into circuit until all the other components have been fitted onto the board. Do not handle this device any more than is absolutely necessary. Fit pins to the board at the points where it will be connected to the sockets.

Once completed the board is mounted on the chassis or base panel of the case using M3 or 6BA fixings. If a metal case is used these should include spacers to keep the connections on the underside of the board clear of the metal casing. Finally, add the point to point style wiring using ordinary multistrand PVC insulated connecting wire.

IN USE

SK4 and SK5 are fed from the 15 volt a.c. output of a train controller, and the *Computerised Train Controller* unit has a suitable output. If preferred the unit could be powered from an internal 15 volt mains transformer having a secondary rating of 100 milliamps or more, but normal safety precautions to prevent an accidental electric shock from the mains supply would then need to be taken. SK1 to SK3 connect to the electric point, and SK1 must connect to the Common terminal of the point (this is usually the middle one of the three terminals). As explained earlier, SK6 connects to the user port of the computer, or whatever output port you wish to utilise. Fig. 6 gives connection details for the VIC-20, Commodore 64, and BBC model B computers, and this assumes line PB1 is to be used to operate the controller.

To test the unit the first task is to set the appropriate line of the user port as an

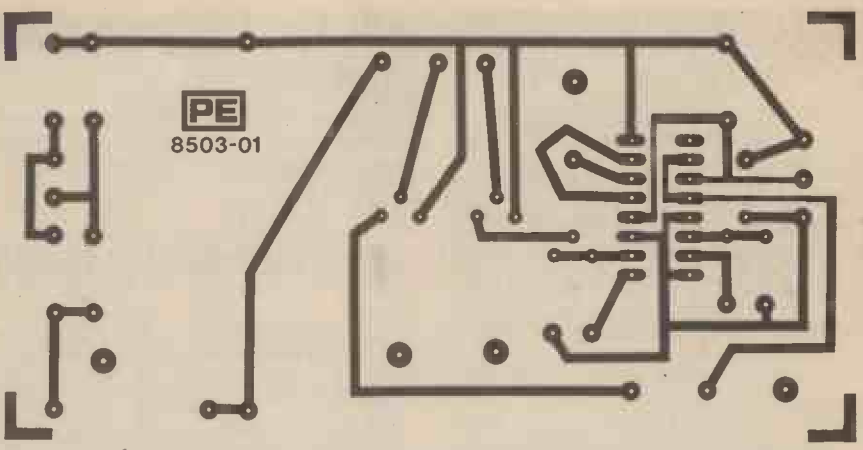


Fig. 5 (a). Printed circuit board (available through EE p.c.b. service No. 8503-01).

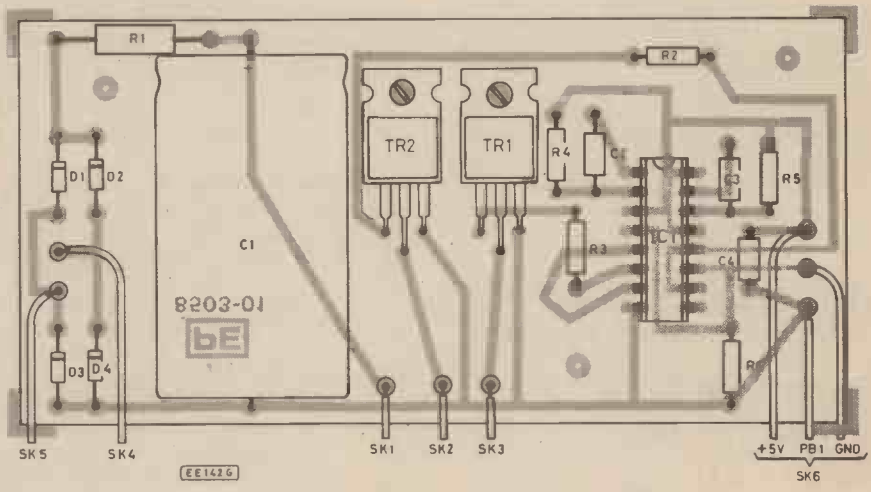
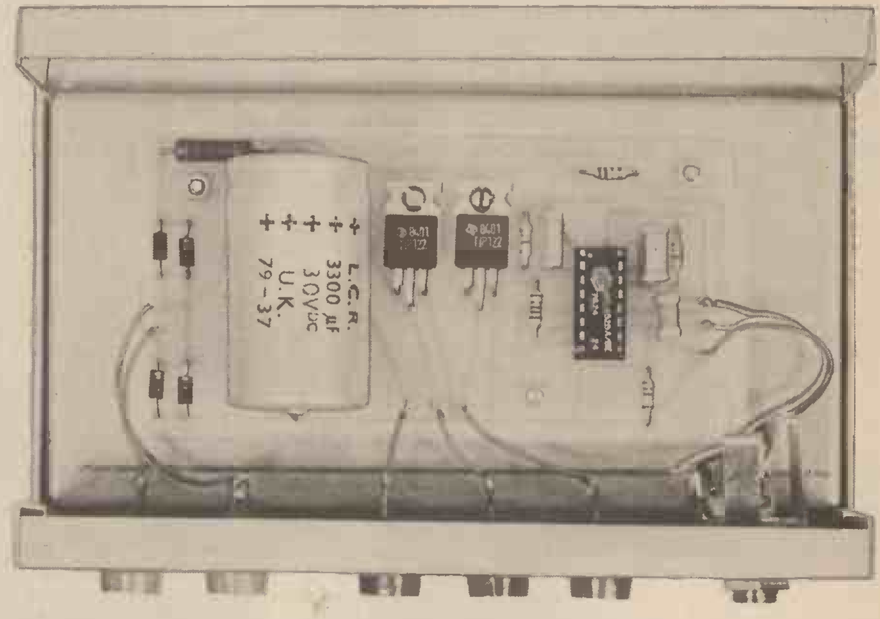


Fig. 5 (b). Component layout.



A simple project indeed. A lid off view of the complete unit.

COMPONENTS

Resistors

R1	270 1W 10%
R2,3	1k (2 off)
R4,5	2M2 (2 off)
R6	100k

All resistors $\frac{1}{4}$W 5% except where stated otherwise

Capacitors

C1	3300μ 30V axial elect
C2,3	220n carbonate (2 off)
C4	100n carbonate

Semiconductors

IC1	4098BE or 4528BE dual CMOS monostable
D1 to D4	1N4004 100V 1A rectifiers (4 off)
TR1,2	TIP122 Darlington power transistors (2 off)

Miscellaneous

SK1 to SK5	4mm sockets (5 off)
SK6	Standard stereo jack socket

Printed circuit board; case about 150 × 100 × 50mm; 16 pin d.i.l. i.c. socket; veropins; fixings; connecting wire and cables; computer connector; etc.

Approx. cost Guidance only **£12**

output. The following is used to achieve this:
POKE 37138,2 (VIC-20)
POKE 57579,2 (CMB64)
?&FE62=2 (BBC model B)
The point is then controlled by writing 0 or 2 to the user port, to set PB1 low and high respectively. For example, with the VIC-20:–
POKE 37136,2
sets PB1 high, and:–
POKE 37136,0
sets it low again. The corresponding addresses for the Commodore 64 and BBC model B computer are 56577 and &FE60. This obviously assumes that no other lines are used as outputs, and the number written to the port might need to be different if they are.

POSITION SENSING

When a model train is run automatically it is normally necessary to have one or more sensors on the track so that the controlling circuit can determine the position of the train when necessary. For example, if the train is to complete a certain number of laps around the track and then run into a siding and stop, the controlling circuit must be able to determine the number of laps completed, switch the points once the appropriate number of laps have been done, and then stop the train at the desired place. A sensor on the main loop of track would be needed to enable a lap counter action to be produced, and another one would probably be needed on the siding to inform the controller when the train had almost reached the desired stopping point. With many automatic systems the train is either switched to full speed or is switched off completely. This does not give very realistic results, and is something that can be considerably bettered with a proper computerised system.

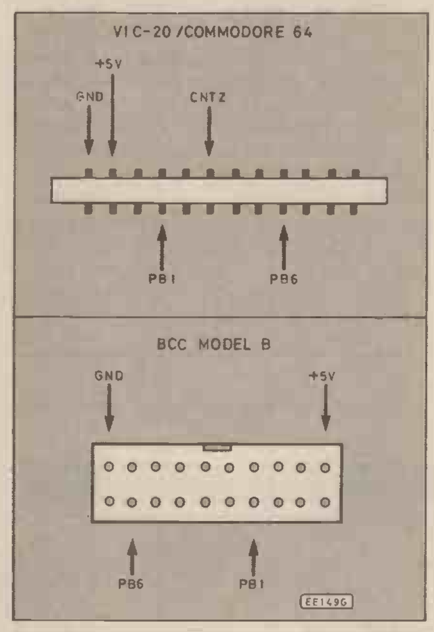


Fig. 6. Connection details for the BBC Model B, Commodore 64 and VIC-20.

The train can be gradually slowed down in advance, and then brought smoothly to a halt as it passes the appropriate track sensor. In this way very realistic results and precise control of the train can be obtained.

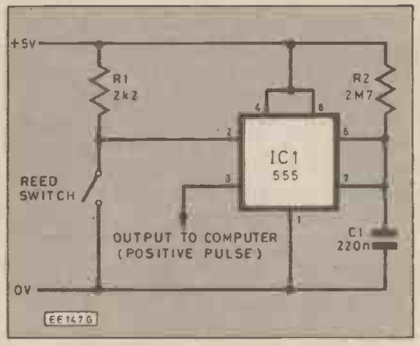


Fig. 7. A 'debounce' circuit for use with reed switches.

The most simple type of track sensor, and probably the most convenient type to use in practice, is a reed switch. This is mounted on or under the track, and operates in conjunction with a small bar magnet mounted on the underside of the train. The switch is normally open, and closes momentarily as the magnet on the train passes over it. Note that the magnet and the switch must be parallel to one another and must pass within a few millimetres of each other if the switch is to be activated.

One way of using this type of sensor is to simply connect the switch from a spare input line of the user port to ground. The internal pull-up resistor of the port results in this line normally being high, but when it is activated the line is briefly taken low. There is a slight problem with this arrangement in that the switch might be closed for only a few milliseconds, making it necessary to monitor the line at a fairly high rate in order to be certain that the signal from the switch is not missed. This problem can be overcome using the circuit of Fig. 7. This is basically just a 555 monostable which is triggered by the track switch, and then provides a positive output pulse of about 0·5 seconds to an input of the user port. This pulse stretching means that the line only has to be checked two or three times per second.

The VIC-20, Commodore 64, and BBC model B computers all have two built-in 16 bit timer/counter which can be used in conjunction with a track sensor to act as a lap counter. One of these is used to provide the control signal for the *Computerised Train Controller* unit, but this still leaves one free to act as the lap counter. With the VIC-20 and BBC machines the input pulses are applied to Timer 2 via PB6 of the user port, but with the Commodore 64 the pulses are fed to Timer A by way of the CNT2 input. Although reed switches suffer from contact bounce to a much lesser degree than most other types of switch, two or three pulses are likely to be generated each time a switch is activated. This can be overcome by using the circuit of Fig. 7 as a debouncer, but in this application R2 can be reduced to about 270k.

The control register for Timer 2 in the VIC-20 and BBC model B computer is at 37147 and &FE6B respectively. To give the correct mode of operation bit 5 is set high. The low byte of the timer is at 37144 and &FE68 respectively, while the high byte is at 37145 and &FE69 respectively. In this application the high byte is not really needed as a range of 255 to 0 (they are down counters) should be adequate, but a value must be written to this address since the low byte is not loaded until this is done. Suppose that you are using the VIC-20, and that you want the train to do ten laps of the track. POKE 37144, 10 would load 10 into the low byte counter latch, and then POKE

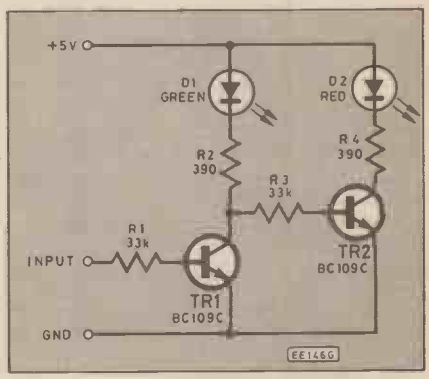


Fig. 8. Simple l.e.d. driver circuit for a red/green signal set.

37145,0 would load 0 into the high byte of the counter and 10 from the latch into the low byte of the counter. Reading address 37144 will return a value of 10, but this will decrement by one each time the sensor is activated. If the train is allowed to run until 37144 equals 0, and then it is stopped, the required ten laps will be completed. Of course, as explained earlier, more realistic results can be obtained by gradually slowing down the train, with a reduction in speed being programmed to occur when address 37144 equals (say) 3, 2, and 1, and the train then being brought to a halt when the returned value equals 0. By suitable positioning of the track sensor the train can be made to stop at the desired position on the track.

With the Commodore 64 the control register for Timer A is at address 56590, and the appropriate mode of operation is obtained by setting bits 1 and 5 of this register high (i.e. POKE 56590,33). The low byte of the timer is at address 56580, and this can be POKEd to the desired value without also writing a value to the high byte (which is at 56591).

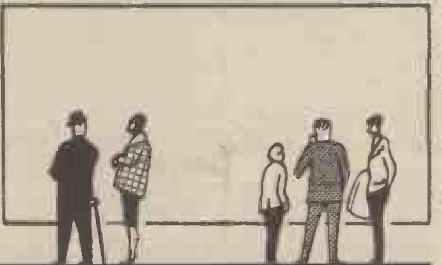
AUTOMATIC SIGNALS

Automatic signals are easily implemented in a computerised system. With one form of automatic signalling the signal is set to "red" as the train passes, and back to "green" again when the train has passed a certain distance along the track. Track sensors are used to indicate to the computer when the train passes the signal, and when it has progressed the required distance along the track. A simple routine then controls the two lights of the signal via an output line of the user port.

With a second type of signal the computer controls the signal or signals under program control, so that the train always stops at a "red" signal and passes a "green" one, giving the appearance that the train is responding to the signals. With either type of signal some sort of driver circuit will almost certainly be needed due to the low output current capability of computer ports. The circuit of Fig. 8 is suitable for use with home-constructed signals using red and green l.e.d.s as the signal lights. The input must be taken high for "green" and low for "red".

Even a fairly modest model train layout can be computerised to good effect, giving added interest with sophisticated automatic control of the layout being easily achieved. As these two articles have shown, with a home-computer as the basis of the design only a few inexpensive accessories are required in order to produce a versatile system. □

SHOP TALK



BY DAVID SHORTLAND

Safety Plug

Most electrical accidents are a result of cut or frayed cables, loose connections, exposure to dampness, contact with water or the abuse or misuse of equipment. The only effective way to guard against such dangers is by using a residual current circuit breaker (RCCB).

The PowerBreaker 20 from **B&R Electrical Products** is an electrical adaptor which has been designed to plug into any standard 13 amp socket prior to plugging in a piece of equipment or an appliance to provide a high degree of protection against electric shocks in the case of an accident.

The adaptor provides RCCB protection which senses a tiny amount of current flowing to earth and cuts off the supply much faster than a fuse could blow.

Additional safety features include a 'power on' indicator, a test button and an automatic current cut-off if the adaptor is plugged into an incorrectly wired socket.

The PowerBreaker 20 is designed for 220/240V operation and is slim enough for two units to fit side-by-side into a double socket.

The price of the PowerBreaker 20 is around £20·00 and is available from a number of retail shops and outlets.

Magenta Electronics

Magenta Electronics who are well known to many readers for their electronic kits have just released their latest catalogue which includes many of their projects which have been featured in both EE and PE as well as a wide range of components and tools.

The catalogue which is free to schools and colleges if ordered on official letterheads is available from **Magenta Electronics Ltd., 135 Hunter Street, Burton-on-Trent, Staffs DE14 2ST** (0283 65435) and is priced at £1·00 including p&p.

Skybridge

Skybridge Electronics who have just opened their new shop at **441 Princes Road, Dartford, Kent** (Skybridge 91454), are now stocking a wide range of components for the hobbyist.

A technical library is also available to customers covering component data by product and manufacturer. Literature can also be provided for constructors who wish to design their own projects using proven 'building blocks'.

Skybridge are currently compiling their catalogue which should be available in the near future. In the meantime their advertisements cover a wide range of stock and the company still offer a procurement service for items they do not hold.

Software Service

Please note the EE Software Service has now been discontinued.

CONSTRUCTIONAL PROJECTS

Heat Setting Indicator

There appear to be very few problems with components, in this issue the only problem that might arise is on the Heat Setting Indicator where the thermistor TH1 can be obtained from **Maplin Electronic Supplies** and should be ordered as WH24B (Thermistor G23).

AA117	0.090
AA119	0.090
AAY32	0.090
AC107	0.200
AC126	0.170
AC127	0.150
AC128	0.150
AC128K	0.230
AC141K	0.300
AC142K	0.300
AC153K	0.230
AC176	0.180
AC176K	0.200
AC187	0.150
AC187K	0.200
AC180	0.170
AC188K	0.230
ACY18	0.480
ACY19	0.480
AD142	0.600
AD149	0.450
AD161	0.220
AD162	0.220
AF124	0.250
AF125	0.250
AF126	0.250
AF127	0.250
AF139	0.220
AF239	0.220
AL112	0.700
AL113	0.[illegible]
ASZ15	1.000
ASZ17	1.000
AU110	1.100
AY102	1.800
AY106	1.800
BA145	0.100
BA148	0.100
BA154	0.060
BA157	0.120
BB101	0.130
BB103	0.190
BB105B	0.180
BB205B	0.240
BC107	0.070
BC108	0.070
BC109	0.070
BC115	0.100
BC118	0.110
BC140	0.190
BC141	0.190
BC142	0.190
BC143	0.190
BC147	0.055
BC148	0.055
BC149	0.055
BC157	0.055
BC159	0.055
BC182	0.060
BC182L	0.050
BC183	0.060
BC183L	0.060
BC184	0.060
BC184L	0.060
BC212	0.060
BC212L	0.060
BC213	0.060
BC213L	0.060
BC214	0.060
BC214L	0.060
BC237	0.070
BC238	0.070
BC300	0.160
BC301	0.180
BC302	0.180
BC303	0.140
BC327	0.060
BC382	0.060
BC337	0.060
BC328	0.060
BC557	0.060
BCY32	1.500
BCY33	1.500
BCY34	1.500
BCY42	0.200
BCY56	0.160

BCY70	0.160
BCY71	0.160
BCY72	0.160
BD115	0.260
BD124P	0.500
BD124	1.100
BD128	0.350
BD131	0.250
BD132	0.250
BD135	0.200
BD136	0.200
BD137	0.200
BD138	0.200
BD139	0.200
BD140	0.200
BD144	0.900
BD150	0.300
BD157	0.380
BD158	0.380
BD166	0.300
BD175	0.300
BD177	0.300
BD179	0.320
BD181	0.450
BD201	0.330
BD202	0.380
BD203	0.420
BD204	0.420
BD222	0.310
BD225	0.310
BD232	0.310
BD237	0.210
BD238	0.240
BD433	0.260
BD437	0.200
BD535	0.380
BD536	0.380
BD537	0.400
BD538	0.400
BDX32	1.800
BDX65	0.800
BF180	0.160
BF181	0.180
BF183	0.200
BF184	0.200
BF185	0.200
BF194	0.050
BF195	0.050
BF196	0.060
BF199	0.060
BF200	0.160
BF257	0.180
BF258	0.180
BF259	0.180
BF336	0.200
BF337	0.200
BF338	0.200
BF362	0.300
BF422	0.210
BF458	0.190
BF459	0.190
BFX29	0.200
BFX84	0.200
BFX85	0.200
BFX87	0.150
BFX88	0.150
BFY50	0.140
BFY51	0.140
BFY52	0.140
BFY56	0.250
BYF57	0.250
BFY64	0.250
BR100	0.140
BSX19	0.150
BSX20	0.150
BSX21	0.160
BSX26	0.160
BSX29	0.190
BZX76	0.180
BT106	0.900
BT109	0.800
BT116	0.800
BT119	1.000
BT120	1.000
BU104	1.000
BU106	0.800
BU108	1.000
BU110	1.100

BU111	1.400
BU126	0.700
BU204	0.750
BU205	0.700
BU208	0.750
BU208A	0.800
BU208D	1.200
BU326	0.850
BU406	0.850
BU407	0.750
BU408	1.000
BU500	1.100
BU526	0.800
BY126	0.060
BY127	0.080
BY133	0.080
BY164	0.220
BY176	0.850
BY179	0.350
BY182	0.320
BY184	0.320
BY187	0.320
BY196	0.200
BY206	0.110
BY207	0.110
BY223	0.720
BYX10	0.150
CA270	0.400
CA3086	0.250
CA3089	1.500
CA3240	0.900
C106D	0.230
MC1327	0.700
MJ2500	1.000
MJ2501	1.100
MJ2955	0.550
MJ3000	1.150
MJ3001	1.150
MJE29A	0.300
MJE30A	0.300
MJE340	0.250
MJE350	0.800
MJE520	0.300
MJE2955K	0.[illegible]
OA47	0.060
OA90	0.040
OA91	0.040
OA200	0.070
OA202	0.070
OC28	1.000
OC29	0.800
OC35	1.000
OC45	0.500
OC71	0.300
OC72	0.500
OC200	1.800
OCP71	1.000
ORP12	1.000
ORP60	1.000
ORP61	1.000
R2008B	0.800
R2010B	0.800
SAS560	1.100
SAS570	1.100
SN76003N	1.400
SN76013N	1.400
SN76023N	1.400
SN76033N	1.500
SN76110N	0.700
SN76115	0.700
SN76226	0.[illegible]
SN76227	0.[illegible]
T2800D	0.520
TAG06-60	0.420
TAG521-200	0.720
TAG4443	0.760
TAG4444	0.760
TAA550	0.160
TBA120S	0.450
TBA395	0.600
TBA396	0.600
TBA520	1.000

TBA530	1.000
TBA540	1.000
TBA560	1.000
TBA800	0.350
TBA810S	0.600
TBA820	0.750
TBA920	1.000
TBA950	1.000
TBA990	1.000
TCA800	2.000
TCA940	1.000
TDA1170	1.000
TDA1412	0.600
TDA2002	0.800
TDA2003	1.500
TDA2020	1.400
TDA2030	1.400
TDA2522	0.800
TDA2530	1.000
TDA2532	1.000
TDA2540	1.000
TDA2560	1.000
TDA2593	1.000
TDA2690	1.000
TIP29	0.150
TIP29A	0.220
TIP29C	0.250
TIP30	0.180
TIP31A	0.240
TIP32	0.240
TIP32A	0.240
TIP33	0.500
TIP34	0.500
TIP41A	0.220
TIP41C	0.250
TIP42A	0.220
TIP42C	0.250
TIP47	0.400
TIP48	0.400
TIP49	0.400
TIP110	0.470
TIP112	0.540
TIP115	0.450
TIP117	0.560
TIP120	0.430
TIP121	0.460
TIP122	0.470
TIP125	0.470
TIP126	0.560
TIP127	0.560
TIP2955	0.340
TIP3054	0.380
TIP3055	0.340
TIS61	0.150
TIS90	0.150
TIS91	0.180
2N.2904	0.200
2N 2905	0.200
2N 2906	0.180
2N 2907	0.180
2N 2926	0.080
2N.3019	0.200
2N 3063	0.180
2N 3054	0.350
2N 3055	0.320
2N.3055H	0.380
2N 3440	0.580
2N 3442	0.850

2N.3771	0.850
2N.3772	0.900
2N.3773	1.000
2N.4031	0.250
2N.4036	0.250
2N 4037	0.250
2N.4443	0.780
2N.4444	0.760
2N 5061	0.200
2N.5294	0.300
2N 5296	0.300
2N.6106	0.400
2N 6107	0.400
2N 6109	0.400
3N 128	0.550
3N 143	0.650
IN.914	0.020
IN.4001	0.040
IN.4002	0.040
IN.4003	0.040
IN.4004	0.040
IN 4005	0.040
IN 4006	0.040
IN.4007	0.060
IN.4148	0.020
IN.5400	0.090
IN 5401	0.100
IN 5402	0.100
IN 5403	0.110
IN 5404	0.110
IN 5405	0.120
IN 5406	0.130
IN 5407	0.130
IN 5408	0.130

VOLTAGE REGULATORS

7803	0.350
7812	0.350
7815	0.350
7818	0.350
7824	0.350
7905	0.350
7912	0.400
7915	0.400
7918	0.400
7924	0.400
78L05	0.280
78L12	0.280
78L15	0.280
74L18	0.280
74L24	0.350
LM309K	1.000
LM317K	2.200
LM317T	1.800
LM323K	4.200
LM723	0.320
78HGKC	5.700
78H05KC	5.200
78GU1C	1.800
79GU1C	2.150
79HGKC	6.700

JAPANESE TRANSISTORS

2SA73	0.300
2SA104	0.320
2SA198	0.220
2SA203	0.300
2SA473	0.370
2SB54	0.250
2SB77	0.320
2SB337	1.200
2SB405	0.220
2SC460	0.210
2SC495	0.600
2SC733	0.400
2SC1161	1.100
2SC1172Y	1.500
2SC1279	0.240
2SC1306	1.000
2SC1307	1.000
2SC1520	0.250
2SC1969	1.300
2SC2029	1.200
2SC2078	1.200
2SC2122A	2.000
2SC2952	0.270
2SD234	0.370
2SK135	4.000
MB3712	1.500
TA7205	1.500
UPC575	1.000

ICS SOCKETS

8 pin	0.060
14 pin	0.[illegible]
16 pin	0.090
18 pin	0.120
20 pin	0.140
22 pin	0.160
24 pin	0.180
28 pin	0.200
40 pin	0.250

VALVES

DY87	0.500
DY802	0.450
ECC82	0.400
ECC83	0.430
ECC84	0.400
ECC85	0.400
ECH81	0.490
ECH84	0.520
ECL80	0.570
ECL82	0.590
ECL84	0.570
ECL85	0.570
ECL86	0.490
EF80	0.310
EF85	0.340
EF89	0.430
EF183	0.450
EF184	0.530
EL34	1.900
EY86	0.310
EY87	0.310
PC97	1.000

PCC85	0.420
PCF80	0.580
PCF200	1.360
PCF801	1.100
PCF802	0.670
PCF806	1.150
PCH200	1.000
PCL81	0.540
PL519	4.500
PCL82	0.630
PCL84	0.500
PCL85	0.550
PCL86	0.550
PCL805	0.550
PFL200	0.850
PL36	0.[illegible]
PL504	0.950
PL508	1.700
PY81	0.700
PY88	0.480
PY500A	1.600

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2V7 to 39V0 120

MEMORIES

2114	2.000
2716	3.000
2532	4.[illegible]
2732	4.[illegible]
2764	7.[illegible]
4116	0.750
6116	0.[illegible]
LM324	0.300
LM380	0.500
LM381	1.900
LM709 Dil	0.[illegible]
LM723	0.320
LM741 Dil	0.150
LM741 Met	0.450
LM3900	0.250
NE555	0.150
NE556	0.400
BYX55/350	0.300
BYX55/600	0.300
BYX55/600	0.300
BYX55/800	0.320
BYX70/500	0.290
BYX70/500	0.310
BYX70/800	0.360
BYX71/600	0.800

LED

LED 3mm RED	0.060
LED 3mm YELLOW	0.100
LED 3mm GREEN	0.100
LED 5mm RED	0.060
LED 5mm YELLOW	0.100
LED 5mm GREEN	0.100

BRIDGE RECTIFIERS

1A/50V	0.160
1A/100V	0.180
1A/200V	0.190
1A/400V	0.210
1A/600V	0.230
1A/800V	0.280
2A/100V	0.350
2A/200V	0.380
2A/400V	0.420
2A/600V	0.540
2A/800V	0.[illegible]
3A/200V	0.[illegible]
3A/400V	0.660
3A/600V	0.780
6A/200V	1.000
6A/400V	0.[illegible]
25A/100V	1.000

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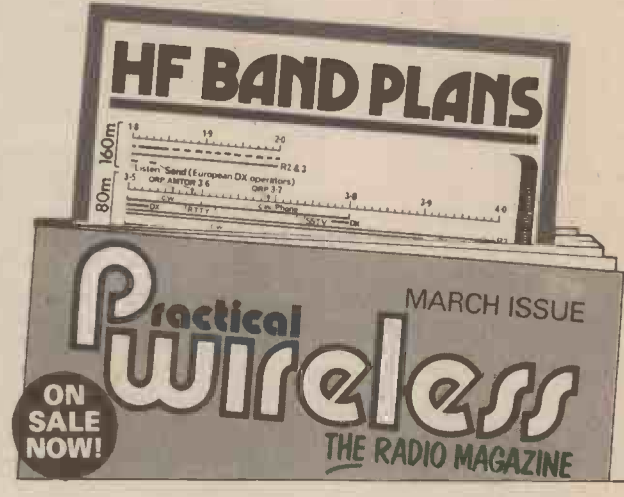

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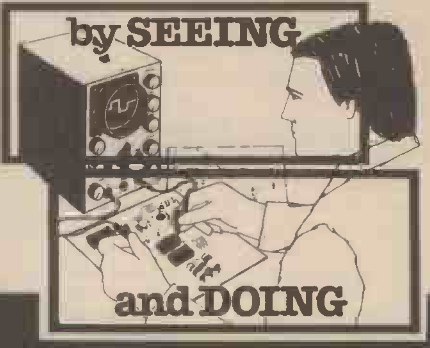

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FOR YOUR ENTERTAINMENT

BY BARRY FOX

Hard Times

If your business is bad, spare a thought for the manufacturers of blank tape. Most of them are making nothing, or selling at a loss.

When the first video recorders, from Philips, came on the market ten years ago, they used half inch tape and ran it at 14·29cms a second to give a maximum of one hour playing time per cassette. A one hour cassette cost around £25.

Modern VHS machines can run the tape at 1·2cms a second, which is half the normal VHS speed of 2·34cms a second. These half speed machines give six hours from a standard VHS E-180 three hour cassette, or even eight hours from a four hour VHS cassette.

The first half speed machines offered pretty poor quality, especially from the sound, but VHS hi fi works at half speed almost as well as at full speed. On hi fi machines the sound is recorded as an f.m. signal by the rotating video heads. This rotational speed, or 'writing speed', remains the same irrespective of linear tape speed.

Picture quality at half speed can be remarkably good. The sound, even in stereo, is excellent.

It is now possible to buy an E-180 VHS cassette for well under £5. That means that it now costs between 50p and £1 per hour to feed a video machine with tape. Compare that to £25 an hour just ten years ago!

The tape manufacturers thought video was going to make their fortunes. The snag was that too many of them thought this. There is now a glut of tape which is why it has fallen to such a low price.

Although the tape manufacturers don't like to talk about it, they are now down to rock bottom manufacturing costs. Even with the most advanced and automated production equipment, they cannot make an E-180 for under around £2.70.

Around half that cost is in the precision plastic moulded shell and mechanism, and the other half in the tape. With raw materials, energy, and capital investment, that £2.70 is just about as low as they can go. Perhaps it can drop to £2.50 in some places where wages, energy costs and chemical supplies are cheap, but no lower.

The duplication houses, which turn out pre-recorded cassettes, can buy an E-180 for around £3. The public expects to pay less than a fiver. Out of that fiver there is VAT and the retailers and wholesalers want their cut. Profits are in pennies or non-existent. There is no brand loyalty in the tape market. People buy what is cheapest.

The tape manufacturers have tried to convince people that they should pay extra for good tape. But market research shows that most video owners are used to poor quality, from badly set-up TV sets and worn or pirate rental tapes. They just don't notice the difference between good and bad tape. Anything sells as long as it produces pictures on the screen.

Another thing the tape manufacturers don't like to talk about is that it isn't practical to run a factory with several production lines, some producing high quality tape and some mid or low quality. It's for the same reason that budget label LP records are as good as full price issues. They all come off the same production line.

Ironically this favours factories which churn out only poor quality videotape! So expect a shake-out in the tape market with only a few of the biggest companies surviving. Already many of them are subsidising video tape reproduction on profits made from audio tape. This still remains reasonably expensive, and profitable.

But not all companies in the video business make audio tape; 3M for instance makes very little audio now. Even companies which make audio tape in bulk, like BASF and TDK, can't go on for ever subsidising video losses from audio gains.

It's like a game of poker. Who will crack first?

Video Split

So far Philips remains the only company to have demonstrated a PAL 8mm camcorder. The latest showing was at Photokina, the European photographic show held in Cologne every two years.

Philips was originally buying in camcorders from Matsushita-Panasonic, as Kodak is of course now doing for sale in America. But Philips says its current models are made in Europe.

Although Kodak made a big splash with 8mm at Photokina, it was NTSC equipment only. There is still no firm date for a launch, or even demonstration, of a PAL version.

The Philips camcorder is splitable, that is to say the camera can be separated from the recorder. This takes us back full circle. In the first days of portable video, everyone said how wonderful it would be to have a single integrated camcorder. Only a few people observed that it might be much more convenient to have a separate camera and recorder because, unlike a film camera, there is no need for the camera to be aligned with the recorder. Light must travel to film in straight lines, but electronic video signals can travel down a wire around as may corners as you like. Now that we have single unit camcorders, for the VHS, Beta and 8mm formats, people are starting to wonder whether it might not be better to have them separate after all.

A professional cameraman who was at Photokina noted with interest that the demonstrations of a Fuji camcorder (made for Fuji by Sony) used a video tape which had been shot on a broadcast quality camera and then dubbed onto 8mm tape. Kodak's demo tape had been shot on film and then transferred to video tape.

I do hope that if and when these companies launch 8mm video in Britain they will at least have the honest good sense to demonstrate tapes shot on the camcorders which they are demonstrating.

Question of Age

How old are you? Sorry for the personal question, but if you are over 35 the Japanese think you are over the hill for making electronics. That puts *me* well and truly out of business.

Hitachi has a TV factory in Wales, at Hirwaun (pronounced Heer-wine). It used to be owned by GEC who sold a half share to Hitachi in late 1978. This followed heavy opposition from British unions and politicians to Hitachi's previous plans to build its own TV factory over here.

The joint venture between GEC and Hitachi was a flop. The factory ran only at around half its potential capacity and lost money on what it made. In March 1984 Hitachi bought out GEC's half share, putting the company almost exactly where it had wanted to be in the mid-70s, i.e. with its own TV factory in Britain. But there was one difference.

Some Japanese companies in Britain have built their own factories, for instance Sony and Matsushita-Panasonic in Wales. Others, Toshiba and Sanyo, have bought factories left empty by European firms. Toshiba took over the Rank factory in Plymouth and Sanyo took Philips' factory in Lowestoft.

In each case the Japanese have been able to employ exactly who they want. On the whole they have gone for younger people. But Hitachi inherited the original workforce.

Soon after buying out GEC, Hitachi sacked 500 people on the last-in, first-out basis. So that made the workforce even older, at least by Japanese standards. The average age at Hirwaun was just under 40, which is twice that of other Japanese factories in Britain.

So just before Christmas 1984, the Hitachi management sent its workforce a now-famous letter. This offered anyone in the age bracket over 35 the chance to quit their job, take £1,800 cash tax free and nominate a 16 year old, probably their son or daughter to take their place. Fifteen people took the bait.

What upset people, and created terrible publicity for Hitachi, was the point on age made in the letter. "As we get older", it read "we become more susceptible to illness, our reflexes become slower, our eyesight becomes less keen and our attitudes more difficult to change."

I asked Hitachi what scientific or medical studies they had done to prove their point. "None," admitted a company spokesman, "but 999 out of 1,000 people would accept that it is true."

May be, may be not. Certainly Mitsubishi in Scotland, with a workforce of 16 year olds, knows the problems of employing too many young poeople. Fresh out of school they don't take work seriously and that is even worse by Japanese standards.

Forgive me if I stop writing now, but my eyesight is failing, my reflexes are slowing down and I feel a cold coming on.

MONITOR Buyer's Guide

ARE YOU dissatisfied with the quality of the television display from your computer, or are you forced to compute only during off-peak viewing time? If the answer to either or both of these questions is "Yes", then this article will help you to select a suitable monitor to satisfy your needs, and the buyer's guide surveys the monitors available for home computers at a reasonable price.

As a first step, however, we need to be able to make sense of the manufacturer's specifications. It is useful, therefore, to start by looking at the ways in which computers generate their displays. We are then in a better position to appreciate what a monitor must be able to do with the signal from the computer.

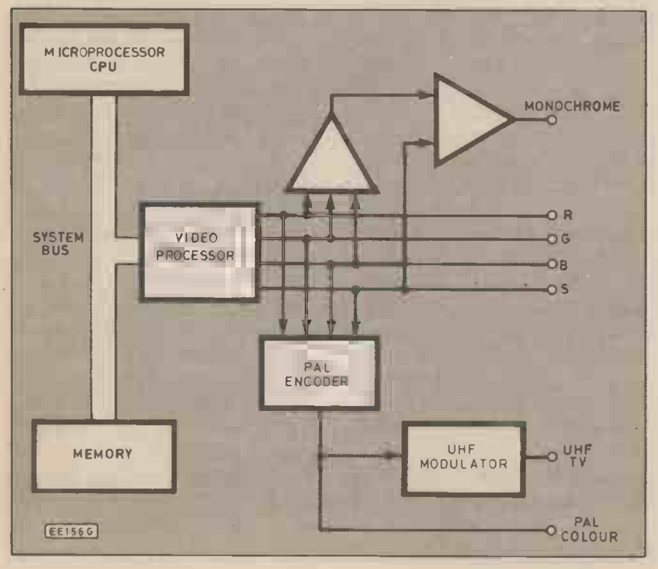
A FEW BASICS

Home computers drive their displays by providing a video output for an external monitor. As we shall see, this signal can take many different forms, but it is basically a convenient way of transferring the picture information from the computer to the screen. The most popular method, available on most computers, is to provide a signal to drive a domestic television through its aerial socket.

Fig. 1 shows a typical arrangement for the video section of a home computer. Basically, the computer's memory (RAM) is shared between the program and the display, with specific regions allocated exclusively for each. The memory area used for the display is often referred to as 'video RAM', while that reserved for programs is referred to as 'user RAM'.

In a shared-memory system, the CPU writes coded information into the video RAM, usually via a language such as Basic. The video processor then reads the codes, and converts them into signal(s) suitable for driving a display (monitor or television). Both of these operations seemingly occur at the same time, but in fact the CPU and video processor time-share the busses and memory. The exact details vary between computers, but the general principles apply to them all. Now let us look at the various types of video signal produced by home computers.

Fig. 1. Small computer video section.



TYPES OF VIDEO SIGNAL

RGB-sync UK television/video pictures use frames of 625 lines. Each frame is drawn in two scans to avoid flicker, the odd-numbered lines on the first scan, and the even-numbered lines on the second scan; a technique known as interlacing. To produce a stable picture, the frames are re-drawn 25 times per second.

The video processor output gives a colour for every possible display position (pixel) in each picture line, even if only to indicate no colour (black). The overall picture is thus represented by a two-dimensional matrix, built up from lines of coloured pixels. The number of pixels in each line depends on the resolution of the computer; the more pixels, the finer the detail which can be displayed. The pixels are usually simple combinations of the primary colours, giving eight possible colours; black, red, green, blue, yellow, magenta, cyan, and white.

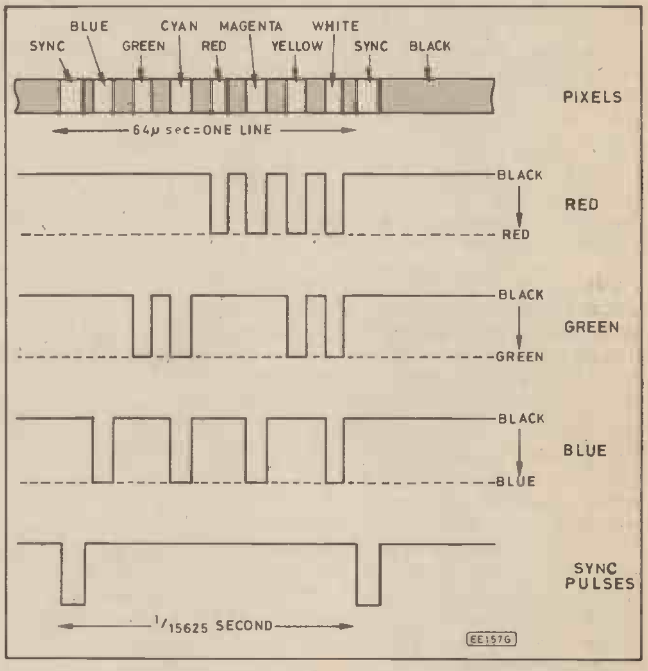


Fig. 2. RGB-sync signals.

On its own, the colour information is not enough to be able to recreate an image, and some control information is required to show the start of each line and frame. Each line therefore starts with a line synchronisation pulse ('sync'), and is followed by the colour information for the pixels in that line. Not all of the 625 lines are used for picture information, since a few lines at the beginning and end of each frame are used to allow the picture spot to move from the bottom back up to the top of the screen.

The display line in Fig. 2 shows the four video processor outputs; red, green, blue, and sync. On many computers these signals are made available to drive a suitable monitor, but even when not accessible externally, the RGB-sync signals are often produced internally by the computer.

Standard colour display tubes use three electron 'guns' to produce the image. Each primary colour component is drawn on the screen by a separate gun, with the beams aligned to illuminate only the appropriately coloured phosphor dots. Thus the image is built up from numerous small clusters of the three primary colours. The RGB-sync signals are ideally suited to drive a colour tube, and monitors which acept such an input are

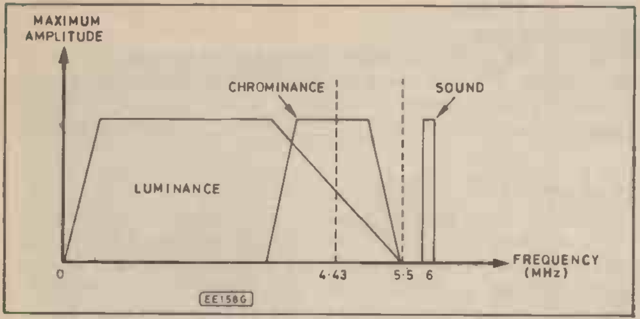


Fig. 3. PAL colour signal bandwidth.

referred to as RGB monitors. However, not all computer owners will have an RGB monitor, so alternative video outputs are usually provided.

PAL Colour The next section of the video circuitry generates a composite colour signal by combining the red, green, blue and sync signals. There are many different methods of combining these signals, but PAL encoding is used in the UK. This composite signal is essential for producing a signal to drive a u.h.f. television, but as Fig. 3 shows there are disadvantages to encoding. With fine picture detail, for example, problems can arise because closely-spaced picture changes are represented by high luminance frequencies. This effect is demonstrated by clothing with close checks or stripes when seen on television; the fine patterns take on unexpected bursts of colour.

The PAL signal is sometimes available as an output, and is particularly suitable for driving the VCR or CTV input provided on some television sets, and represents a significant improvement over using the u.h.f. output.

UHF Television The modulator used in home computers is designed to produce a u.h.f. signal which can be connected to the aerial socket of an unmodified domestic television. The limitations of the PAL technique have already been mentioned, but it shoud be noted that the limited modulator bandwidth also limits the maximum resolution available with the u.h.f. signal. The output frequency of the modulators used in home computers (usually channel 36) also tends to drift slightly during warm up. This may necessitate adjustment of the television's tuning controls to maintain the sharpest possible picture, particularly on older sets.

The u.h.f. signal is initially the most useful output for home computing since it allows the computer to be used immediately with an unmodified televison set. The use of this output does impose some limitations on image quality, but in many cases these will not be important, and a domestic television will provide adequate performance.

Monochrome In many applications a clear and sharp high resolution display is of greater importance than colour; the best example of this is perhaps word processing. However, 80-column text is typically composed of characters which are eight pixels across (i.e. 640 pixels on each line), and this is well beyond the capabilities of a standard colour television. A monochrome monitor is therefore often preferred when high resolution is more important than colour.

A PAL signal can be used to drive a monochrome monitor, but it results in the loss of the very resolution which we are striving to retain. Instead a monochrome signal is generated by summing (rather than encoding) the red, green, and blue signals. This shows the different colours as shades of grey, but retains the highest possible resolution; the sync information is then added to produce a composite monochrome signal,

TYPES OF MONITOR

An RGB monitor is without doubt the ideal type for colour displays since it makes the best possible use of the information from the computer. The major decisions to make in choosing an RGB monitor relate to price, screen size and resolution. Choice of screen size is rather limited to what is actually available; most RGB monitors have 14in screens. Resolution is a rather more involved matter.

For a good display, a monitor should have a bandwidth of approximately 1MHz for every 60 pixels in each display line. Thus, 80-column text from a computer with 8-pixel characters (i.e. 640 pixels per line), will be clearly visible on a 10–12MHz monitor. A lower bandwidth may produce acceptable results, but this will depend on the degree of image sharpness required. The minimum bandwidth to distinguish between adjacent pixels is around 1MHz for every 120 pixels in each line. In the example above this represents a 6MHz bandwidth. With bandwidths below this minimum, adjacent pixels begin to merge into one another, progressively losing detail. The usable bandwidth of a colour television is typically 4·5MHz.

RGB monitors are often referred to as a standard, medium or high resolution, with bandwidths of typically 7MHz, 10–12MHz, and 14MHz, respectively. As an alternative to bandwidth, horizontal resolution is often quoted, and will typically be 480, 640 or 800 pixels, respectively. The safest choice with an RGB monitor is to choose one with a horizontal resolution of 640 pixels or more. This should cope with even the highest resolution displays currently available for home computers.

Monitor/Televisions A dual purpose monitor/television represents an ideal compromise for many computer owners. Ideally such a set should have an RGB-sync input, rather than the PAL colour input associated with VCR's. With such a set, the problems associated with PAL encoding, limited modulator bandwidth, and the modulator warm-up drift, are avoided.

The set is still usable as a conventional television, although this may be considered a disadvantage! It should be borne in mind that such sets have usually been designed primarily as televisions, but the bandwidth is still usually adequate for all but the most exacting requirements.

Monochrome A number of phosphor colours are available for monochrome monitors. These are usually white (as in conventional black-and-white televisions), green (most popular), and amber. The colour chosen is a matter of personal taste, although green is considered to minimise the strain associated with long periods of use, and is by far the most readily available.

Most monochrome monitors have much higher bandwidths than RGB monitors, with 18–24MHz models readily available at little or no extra cost. Finding a monochrome monitor with adequate bandwidth is therefore not usually a problem.

CHOOSING A MONITOR

You are now ready to look for a monitor, but which type do you choose? Before starting, is is well worth looking at the image on your television and deciding what you feel is not quite right with it. Next think carefully about what you want to use the monitor to display, and decide on the performance improvements required. Price inevitably features high on the list of factors influencing any selection. Other considerations include the need for colour, and whether a custom-designed monitor can be justified or is a monitor/television more appropriate? The outputs available from the computer may limit the choice slightly, although it may be possible to obtain an interface to provide any missing ouputs. Only when these factors have been considered will you be ready to start choosing a monitor.

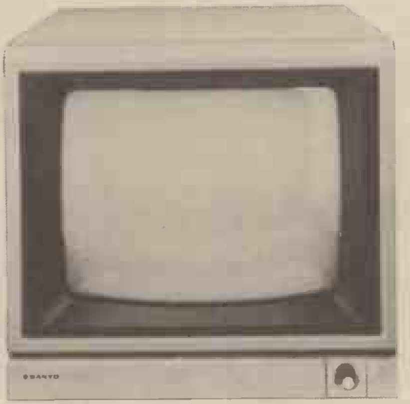
When looking at a monitor, there are some general points worth noting. First, try it out on the highest resolution display you will be using, and in particular see if the text is easily readable. Putting up 80-column text, for example, provides a simple but severe test. Next, fill the whole screen with 'plus' signs and look to see if they vary in shape or size across the display; they shouldn't! With the same display, look for any signs of picture shimmer caused by poor power supply design. Next, try producing as white a display as possible (e.g. lines of white blocks), and check that the brightness is constant across the screen; this again checks the power supply.

Finally, always try out a monitor on an image which is typical of your most exacting requirements, and then compare the results with at least one other model.

MONITOR Buyer's Guide

Models: Kaga models K12R1, K12R2 and K12R3 **Screens:** All 12in. colour **Inputs:** RGB/PAL, RGB, RGB **Resolution:** low, medium, high **Bandwidths:** all 15MHz **Audio Output:** yes, no, no **Prices:** £215, £275, £399 **Supplier:** *Data Efficiency Ltd., 2 Maxted Road, Hemel Hempstead, Herts, HP2 7LE (0442 60155).*

Model: Zenith ZVM-124 **Screen:** 12in. mono (amber) **Input:** TTL **Resolution:** not known **Bandwidth:** 22MHz **Audio Output:** no **Price:** £128 **Notes:** Tilt base available at £8, Commodore cable £6 **Supplier:** *Zenith Data Systems Ltd., Bristol Road, Gloucester, GL2 6EE (0452 29451).*



Model: Sanyo CD3115 **Screen:** 14in. colour **Input:** RGB **Resolution:** high **Bandwidth:** not known **Audio Output:** no **Price:** £499 **Supplier:** *Micro Peripherals Ltd., 69 The Street, Basing, Basingstoke, Hants (0256 473232).*

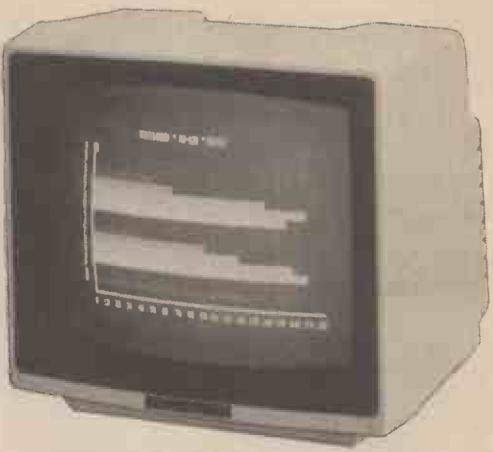
Model: Ferguson MC01 TV/Monitor **Screen:** 14in. colour **Input:** composite/RGB **Bandwidth:** 25MHz **Resolution:** medium **Audio Output:** yes **Price:** £229 **Notes:** separate input sockets with auto. signal sensing and switching **Supplier:** *High Street retail outlets.*

Model: Sanyo DM 8112CX **Screen:** 12in. mono (green) **Input:** composite **Resolution:** not known **Bandwidth:** 18MHz **Audio Output:** no **Price:** £99 **Supplier:** *Micro Peripherals Ltd., 69 The Street, Basing, Basingstoke, Hants (0256 473232).*

Model: Tandata C10 TV/Monitor **Screen:** 10in. colour **Input:** RGB **Resolution:** medium **Bandwidth:** not known **Audio Output:** yes **Price:** £350 **Notes:** also includes infra-red remote control **Supplier:** *Tandata Marketing Ltd., Albert Road North, Worcs, WR14 2TL (06845 68421).*

Model: Tandata C12 **Screen:** 12in. colour **Input:** RGB **Resolution:** medium **Bandwidth:** not known **Audio Output:** no **Price:** £230 **Notes:** comes complete with anti-glare screen **Supplier:** *Tandata Marketing Ltd., Albert Road North, Worcs, WR14 2TL (06845 68421).*

Models: Barco DCD1640, DCD2740 **Screens**: 16in. colour and 27in. colour **Inputs**: RGB **Resolution**: medium **Bandwidth**: 10MHz **Audio Output**: yes **Prices**: £425 and £520 **Notes**: Various models available with options **Supplier**: *Cameron Communications, 3 Burnfield Road, Glasgow, GH46 7TH (041-633 0077).*



Model: Kaga KG 12N **Screen**: 12in. mono (green) **Input**: composite video **Resolution**: not known **Bandwidth**: 15 MHz **Audio Output**: no **Price**: £109 **Supplier**: *Data Efficiency Ltd., 2 Maxted Road, Herts, HP2 7LE (0442 60155).*

Model: Tandata C14F **Screen**: 14in. colour **Input**: RGB/composite **Resolution**: not known **Bandwidth**: 15MHz **Audio Output**: yes **Price**: £199 **Supplier**: *Tandata Marketing Ltd., Albert Road North, Malvern, Worcs, WR14 2TL (06845 68421).*

Model: Akai CTE 142 TV/Monitor **Screen**: 14in. colour **Input**: RGB/TTL **Resolution**: medium **Bandwidth**: not known **Audio Output**: yes **Price**: £299 **Supplier**: *Craig Hi-Fi, T/A Spacial Audio, 29 Tottenham Court Road, London W.1 (01-637 8702).*

Model: JVC TM90 PSN **Screen**: 10in. colour **Input**: RGB **Resolution**: not known **Bandwidth**: not known **Audio Output**: yes **Price**: £439 **Supplier**: *JVC, Eldonwall Trading Estate, Staples Corner, 6–8 Priestly Way, London (01-450 2621).*

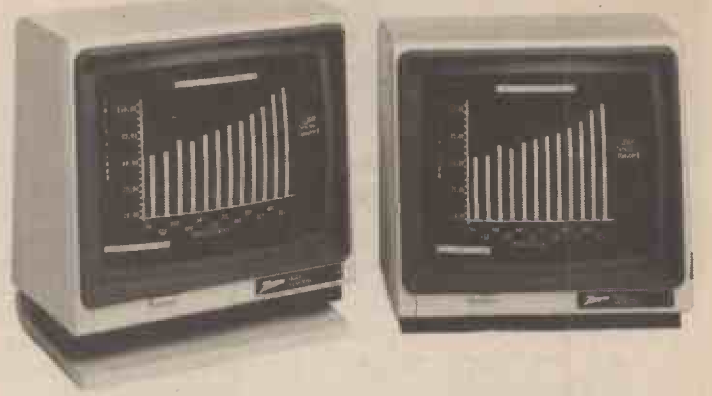
Model: Barco DCD 2240 F PAL **Screen**: 22in. colour **Input**: RGB **Resolution**: not known **Bandwidth**: not known **Audio Output**: yes **Price**: £490 **Supplier**: *Cameron Communications, 3 Burnfield Road, Glasgow, GH46 7TH (041-633 0077)*

Model: Sony PVM-91CE **Screen**: 9in. mono **Input**: Composite **Resolution**: high **Bandwidth**: not known **Audio Output**: no **Price**: £250 **Supplier**: *Metro Video Ltd., 5 Landsdowne Way, London, SW8 (01-928 2088).*

MONITOR Buyer's Guide

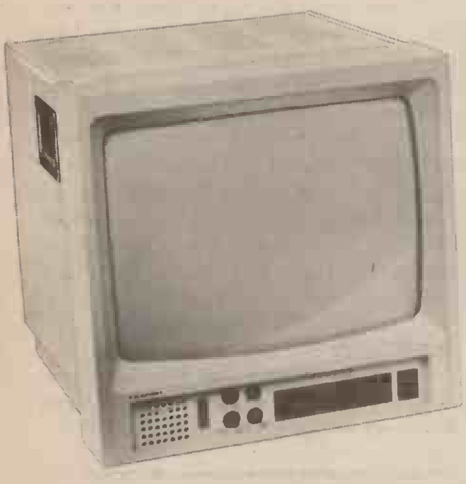
MONITOR Buyer's Guide

Model: Zenith ZVM 133 **Screen**: 13in. colour **Input**: RGB **Resolution**: not known **Bandwidth**: 20MHz **Audio Output**: no **Price**: £395 **Notes**: Tilt base available at £8, Commodore cable £6 **Supplier**: *Zenith Data Systems Ltd., Bristol Road, Gloucester, GL2 6EE (0452 29451).*



Model: Zenith ZVM-122 and ZVM-123 **Screen**: 12in. mono (ZVM-122 amber, ZVM-123 green) **Input**: composite **Resolution**: not known **Bandwidth** 15MHz **Audio Output**: no **Price**: £95 **Notes**: Tilt base available at £8, Commodore £6 **Supplier**: *Zenith Data Systems Ltd., Bristol Road, Gloucester, GL2 6EE (0452 29451).*

Model: Microvitec Cub C14-P **Screen**: 14in. colour **Input**: RGB **Resolution**: medium **Bandwidth**: not known **Audio Output**: no Price: £235 **Supplier**: *Microvitec Ltd, P.O. Box 188, Futures Way, Bolling Rd, Bradford (0274 390011).*



Model: Bosch CQM 67-120 **Screen**: 27in. colour **Input**: Video, RGB **Resolution**: not known **Bandwidth**: not known **Audio Output**: yes **Price**: £955 **Supplier**: *Teletape Ltd., 12 Tolden Square, London, W1 (01-434 3311).*

Model: Philips PTC1202 **Screen**: 12in. mono (green) **Input**: composite **Resolution**: not known **Bandwidth**: 22MHz **Audio Output**: no **Price**: £118 **Notes**: Also available, orange screen version at £99 **Supplier**: *Swift Sasco Ltd., Box 2000, Crawley, Sussex (0293 28700).*

Model: Fidelity CM14 **Screen**: 14in. colour **Input**: RGB/composite **Resolution**: not known **Bandwidth**: 12MHz **Audio Output**: yes **Price**: £199 **Supplier**: *Micro Peripherals Ltd., 69 The Street, Basing, Basingstoke, Hants (0256 473232).*

Model: Sony Trinitron PVM-1370 **Screen**: 13in. colour **Input**: RGB **Resolution**: not known **Bandwidth**: 10MHz **Audio Output**: yes **Price**: £899 **Supplier**: *Metro Video Ltd., 5 Landsdowne Way, London, SW8 (01-928 2088).*

a regular feature for the Spectrum Owner...

by Mike Tooley BA

WELCOME to "On Spec" our new monthly page devoted to the Sinclair Spectrum. If you don't happen to own a Spectrum please don't turn the page yet as we hope that there will be something here that will interest everyone.

At this point, somebody out there is bound to be wondering why we have chosen to devote one whole page of the magazine to the Spectrum. There are three main reasons for this which, for the benefit of the unconverted, we will just take time to explain.

The Spectrum has enjoyed immense popularity and, to date, has outsold all other personal computers in the U.K. The Spectrum is readily available in several of the major high street stores as well as by mail order and, most importantly, it provides an excellent specification at low cost. Now, with the arrival of the Spectrum-Plus, it looks as if this particular microcomputer will continue to be a winner for Sinclair and we aim to show you that you can do more with it than just play games or dabble with BASIC! Incidentally, BBC Micro owners will be interested to learn that our sister publication, *Practical Electronics,* will be running a similar series aimed at the BBC Micro.

If you don't have a Spectrum of your own and can't get your hands on one, don't panic. The projects which we describe can, with very little modification, be easily adapted for a variety of other micros. The commonly available machines which are most closely related to the Spectrum (by virtue of the microprocessor used) are the Sinclair ZX81, Tandy TRS80Models I and III, Research Machines 380Z, Sharp MZ80 and Video Genie.

Spectrum I/O

Despite all its good points, the lack of "on-board" I/O is one of the Spectrum's major shortcomings. Happily, Sinclair have at least provided us with a means of connecting external devices to the Spectrum with the aid of the 28-way double-sided edge connector at the rear of the machine. This gives access to all of the system data and address bus lines as well as the principal control lines, clock, and power rails.

At this point, and before readers rush to their soldering irons, it is important to stress that these lines are *not buffered* and that any inadvertent misconnection could potentially cause permanent damage to the Spectrum. It is, therefore, *essential* to carefully check any external wiring since a single misplaced wire could result in an expensive repair.

Edge connectors

Several suppliers stock suitable edge connectors which will mate directly with the p.c.b. The connector is normally described as an "open end double-sided 2·54mm pitch 28-way connector", the Vero part number for which is 838–24826A.

The pin connections for the edge connector are shown in Fig. 1. The upper (component) side is labelled "A" whilst the lower (foil) side is labelled "B". Connections on both sides are numbered 1 to 28 and a polarising notch is fitted in position 5.

Errors

It should be noted that the diagram of this connector shown in the original Spectrum BASIC Programming Manual is a little confusing as it shows the view of the connector as it would appear looking *out* of the Spectrum (i.e. it is a pin view of the connector itself, and not the pads of the double-sided p.c.b.). Furthermore, the diagram shows a −12V line which is, in fact, 12V a.c. and is connected directly to the collector of the oscillator transistor, (TR4) used in the on-board d.c.-to-d.c. converter. This error has been perpetuated in several other publications, so beware!

Over to you . . .

Unlike most of the rest of *Everyday Electronics,* we will be relying on reader input on this particular page. Our aim is that this page will act as a "bulletin board" for Spectrum owners, providing a regular point for the exchange of information related to hardware and interfacing. To this end we welcome contributions from readers on any I/O related topic. It must be stressed, however, that we cannot provide individual written replies to reader's queries. So as not to deter the curious, we will, however, be pleased to raise (and also attempt to provide some solutions!) all topics of general interest. Furthermore, subject to the level of response from readers, we also hope to produce a regular "Update" sheet which will both provide a more immediate response to reader's problems and also provide a means of including items such as program listings which, due to restrictions of space, could not usually be included within this page.

As an inducement to write in with your news and comments, a copy of the latest "Spectrum Update" will be sent to all those who include a stamped addressed envelope. So, let us know what you are doing, or would like to do, with your Spectrum: we will do the rest!

NEXT MONTH we shall be describing a simple four-channel input interface which can be built for well under £5!

Please Note:

All contributions to "On Spec" should be sent to the following address and not to the Editorial Offices:

Mike Tooley,
Department of Technology,
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Heath Road,
WEYBRIDGE,
Surrey,
KT13 8TT

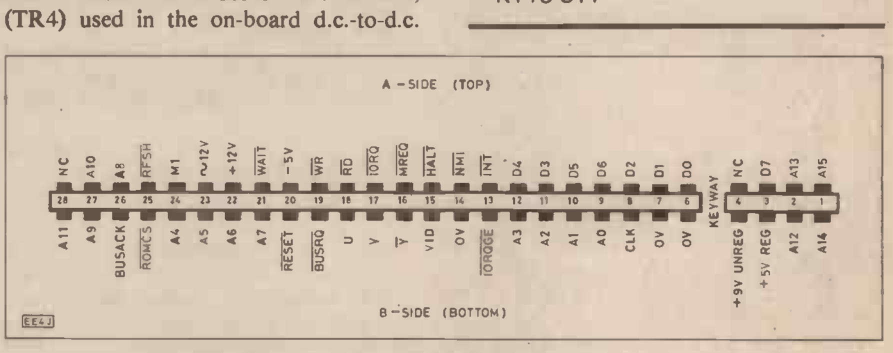


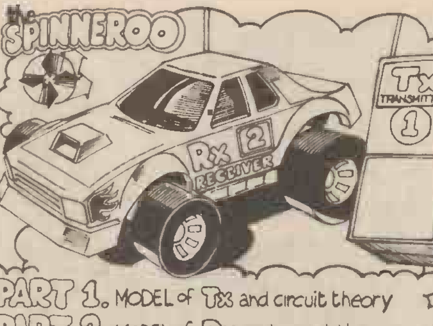
Fig. 1. The Spectrum Edge Connections

FUNTRONICS WITH RADIO CONTROL

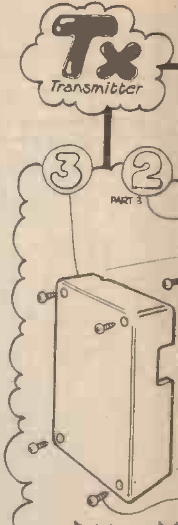
PART 1

PART 1 (OF 3 PARTS) WILL LOOK AT THE TRANSMITTER (Tx FOR SHORT)

COMPLETE COMPONENT LISTS WILL BE GIVEN IN PART 3



PART 1. MODEL of Tx and circuit theory
PART 2. MODEL of Rx and circuit theory
PART 3. Complete Component lists for Tx & Rx



by Thakery

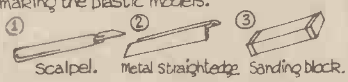
INTRODUCTION.

If you're interested in Radio Control for the pure pleasure of operating the controls then you can very easily buy complete models or pre-tuned outfits ready to fit into an adopted model of your own choosing. However, if you want to make everything yourself then start here. The circuits will be for a simple 'single channel tone transmitter' system and the models for Transmitter and Receiver will be formed from 2 mm thick high impact polystyrene sheet. There will be a certain amount of vacuum forming will be required for the receiver model but don't worry about that until you reach part 2.

Tuning the circuits for Tx & Rx will be the most difficult part of the project and there are ways of doing this without expensive equipment.

All components will be readily available from most known suppliers. The Crystal will work on the 27MHz band (same as Citizen band). The transistors will have a minimum fT of 50MHz such as the 2N3553, BFY51, BC109 & 2N2221 or 2N4292 ... but all components will be fully detailed & listed in part 3.

You will need the following instruments for making the plastic models.



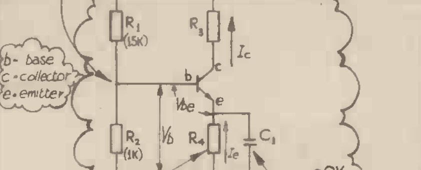
You will also require a good adhesive like 'clear Evo stick' but use it sparingly.

COMBO You will come across many terms in the world of 'Radio Control' but for the time being all you need know is that your Tx & Rx is called a 'Combo'

THEORY — NPN TRANSISTOR SUPER SWITCH

BASE BIAS Current I_c will not flow until a BIAS of ·6V is applied to the base. This ·6V bias is formed by the *POTENTIAL DIVIDER* $R_1 - R_2$. The calculations are very simple...

$$V_b = \frac{V_{cc}}{R_1 + R_2} \times R_2 = \frac{10}{15+1} \times 1 = \cdot 62\,V.$$

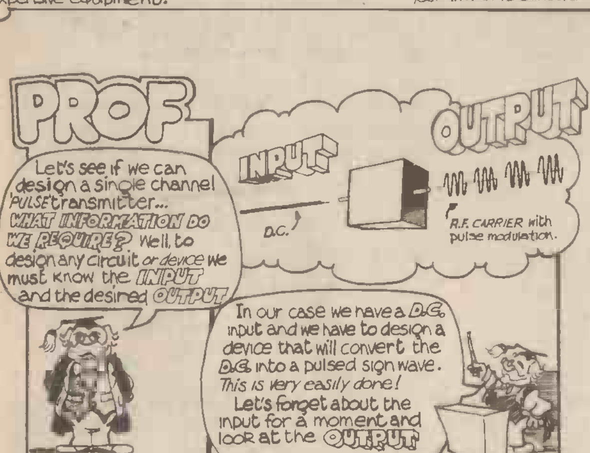


D.C. STABILISATION. Emitter resistor R_4 provides a negative feedback loop giving stability to the static conditions of the amplifier. Since $V_{be} = V_b - V_e$ then an increase in V_e produces a decrease in V_{be} hence reducing base current & restoring I_c & I_e to their previous value.

DECOUPLING CAPACITOR This capacitor very simply protects a component or a complete stage from the effect of a.c. current. Should there be any a.c. signal in the current then it will be short circuited to earth. Remember...

$$X_c = \frac{1}{2\pi fC}$$

higher the frequency the lower the reactance (X_c) or opposition to a.c. current.



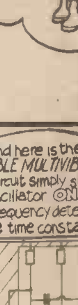
LEGAL R

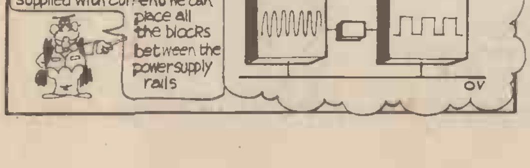
Under law, any operator of a ... can be held responsible for dan... property or people. Third party ... requirements, particularly in the ... For club members taking part in ... cover is obligatory.

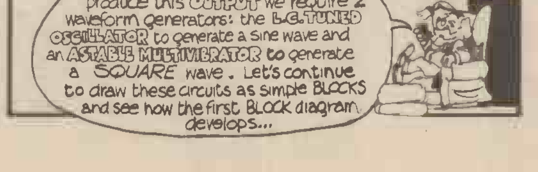
The operation of models in pu... local bye-laws and other local an... ictions. The noise level from m... measured at a distance of ...

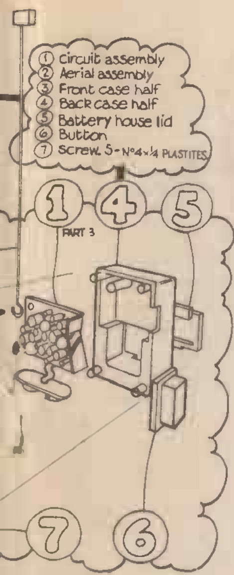
JOIN A CLUB! A club will b... know where and when radio ... operated. Many clubs ... facilities for insuran...

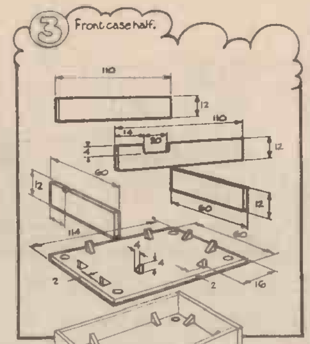
No licence is required for the operation of models by radio control (since 1981). It is the responsibility of the manufacturer to take all permitted frequences etc into account and the responsibility of the modeller NOT to work in some 'illegal' manner.

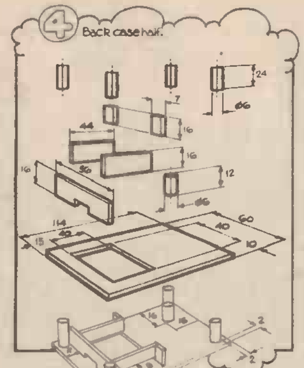


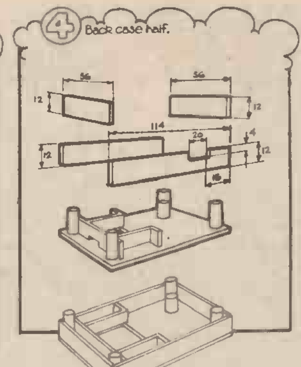


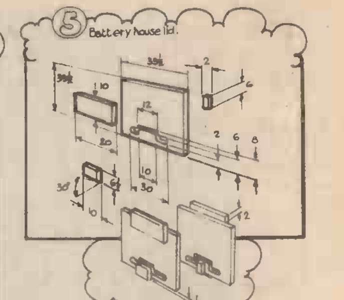


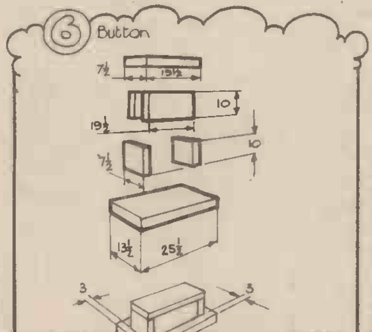




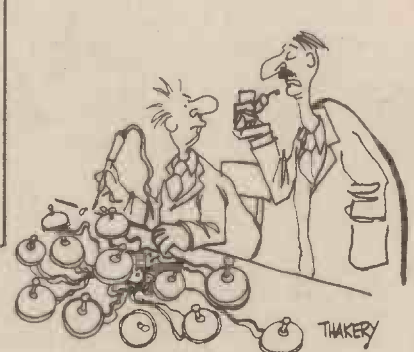








⑦ The screws are best fixed when all the parts are made and fitted. This will be shown in part 3 along with other tips on how to make the best job of your model.

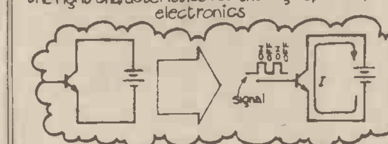


"Smith, I don't think you quite understood when I said that transistors are like switches."

THEORY

TRANSISTOR SUPERSWITCH

Everyone is familiar with pressing a button or switch to close a circuit and make current flow. This works alright but it doesn't work nearly fast enough or have the right characteristics for the high speed of electronics



The TRANSISTOR is capable of switching ON & OFF MILLIONS of times per second. This sort of speed is essential when you consider a circuit such as the one we are looking at (27 MEGAHERTZ signal)

There are 3 basic configurations of transistor circuits but we'll be looking at just one THE COMMON EMITTER because it is most widely used due to its flexibility and high gain.

Solutions on page 169

EQUIREMENTS

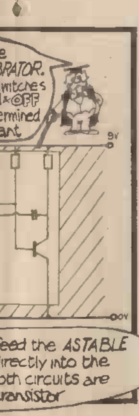
a radio control model
mages or injury caused to
y insurance is thus a legal
case of R.C. aircraft.
n competitions insurance

ublic parks is subject to
d national government restr-
models must not exceed 85dB(A)
5 metres.
e aware of local bye-laws,
o controlled models can be
s also provide their own
nce.

fT

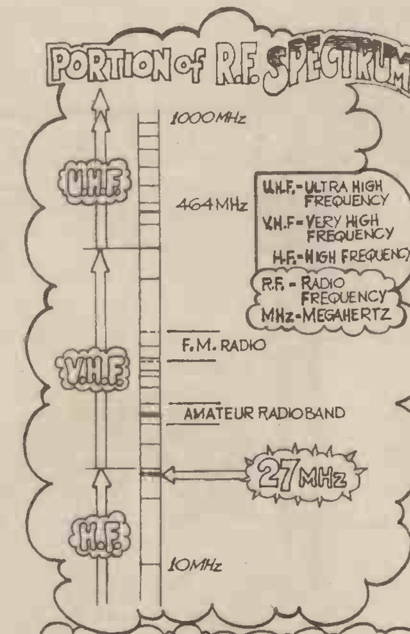
fT is the Transition frequency of a transistor and is a very important parameter when choosing the right transistor for an oscillator.

Put simply, it measures the highest frequency at which the transistor can be used as an amplifier: it also gives the gain bandwidth product for the transistor



feed the ASTABLE
irectly into the
oth circuits are
ransistor

"DON'T WORRY, DAD, I'M PRETTY GOOD WHEN I GET TO THE BOILING HOT SOUP"



There are other frequency bands available to the Radio controller but the 27MHz is the most popular.

LINK-UP

Link-up the letters to form a chain of words related to RADIO CONTROL

START

T	R	•	R	E	I	V	T	R	A
I	O	L	A	C	E	E	R	S	N
O	P	P	T	N	N	C	R	M	I
N	O	R	S	E	A	H	E	T	T
A	L	■	Y	L	C	O	M	B	O
■	F	■	R	C	O	V	R	E	S
E	R	■	■	D	C	I	Y	O	J
Q	U	P	L	N	K	T	S	T	Z
N	E	M	I	A	B	M	E	R	E
C	Y	A	T	U	D	E	G	A	H

WORD	CLUE
① B _ _ _ _ _ B	'E' before 'I'
② _ _ _ _ S _ _ I _ _	sends carrier wave
③ _ _ A _ _ L	Not the English one
④ _ _ _ _ Q	Tx & Rx
⑤ S _ _ Y _	Has gears.
⑥ _ _ _ _ I _ _	sticks to the frequency
⑦ _ _ O _ Q _ _ _ N _ L	All directions.
⑧ _ B _ Q _ _ _ C _	comes in cycles
⑨ _ M _ L _ _ _ _	Can be modulated
⑩ _ _ G _ _ _ I _	You'll need 27.
⑪ _ _ _ S _ _ K	Best control
⑫ _ A _ _	Not a musical one.

NICAD CHARGER

J.R.W. BARNES

What's the difference between a drained nicad and a drained dry battery? You've guessed it. *A drained pocket!*

AS THE use of electronics becomes more widespread so does the requirement for a portable source of power. Most portable electronic equipment relies on 'dry' (primary) batteries for a power supply. When the use is occasional or the current drain is low they provide a compact source of energy.

The chief problem is that of cost when the power required is large. Alkaline batteries last longer than the normal zinc carbon type batteries but cost more. Incidentally, alkaline batteries have better discharge characteristics; the internal resistance does not rise, and hence the output voltage on load falls until the battery is almost completely exhausted. This means that a larger percentage of the chemical energy in a new battery can be converted into electrical energy.

Two alternatives to using batteries exist. Either a mains power supply may be used if the equipment is located where a suitable supply can be found, or rechargeable (secondary) batteries can be used. Of the many kinds of secondary cells, nickel cadmium is the most common.

Nickel cadmium or 'nicad' batteries differ from zinc carbon batteries in several respects. The output voltage per cell is lower; 1·25 volts versus 1·5 volts. The internal resistance is much lower, in fact the internal resistance is so low that nicad batteries should never be short circuited because they can overheat and explode.

Care must also be taken not to damage the cells when charging. In practice this means charging the batteries with a constant current source.

POPULAR BATTERIES

Most electronic equipments use one of five sizes of battery. These battery sizes are also available as rechargeables. The sizes are:

D	U2,HP2,SP2 etc.
C	HP11,SP11 etc.
AA	HP7,SP7
AAA	HP16

All the above batteries are single cells and have a nominal terminal voltage of 1·25 volts. The other popular battery is the PP3 size which has a nominal output of 9 volts.

The unit described here can charge either a single PP3 or up to ten of the single cell types connected in series.

Charging rates have been chosen so that the batteries will be fully charged in sixteen hours but will not be damaged if they are left for longer than this.

CHARGING CURRENTS

Physics students will know that the total charge in battery can be obtained by integrating the current with respect to time. If the charging current is constant, then the charge in battery is equal to the product of the current and the charging time. The same applies when the battery is discharged, the charge extracted is the product of the output current and the time. These are the criteria used to describe the capacity of a battery. It is usually measured in mAh (milliampere hours).

For a given case size the capacity of nicad batteries varies slightly, generally those with a higher capacity cost more.

The capacity of the cells is used to calculate the current required to fully charge the cells. For example a D cell with a capacity of 4000mAh will require a charging current of 250mA to be fully charged in sixteen hours.

The charging currents, and capacities of popular batteries are given in Table 1.

TABLE 1

Size	Capacity mAh	Charge Current mA
PP3	100	5·5
AAA	160	10
AA	450	30
C	1800	120
D	4000	250

CIRCUIT

The full circuit diagram of the unit is shown in Fig. 1. The mains transformer

T1 reduces the input voltage to 15 volts a.c. and provides isolation. Rectifier diodes D1 to D4 rectify this current which is then smoothed by C1.

R1 provides current for the l.e.d. D5. This l.e.d. performs two roles. Firstly, it acts as a power on indicator. Secondly, it fixes the base voltage of TR1 at 2·2 volts above the negative rail.

The two transistors, TR1 and TR2, are wired in the Darlington configuration, and can be considered as one high gain transistor. The Darlington is biased on when there is 1·4 volts across its base and emitter. This means 0·8 volts will appear across the emitter resistor.

The emitter current Ie=Ib + Ic, but, Ib is very small compared to Ic. From Ohm's we have I=V/R, so by suitable choice of emitter resistor the collector current of the transistor can be set. The switch S2 and the resistors R2–R9 allow different values of current to be selected.

This allows the charger output current to be controlled. The resistors are connected in parallel to allow commonly available 0·25 Watt resistors to be used.

THERMAL DESIGN

As with most power supply projects some form of cooling is required for the series transistor. Component supplier's catalogues will reveal many different shapes and sizes of heatsink. They range from a simple piece of bent sheet to complex aluminium extrusions. As a figure of merit, the performance of a heatsink is measured in degrees Centigrade per Watt. This is called the thermal resistance, and is analogous to electrical resistance. Instead of volts, potential is measured in degrees Centigrade, the flow of thermal energy per second being measured in Watts.

So how do we choose a heatsink for a given application? The most important decision is the selection of the maximum permissible junction temperature. Normally for silicon devices a temperature of 100°C is acceptable. The other important parameter is the maximum power that will be dissipated in the transistor under 'worst case' conditions.

Using the formula, Watts = volts × amps. Take the maximum volts that can appear across the transistor, 20 volts, and the maximum current that can flow through the transistor 250mA. This gives a power dissipation of five watts. Now the thermal resistance from the junction to the heatsink must be calculated. Like electrical resistance, thermal resistances are simply added together when the heat energy has to travel through several materials. Between the junction of the transistor and the ambient air there are three thermal resistances; that internal to the transistor, the thermal resistance of the insulating washer, and the thermal resistance of the heatsink. The first two must be obtained from manufacturer's data sheets. The third is the parameter to be calculated so that a suitable heatsink can be found.

CALCULATION

Thermal Resistance junction case		1·2
Thermal Resistance insulator		1·0
	total	2·2°C/W

Hence, with five Watts being dissipated the heatsink will be 11 degrees cooler than the junction. If a maximum ambient temperature of 40°C is assumed, then the temperature of the heatsink may be allowed to rise to 49°C (above air) before the temperature of the junction reaches 100°C. With five Watts being dissipated then, a thermal resistance, heatsink to air of better than 10°C/W is required.

PRACTICALITIES

So much for the calculation, now let us consider the practicalities. With all mains powered equipment a plastic case is desirable in the interests of safety.

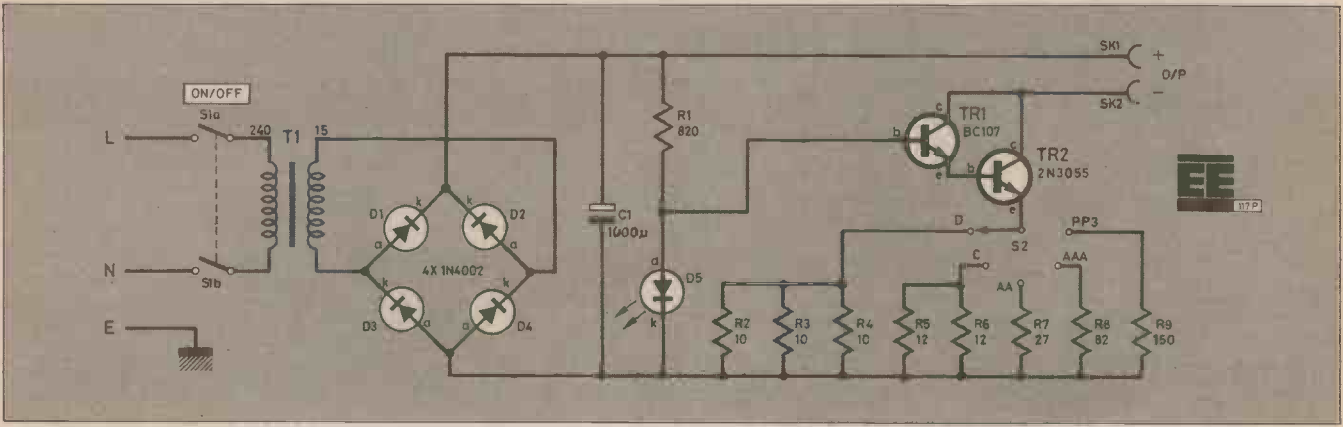
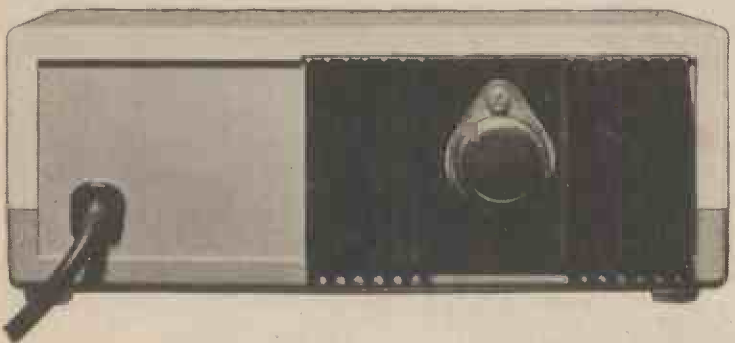


Fig. 1. Full circuit diagram for the Nicad Charger.



Although the transistor would be perfectly alright with a heatsink temperature of 90°C it would cause a nasty burn if touched. If the maximum temperature of the heatsink is to be 50°C then a thermal resistance of 4°C/W is required. This can be obtained from a two inch length of aluminium extrusion as used on the prototype.

CONSTRUCTION

CIRCUIT BOARD

The charger circuit is built on a piece of stripboard (0·1 inch pitch) 22 holes by 30 strips. Begin construction by drilling the four mounting holes, 3·5mm diameter. There is one break in the copper strip. Constructors are advised to fit Veropins for the flying leads. It is best to leave the large electrolytic capacitor C1 until last, otherwise the components can be mounted in any order. Take care to get the capacitor and the diodes the right way round.

HEATSINK

The heatsink was mounted on the rear panel of the box. The details can be seen in the photographs. Care should be taken to deburr the holes in the heatsink so that they do not damage the insulating washer. The insulating washer can either be a traditional mica one, in which case a thin coating of thermal grease should be smeared on both sides of the washer. Alternatively one of the more modern impregnated washers can be used.

It is good practice to insulate the base and emitter leads of the transistor with small pieces of rubber sleeving. When the transistor has been mounted on the heatsink it is wise to check the continuity between the transistor and the panel.

In the prototype a strain relief grommet which prevents the mains cable from being pulled out of the charger. If you cannot obtain one of these a P clip should be used to anchor the flex.

Five holes need to be made in the front panel. The diameters of these holes should be made to suit the components purchased. The positions of the holes can be obtained from the photograph of the unit.

The panel lettering can be applied using rub-down dry transfer lettering followed by a protective coat of varnish.

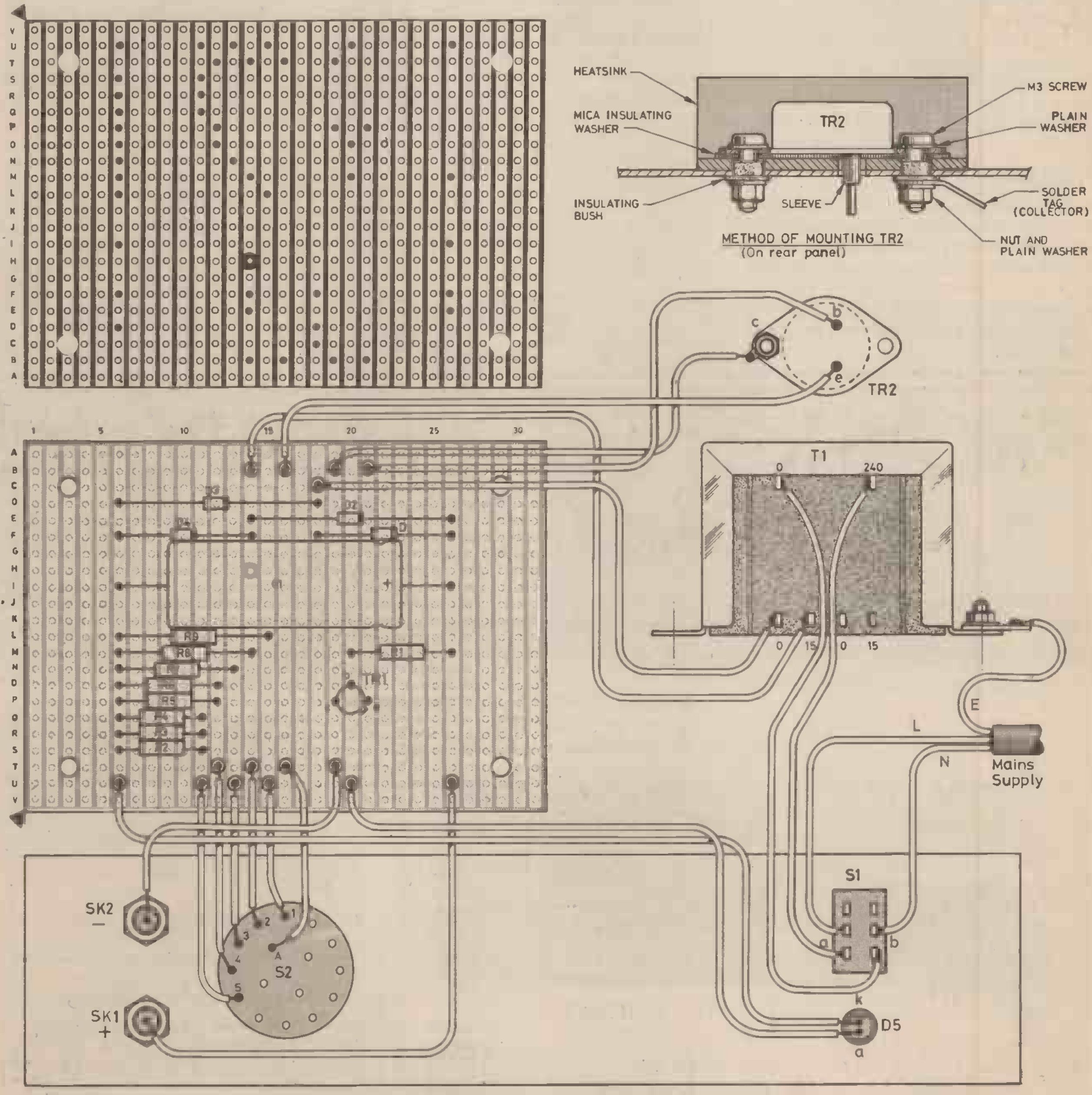
WIRING

The circuit board is bolted to the bottom of the case using 10mm spacers and 3mm screws. The transformer is bolted to the case using 4mm screws.

The interwiring details are shown in Fig. 2. With the exception of the mains wiring, 7/0·2 wire should be used for all the connections. For the mains wiring use 14/0·2. Take care with the polarity of the light emitting diode.

IN USE

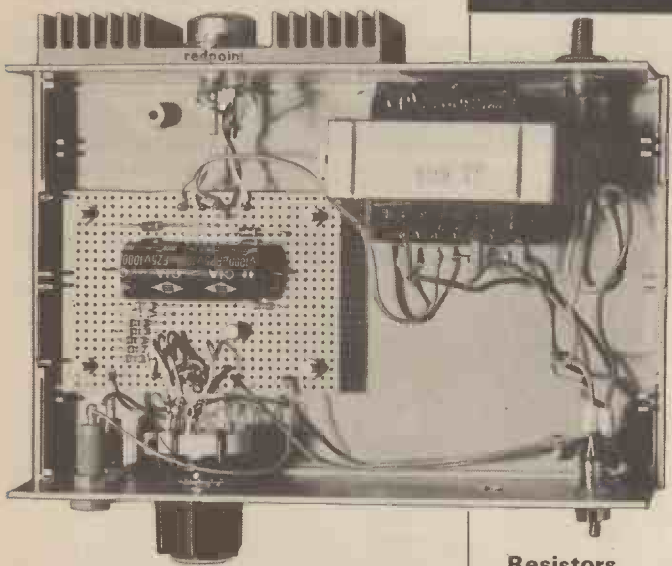
Some form of holder will be needed for the batteries, or in the case of a PP3 battery only a clip is necessary. Since the requirements of individuals will vary considerably no details can be given.



EE118P

Fig. 2. Stripboard layout, wiring diagram and mounting details for TR2.

The batteries are connected to the unit; observing polarity, the positive output



goes to the positive terminal of the battery. The correct charging current is selected with the switch then the unit is turned on. The batteries will be fully charged in about sixteen hours, shorter if they were not fully discharged. No damage will result if the batteries are left longer. Under no circumstances attempt to charge a battery on a higher current range than recommended, nor should any attempt be made to charge ordinary zinc carbon batteries. □

COMPONENTS

Approx. cost Guidance only **£15**

See Shop Talk page 146

Resistors

R1	820
R2,3,4	10 (3 off)
R5,6	12 (2 off)
R7	27
R8	82
R9	150

All resistors are 0·25 W carbon film

Capacitors

C1	1000µ 25v. Electrolytic axial leads

Semiconductors

D1-D4	1N4002 (4 off)
D5	Light Emitting Diode must be yellow. With panel mounting holder
TR1	BC107
TR2	2N3055 npn power transistor

Miscellaneous

T1	15 volt 12 VA mains transformer
S1	Double Pole Double Throw (dpdt) toggle switch
S2	Single pole 12-way rotary switch with adjustable stop, set to five ways.
SK1,SK2	4mm sockets, one each red and black

Veroboard; Veropins; 3 mm nuts and bolts; 4 mm nuts and bolts; 10 mm spacers, 4 required; Insulated mounting kit for a T03 transistor; Knob for S2; Mains cable; Grommet for above; Case; Insulated wire.

VIGIL ON SMALL BOAT RADAR

The Marine System Division of Mars Electronics have launched two new radar products, Vigil-2 and Vigil-RM. Their first product, Vigil Radar, was launched in 1983 and quickly became a market leader in small boat radar. With a wide range of advanced and unique features, Vigil-2 and Vigil-RM are destined to maintain this position.

Vigil-2 is basically an improved version of Vigil Radar and like its predecessor is designed mainly for yachts. Many changes are purely cosmetic, such as the redesigned head moulding and instrumentation. Major functional improvements include the clearer display and increased visual persistence. The complete system can easily be installed by the d.i.y. yachtsman, with only simple connections to be made between the scanner and control unit, both of which are easily mounted.

"The new Vigil Radar offers *Sailor friendly design* at a very friendly price"

The Vigil-RM whilst remaining ideal for yachtsman, has also been aimed at the workboat and power boat market. It is a luxury item offered at a surprisingly low cost (less than £2000), providing features which have previously only been available on more expensive equipment.

A unique feature of the Vigil-RM is its modular design which allows the control unit to be mounted remote to the display, making better use of space. Additionally all the controls are operated from a portable infra-red transmitter giving much greater freedom to the operator. Display controls include: variable range markers (VRM's), electronic bearing markers (EBM's), range rings and sea and rain clutter. There are three levels of screen intensity and four levels of brilliance permitting clear day or night time vision.

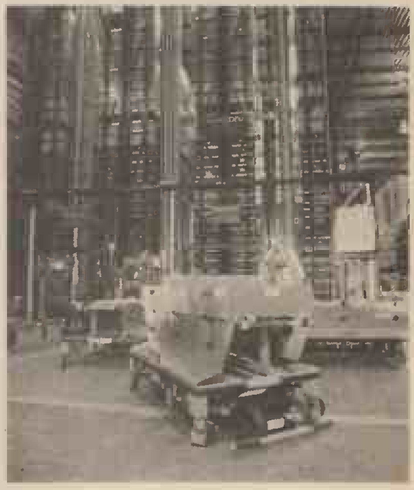
Mars Electronics are associated with Mars the confectioners and were originally set up to provide further outlets for their confectionery products. They achieved this by setting up Mars Money Systems Division which produces electronic coin validation mechanisms for vending machines.

Since then, two new divisions have been created, Marine Systems and Automatic Test Equipment. They claim to be market leaders in both coin validation systems and small boat radar, and although it will be some time before they launch a product in the ATE field, they confidently predict their superiority in this area.

Their success to date can be attributed to many factors, not least their modern manufacturing and stock handling methods at their factory in Reading.

They have one of Europe's most advanced materials handling system with *automatic transportation vehicles* and computer controlled stock handling. Additionally most of their process machinery is automated or computer controlled making small to medium scale production very cost-effective. This together with their niche marketing strategy makes them very competitive in whatever area they choose to trade.

The photograph below shows one of the Automatic Guided Vehicles transporting materials, under computer control.



HOME VIDEO

AN ALL-IN-ONE video camera-recorder that uses standard ½in. VHS video cassette tapes has just been announced by Panasonic.

Capable of four hours recording and playback, the NV-M1 VHS Movie is Panasonic's answer to the growing demand for a lightweight, easy-to-use video camera with a built-in recording/playback capability using standard VHS video cassette tapes. The snap-on-rechargeable battery pack can power the unit for up to 2 hours of continuous recording.

The electronic viewfinder (EVF) is a ½in. black and white TV screen that is claimed to give easy focussing and doubles up as a playback monitor for immediate checking of recordings. Playback is also possible by connection to a TV monitor or TV set. The playback functions also include cue and review as well as still playback.

A new M-shape tape loading system, in which the tape is wound around the cylinder for a full 270 degrees (compared to 180 degrees in the conventional system), enables a reduction in diameter of the video head cylinder down to two-thirds the diameter of conventional cylinders.

A ½in. high-band Newvicon pick-up tube features a low-light capability for shooting in levels as low as 10 lux. Additional camera features include a 6× power zoom lens with macro function and automatic white balance adjustment.

SHOP TALK

The first new-style British Telecom Shop opened in Southend High Street, recently.

The shop sells a wide range of telephones, business equipment and telephone accessories. Customers will also be able to pay their telephone bills at the shop and make general enquiries about other services.

EXPANSION

Bell Canada International (BCI) of Ottawa, Canada, has expanded its European activities with the acquisition of General Computer Systems Ltd., of Feltham, Middlesex, one of the UK's leading repair and maintenance service companies.

This is the initial step in a planned development and represents its first outright take-over of a UK company.

Sony Broadcast have appointed Mr. Mitsuru Ohki as Administrative and Commercial Director.

POWER HOUSE

Advanced Power Supplies, the power supply manufacturer formed in April 1984 as a result of a management buy-out of the former Gould Power Conversion Division, has purchased instrument distributor specialist House of Instruments.

Commenting on the move, Tony Jannece, Chairman of Advance, says: "We are very pleased to be able to acquire an entrepreneurial firm like House of Instruments in an area which complements our existing manufacturing operations.

Test Line

Automatic line test equipment worth £20 million is to be bought by British Telecom to speed telephone fault detection and repair for about 10 million customers.

Beginning next month (March) the equipment will be installed in about 100 of British Telecom's 360 repair service controls, which are the nerve centres of its fault repair service.

It is claimed that the equipment will automatically test customers' lines and equipment overnight to pinpoint degradation before it develops into faults which could affect telephone service.

ADVENTURE CABIN

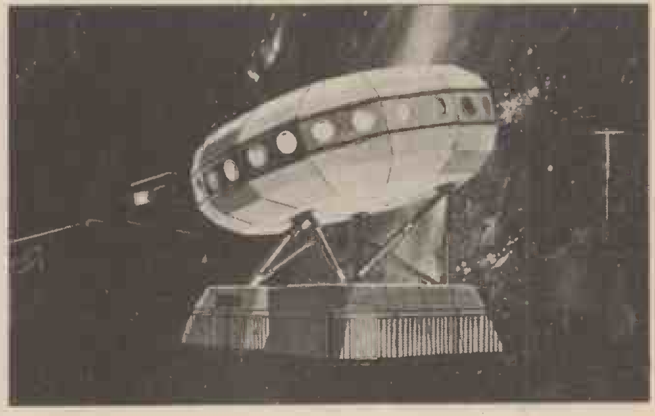
AN AMUSEMENT "Star Ship" machine that moves in synchronization with an image projected on a screen inside the cabin has been developed jointly by Mitsubishi Electric Corp. and Korakuen Stadium Co.

The "Flying Cabin" simulates space travel: the cabin sways, careens and dives in line with changing scenes of ground surfaces and deep space projected on a large screen.

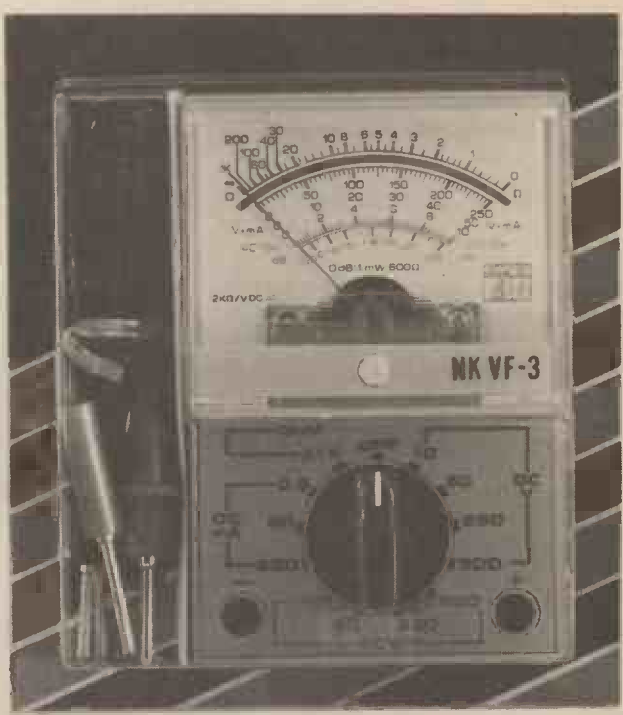
A six axis hydraulic system is used in the flight simulator and is employed in the Flying Cabin for computer controlled synchronization of the moves of the 44-man craft with the screen's images and the six channel sound system.

The two companies hope to sell 20 systems in Japan and 40 systems abroad in the coming five years, chiefly to amusement parks, shopping centres and science museums. It will only cost the purchaser £300 million Yen!

Architect's concept of the "Flying Cabin"



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



SCREENING

THE PROBLEMS of radio frequency interference (RFI) has been increasing over the years as metals have been replaced by modern plastics to house electronic components and switching circuits. Although more aesthetically acceptable, cheaper and lighter, plastics are "transparent" to radio waves, and so protective screening becomes essential to prevent damage or malfunctioning.

Now a new zinc coating process which, it is claimed, eliminates RFI has been developed by **Deccospray**.

The process, called Decco-screening, consists of the homogeneous appliction of molten zinc to the internal surfaces of plastics enclosures without deforming, discolouring, or weakening the base material.

It is claimed that electro magnetic energy is absorbed by the coating, and external radio frequency interference is subsequently reflected. This interference can be caused by such mundane things as vehicle ignitions, fluorescent lights, radio transmitters, or refrigerators.

Deccospray Ltd.,
Dept EE, Eastmore Street,
Woolwich Road, Charlton,
London, SE7 8NA.

PRINTER STAND

THE range of computer furniture from Alinco has been extended to include two new universal printer stands. These all steel "trolleys" have been engineered to take most printers, in both 80 and 132 column styles.

A useful feature of these stands, when fitted with optional basket and shelf, is that they can carry up to three type of continuous stationery. Also offered as an extra are castors that interchange with the standard glides.

The stands are supplied in quick assembly form, with simple illustrated instruction sheets, together with the necessary spanners.

It is claimed that using sound absorbing foam pads stops noise and vibration transmission and that they remain stable when fully loaded and/or mobile. All sharp corners and edges have been avoided in the design.

For further information, stockists and literature write to:

Alinco,
Dept EE, Albert Drive,
Victoria Industrial Estate,
Burgess Hill,
West Sussex, RH15 9TN.

CONTROL CENTRE

FOR USE in the ever increasing number of homes where the family TV set is now the heart of an increasingly complex array of electronic entertainment equipment, **Ross Electronics** of London have introduced their RF-170 Television Control Centre.

The centre provides instant selection of TV, video recorder, home computer, video game and Cable TV or additional VTR dubbing and monitoring facilities. It has one phono and 5 co-axial input sockets which may be interconnected through a bank of six low-loss slide switches.

Supplied with a switching chart, the Ross RF-170 retails at a VAT inclusive price of around £31.95.

More details may be obtained from:

Ross Electronics,
Dept EE, 49/53 Pancras Road,
London, NW1 2QB.

POCKET MULTIMETER

A LOW-COST, "spare" multimeter is always a very useful piece of test gear to have in the workshop as it can always "double" as a temporary monitoring meter prior to installing the more expensive final item.

Just such a meter is now being marketed by **Harris Electronics**. Manufactured by TMK Test Instruments, the VF-3 is a four function, 12 position, 16 ranges 2000 ohm/volt multimeter that is claimed to sell for under £7.

The range selection of the pocket-sized multimeter is by a single rotary switch and readings are taken from an analogue, mirror scaled, meter. The meter will read: volts, a.c. and d.c; d.c. current (mA); ohms (0–1k) and decibels.

The VF-3 comes packaged in a protective "blisterpack" complete with test leads and battery.

Further details may be obtained from:

Harris Electronics (London),
Dept EE, 138 Grays Inn Road,
London, WC1X 8AX.

APRIL FEATURES...

FIBRELARM

Based on a winning design from the Schools Design Prize Competition 1984. Protect your valuables with this fool-proof loop alarm which employs fibre optic cable. The Fibrelarm can easily be modified to be used in a variety of security projects.

INSULATION TESTER

With your own instrument (and it needn't be expensive) you may check the insulation of domestic appliances and mains wiring as often as you like, without calling in a professional.

CYBERVOX ROBOT VOICE

Voice synthesisers, whether fitted to a car or a robot, tend to sound like depressed Daleks with a cold. Cybervox, interfacing between microphone and amplifier, can make your voice sound equally weird! This project offers endless opportunities to create strange sound effects.

EVERYDAY ELECTRONICS and computer PROJECTS

APRIL 1985 ISSUE ON SALE FRIDAY, MARCH 15

SQUARE one FOR BEGINNERS

THE FLOW OF ELECTRIC CURRENT is usually "explained" by analogy. The description of the way that water flows through piping is often used, and this can be very helpful in appreciating the function of such electrical components as resistors and capacitors. However, the analogy used to describe transistor action, which is the subject of this month's *Square One*, is somewhat different.

NUCLEAR PHYSICS

Electricity is a very vague term, although its usage is common. In simplest terms, electricity implies simply the presence of electrons. An electron is conveniently visualised (and often characterised) as being a small sphere with a radius of 2.818×10^{-13} centimetres.

This implies that it would take rather more than 1,770,000,000,000 electrons packed side-by-side to form a line one centimetre long. Electrons, of course, do not behave like this, and their "size" is deduced from the behaviour of atoms under particular kinds of electromagnetic stress.

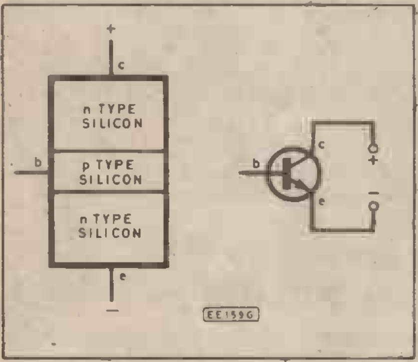


Fig. 1. Transistor construction.

The structure of atoms, moreover, is poorly understood, and each new "explanation" raises more questions that it answers. Nuclear physics is a fascinating pastime, but provides very little practical information.

ELECTRON MOVEMENT

The scientists of the nineteenth century were practical men. They wanted to make interesting or useful things which *worked.* Electricity was, in a very real sense, less mysterious then than it is now: a source of the mysterious power flow (a cell) could be easily got, or made, and its properties put to use. And today, when we switch on a piece of electronic equipment, we do not normally stop to reflect on the properties of electrons.

If we accept that some substances (conductors) have electrons which move easily towards a positive electrode, and are expelled from a negative electrode—as in a simple cell—then the idea of electron flow is at least comprehensible. Insulators have no such free electrons, and semiconductors only a very few. So why are semiconductors so important? The short answer is that the movement of electrons can be precisely controlled.

Essentially, solid-state electronics is concerned with the flow of electricity through semiconductors, the most commonly used of which (at present) is silicon. In *n-type* silicon, there are a relatively large number of electrons free to move, and in *p-type*, there is a shortage.

TRANSISTORS

A transistor is constructed (in principle) as shown in Fig. 1. A narrow piece of p-type silicon is sandwiched between two pieces of n-type; connections are made to each end, and

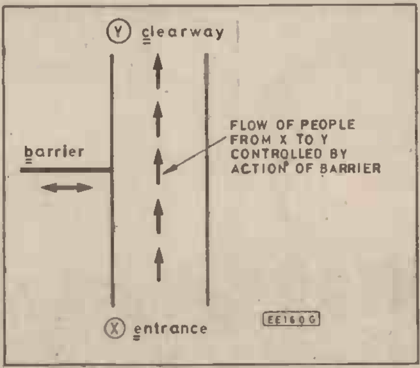


Fig. 2. People analogy.

to the piece in the middle. The connections—emitter, collector, and base—are also shown in the standard symbol.

The movement of electrons in the device can be described by analogy with the movement of people through a street, as in Fig. 2. The street is very crowded, and no-one is moving. The equivalent situation is a transistor with no power applied.

When power is switched on, the negatively-charged electrons are attracted to the positive electrode, and injected from the negative one, as shown in Fig. 3, so that electrons flow from the *emitter* to the *collector*, via the *base*. A very few electrons (fewer than five per cent) flow from the emitter through the base.

The voltage at the base is the key to current amplification. When the base voltage is made more positive, the current flow increases from emitter to collector. When it is made more negative, it decreases. It is as though, in Fig. 2,

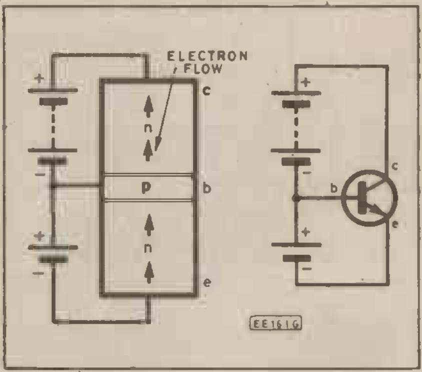


Fig. 3. Transistor electron flow.

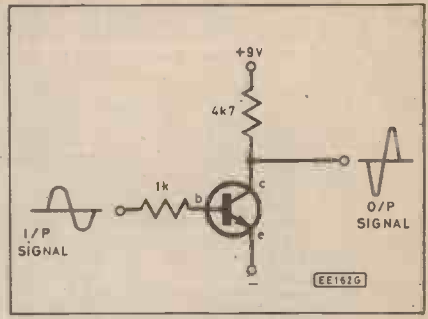


Fig. 4. Transistor amplifier.

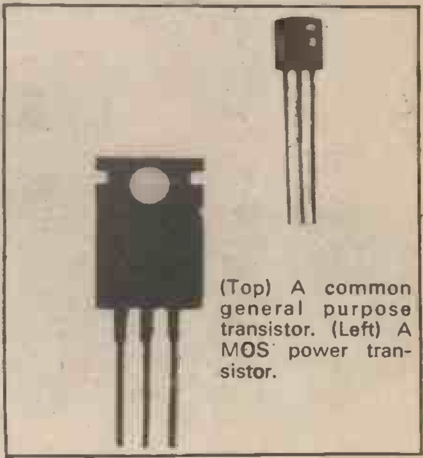
the large flow of people through the street were controlled by one person who could move a barrier across. A small change in the distance the barrier moves makes a very big difference to the number of people able to move from Entry to Clearway.

Similarly, in a real transistor, the large flow of current from emitter to collector is controlled by a very small base current. The barrier that the p-type silicon represents is decreased, or increased by, respectively, a positive or a negative base voltage.

AMPLIFICATION

Different transistors have different characteristics in this respect (current amplification factors), but, for example, a change of 25μA at the base might cause a change of 1mA at the collector. Current gain is thus $\frac{1}{0.025} = 40$.

Ohm's famous law states that the voltage developed across a resistor equals the product of current flow and resistance value; symbolically, $V = IR$.



(Top) A common general purpose transistor. (Left) A MOS power transistor.

Hence, in the example of Fig. 4, where there is a 4k7 resistor between the collector and the positive terminal, a collector current change of 1mA will cause a voltage change at the collector load resistor of $1 \times 10^{-3} \times 4.7 \times 10^3$, that is, 4.7 volts. Different values of load resistor will of course result in different values of voltage change. The input (base) voltage was due to a current of 25μA flowing through a 1k resistance, and hence was $25 \times 10^{-6} \times 1 \times 10^3 = 25$mV. Thus the voltage gain of the circuit is $\frac{4.7}{0.025} = 188$.

As the small signal input varies, the output signal varies by a much greater amount, and this simple circuit is the basis for the amplifiers used in so many different applications today.

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.

LOGIC PROBE AND PULSER

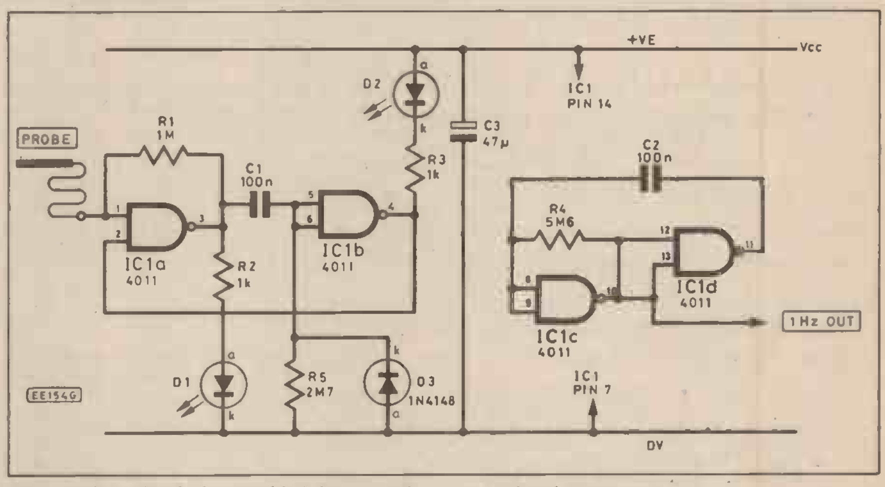
THE Logic Probe described here is easy to make and provides a useful piece of inexpensive test equipment. It can test for the conditions of high impedance, high, low or pulsing.

When the probe input is open circuit, the output of IC1a is held at $\frac{1}{2}$Vcc by the feedback resistor R1. The input to IC1b is held low by R5 which gives the condition of D2 off and D1 dimly lit.

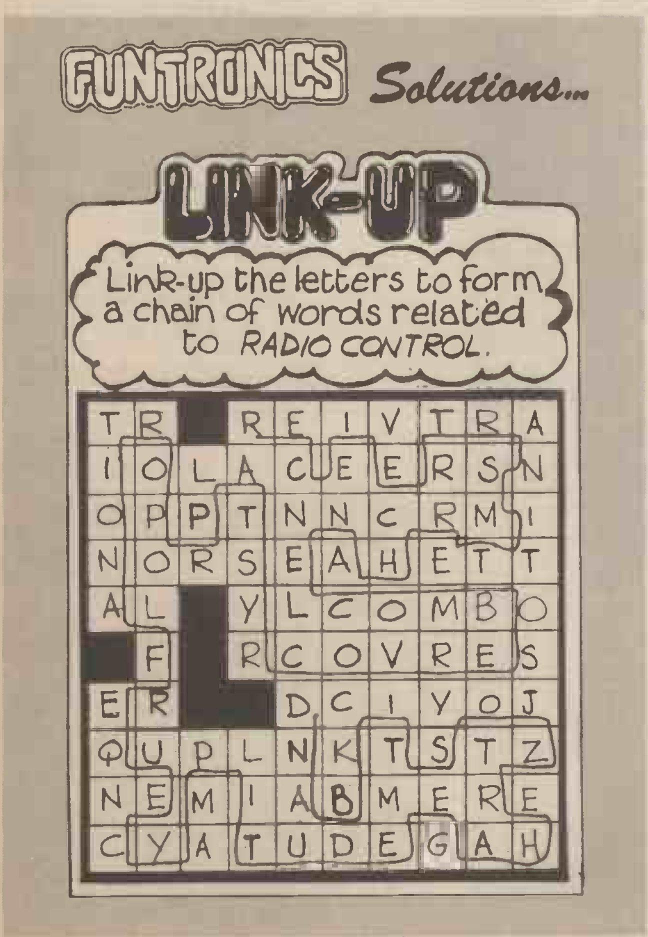
When the probe is at logic '1', D1 is extinguished and when the probe is at logic '0' D1 is brightly lit.

If the circuit receives pulses then, short pulses are transmited to IC1b and the l.e.d., D2 is lit. This enables all conditions to be indicated.

To make use of the two remaining gates a 1Hz pulsing circuit is provided by a multivibrator made up of IC1c and IC1d and their associated components.



W. A. Adam, Kettering, Northants.



PLEASE TAKE NOTE

Mini Workshop Power Supply *(December '84)*.

The p.c.b. has a track missing from C1 negative end to C2 negative end. An insulated wire link between these points will correct the error.

Doorchime *(December '84)*

The circuit diagram on page 759 is incorrect. The left-hand end of R10 should connect to pin 2 of IC3 and also to R7. The junction of R8 and R9 *should* go to pin 3 of IC3 as published, but should *not* also connect to R10. On page 760, IC1 is shown the wrong way round on the component layout.

Computer Club *(February '85)*

We regret that there are several line amendments to the **Culuplex** game and these should now read as follows:

```
 5Ø PRINT TAB(c,Ø)" "TAB(27,r)"
    "TAB(Ø,29)SPC26:*FX15,1
 8Ø PRINT CHR$7 TAB(1,27)"NIL MOVE TRY
    AGAIN(Y/N)"
22Ø Colour2:PRINT TAB(29,31)"BLUE=";S(2);
26Ø C=12:nc=13:r=1
33Ø IF INKEY(-58)ANDr>2nr=r-1
42Ø C=C+IN:SQ=POINT(c,nr):IFSQ=3THEN42Ø
56Ø PRINT TAB(2,29)SPC23:s=Ø
59Ø SQ=POINT(c,r):IFSQ=ØSQ=p:s=s+1:GOTO62Ø
61Ø SQ=3:s=s+2:FR=FR-1
```

FAULT FINDING

E. A. Rule Part 5

WE NOW come to an area of fault finding that to most engineers is a nightmare, that of the 'intermittent fault'. This type of fault can range from an almost continuous fault condition to that of a fault every few days or even months. Without any doubt these are the most difficult to locate because chances are that each time you attempt to trace the fault, it will 'clear' and of course while the unit is working correctly, there is no fault to find! It is convenient to group intermittent faults into three groups.

The first group is where some form of mechanical pressure will actually affect a fault condition, for example tapping a printed circuit board or slightly bending it. This type of fault is often due to a broken printed circuit track or a 'dry' joint, however it can be due to faulty components.

The second group is where the fault appears after a period of time and then later clears itself again without any movement of boards or components.

The third group is where the fault condition is effected by temperature change. There are others of course but these three groups will cover most eventualities.

CAREFUL DETECTION

Quite often after a fault has appeared you will find that as soon as a piece of test equipment is connected up, a voltmeter for example, the fault clears. This happens because the small voltage surge produced when connecting up test equipment is enough to clear the fault. Because of this, test equipment often has to be left connected into the circuit until the fault appears and a note made of any changes in instrument readings. Sometimes it is necessary to have a number of test instruments connected up for long periods.

It is also possible to rectify what you believe is the fault, only to have it reappear days or months later! Very careful detective work is required if intermittent faults are to be found and cleared. Procedure in general is similar to that used to trace 'normal' faults, first try to reduce the area of search using the methods described last month, for example, a variation in signal strength may also show as a change in the signal strength of a tuning meter, indicating a fault condition somewhere in the RF or AGC sections. If the meter remains steady, then it could be an audio fault and the search can be confined to that section, etc.

The signal tracing methods referred to last month could also be used, in fact, often this is the only satisfactory method. The problem is that test equipment has to be tied up for long periods until the fault appears. However, working backwards stage by stage should quickly reveal the problem area.

MECHANICAL POINTERS

When a fault can be produced by tapping or flexing a board or component (group 1), the secret of success is to reduce the amount of pressure used until only a very light pressure produces the fault, which will normally be in the most sensitive area, i.e. the area requiring the least touch. A plastic knitting needle is a useful tool for applying light pressure to a small area or for tapping components.

Do not use a *metal* tool for this as the static charge it carries can cause misleading results, it could also add faults by shorting something out by accident.

TIME DEPENDANT FAULTS

With the type of fault that is dependant on time (group 2), the only way to trace these is by signal tracing and leaving test equipment connected into the suspected circuit. Fig. 1 shows one example where the audio section of a receiver is suspected. An oscilloscope should be used but if one is not available it may be possible to monitor the signal present by feeding it into an external amplifier. One word of

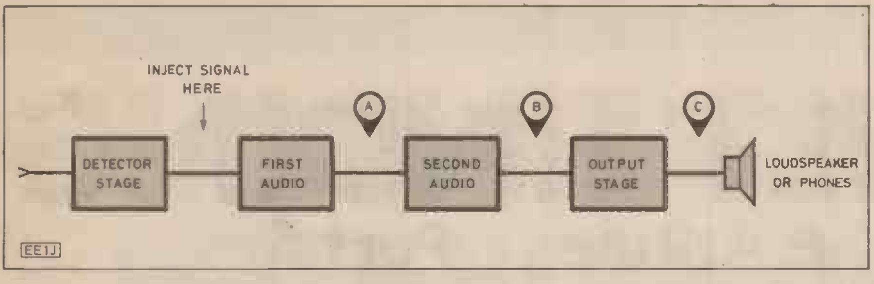


Fig. 1. A signal injected into an early stage can be monitored at points A, B, and C, to see if it 'disappears' when the fault occurs.

caution, always place a series capacitor (0·1 to 0·01 microfarad) in all test equipment leads when tracing a signal as many parts of a circuit carry high voltages which could damage sensitive test equipment. It goes without saying of course that this method should not be used when measuring d.c.

In Fig. 1, a signal variation at say the loudspeaker (point c) but a steady signal on the scope would mean that the fault was between those two points. If both scope and speaker signals show a variation then the fault would be before the point of monitoring i.e. between the input and the first stage showing a steady signal (A or B). Methods like this will locate the faulty stage but it takes time and keeps test equipment tied up for long periods. If possible connect a number of pieces of test equipment into the suspected circuit, voltmeter, scope, etc and see if any of the signals displayed change when the fault occurs, this will give you a positive clue as to where the fault lies.

REASON OUT THE RESULTS

Try to reason out the observed results, for example if the voltage falls at one test point, should it also fall at another? Fig. 2 shows a simple example of this procedure. A voltage check of this stage (simplified) showed that when the fault occurred, the voltage at point E was steady, at point D it increased slightly, at A it increased slightly, fell at C and went very high at B. The most likely suspect therefore was the transistor TR1. If point A had shown a decrease instead of an increase then R1 or R2 could be suspect, as a reduced voltage here would reduce the current through the transistor and also cause its collector voltage to rise. However, as the collector voltage rose even with a slight increase in Base voltage, a faulty transistor was diagnosed.

TEMPERATURE DEPENDANT FAULTS

When a fault is temperature dependant (group three) a very useful tool is a freezer spray These sprays can reduce the temperature of a component to below minus 20°C in a few seconds and this sudden drop will often reveal the faulty component. Broken printed circuit tracks will also often show up under this treatment as the drop in temperature causes the board to contract and 'pulls' the broken track apart, stopping operation until the board warms up again. Keep the sprayed area small. Remember it is the most sensitive area that is most likely to contain the faulty component or track. Spraying a large area may well develop the fault but it will not tell you where it is. Suspected noisy transistors will also respond to the spray treatment.

Transistor noise normally falls as the temperature falls, so a sudden drop brought about with the spray will produce a similar drop in noise, a repeat spray should confirm the test. Be careful if you are using the freezer spray near oscillator circuits because you could cause enough change in operating frequency to cause misleading results.

Like all servicing aids, a degree of common sense is required. Another method of revealing temperature sensitive faults is to use a hair dryer, in this case of course you can either heat up the suspect area or with the heater element off, gently cool it down. Don't overdo the heat, however, or you may add more faults due to damaged components.

FROM EXPERIENCE

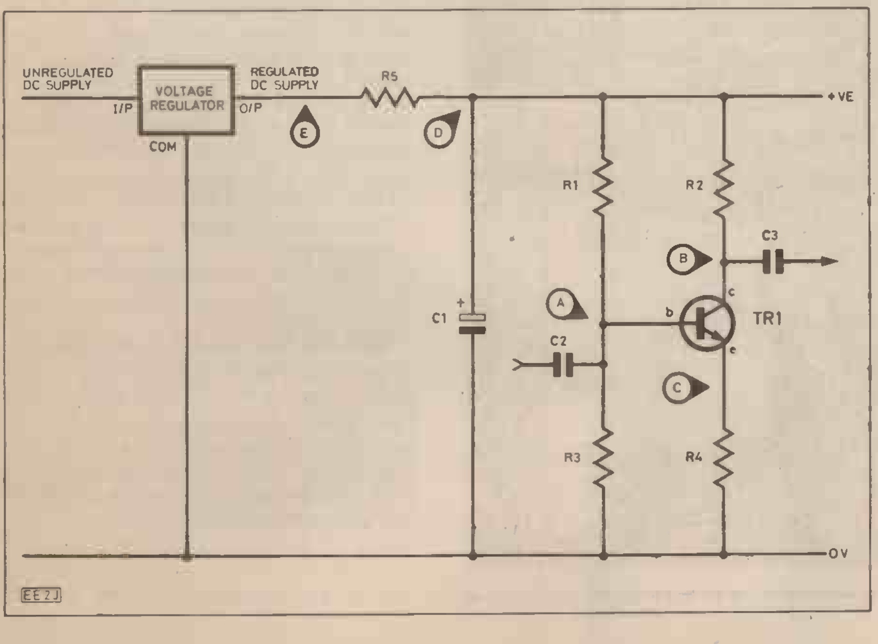
The author has spent many hours tracing intermittent faults but one that stands out was on a new production line Hi-Fi receiver. This set would suddenly stop working and could always be started again by tilting it to one side. Sometimes tapping would produce the fault, at other times it just simply happened. By using the signal tracing method the fault was finally tracked down to an IF transformer. Removing this component and removing its can revealed all. A loose piece of solder was hanging from one of the connections to a coil, as it moved it shorted the coil out to the can.

A more recent fault was one of intermittent distortion at loud volume on a portable transistor radio. At low volume all was well but at the higher levels distortion would suddenly appear. Tapping or flexing boards etc had no effect. Signal tracing traced the fault to the loudspeaker. This had a broken braided lead from its cone to its tag panel and as the cone moved at loud volume levels the lead became open circuit as the cone returned to its relaxed position the lead re-made contact. This constant making and breaking caused the distortion.

Another recent case of similar distortion followed by fuse blowing was traced to a loose fixing screw on a power transistor. As the transistor heated up the screw became loose and contact was broken, the reverse in fact to what one would expect. From several years of bitter experience I have learned that some of the most complicated symptoms are due to very simple causes.

Next month we shall take a look at faults found on cassette recorders.

Fig. 2. Monitoring the voltages at various points.



STORAGE HEATER SETTING INDICATOR

T. A. PRIEST

CONSIDERABLE ECONOMY in fuel bills can be obtained if the charge setting control on your storage heaters is carefully set to suit weather conditions; especially during Autumn and Spring when rapid changes of weather are experienced. This Guide was devised to take the guesswork out of that operation.

It was reasoned that with good insulation the full capacity of the storage heaters installed should maintain an indoor temperature of 18 degrees C when it is freezing outside (0 degrees C). Also that when the outdoor temperature rises to 14 degrees C it should only be necessary to use the minimum setting of the storage capacity to maintain a 4 degrees C difference inside (18 degrees C). On this basis, if the guide could be made to indicate outside temperatures from 14 degrees down to 0 degrees C in four stages, this would be an indication of the charge setting required.

HOW IT WORKS

The circuit diagram is shown in Fig. 1. The thermistor, R23, is a temperature sensitive resistor whose resistance changes from about 1k5 at 15 degrees C to 2k5 at 0 degrees C—it is suitably protected and mounted. TR1, R1, R2, and R3 form a constant current circuit (similar to that used for charging Nicad batteries) which will pass a constant current through the thermistor.

The circuit was calibrated and the volt drops analogous to 14 degrees C, 10 degrees C, 7 degrees C, 4 degrees C, and 1 degree C were measured. The resistance chain VR1 and R5 to R11 with constant current supply from TR2, R4, R12 and R13 provides reference volt drops equal to those measured.

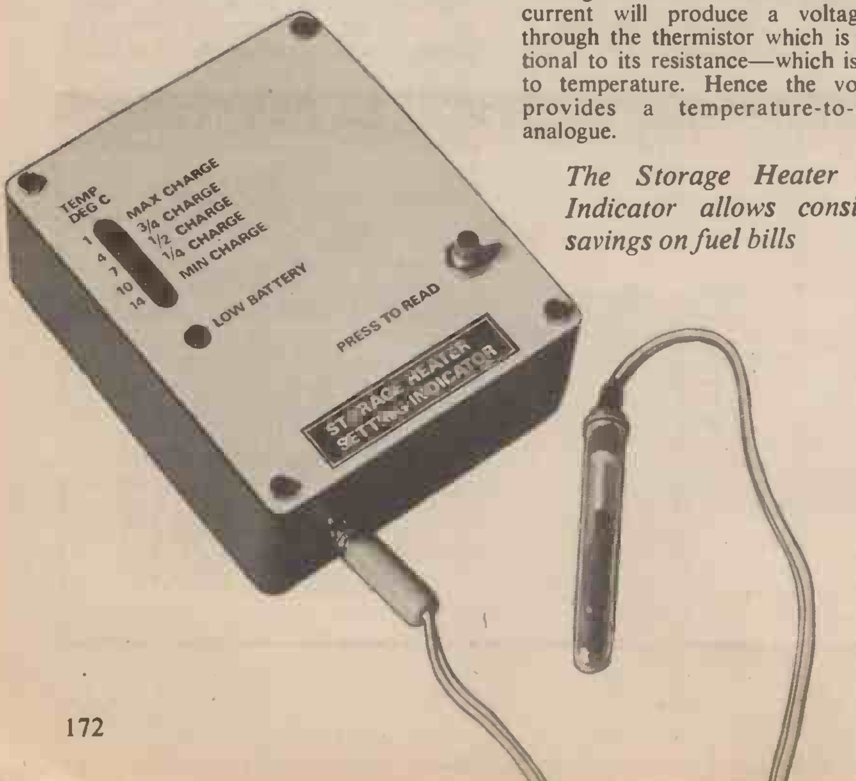
Table 1. Heater setting indications

NUMBER OF L.E.D.s ALIGHT	CORRESPONDING OUTSIDE TEMPERATURE	INDICATED CHARGE SETTING REQUIRED
1	14°C to 10°C	MINIMUM
2	10°C to 7°C	QUARTER
3	7°C to 4°C	HALF
4	4°C to 1°C	THREEQUARTERS
5	LESS THAN 1°C	MAXIMUM

To allow for the battery running down and to stablise this circuit the supply is taken from IC1 which provides a stabilised five volts. A push-to-make switch is used to activate the circuit so as to conserve the battery and reduce heating of the thermistor. The constant current will produce a voltage drop through the thermistor which is proportional to its resistance—which is related to temperature. Hence the volt drop provides a temperature-to-voltage analogue.

Five operational amplifiers IC2b and IC2c and IC3a, IC3b and IC3c are used as comparators to compare the voltage drop across the thermistor with each of the reference voltages.

As the voltage drop from the sensor exceeds the reference voltage drop on each of the comparators the inverting input will become positive of the non-inverting input. This will swing the output from 9 volts to 0 volts and sink 2mA through the appropriate l.e.d. and control resistor (lighting the l.e.d.). This provides the required indication—see Table 1.



The Storage Heater Setting Indicator allows considerable savings on fuel bills

INDICATED SETTINGS

The indicated settings can only be used for broad guidance and must be adjusted by experience because each installation will be different, with varying insulation and heating.

The two ICs used provide eight op-amps, so one of the surplus units is used in conjunction with a potential divider (R15 and R16) to indicate when the battery voltage falls to 7·7 volts. At this point the output from the divider falls to 4·98 volts—just below the stablised voltage—and l.e.d. D1 will light.

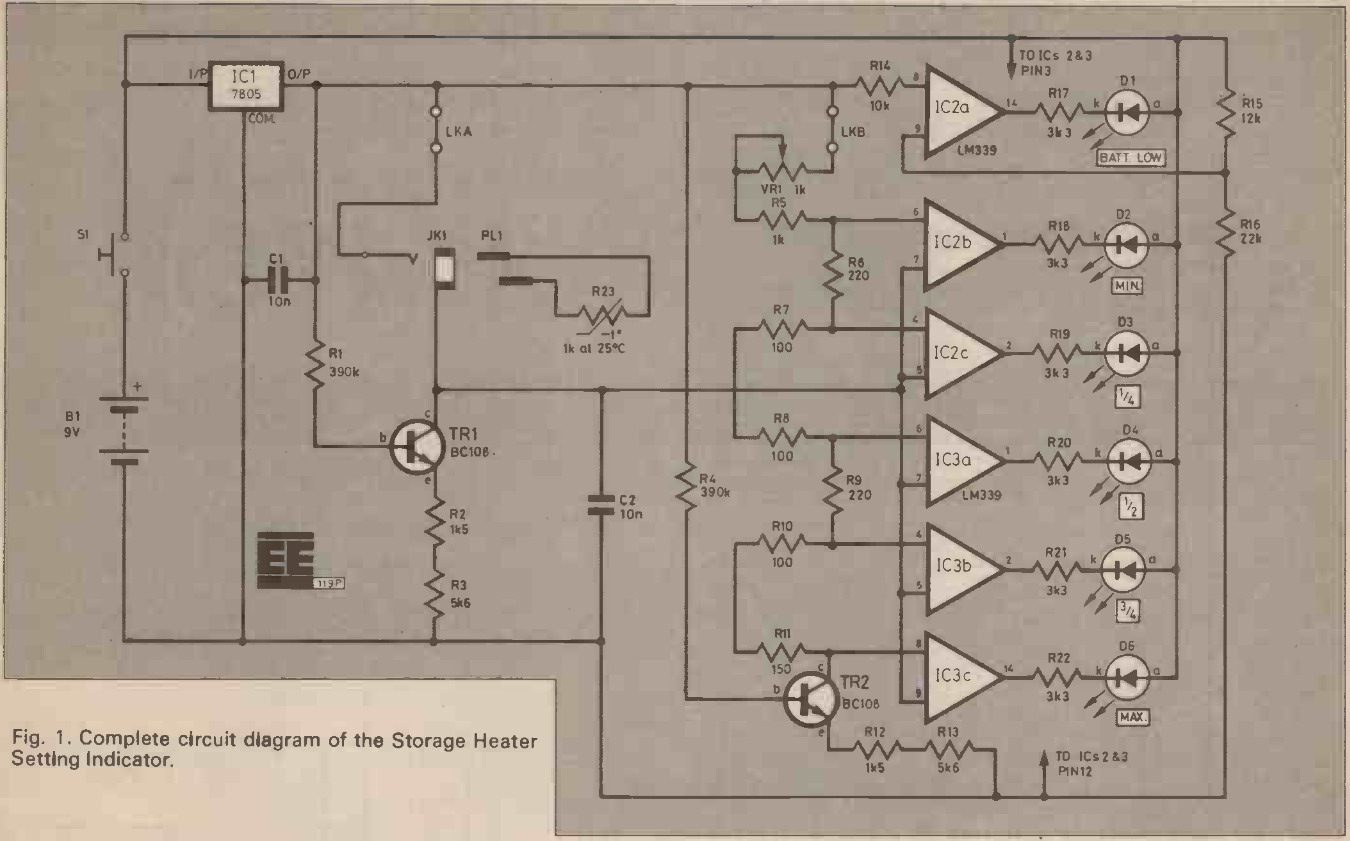


Fig. 1. Complete circuit diagram of the Storage Heater Setting Indicator.

CONSTRUCTION starts here

The layout of components on a 31 hole by 23 strip single sided strip board is shown in Fig. 2.

Sockets are used for the two ICs so that the unused pins of the op-amps can be removed to facilitate a compact layout—pins 10, 11 and 13 are removed from the sockets.

Insulated sleeving is used on component leads and connecting links where there is a risk of shorting—R14, R15 and R16 and links, LKA and LKB. The l.e.d.s should be carefully mounted all at the same height so that they can be positioned just below the opening in the lid of the box.

The usual precautions should be taken when making the required breaks in the strips. Avoid shorting them with solder and use a heat sink when soldering.

Fig. 3 shows how the circuit board, switch, sensor input, jack socket and battery are arranged and connected in the box. Adhesive pads are used to hold the battery, board and blocks in place. Blocks are fitted beneath the circuit board to lift the l.e.d.s to show through. Fig. 4 shows the method of mounting the thermistor. The thermistor leads are soldered to one end of a piece of lighting flex of sufficient length to enable it to be mounted under the eaves on the north side of the house while the other end of the flex is

COMPONENTS

Resistors

R1, R4	390k (2 off)
R2, R12	1k5 (2 off)
R3, R13	5k6 (2 off)
R5	1k
R6, R9	220 (2 off)
R7, R8, R10	100 (3 off)
R11	150
R14	10k Carbon ±5% ¼W
R15	12k
R16	22k
R17–R22	3k3 Carbon ±5% ¼W (6 off)
R23	Miniature bead thermistor 1k at 25°C
VR1	1k preset stripboard mounting

All resistors metal film 1% ¼W unless stated

See Shop Talk page 146

Capacitors

C1, C2	10n polyester

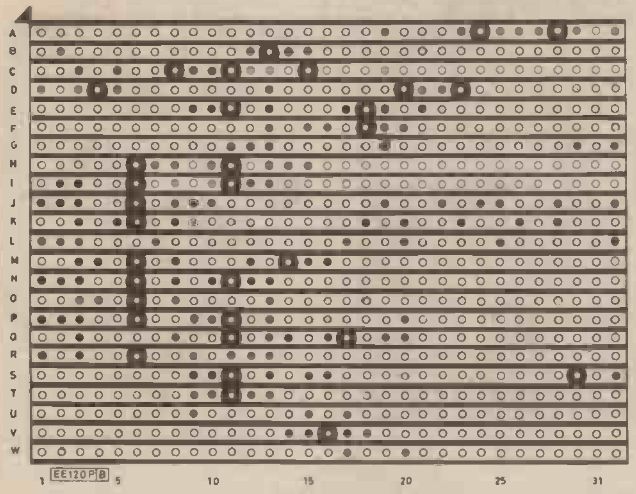
Semiconductors

D1-D6	5mm red l.e.d. (6 off)
TR1,TR2	BC108 plastic npn (2 off)
IC1	78LO5 voltage regulator
IC2,IC3	LM339 low power quadruple comparator (2 off)

Miscellaneous

14-pin d.i.l. socket (2 off)
"Push-to-make" miniature switch
Jack and socket 2·5mm mono
PP3 battery connector
Stripboard 31-hole 23-strip
Plastic box 11cm × 9cm × 3·5cm internal
As required flexible cable 2 ×7/0·25mm
PP3 battery 9V

COMPONENTS approximate cost £14.50



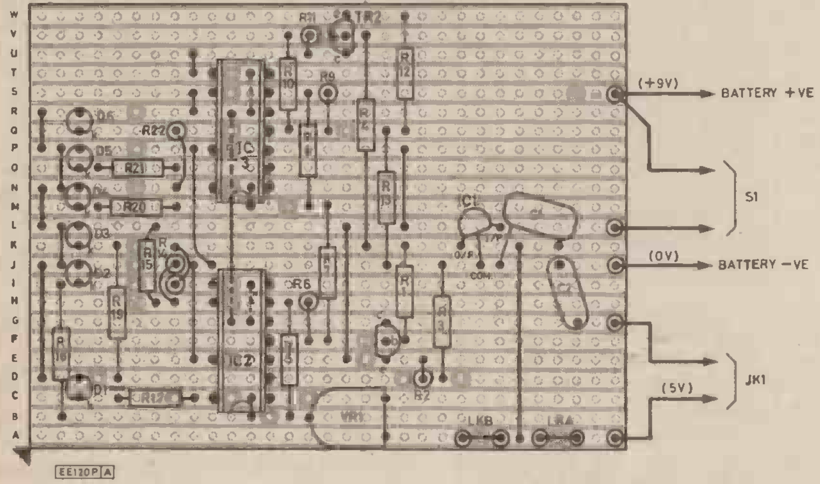


Fig. 2. The stripboard and component layout of the Storage Heater Setting Indicator.

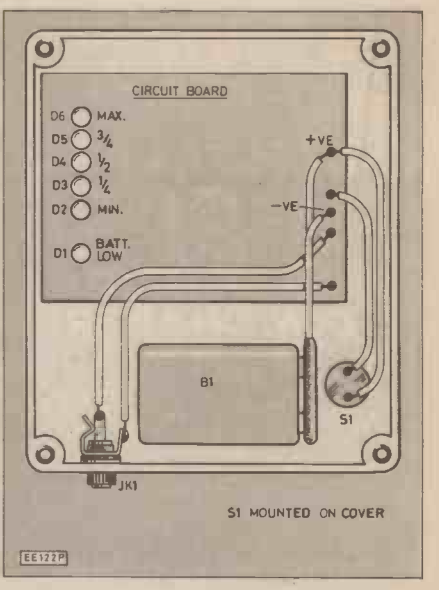
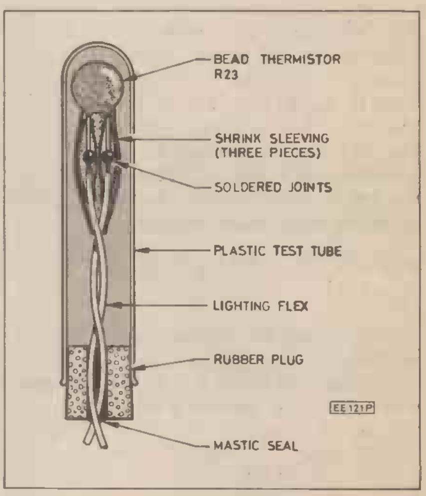
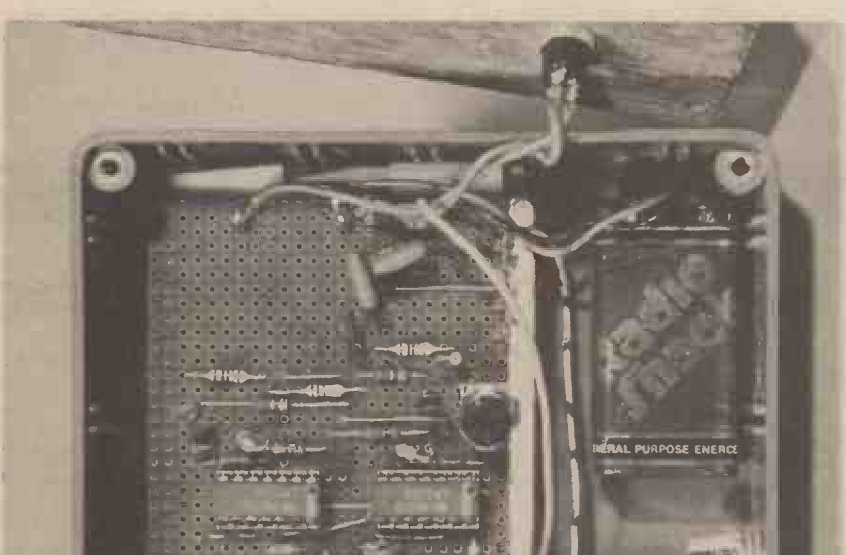


Fig. 3. (above) The component layout of the Storage Heater Setting Indicator.

Fig. 4. (below) Method of mounting the thermistor, R23.





plugged into the unit in some convenient position within the house.

The soldered joints are insulated with shrink sleeves and the joint given mechanical protection by fitting a shrink sleeve over the whole. It is then mounted inside a small plastic test tube, the flex being passed through a rubber stopper and made watertight with mastic. The other end of the flex is fitted with a jack plug.

ADJUSTMENT

The only adjustment necessary on completion is to adjust VR1 until l.e.d. D2 just lights when the sensor is at 14 degrees C, there will then be a voltage of 4·23 volts at pin 6 of IC2.

If held on for 5 seconds the sensor will be heated and its temperature will rise by 1 degree C. This can be used to see if the temperature is *just* below what is indicated—for in that case one of the l.e.d.s will go out if the switch is held on. □

DIGITAL ELECTRONICS

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

PART SIX

IN the last article we looked at logic counters and shift registers and some of their applications. We will now take a look at the many types of memory devices available for use in digital systems.

First of all, why do we need memory devices at all? Well, sometimes we need to obtain information and store it away for later use, say whilst carrying out calculations or whilst waiting for fresh data, etc. At other times we sometimes need to store fixed data for access at later stages. Therefore, some storage mechanism is required and this is provided in many different forms, with the exact form chosen being dependent upon the application required.

RANDOM ACCESS MEMORY (RAM)

One of the most widely used memory devices is the 'RAM' or 'RANDOM ACCESS MEMORY'. In digital electronics we are generally concerned with the use of binary manipulation, with the use of logic '1's and '0's indicating the presence or absence of an electrical/electronic signal. A RAM can be considered to be like a set of 'pigeon-holes' with each hole being able to hold an object. Hence, at any time, each pigeon-hole can be full or empty, this being representative of logic '1' or '0' respectively, as considered for the electrical signal above. The RAM is, in fact, a device capable of storing data in the form of a '1' or '0' in the suggested manner described. Therefore, a 'Byte' of information (8 bits) would be stored as a series of '1's or '0's, in eight successive 'pigeon-holes'.

RAM's have the capability of being accessed by reading (i.e.: looking at any pigeon-hole and obtaining a copy of the data contained within it) or by writing (i.e.: by changing the contents within the pigeon-hole). They can be altered by the user, using program control.

READ ONLY MEMORY (ROM)

'ROM', or 'READ ONLY MEMORY' is, just like the name suggests, a device capable of storage but not capable of changing the information stored. In other words, it can be read but not written into. It is, therefore, equivalent to a similar set of pigeon-holes to those described above, but with a glass cover over the holes so that the user can view the contents but in no way can he change the state of the contents. A ROM is, generally, given fixed data for a device to work to. For example, a computer may have an 8K byte ROM device associated with it, that contains certain fixed instruction or fixed data for use by the computer. It may have the computer's display instructions or it may have fixed routines that are capable of being called by the computer during a program. ROM devices have their contents fixed during manufacture only and are 'non-volatile' (i.e.: Switching the power off does not lose the contents.)

PROGRAMMABLE READ ONLY MEMORY (PROM)

The name 'PROM' is a cover-all that is given to the different types of Programmable Read Only Memories that are available. They are programmable in the sense that, although they are designed to be accessed by reading only (i.e.: data can only be 'looked at'), they can be reprogrammed, using special techniques to be described below, to have a different set of data contained within them. Generally, special circuits or special pieces of equipment are required to carry out these programming techniques. It cannot be done using program control. Three different types of PROM should be described, these being:—

(1) EPROM

The most popular PROM in use. Data is entered in a specific way (say electrically) and is fixed until it is required to change the data in some way. EPROM means 'Erasable Programmable Read Only Memory' and, as the name implies, data can be erased. The technique used is to expose the actual chip (which is made visible through a special window on the package) to ultra-violet light for a certain length of time, after which new data can be entered.

(2) EAROM

This is the 'Electrically Alterable Read Only Memory'. These are not widely used but programming and altering of data is carried out by electrical/electronic means. They are generally slow to alter.

(3) EEPROM (or E^2PROM)

This is the 'Electrically Erasable PROM', where the whole contents of the device are erasable by electrical means.

APPLICATIONS OF MEMORY DEVICES

There must be more applications for memory devices in the computing circle than in any other field, with RAM's, ROM's and PROM's all being used for various functions. However, these will be discussed in greater detail later. For the moment we will discuss the non-computer applications, such as in combinational logic circuitry, where, if outputs are required for a large combination of inputs. the use of a memory device may be worthwhile.

USE IN COMBINATIONAL LOGIC

We have, in previous articles within this series, already discussed the ways of implementing combinational logic circuits, where outputs are obtained only when certain input combinations are provided. The ways previously mentioned were using hard wiring to logic gates and using MSI multiplexor chips, again involving hard wiring. The multiplexor, with its 'local' pin to pin wiring to provide the required functions (as previously described) has obvious advantages over the use of hard-wired gates since the overall printed circuit board size may possibly be reduced, the amount of copper tracking on the board may be reduced and also the amount of chip to chip wiring may be reduced. Since the above factors all tend to reduce manufacturing costs, whether for a single unit or for many units, there are obviously therefore, many reasons to look to the multiplexor as an aid to design of combinational logic circuits. But the problem (if it is a problem) is that, even with the multiplexor, there is still pin to pin wiring to be done and, if changes are required to the input logic at some later stage, this involves either changes to the pin wiring or changes to the circuit board tracking. In the latter case this could possibly involve redesigning of the circuit board completely.

How much simpler it would be if a design could be made using little wiring and with the logic, to determine the various input/output requirements, available in software form, so that any later changes would involve reprogramming only and no wiring or circuit board changes. Using a PROM as the component to contain the fixed data involved with the logic, such a thought becomes a reality.

Let us consider a previous example in these articles, where:—

$$F = \bar{A}BC\bar{D} + \bar{A}B\bar{C}D + AB\bar{C}\bar{D} + ABC\bar{D} + ABCD + A\overline{BCD} + A\bar{B}CD + \bar{A}\bar{B}C\bar{D} + \bar{A}\bar{B}CD$$

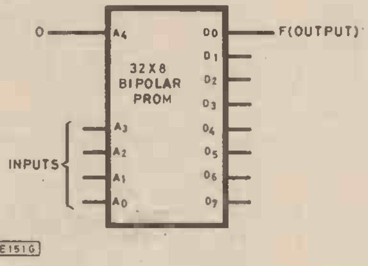
Now let us consider the use of a PROM device to implement the above logical expression. There is, for example, a 32 × 8 bit bipolar PROM available. It is so called because it can contain 32 lines of 8-bit words. Now remember that an 8-bit word is called a Byte. Therefore this particular PROM can contain 32 Bytes of information. In order to address these 32 Bytes (i.e.: select the byte required) on the PROM, there are 5 address pins, which are A_0 through to A_4 (remember that $2^5 = 32$), and it is to these pins that we will connect our input data lines, A, B, C and D.

Let us look at the truth table for our function F and consider the input/output requirements. Since we have only 4 inputs, A, B, C and D and the PROM address lines have 5 connections, we must realise that if we had a 5th input, E, this would be connected to the largest significant address line of the PROM, A_4. Since we do not have an input E, then A_4 must be connected to logic '0'. Inputs A, B, C and D are connected to A_0, A_1, A_2 and A_3 respectively.

Inputs					Required Output	Prom Word Addressed
A	B	C	D	E	F	(D0–D7)
0	0	0	0	0	0	00000000
1	0	0	0	0	1	10000000
0	1	0	0	0	0	00000000
1	1	0	0	0	1	10000000
0	0	1	0	0	1	10000000
1	0	1	0	0	0	00000000
0	1	1	0	0	1	10000000
1	1	1	0	0	1	10000000
0	0	0	1	0	0	00000000
1	0	0	1	0	0	00000000
0	1	0	1	0	1	10000000
1	1	0	1	0	0	00000000
0	0	1	1	0	1	10000000
1	0	1	1	0	1	10000000
0	1	1	1	0	0	00000000
1	1	1	1	0	1	10000000

Truth table showing the PROM function required.

Looking at the truth table, we have the five input lines A through to E, together with the function output F. We also have another column which represents the PROM WORD that will be put out onto the data lines when inputs A, B, C D and E are set to the relevant states (i.e.: when A, B, C, D and E have the corresponding input address word present). Note that, in this example, we are interested in only 1 bit of the output word since that will satisfy the requirements of F output, which is only a single bit anyway. We have shown the lowest significant data bit, D0, to be used but any of the data bits, D0 through to D7 could have been selected. The actual word that is output on the eight data lines is programmed into the PROM and can contain any combination of '0's and '1's so long as the actual bit that we are interested in contains the correct data required with the respective input word addressed. The diagram below shows the actual connections made to the 32 × 8 bipolar PROM used, with F output being taken, in this instance from D0 data line.



The 32 × 8-bit PROM.

Now one point to consider it that, because we have set A_4 to logic '0', and are only using address lines A_0 to A_4, we are only addressing a possible $2^4 = 16$ data words out of a total of 32 possible words. Therefore, our 32 × 8 PROM is only being used at 50% efficiency. However, we still have the savings previously mentioned, in chip-to-chip wiring, pin-to-pin wiring and ease of making alterations, so the use of this PROM is still quite an advantage. Also it could be that, if we use another data line bit, say D7, as an output we could, instead of setting A_4 to '0', put an actual input E onto A_4 and thus the total memory capabilities of the PROM would be used. An exercise should be done at this stage, with no consideration being given as to the means of 'Blowing the PROM' (i.e.: entering the 'fixed' data into the memory) either in the exercise or in the description above. Just appreciate that this is possible.

Exercise 1

A device has four outputs for alarm purposes. Show how a 32 × 8 bipolar PROM can be used to give an output condition when more than 2 alarm outputs are present.

Draw the truth table and the circuit diagram.

USE OF MEMORY IN COMPUTER DESIGN

All computer systems need some form of memory, both for fixed data and for variable data. Let us consider a typical computer system and see how memory is used.

OPERATING SYSTEMS

Every computer system uses an 'Operating System'. This is a fixed set of rules which the computer uses in order to function in an orderly manner. It is the basic tool that tells the computer how to operate, in the sense of how the user can gain access to it and information from it. Because the Operating System is fixed data, it must be stored in such a way that it cannot be changed, or lost in any way. There are two ways of storing such data. The usual way is to put all the information into a ROM chip which is then installed as a unit onto the main processing circuit board. The processor used in the computer system then interrogates the ROM for the information as required.

Another way of storing the Operating System data is to save the data onto 'Floppy Disks'. These are disks that contain 'tracks' which can be magnetised, or demagnetised, as required, to represent the binary information. Special 'Reading Heads' are used to look at the disks and get the necessary information. So, if Floppy Disks are used to store the Operating System for a computer, then the information is first of all loaded from the disk (which involves merely 'reading' the fixed information contained within it) into the computer RAM memory, which the processor uses in the same way as for the ROM method previously described. This has the possible disadvantage that a shut-down of the power supply will result in the RAM data being lost (unless a battery backed supply is used) and the necessity to reload from the disk.

APPLICATION DATA

This is data that is used by the computer for a particular application and, because it is data that on occasions may require changing, due to specifications for a particular system being altered, then Applications Data is generally kept in PROM form. For example, a computer-operated lathe system will probably use an Applications PROM that contains all the fixed information (such as sizes, tolerances, shapes, etc.) for a particular item to be manufactured. A change in specification of the item will require a reprogramming of the Application PROM.

PROGRAM

The actual program that the computer runs can be stored in many ways. In the case of the lathe system described above, the program would probably be in PROM form to facilitate changes at a later date. For most other applications the program will most likely be stored either on magnetic tape or on disks. For example, for many home computers software is sold on cassette tapes. In some of the older computer systems still to be found in use, programs are stored on paper tape (and are then read by a tape reader) or on program cards. The latter type incorporate cards with coded holes patterns that are read by special card reading machines.

VARIABLE AND FIXED DATA

Variable data used in computers, by its obvious need to be stored and recalled or altered at any time required, must be stored in RAM form, although, depending on the application, it may additionally be temporarily saved on magnetic tape or disk.

Fixed data used in computers would be normally put into PROM to enable easy changes to be made at later dates. Alternatively it could also be put into disk form or magnetic tape form and 'Called' as required. It is also possible that it would be incorporated into either the operating system, the application data or the program, or any combination of these.

BINARY NUMBERS

Binary numbers which are used in computing, work to a base of 2. That is to say, they have only two figures in use, '0' and '1', which, as we have seen before, represent low and high respectively. Therefore, numbers written adjacently in binary form are a factor of 2 apart. For example, 1011 is equivalent to $(1 \times 8) + (0 \times 4) + (1 \times 2) + (1) = (1 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (1 \times 2^0) = 11$ in decimal. We can therefore, as in decimal or any other base system, write down any number we wish, in this case by a series of '0's and '1's. Try the following exercise:—

Exercise 2

(a) Convert 736 octal (base of 8) to its decimal equivalent.

(B) Convert 348 octal (base of 8) to its decimal equivalent.

(c) Convert 1011101 binary (base of 2) to its decimal equivalent.

(d) Convert 1101 binary (base of 2) to its decimal equivalent.

(e) Convert 1101 binary (base of 2) to its octal equivalent.

Now, in the description above, we have stated whether a number is to base 10, 8 or binary by giving the numbers followed by the word 'decimal', 'octal' or 'binary' respectively. There is another way to give this information. We simply give the numbers a suffix which is the base number. Hence:

836_{10} = 836 decimal
235_8 = 235 octal
101_2 = 101 binary

Sometimes the suffix is omitted completely in which case great care must be taken to remember which base is being used. Obviously, 836 decimal would not be the same as 836 octal.

BINARY CODED DECIMAL (BCD)

Let us consider, as an example, the number 50 (decimal). Now, in binary form, this would be equivalent to 110010 (binary), since 50 = 32 + 16 + 2 in decimal. Now looking at this binary number, let us encode it as a number of 4 bit words, and since our word here has only 6 bits, give it two extra '0's so that we can have two 4 bit words thus:

0011,0010

If we now look at each of the two words in turn and convert each to decimal form. From the above code we get 3,2, which we put together to say 32, this being the Binary Coded Decimal equivalent of 50 decimal and 110010 binary.

Why do we say 'Binary Coded Decimal'? Well, we are giving a code for a numbering system and that code utilises numbers from the decimal system. It follows therefore that, in Binary Coded Decimal, we can only represent numbers from 0 decimal (0000 binary) up to 9 decimal (1001 binary) therefore, for example, 999 binary coded decimal would be equivalent to 100110011001 in binary form, which in turn could be converted to 2457 in decimal form (2048 + 256 + 128 + 16 + 8 + 1).

From what we have said above, that binary coded decimal only uses the figures 0 to 9, it should become obvious that it is an inefficient number code, since there is a four bit code in use that does not utilise the equivalents of 10 to 15 (which are 1010 to 1111). Nevertheless it does allow some contraction of the size of the written numbers for either binary or decimal. For example, the binary numbers 1001001001010111, which contain 16 bits, are equivalent to 37463 in decimal, which uses 5 digits. However, breaking the 16 bits into 4 groups of 4 bits, we get, in BCD, 9257 which utilises only 4 digits.

HEXADECIMAL

The term 'hexadecimal' is quite often used in computer magazines and sometimes electronics journals and is the name given to the number system to the base 16. Now, we do not have any figures which signify the values above 9 and so, for hexadecimal systems, we use letters as well as numbers. Below are listed the hexadecimal equivalents of the decimal numbers 0 to 20, together with the binary equivalent.

Notice the pattern for the hexadecimal numbers. Since a base of 16 is used, we have 0 to 9 as in decimal, then we use the letters A to F for the 10 to 15 numbers. If we exceed 15 then the last significant column is zeroed and the next column assumes an increment. In this case 0 is increased by 1 to 1. Therefore, as with any other base of numbers, we can give any number we wish, but by using numbers 0 to 9 and letters A to F. Hence, 2A3 is equivalent to $(2 \times 16^2 + 10 \times 16^1 + 3 \times 16^0) = 512 + 160 + 3 = 675$ in decimal. Try some more exercises:

Decimal	Binary	Hexadecimal
0	00000	00
1	00001	01
2	00010	02
3	00011	03
4	00100	04
5	00101	05
6	00110	06
7	00111	07
8	01000	08
9	01001	09
10	01010	0A
11	01011	0B
12	01100	0C
13	01101	0D
14	01110	0E
15	01111	0F
16	10000	10
17	10001	11
18	10010	12
19	10011	13
20	10100	14

Table showing the Hexadecimal equivalent of decimal numbers.

Exercise 3

(a) Give the BCD equivalent of 01001001 binary.

(b) Give the decimal equivalent of 01001001 binary.

(c) Give the hexadecimal equivalent of 01001001 binary.

BINARY ADDITION

Let us first consider the addition of two decimal numbers, say 46 and 73:

46 + 73 = 119

We first of all say 6 + 3 = 9. This is equivalent to a number less than 10 (which is the base) so we write down 9 as part of our answer. We then say 4 + 7 = 11. This is 1 more than 10 so we write down the 1 as part of our answer and, because we have 'carried' a 10, we must write down a 1 in our next column of numbers.

The method is exactly the same that we use for binary numbers, but remembering that we are working to base of 2 instead. Let us consider the addition of binary numbers 111 and 110:

110 + 111 = 1101

As before, we start by adding the numbers in the least significant column. In this case 0 + 1 = 1. Write it down, since it is 'less than 2'. Next we add the two middle figures together 1 + 1 = 0 with a carry of 1 which is added to the most significant bit. The 0 is written down. In the third column we have 1 + 1 + 1 (remember we have a carry 1 also). This is best done in two parts. Now 1 + 1 = 0 with a carry 1, which is passed onto the next column. We then say 0 + 1 (i.e.: the 0 we have just obtained + the carry from column 2) is equal to 1. We then write down this 1. In the fourth column, we only have the carry 1 from column 3 so we write it down. Our answer is then 1101.

Let us check our answer. Convert each sum to be added and convert to decimal, 110 = 6 and 111 = 7. Now 6 + 7 = 13. Our answer from the binary addition is 1101 which is, of course, equivalent to 13 in decimal, so our answer is correct.

It does seem a lengthy explanation for what is really quite simple but the rules to follow are quite straightforward:

0 + 0 = 0.
0 + 1 = 1.
1 + 1 = 0 carry 1.
1 + 1 + 1 = 1 carry 1.

BINARY SUBTRACTION

Binary subtraction is not quite as easy as addition, but nevertheless it can easily be worked out by comparing with decimal subtraction. Consider 784–366 in decimal:

$$784 - 366 = 418$$

First of all we say 4 – 6 'won't go'. So we add 10 to the 4, to make 14 and then say 14 – 6 = 8. Write down the 8. We have 'borrowed' a 10 from column 1 so we must 'return' it to column 2 by adding 1 to the figure on the bottom line. We don't return a 10 since there is a factor of 10 between columns. We then say 8 – 7 = 1. Write it down. (Remember the 7 is 6 + 1 'returned'.) We then say 7 – 3 = 4, which we write down.

Above we are using base of 10. In binary we are using base of 2. Otherwise the rules are similar. Consider the subtraction 110 – 101, in binary.

$$110 - 101 = 001$$

First we say 0 – 1 'won't go', so we add 2 (since we have a base of 2) to the top figure of the first column. Then 2 – 1 = 1. Write this down. Since we have 'borrowed' a 2 we must 'return' it to the middle column, but we only 'return' a 1, not a 2, since there is a factor of 2 between columns. We therefore add this to the 0 on the bottom line. We then say 1 – 1 = 0. Write down a 0. In the next column we say 1 – 1 = 0. Write it down. Therefore, our answer is 001, which is 1 in decimal.

As a check, convert to decimal values and see what the answer in decimal would be. 110 = 6 and 101= 5, with 6 – 5 = 1, giving the correct answer.

OCTAL ADDITION AND SUBTRACTION

In octal addition and subtraction we observe the same rules yet again, but we must remember that we are working to a base of 8.

HEXADECIMAL ADDITION AND SUBTRACTION

Hexadecimal again carries the same set of rules as those above, but here a base of 16 is used. It is not so straightforward since we are trying to add or subtract letters, not numbers, in some cases. As an example, consider 5A3 + 27A in hexadecimal.

$$5A3 + 27A = 82D$$

We must first add 3 + A. This is best done by remembering that A is equivalent to 10 in decimal, so that 3 + 10 = 13. 'Convert' this back to hexadecimal to give D, which we write down. We then have to add A + 7. Convert the A to decimal, to give 10 + 7 = 17. Now this is 2 more than F, so write down the 2 and carry 1 to the next column. Finally 5 + 2 + carry 1 = 8. So our answer is 82D. Similar mathematical rules apply for hexadecimal subtraction, but take care with the base of 16. Note that a number to the hexadecimal code is sometimes written either preceded by a $ or with an H after. (For example 30H = $30.)

The advantages of hexadecimal are numerous. Firstly it is an efficient code. Secondly a direct conversion to binary is possible. (For example, $3AE = 3 \times 16^2 + 10 \times 16^1 + 14 \times 16^0 = 942$ decimal.) Thirdly it is of great use in the 'bus system', to be explained later, used by microprocessors. Also, as previously mentioned, because a large base is used, compression of numbers is available. (E.g.: 65535 in decimal carries 5 digits whereas its equivalent in hexadecimal, FFFF, carries only 4 digits/characters.)

CODES USED IN NUMBERING SCHEMES

There are several coding schemes used, some of which are set out below.

ASCII (American Standard Code for Information Interchange)

This is a universally accepted code for the transmission of data of an alphanumeric nature. It is a 7-bit code which gives a total of $2^7 = 128$ characters. It is widely used by teleprinters (and computers which 'talk' to each other) and also is used by peripherals and computers in communication to each other. The code allows all upper and lower case letters, together with numbers and certain 'control characters' and special characters. Some examples are set out below:

Character	Binary	Hex.
0	0110000	30
1	0110001	31
2	0110010	32
3	0110011	33
9	0111001	39
A	1000001	41
B	1000010	42
C	1000011	43
LINEFEED (LF)	0001101	0D
@	1000000	0A
CARRIAGE RETURN (CR)	0001010	40

Some examples of the ASCII code used by computers and peripherals.

EXCESS-3 CODE

This code is quite easily achieved by adding 3 to the standard BCD code. For example:

Number	BCD	Excess-3
0	0000	0011
1	0001	0100
2	0010	0101
3	0011	0110
4	0100	0111
5	0101	1000
6	0110	1001
7	0111	1010
8	1000	1011
9	1001	1100

The Excess-3 code.

Now, if an imaginary line is drawn between 4 and 5 it is seen that there is an 'inverse symmetry' at each side of this line. For example, looking at 4, which has an excess-3 code of 0111, the inverse of this is 1000, which is the excess-3 code of 5 at the other side of the line. Hence it is said to be self-complementing. Arithmetic can be performed on excess-3 coded numbers providing certain rules are carried out. These will not be explained here but they involve adding or subtracting 3 from the answer of any arithmetic, depending on whether there is a carry or not available.

Certain arithmetic processes are available and are used to make life easier for computers when carrying out calculations, and also to speed up the process of calculation. These processes are described below:

ONES' COMPLEMENT

Ones'-Complement is often used in mathematical processes. This is simply the taking of each bit in turn in a word and inverting. Thus a '0' becomes a '1' and a '1' becomes a '0'. For example: Form the 1's complement of 01010111. This simply alters to 10101000.

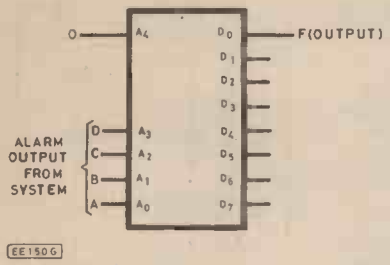
TWOS' COMPLEMENT

Two's-Complement is formed by taking the 1's complement of a number and then adding 1. For example: Form the 2's complement of 01010111. This becomes, in 1's complement 10101000 (as before). Adding 1 gives 10101001, which is the 2's complement.

In this article, we have considered certain number and coding systems and types of arithmetic used primarily by computers. In the next article in the series we shall consider the systems which utilise such numbering and coding techniques and the arithmetic processes mentioned, the systems with which we are concerned being the computers themselves. We will be looking at the basic formation of computers, including microprocessors and will consider simple design techniques, with an exercise in designing a microprocessor-based system. An introduction to microprocessor programming techniques (software only) will be included, which should provide a basis for further learning and research.

Answers to Exercises.

Exercise 1



The 32 × 8-bit EPROM used in the alarm circuit to give the required output. The unused outputs D1 to D7 may be used for other purposes such as extra functions. Also A4 may be used to take full advantage of the 32 × 8-bit EPROM.

Truth Table showing the alarm output

Alarm Outputs					Required Function	Data Word Addressed
A	B	C	D	E	F	D0(D1–D7)
0	0	0	0	0	0	0 XXXXXXX
1	0	0	0	0	0	0 XXXXXXX
0	1	0	0	0	0	0 XXXXXXX
1	1	0	0	0	0	0 XXXXXXX
0	0	1	0	0	0	0 XXXXXXX
1	0	1	0	0	0	0 XXXXXXX
0	1	1	0	0	0	0 XXXXXXX
1	1	1	0	0	1	1 XXXXXXX
0	0	0	1	0	0	0 XXXXXXX
1	0	0	1	0	0	0 XXXXXXX
0	1	0	1	0	0	0 XXXXXXX
1	1	0	1	0	1	1 XXXXXXX
0	0	1	1	0	0	0 XXXXXXX
1	0	1	1	0	1	1 XXXXXXX
0	1	1	1	0	1	1 XXXXXXX
1	1	1	1	0	1	1 XXXXXXX

'X' = 'DON'T CARE'

In the next article, we will be taking a look at computer design and basic software techniques.

Exercise 2

(a). $736_8 = (7 \times 8^2) + (3 \times 8^1) + (6 \times 8^0) = (7 \times 64) + (3 \times 8) + (6 \times 1) = 478$ decimal.

(b). $348_8 = (3 \times 8^2) + (4 \times 8^1) + (8 \times 8^0) = (3 \times 64) + (4 \times 8) + (8 \times 1) = 232$ decimal.

(c). $1011101 = (1 \times 2^6) + (1 \times 2^4) + (1 \times 2^3) + (1 \times 2^2) + (1 \times 2^0) = 64 + 16 + 8 + 4 + 1 = 93$ decimal.

(d). $1101 = (1 \times 2^3) + (1 \times 2^2) + (1 \times 2^0) = 8 + 4 + 1 = 13$ decimal.

(e). $1101 = 13$ decimal $= (1 \times 8^1) + (5 \times 8^0) = 15$ octal.

Exercise 3

(a). 01001001 = 0100,1001 = 49 in BCD.

(b). 01001001 = (64 + 8 + 1) = 73 in decimal.

(c). 01001001 = 73 in decimal $= (4 \times 16^1 + 9 \times 16^0) = 49$ in hexadecimal.

Note that the answers to (a) and (c) are identical. This will only happen when a BCD equivalent can be given. For example, if the figures in binary were 10011111 then no BCD value could be given since the last 4 significant are greater than 9. However, the hexadecimal equivalent would be 9F.

COUNTER INTELLIGENCE

BY PAUL YOUNG

I would first like to thank those readers who were kind enough to write and enquire why my column failed to appear in the November issue. Poor old Young was visibly shaken, when I noticed my name was missing. "Rumbled, after ten years" was my comment. However, it turned out that there was too much material for the magazine to accommodate.

Acoustic Comment

I am sure most electronic enthusiasts go through a Hi Fi phase, and it naturally follows that they would at the same time become interested in acoustics. Ruminating about it a few days ago, it occurred to me that acoustics have gone through three distinct stages in the last hundred years.

Stage one, was the period prior to World War Two, when the science of acoustics hadn't even been thought of. When an architect designed a building, he had no idea whether acoustically it would be good or bad.

At one end of the scale, you had the good old Queen's Hall, which was almost perfect, due, I was informed, to the auditorium being shaped like the end of a violin. Be that as it may, I can personally vouch for its excellence, having enjoyed many a Promenade Concert there. Regretfully it was destroyed by the Luftwaffe during the Blitz. I expect Sir Thomas Beecham attributed this to the Germans not liking the way Sir Henry Wood interpreted their composers, but I must admit this is pure conjecture on my part. At the other end of the scale, you have the Albert Hall, which has this dreadful echo, and to actually quote Sir Thomas Beecham this time, he said, "It was the only place in the world, where a British composer would hear his work performed more than once."

At stage two you come to the post war period, and by now acoustics were an established science. You have a splendid example of this in the Festival Hall, designed to be acoustically perfect, whether full or empty.

Finally you come to the third stage, where, or so it appears to me, the building is constructed without any thought given to the acoustics at all, and its faults are compensated by sound reinforcement. I recently had the opportunity of witnessing this type of approach having been invited to attend the opening of a new ice rink. A grand affair it was, and everything was perfect, except for one thing, no one could understand a word of the announcements.

I contacted the management next day, and they put me in touch with the engineers who installed the system. I spoke to the head of the firm, and he told me they had spent several days carrying out tests and fitting microphones and speakers where they were required. When the final adjustments had been made, it was almost perfect. Unfortunately, a day or two before the opening along comes a disc jockey who alters all the controls and the result is cacophony. I suppose the thought strikes me, that, after shooting the disc jockey surely the manufacturers should make provision for locking all the vital controls?

Hi Fi Short Cuts

To demonstrate that the subject has a lighter side, let me recount the experience I had with a hi fi customer several years ago. He attributed the lack of perfection of his hi fi to the acoustic properties of his living room. What was happening, he explained, was that the sound bounced back off the wall and landed here, and he pointed to indicate a position at the base of his neck.

Realising that I was dealing with someone who ought to have been certified long ago, I decided it was safest to try and humour him. "What did you do then," I asked, trying to appear eager to hear his words of wisdom. "Oh! I soon got round that all right, I cut four inches off the legs of all the chairs."

Suppressing my astonishment, I asked, "And did that cure it?" His expression clouded over. "No, not entirely, especially in the higher register."

Struggling to keep a straight face, I asked him, "And what did you do then?"

"Oh! curing that was even simpler, I knocked the wall down!!"

Computer Tale

I do sometimes get annoyed at the way computers are used. Calling at an electrical wholesaler the other day I was told that I couldn't be supplied with any order less than £3, as each entry on the computer costs the firm £2. I accepted this. I was then informed that the order had to be fed into the computer before I could be served and twenty minutes later I was still waiting.

I was interested to see that the Fredkin Foundation of Boston, Massachusetts, is offering $100,000 to the first person who can write a computer program which subsequently makes a genuine mathematical discovery. I don't like to be dogmatic on any subject, particularly electronics, but I would wager that their money is safe for all time.

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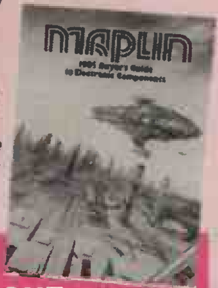

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