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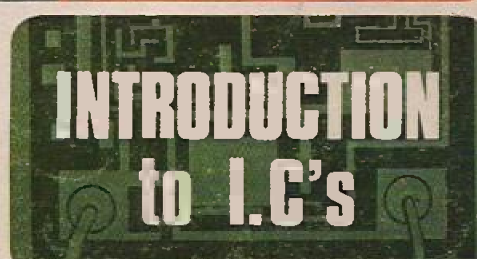

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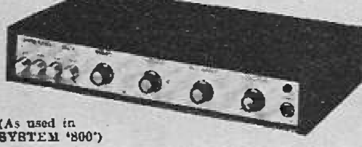
PREMIER 800 STEREO AMPLIFIER



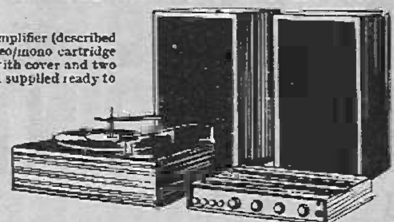
(As used in SYSTEM '800')

A truly high quality stereo amplifier—compare the specification, compare the price. Output: 5 watts per channel. Frequency response: 30–20,000 Hz — 2 db. Distortion: 1% Output Impedance 8 ohms nom. Inputs equalised to R.I.A.A. Magnetic 4mV. Ceramic 100mV. Tuner 100mV. Tape 100mV. Tape out 150mV. Din sockets for inputs and outputs. Controls: Bass, Treble. Volume, Balance, Selector. Mono / Stereo switch. Stereo headphone socket. Attractive slim line design teak cabinet with aluminium front panel. Size 12¼" x 6¼" x 2¼"

ONLY **£17·85** Carr. 50p.

PREMIER HI-FI STEREO SYSTEMS

SYSTEM 'ONE'



Consists of the Premier 800 Mk II all transistor stereo amplifier (described left) Garrard auto/manual record player unit fitted stereo/mono cartridge with diamond stylus and mounted in teak finish plinth with cover and two cloth front loudspeaker systems. Absolutely complete and supplied ready to plug in and play. The 800 Mk II amplifier has an output of 5 watts per channel with inputs for ceramic and magnetic pick-up, tape and tuner also tape output socket and headphone socket. Controls: Bass, Treble. Volume, Balance, Selector. Mono/Stereo switch. Headphone socket. Power on/off. Teak finish cabinet with aluminium front panel. Size: 12¼in. × 6¼in. × 2-in.

£43·00

Carr. £1·75

SYSTEM 'TWO'

As above but with slotted front teak finish loudspeakers. Garrard SP25 Mk. III and magnetic cartridge

£49·50

Carr. £1·75

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Gives the best possible reproduction of records, radio and tape at a reasonable price.

Fitted with all the controls and facilities you're ever likely to want, the Paragon gives you a degree of sophistication that is usually only found with amplifiers costing twice its price. It has bass and treble slide controls, volume and balance knobs, and eight push-buttons. There's also a standard stereo jack socket on the front panel, plus a ceramic/magnetic cartridge switch and a mains outlet socket on the back panel.

Specification: 10+10 watts into 8 ohms. Power/frequency response: 0dB 10 watts into 8 ohms - 3dB 20Hz - 25KHz. Distortion typically less than 0·25%. Inputs for Magnetic phono (4mV) Ceramic phono (66mV) Radio/Tape(100mV). High and low filters. Teak finish cabinet. Size: 12¾" × 5¾" × 10½".

£27·50 P. & P. 50p.

PREMIER STEREO SYSTEM '64'

Consists of the Premier Paragon Stereo Amplifier. Garrard SP25 III in teak finish plinth with cover and fitted Goldring G800 stereo magnetic cartridge plus a pair of Marsden Hall Annex 100 Loudspeaker Systems. Complete with Free leads and plugs. **£64** Carr. & Insurance £1·75

MSB-3002 Stereo Tuner Amplifier

£35·00

P & P 50p

Fantastically low-priced stereo tuner amplifier covering LW, MW & VHF with built-in decoder for stereo reception. Output 2 x 4 watts RMS. Input for ceramic or crystal pick-up. Output for tape recorder. Switched A.F.C. Stereo headphone socket. Controls—volume, tone, balance, selectors and tuning. Attractive walnut finish cabinet with 2 matching speakers.

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All transistor stereo amplifier mounted into teak finish plinth with cover and Garrard 2025 T/C autochanger and a pair of matching teak finish cloth front speaker systems.

- ★ Output 4 watts rms per channel.
- ★ Separate volume, bass, treble and balance controls.
- ★ Stereo/Mono ceramic cartridge.
- ★ Tape/Tuner input and Tape output sockets.
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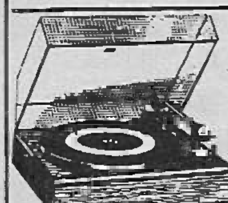
15 foot curly cord. £1·50. P. & P. 10p.



GARRARD SP25 MK III SINGLE RECORD PLAYER FITTED GOLDRING 800 MAGNETIC STEREO CARTRIDGE. COMPLETE IN TEAK PLINTH WITH COVER.

PREMIER PRICE **£17·50** P. & P. £1

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- ★ Fast forward
- ★ Eject
- ★ 3 watts per channel output
- ★ 12v DC negative earth
- ★ Speaker impedance 8 ohms
- ★ Measures 175mm. D. × 152mm. W. × 50mm. H.
- ★ Matching pair of wedge-shaped speakers.

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£12.64 P. & P. 25p

MODEL 630 MULTITESTER

Ranges: DC Voltages: 0, 3, 15, 60, 300, 600, 1,200V (30,000 ohms/V). AC Voltages: 0, 6, 30, 120, 600, 1,200V (15,000 ohms/V). DC Current: 0, 0·03, 3, 30, 300mA. Resistance: 0, 16k, 160k, 1·6M, 16M ohms (10, 100, 10k, 100k ohms at centre scale). Decibels: —20 to +63db.

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Compares with meters costing double its price. Features large easy-to-read meter, unusually high sensitivity—wide choice of ranges. With test leads, batteries and manual. Size: 4¾" × 3½" × 1". Ranges: DC Voltages: 5, 25, 50, 500, 2,500V, (20,000 O.P.V.). AC Voltages: 10, 50, 100: 500, 1,000V (10,000 O.P.V.). DC Current: 50μA, 2·5, 250mA. Resistance: 6k, 6M ohms. Decibels —20 to +22 db. Capacitance: 10μF to 0·100μF, 0·100μF to 0·1μF. Optional leather case. **£8.85** P. & P. 25p

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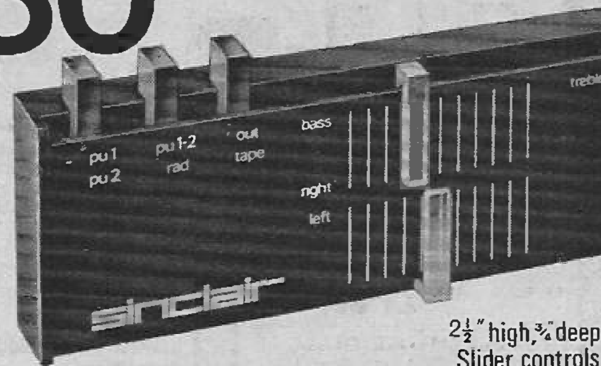
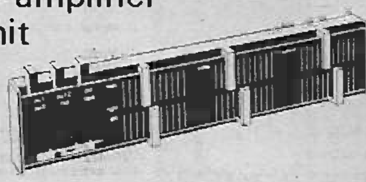


Living with hi-fi takes on new meaning with Project 80 modules. They can be assembled virtually anywhere, creating opportunities to install systems hitherto only dreamed about and never before made practical. Quality and reliability are everything you could wish for. Units are mounted by 6BA bolts at rear passing through drilled holes, cases are in black with white embellishment.

$2\frac{1}{2}$" high, $\frac{3}{4}$" deep
Slider controls
New circuitry

Stereo 80 pre-amplifier and control unit

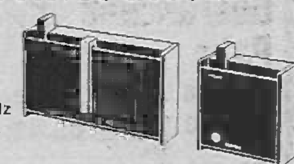


Each channel has independent tone and volume slider controls enabling exceptionally good environmental matching to be obtained. A virtual earth input stage forms part of the up-dated circuitry which includes generous overload margins. Clear instructions with template are supplied.

Size – 260 × 50 × 20mm ($10\frac{1}{4} \times 2 \times \frac{3}{4}$ ins)
Inputs – Mag. P.U. 3mV RIAA corrected; Ceramic P.U., Radio, Tape
S/N ratio – 60db
Frequency range – 10Hz to 25KHz ± 3dB
Power requirements – 20 to 35 volts
Outputs – 100mV + AB monitoring for tape
Controls – Press button for tape, radio and P.U. Sliders for Volume, Bass and Treble.

R.R.P. £11.95 +£1·19 V.A.T.

Project 80 FM tuner and stereo decoder

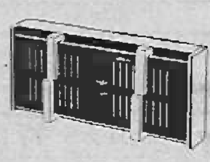


FM Tuner
Size – 85 × 50 × 20mm
Tuning range – 87.5 to 108 MHz
Detector – I.C. balanced coincidence.
AFC – Switchable
One 26 transistor I.C.
Twin dual varicap tuning
Distortion 0.2% at 1 KHz for 30% modulation
4 pole ceramic filter in I.F. section
Sensitivity – 4 microvolts for 30dB quieting
Output – 300mV for 75 KH deviation

Decoder–
With gallium arsenide tuning beacon and 19-transistor I.C
Size – 47 × 50 × 20mm

FM tuner R.R.P. £11.95 +£1·19 V.A.T.
Decoder R.R.P. £7.45 +0·45p V.A.T.

Project 80 active filter unit



Size – 108 × 50 × 20mm ($4\frac{1}{4} \times 2 \times \frac{3}{4}$ins)
Voltage gain – minus 0·2dB
Frequency response – 36Hz to 22KHz. controls minimum
Distortion – at 1 KHz – 0·03% using 30V
HF cut off (scratch) – 22KHz to 5·5KHz. 12dB/oct. slope
L.F. cut off (rumble) – 28dB at 70Hz. 9dB/oct. slope

R.R.P. £6.95 +0·69p V.A.T.

Z.40 & Z.60 power amplifiers

Z.40
Size – 55 × 80 × 20mm
Input sensitivity – 100mV
Output – 15W RMS continuous 8 Ω (35V).
Frequency response – 10Hz – 100KHz ± 1dB
Signal to noise ratio – 64dB
Distortion – less than 0·1% at 10W into 8 Ω
Power requirements – 12-35 volts

R.R.P. £5.45 +0·54p V.A.T.

Z.60
Size – 55 × 98 × 20mm
Input sensitivity – 100 250mV
Output – 25W RMS 8 Ω (45V).
Distortion – typically 0·03%
Frequency response – 10Hz to more than 200KHz ± 1dB
S/N ratio – better than 70dB

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PZ.6 35V stabilised
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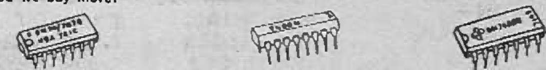

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SN7428N	0·43	0·43	0·37
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SN7433AN	0·57	0·57	0·50
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SN7438N	0·43	0·43	0·37
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SN7473N	0·44	0·41	0·37
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SN7476N	0·45	0·36	0·32
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SN7493N	0·75	0·70	0·63
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SN74121N	0·57	0·57	0·50
SN74122N	0·80	0·80	0·70
SN74123N	1·44	1·44	1·28
SN74125N	0·69	0·69	0·60
SN74126N	0·69	0·69	0·60
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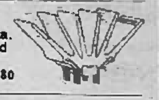
ACY39	65p	BCY71	20p	LM309K	1·87	OC77	55p	2N697	15p	2N3866	75p
AD149	50p	BCY72	13p	MAT121	25p	OC81	28p	2N706	10p	2N3903	15p
AD161	39p	BD124	80p	MJE340	50p	OC83	25p	2N930	20p	2N4002	14p
AD162	39p	BD131	45p	MJE520	65p	OC140	65p	2N987	45p	2N4126	15p
AF117	20p	BF115	22p	MJE3055	75p	OC170	25p	2N1132	25p	2N4871	35p
AF118	50p	BF180	33p	MPF105	46p	OC200	55p	2N1304	22p	2N5457	36p
AF139	33p	BF194	13p	NKT217	45p	OC202	90p	2N1613	20p	28001	3·00
AF186	40p	BFX13	25p	NKT404	80p	OCP71	1·00	2N1671	1·00	28026	8·90
AF239	44p	BFX34	55p	OA5	60p	ORP12	55p	2N2147	75p	28303	70p
ASY27	30p	BFX88	22p	OA81	10p	ORP60	45p	2N2160	69p	40250	45p
BA115	10p	BFY50	20p	OA200	8p	P346A	20p	2N2926	10p	40361	45p
BAX13	5p	BFY51	20p	OA202	10p	TIL209	35p	2N3053	20p	40362	40p
BC107	15p	BFY64	45p	OC16	85p	TIP29A	49p	2N3054	45p	40408	50p
BC108	15p	BFY90	75p	OC20	1·25	TIP30A	58p	2N3055	45p	40486	75p
BC109	15p	BLY36	6·25	OC28	65p	TIP31A	61p	2N3440	50p	40636	1·00
BC109C	14p	BSX20	15p	OC35	55p	TIP41A	74p	2N3442	1·10	40430	85p
BC113	16p	BU105	2·20			TIP42A	90p	2N3525	80p		
BC147	12p	BY100	15p			TIS43	28p	2N3614	59p		
BC169C	14p	BY127	15p			V405A	25p	2N3702	11p		

TBA800 5 WATT I.C.

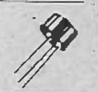
Suitable alternative to SL403D. 5/30 volt operated. 8/16 ohm 5 watt output.
With circuits and data £1·50

Sinclair IC12



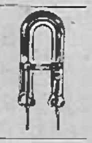
with circuits and data. 6 watt IC with printed circuit board
28 volt operated £1·80

ZN414 IC



Integrated circuit radio as featured by many magazines (PW Jan. 73 Reprint Ref. No. 19 for 10p) £1·20

STROBE TUBE



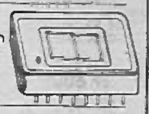
ZFT4A/XTF2. Suitable for Dec. '73 Pract. Electronics £2·50

ST2 (D32) DIAC 25p
CRS1/40 SCR 45p

Ultrasonic Transducers

Operate at 40Khz up to 100 yds. Ideal remote switching and signalling. Complete with data transmitter and receiver new I.C. circuits.
Per pair £5·90
TA960 IC with socket £1·80

3015F 7 SEG.



I.C. size complete with data price £1·70 each (digital clock circuits ref. No. 31, 15p)

TRANSISTORS SPECIAL OFFER

2N3055
25 ......47p ea
100 ......42p
500 ......39p
1000 ......34p

AF117
25 ......15p ea
100 ......13p
500 ......12p
1000 ......10p

BY127
25 ......12p ea
100 ......10p
500 ...... 9p
1000 ...... 8p

OC35
25 ......46p ea
100 ......42p
500 ......38p
1000 ......34p

ZENER DIODES

400 m/w BZY88/BZX83. From 3·3 volt – 33 volts 10p each

1·3 watts 5% Miniature Tubulars IN4700 series. From 3·3 volt – 33 volt 18p each.

10 watts. Stud Mounting. ZS series 6·8 volts – 100 volts 5% 40p each.

LINEAR I.C.

702C (T05)	75p
709C (T05)	39p
709C (D.I.L.)	39p
723C (T099)	90p
723C (D.I.L.)	90p
728C (D.I.L.)	45p
728C (T099)	45p
741C (T05)	50p
741C (D.I.L.)	50p
747C (T099)	£1·0p
748C (D.I.L.)	61p

SILICON RECTIFIERS

1 amp series IN4001 to IN4007 From 6p ea
1·5 amp PL4001 to PL4007 From 8p ea
3 amp PL7001/IN5400 From 14p ea
Send for full list 36

MORE OF EVERYTHING AT
HENRY'S
See pages 74 & 75 and Back Cover of this magazine.
BEST VALUE

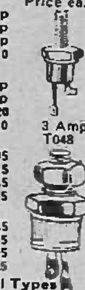
Semi-Conductor QUANTITY DISCOUNTS

10% 12+, 15% 25+, 20% 100+

Any one type except where quantity discounts shown.

Min. order £1·00 please.

TRIACS – Stnd. mounting with accessories



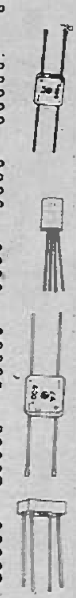
3 Amp T048

Type	P.I.V.	1–11 Price ea.
3 AMP RANGE		
SC35A	100v	80p
SC35B	200v	85p
SC35D	400v	90p
SC35E	500v	£1·20
6 AMP RANGE		
SC40A	100v	90p
SC40B	200v	95p
SC40D	400v	£1·20
SC40E	500v	£1·50
10 AMP RANGE		
SC45A	100v	£1·05
SC45B	200v	£1·15
SC45D	400v	£1·45
SC45E	500v	£1·85
15 AMP RANGE		
SC50A	100v	£1·45
SC50B	200v	£1·65
SC50D	400v	£1·95
SC50E	500v	£2·25

TRIACS – Additional Types
40430 TRIAC (T066) 85p
40669 TRIAC (Plastic) 90p
40486 TRIAC (T05) 75p

NEW RANGES BRIDGE RECTIFIERS

FEATURES SMALL SIZE AND LOW COST Sizes are approx.



250M/A QUARTER AMP
B025/05 50 PIV 18p
B025/10 100 PIV 18p
¼ x ¼ x ¼" dia.

½ AMP 1-11 Pricing

Type	P.I.V.	Price ea.
B05/05	50v	20p
B05/10	100v	22p
B05/20	200v	23p
B05/40	400v	25p
B05/60	600v	27p

½H x ½L x 3/16" dia.

1 AMP P.I.V.

B1/05	50v	25p
B1/10	100v	25p
B1/20	200v	28p
B1/60	600v	30p

½H x ½L x 3/16" dia.

1 AMP P.I.V.

W005	50v	29p
W01	100v	30p
W02	200v	32p
W06	600v	35p

⅜ x ⅜" Tubular

2 AMPS P.I.V.

B2/05	50v	35p
B2/10	100v	40p
B2/20	200v	45p
B2/60	600v	50p
B2/100	1000v	55p

½H x ½L x 3/16" dia.

4 AMPS P.I.V.

B4/100	100v	55p
B4/200	200v	59p
B4/400	400v	65p
B4/600	600v	75p
B4/800	800v	£1·00

½H x ½L x 3/16" dia.

6 AMPS P.I.V.

B6/05	50v	65p
B6/10	100v	70p
B6/20	200v	80p
B6/40	400v	90p
B6/6x0	600v	£1·00

½H x ½L x 3/16" dia.

SILICON CONTROLLED RECTIFIERS

Type		1–11
ONE AMP (T05) P.I.V		
CRS 1/05AF	50v	30p
CRS 1/10AF	100v	30p
CRS 1/20AF	200v	35p
CRS 1/40AF	400v	45p
CRS 1/60AF	600v	55p
THREE AMP (T048)		
CRS 3/05AF	50v	40p
CRS 3/10AF	100v	40p
CRS 3/20AF	200v	45p
CRS 3/40AF	400v	55p
CRS 3/60AF	600v	65p
FIVE AMP		
CRS 5/400	400v	60p
SEVEN AMP (T048)		
CRS 7/100	100v	60p
CRS 7/200	200v	67p
CRS 7/400	400v	85p
CRS 7/600	600v	95p

All types offered subject to availability. Prices correct at time of press E. & O. E. 10% VAT to be added to all orders. UK post, etc. 15p. per order.

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EDGWARE ROAD, W2

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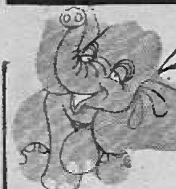
IRONS · TOOLS · VALVES · POT CORES MOST TYPES OF COMPONENTS
You need a catalogue! 55p post paid complete with Discount Vouchers



UK's LARGEST RANGE OF KITS & GADGETS

TEST EQUIPMENT

MULTIMETERS

(carr. etc. 30p)

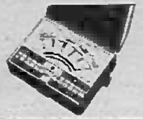
M210	20K/Volt Slimline	6·75
TLH33D	2K/Volt Robust	7·50
U437	10K/Volt Steel case. AC up to 40 KHz	4·95
U4324	20K/Volt with AC current ranges	8·00
AF105	50K/Volt	11·95
U4313	20K/Volt AC current. Steel case	10·50
U4341	Plus Built in transistor tester	10·50
Model 500	30K/Volt	9·95

OTHER EQUIPMENT

SE250B	Pocket Signal Injector	2·10 carr. 15p
SE500	Pocket Signal Tracer	1·70 carr. 15p
TE15	Grid Dip meter 440kHz–280mHz	15·00 carr. 30p
TE40	AC Millivoltmeter 1·2mHz	18·95 carr. 35p
TE65	28 Range valve voltmeter	19·95 carr. 40p
TE20D	120kHz–500mHz RF Generator	17·95 carr. 40p
TE22D	20Hz–200kHz Audio Generator	18·95 carr. 40p
SE350A	Deluxe Signal Tracer	12·50 carr. 20p
SE400	Volts/ohms/R-C sub./RF field/RF gen.	14·75 carr. 20p

New Revolutionary Supertester 680R

680R Multi-tester £18·50

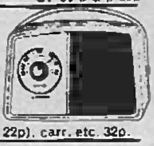


Accessories	
Transistor tester	11·00
Electronic voltmeter	18·00
Ampclamp	11·95
Temperature probe	11·95
Guass meter	11·95
Signal Injector	5·95
Phase Sequence	5·95
EHT Probe	5·95
Shunts 25/50/100A	4·50 each

A SELECTION OF INTERESTING ITEMS

C3025	Compact transistor tester	6·30 p & p 15p
E1300	Mono mag. cart. preamp.	2·75 p & p 15p
E1310	Stereo mag. cart. preamp.	4·67 p & p 25p
Easiphone telephone amplifier		7·95 p & p 25p
D1203	Teleamp. with PU coil	4·40 p & p 20p
LLt	Door Intercomm. and chime	7·95 p & p 25p
Chattalite (lights as you talk)		13·90 p & p 20p
1 Kw Dimmer/controller		3·00 p & p 10p
9" Twin spring unit For		3·30 p & p 15p
16" Twin spring unit Reverbs		6·85 p & p 25p
Car Tachometer Electronic		8·95 p & p 15p
VHF 105 Aircraft Band Corrector		4·50 p & p 15p
B2005 4 Ch. mic. mixer		3·75 p & p 15p
B2004 2 ch. Stereo mixer		5·95 p & p 15p
PK3 Kit. Etch your own printed circuits		£1·50 p & p 20p

BUILD THIS RADIO



Portable MW / LW radio kit using Mullard RF/IF module. Features MW — bandspread for extra selectivity. Slow motion tuning. Fibre glass PVC cabinet. 600MW output. All parts £7·98 (battery 22p). carr. etc. 32p.

EXCLUSIVE: SPECIAL OFFERS

MW/LW CAR RADIO
+ or − Earth with speaker and fixings. £6·50 carr./packg. 30p.

8 TRACK CAR STEREO
(− Earth) with speakers in Pods & fixings. £12·50 carr/packg. 40p.

HANIMAX HC1000
Battery cassette recorder. £10·50 carr/packg. 25p.

HANIMAX HC2000
Battery/Mains cassette recorder. £13·50 carr/packg. 30p

AKAI GXC40
Stereo cassette recorder. £59·95 carr/packg. 50p. Pair Akai ADM microphones. £6·95 carr/packg. 20p.

5 WAVEBAND PORTABLE TWIN SPEAKER RADIO.
FM/MW/SW/AIRCRAFT—PUBLIC SERVICES. £10·45 carr/packg. 30p.

PORTABLE CASSETTE TAPE PLAYER—
for car or carry around. £7·25 carr/packg. 20p.

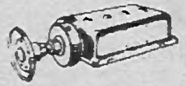
HANIMAX BC808 POCKET CALCULATOR WITH % KEY. £28·95.

SPECIAL PURCHASES

AVOMETER MOVEMENTS

AVO 8 or 9 50mA MOVEMENTS. Ex Brand New AVO's £3·50 Post 20p.

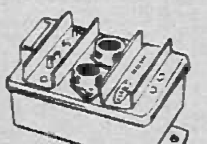
UHF TV TUNERS CHANNELS 21 TO 64



Brand new transistorised geared tuners for 625 Line Receiver IF output. £2·50. Post 20p.

EASY TO BUILD KITS BY AMTRON— EVERYTHING SUPPLIED

Model No.		
310	Radio control receiver	2·98
300	4-channel R/C transmitter	5·95
345	Superhet R/C receiver	5·95
455	AM signal generator	12·33
65	Simple transistor tester	1·40
115	8 watt Amplifier	3·90
120	12 watt amplifier	4·70
125	Stereo control unit	5·70
130	Mono control unit	3·60
605	Power supply for 115	4·55
610	Power supply for 120	4·55
615	Power supply for 2 x 120	5·73
230	AM/FM aerial amplifier	2·93
240	Auto packing light	5·90
275	Mic. preamplifier	6·08
570	LF generator 10Hz–1mHz	15·80
575	Sq. wave generator 20Hz–20Khz	14·60
590	SWR meter	12·85
620	NI-CAD Charger 1·2–12v	8·00
630	STAB Power supply 6-12v 0·25-0·1A	8·15
690	DC motor speed Gov.	2·87
700	Electronic Chaffinch	7·00
705	Windscreen wiper timer	6·80
760	Acoustic switch	10·75
780	Metal Detector (electronics only)	9·65
790	Capacitive Burglar alarm	6·85
835	Guitar preamp.	4·25
840	Delay car alarm	6·15
875	CAP. Discharge ignition for car engine (−Ve Earth)	13·15
80	Scope Calibrator	2·25
255	Level Indicator	6·15
525	120–160mHz VHF timer	11·30
715	Photo cell switch	7·70
795	Electronic continuity tester	4·30
860	Photo timer	13·25
871	Slide projector auto feed control	7·15
235	Acoustic Alarm for driver	7·60
465	Quartz XTAL checker	8·75
220	Signal Injector	2·30
390	VOX	15·50
432	Testakit	19·30
670	Buffer Battery Charger	6·55
885	Capacitive Contact Alarm	6·25
850	Electronic Keyer	18·75
820	Electronic Digital Clock	58·50



ALL KITS OFFERED SUBJECT TO STOCK AVAILABILITY

Prices correct at time of preparation. Subject to change without notice.

BUILD THIS TUNER

MW/LW Radio Turner to use with any amplifier. Features Mullard RF/IF module Ferrite aerial, built in battery. Excellent results. Size 7" x 2¼" x 3¾". All parts £4·85, carr. 15p.

MULTI-USE & RADIONIC KITS

10–1	10 Projects	3·60
50–1	10 Projects	8·00
150–1	150 Projects	13·20
Telephone Communicator		7·20
X20	20 (Elec.) Projects	4·95
X40	40 (radio) Projects	9·45

(carr./packing 40p)

All transistor circuits with hand books

All types offered subject to availability. Prices correct at time of press E & OE. 10% VAT TO BE ADDED TO ALL ORDERS. UK post etc. 15p per order unless stated.

GARRARD BATTERY TAPE DECK

GARRARD 2 speed 9 volt tape decks. Fitted record/play and oscillator/Erase heads. Wind and rewind controls. Takes up to 4" spools. Brand new complete with head circuits. £9·50 carr. 30p

TOP QUALITY SLIDER CONTROLS

60mm stroke high quality controls complete with knobs (post, etc. 15p any quantity).

Singles Log and Lin 5K, 10K, 22K, 50K, 100K, 250K, 500K, 1 Meg. 45p each.

Ganged Log and Lin 10K, 22K, 50K, 100K, 250K, 65p each. (Quantity discounts available)

Complete with knobs.

MARRIOT TAPE HEADS

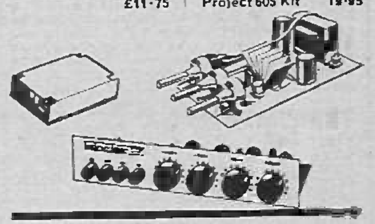
4 TRACK MONO or 2 TRACK STEREO
'17' High Impedance £2·00
'18' Med. Impedance £2·00
R730/E73 2 track mono Record/Erase low Imp. 75p pair.
Erase Heads for '17' and '18' 75p
'63' 2 track mono, Hi Imp. £1·75
'43' Erase Head for '63' 75p
(Post, etc. 15p any quantity).

SINCLAIR, MINIATURE AMPLIFIERS & TUNER/DECODER

AMPLIFIERS (carr., etc. 20p)

4-300, 0·3 watt 9 volt	1·75
104, 1 watt 9 volt	2·80
304, 3watt 9 volt	2·95
555, 3 watt 12 volt	3·10
E1208, 5 watt 12 volt	5·10
608, 10 watt 24 volt	4·10
410, 10 watt 28 volt	4·95
E1206, 30 watt 45 volt	9·95
E1210, 2½ + 2½ watts 12 volt	7·25
RE500, 5 watt IC mains operated Amplifier with controls	£6·30
SAC14, 7 + 7 watt Stereo with controls	£8·70
SAC13, 15 + 15 watt Stereo with controls	£11·75

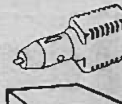
SINCLAIR (carr. 20p)
PROJECT 60
Z30 3·57 Z50 4·37
Stereo 60 Preamp. 7·97
PZ5 £3·97, PZ6 £6·37
PZ8 (for Z50) £4·77 (TRANS £2·95)
AFU £4·45
New SINCLAIR PROJECT 80
Stereo Preamp. 11·95
Audio Filter Unit 6·95
Z40 15 Watt Amp. 5·45
Z60 25 Watt Amp. 6·95
PZ5 Mod. for 1 on 2 Z40 4·98
PZ6 Mod. (S Tab) 1 on 2 Z40 7·98
PZ8 Mod. (S Tab) 1 on 2 Z60 7·98
TRANSFORMER FOR PZ8 2·95
Project 605 Kit 19·95



POWER SUPPLIES FOR EVERY PURPOSE

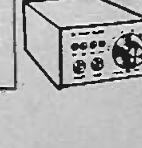
(All cased unless stated chassis)

470C 6/7½/9 volt 300 MA (includes Multi-Adaptor for Tape Recorders, etc.)	2·15 post 20p
Car Lighter Voltage Adaptors 300mA (State voltage 6v, 7½v, 9v)	1·95 ea. post 25p
SC202 3/6/7½/9 volt 400mA	3·35 carr. 30p
HC244R Stabilised version	4·35 carr. 30p
P500 9 volt 500mA	2·90 post 20p
P11 24 volt 500mA (chassis)	2·90 post 20p
P15 26/28 volt 1 amp (chassis)	2·90 post 20p
P1080 12v 1 amp (chassis)	4·25 post 20p
P1081 45v 0·9 amp (chassis)	7·50 post 20p
P12 4½–12 volt 0·4–1 amp	7·15 post 30p
SE101A 3/6/9/12 volt 1 amp (Stab.)	10·30 post 25p
RP164 6/7½/9/12 1 amp (Stab.)	10·20 post 30p



FIBRE OPTICS

0·01 Diam. Mono Filament £1·50 per 25 metre reel
0·13 Diam. 64 Fibres Sheathed. £1·00 per metre
SPRAYS 15mm Diam. Mares Tails £9·50.



Henry's RADIO LIMITED
EDGWARE ROAD, W2

SEE FACING PAGE FOR ADDRESSES

YATES ELECTRONICS (FLITWICK) LTD

DEPT. E.E., ELSTOW STORAGE DEPT.
KEMPSTON HARDWICK,
BEDFORD.

C.W.O. PLEASE. POST AND PACKING PLEASE ADD 10p TO ORDERS UNDER £2.

Catalogue which contains data sheets for most of the components listed will be sent free on request. 10p stamp appreciated.

Callers Welcome Mon. to Sat. 9 a.m. 5 p.m.

PLEASE ADD 10% VAT

RESISTORS

½W Iskra high stability carbon film—very low noise—capless construction.
⅓W Mullard CR25 carbon film—very small body size 7·5 x 2·5 mm.
⅛W 2% ELECTROSIL TR5.

Power watts	Tolerance	Range	Values available	Price 1–99	Price 100+
½	5%	4·7Ω–2·2MΩ	E24	1p	0·8p
½	10%	3·3MΩ–10MΩ	E12	1p	0·8p
⅛	2%	10Ω–1MΩ	E24	3·5p	3p
¼	10%	1Ω–3·9Ω	E12	1p	0·8p
⅓	5%	4·7Ω–1MΩ	E12	1p	0·8p
4	10%	1Ω–10Ω	E12	6p	5·5p

Quantity price applies for any selection. Ignore fractions on total order.

DEVELOPMENT PACK

0·5 watt 5% Iskra resistors 5 off each value 4·7Ω to 1MΩ.
E12 pack 325 resistors £2·40. E24 pack 650 resistors £4·70.

POTENTIOMETERS

Carbon track 5kΩ to 2MΩ, log or linear (log ¼W, lin ½W).
Single, 12p. Dual gang (stereo), 40p. Single D.P. switch, 24p.

SKELETON PRESET POTENTIOMETERS

Linear: 100, 250, 500Ω and decades to 5MΩ. Horizontal or vertical P.C. mounting (0·1 matrix).
Sub-miniature 0·1W, 5p each. Miniature 0·25W, 7p each.

TRANSISTORS

AC107	15p	AF126	20p	BF115	25p	OC42	12p	2N3707	12p
AC126	12p	AF139	32p	BF173	20p	OC44	12p	2N3708	10p
AC127	15p	AF178	32p	BF177	28p	OC45	12p	2N3709	11p
AC128	15p	AF180	40p	BF178	32p	OC70	12p	2N3710	11p
AC131	12p	AF181	40p	BF179	32p	OC71	12p	2N3711	11p
AC132	12p	BC107	12p	BF180	32p	OC72	12p	2N3819	32p
AC176	15p	BC108	12p	BF181	32p	OC81	12p	2N4062	12p
AC187	22p	BC109	12p	BF194	14p	OC82D	12p	2N4286	20p
AC188	22p	BC147	12p	BF195	14p	2N2646	60p	2N4289	20p
AD140	50p	BC148	12p	BF197	15p	2N2904	20p	40360	35p
AD149	45p	BC149	12p	BF200	32p	2N2926	10p	40361	35p
AD161	33p	BC157	14p	BFY50	20p	2N3054	58p	40362	40p
AD162	36p	BC158	14p	BFY51	20p	2N3055	60p	40408	40p
AF114	20p	BC159	14p	BFY52	20p	2N3702	13p	ZTX108	15p
AF115	20p	BC187	22p	BUY105	225p	2N3703	12p	ZTX300	15p
AF116	20p	BD131	75p	OC26	45p	2N3704	13p	ZTX302	20p
AF117	20p	BD132	75p	OC28	50p	2N3705	12p	ZTX500	15p
AF118	38p	BD133	75p	OC35	50p	2N3706	11p	ZXT503	20p

ZENER DIODES

400mW 5% 3·3V to 30V, 12p.

WIRE WOUND POTS. 3W, 10, 25, 50Ω and decades to 100kΩ, 35p.

DIODES

RECTIFIER

BY127	1250V	1A	12p
IN4001	50V	1A	7p
IN4002	100V	1A	8p
IN4004	400V	1A	8p
IN4006	800V	1A	10p
IN4007	1000V	1A	10p

SIGNAL

OA85	7p
OA90	5p
OA91	5p
OA202	7p
IN4148	5p
BA114	8p

SLIDER POTENTIOMETERS

86mm x 9mm x 16mm, length of track 59mm.

SINGLE 10K, 25K, 100K log. or lin. 40p.

DUAL GANG, 10K + 10K etc. log. or lin. 60p.

KNOB FOR ABOVE, 12p.

FRONT PANEL, 65p.

18 Gauge panel 12in x 4in with slots cut for use with slider pots. Grey or matt black finish complete with fixings for 4 pots.

BRUSHED ALUMINIUM PANELS

12in x 6in, 25p
12 in x 2½in, 10p
9in x 2in, 7p

THYRISTORS

2N5060	50V	0·8A	30p
2N5064	200V	0·8A	47p
106F	50V	4A	40p
106D	400V	4A	55p

ALUMINIUM BOXES

AB7	2½" x 5¼" x 1½"	50p	AB14	7" x 5" x 2½"	84p
AB8	4" x 4" x 1½"	50p	AB15	8" x 6" x 3"	108p
AB9	4" x 2½" x 1½"	50p	AB16	10" x 7" x 3"	122p
AB10	4" x 5¼" x 1½"	50p	AB17	10" x 4½" x 3"	108p
AB11	4" x 2½" x 2"	60p	AB18	12" x 5" x 3"	120p
AB12	3" x 2" x 1"	44p	AB19	12" x 8" x 3"	160p

HEATSINKS—REDPOINT

2W	24p	4W	45p	TO5 Clip	5p	TO1	Single	5p
3W	36p	6W	60p	TO18 Clip	5p	TO1	Double	8p

TRANSFORMERS All have 240V primary

MT30/2	0–12–15–20–24–30V	2A	£2·85
MT50/½	0–19–25–33–40–50V	½A	£1·90
MT50/1	0–19–25–33–40–50V	1A	£2·55
MT50/2	0–19–25–33–40–50V	2A	£3·50
MT60/½	0–24–30–40–48–60V	½A	£2·10
MT60/1	0–24–30–40–48–60V	1A	£2 80
MT60/2	0–24–30–40–48–60V	2A	£3 80

MULLARD POLYESTER CAPACITORS C296 SERIES

400V: 0·001µF, 0·0015µF, 0·0022µF, 0·0033µF, 0·0047µF, 2½p. 0·0068µF, 0·01µF, 0·015µF, 0·022µF, 0·033µF, 3p. 0·047µF, 0·068µF, 0·1µF, 4p. 0·15µF, 6p. 0·22µF, 7½p. 0·33µF, 11p. 0·47µF, 13p.
160V: 0·01µF, 0·015µF, 0·022µF, 0·033µF, 0·047µF, 0·068µF, 3p. 0·1µF, 3½p. 0·15µF, 4½p. 0·22µF, 5p. 0·33µF, 6p. 0·47µF, 7½p. 0·68µF, 11p. 1·0µF, 13p.

MULLARD POLYESTER CAPACITORS C280 SERIES

250V P.C. mounting: 0·01µF, 0·015µF, 0·022µF, 3p. 0·033µF, 0·047µF, 0·068µF, 3½p. 0·1µF, 4p. 0·15µF, 0·22µF, 5p. 0·33µF, 6½p. 0·47µF, 8½p. 0·68µF, 11p. 1·0µF, 13p. 1·5µF, 20p. 2·2µF, 24p.

MYLAR FILM CAPACITORS 100V

0·001µF, 0·002µF, 0·005µF, 0·01µF, 0·02µF, 2½p. 0·04µF, 0·05µF, 0·068µF, 0·1µF, 3½p.

CERAMIC DISC CAPACITORS

100pF to 10,000pF, 2p each.

ELECTROLYTIC CAPACITORS

(µF/v) 1/63, 1·5/63, 2·2/63, 3·3/63, 4·7/63, 6·8/40, 6·8/63, 10/25, 10/63, 15/16, 15/40, 15/63, 22/10, 22/25, 22/63, 33/6·3, 33/16, 33/40, 47/4, 47/10, 47/25, 47/40, 68/6·3, 68/16, 100/4, 100/10, 100/25, 150/6·3, 150/16, 220/4, 220/6·3, 220/16, 330/4, 6p. 47/63, 100/40, 150/25, 220/25, 330/10, 470/6·3, 7p. 68/63, 150/40, 220/40, 330/16, 1000/4, 10p. 470/10, 680/6·3, 11p. 100/63, 150/63, 220/63, 1000/10, 12p. 470/25, 680/16, 1500/6·3, 13p. 470/40, 680/25, 1000/16, 1500/10, 2200/6·3, 18p. 330/63, 680/40, 1000/25, 1500/16, 2200/10, 3300/6·3, 4700/4, 21p.

SOLID TANTALUM BEAD CAPACITORS 12p

0·1µF	35V	2·2µF	35V	22µF	16V
0·22µF	35V	4·7µF	35V	33µF	10V
0·47µF	35V	6·8µF	25V	47µF	6·3V
1·0µF	35V	10µF	25V	100µF	3V

VEROBOARD

	0.1	0.15
2½ x 3¾	22p	16p
2½ x 5	24p	24p
3¾ x 3¾	24p	24p
3¾ x 5	27p	27p
17 x 2½	75p	57½p
17 x 3¾	100p	78p
17 x 5 (plain)	—	82p
17 x 3¾ (plain)	—	60p
17 x 2½ (plain)	—	42p
2½ x 5 (plain)	—	12p
2½ x 3¾ (plain)	—	11p
Pin insertion tool	52p	52p
Spot face cutter	42p	42p
Pkt. 50 pins	20p	20p

JACK PLUGS AND SOCKETS

Standard screened	18p	2·5mm insulated	8p
Standard insulated	12p	3·5mm insulated	8p
Stereo screened	35p	3·5mm screened	13p
Standard socket	15p	2·5mm socket	8p
Stereo socket	18p	3·5mm socket	8p

D.I.N. PLUGS AND SOCKETS

2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin Plug 12p. Socket 8p.
4 way screened cable, 15p/metre.
6 way screened cable, 22p/metre.

BATTERY ELIMINATOR £1.50

9V mains power supply. Same size as PP9 battery.

LARGE (CAN) ELECTROLYTICS

1600µF	64V	74p	2500µF	64V	80p	4500µF	16V	50p
2500µF	40V	74p	2800µF	100V	£2·60	4500µF	25V	£1·68
2500µF	50V	58p	3200µF	16V	50p	5000µF	50V	£1·10

HIGH VOLTAGE TUBULAR CAPACITORS—1,000 VOLT

0·01µF	10p	0·047µF	13p	0·22µF	20p
0·022µF	12p	0·1µF	13p	0·47µF	22p

POLYSTYRENE CAPACITORS 160V 2½%

10pF to 1,000pF E12 Series Values. 4p each.

SMOKE AND COMBUSTIBLE GAS DETECTOR—GDI

The GDI is the world's first semiconductor that can convert a concentration of gas or smoke into an electrical signal. The sensor decreases its electrical resistance when it absorbs deoxidizing or combustible gases such as hydrogen, carbon monoxide, methane, propane, alcohol, North Sea gas, as well as carbon-dust containing air or smoke. This decrease is usually large enough to be utilized without amplification. Full details and circuits are supplied with each detector.
Detector GDI, £2. Kit of parts for detectors including GDI and P.C. board but excluding case. Mains operated detector £5·20. 12 or 24V battery operated audible alarm £7·30. As above for PP9 battery, £6·40.

PRINTED BOARD MARKER 97p

Draw the planned circuit onto a copper laminate board with the P.C. Pen, allow to dry, and immerse the board in the etchant. On removal the circuit remains in high relief.

METERS

1½" Scale-500uA, 1mA, 10mA, 100mA £1·90

BULGIN MAINS CONNECTORS

3 Pin	1½A	Chassis Plug	10p	3 Pin	1½A	Chassis Socket	18p
		Line Socket	13p			Line Plug	13p
3 Pin	3A	Chassis Plug	10p	3 Pin	3A	Chassis Socket	21p
		Line Socket	14p			Line Plug	23p
3 Pin	5A	Chassis Plug	16p	2 Pin	5A	Line Plug	20p
		Line Socket	15p				

THERMISTORS

VA1005	15p
VA1026	15p
VA1033	15p
VA1055S	15p
VA10665	15p
VA1077	15p
R53	£1·35

WAVECHANGE SWITCH 23p

1p 12W, 3p 4W, 2p 2W, 2p 6W, 4p 3W

ROTART MAINS SWITCH

D.P. 2A 32p

LINEAR IC's

709	14 pin DIL	40p
741	8 pin DIL	40p
741	14 pin DIL	38p
723	14 pin DIL	95p
747	14 pin DIL	85p
748	8 pin DIL	45p

DIL Sockets 14 pin and 16 pin 16p

The Sinclair Cambridge... no other calculator is so powerful and so compact.

Complete kit - £24·95! (PLUS VAT)

The Cambridge – new from Sinclair
The Cambridge is a new electronic calculator from Sinclair, Europe's largest calculator manufacturer. It offers the power to handle the most complex calculations, in a compact, reliable package. No other calculator can approach the specification below at anything like the price – and by building it yourself you can save a further £5·50!

Truly pocket-sized
With all its calculating capability, the Cambridge still measures just $4\frac{1}{2}'' \times 2'' \times \frac{11}{16}''$. That means you can carry the Cambridge wherever you go without inconvenience – it fits in your pocket with barely a bulge. It runs on ordinary U16-type batteries which give weeks of life before replacement.

Easy to assemble
All parts are supplied – all you need provide is a soldering iron and a pair of cutters. Complete step-by-step instructions are provided, and our service department will back you throughout if you've any queries or problems.

Total cost? Just £27·45!
The Sinclair Cambridge kit is supplied to you direct from the manufacturer. Ready assembled, it costs £32·95 – so you're saving £5·50! Of course we'll be happy to supply you with one ready-assembled if you prefer – it's still far and away the best calculator value on the market.

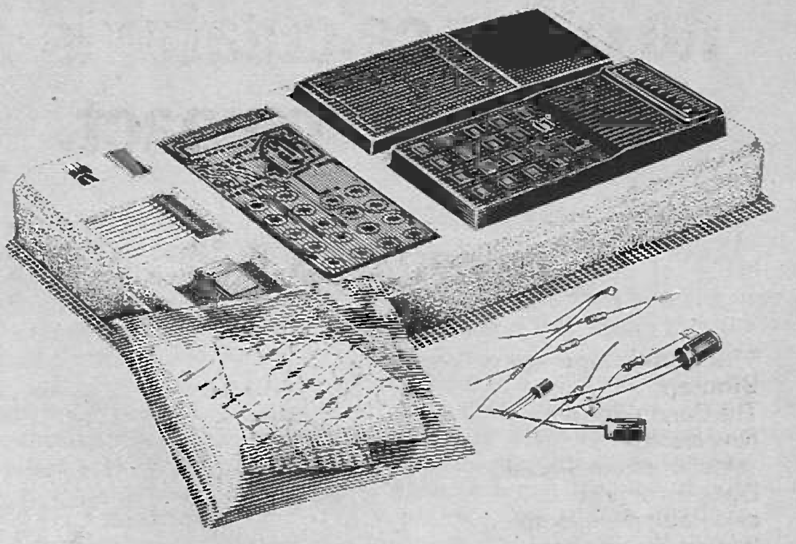
* Uniquely handy package. $4\frac{1}{2}'' \times 2'' \times \frac{11}{16}''$, weight $3\frac{1}{2}$ oz. Smart black and tan styling.
* Standard keyboard. All you need for complex calculations.
* Keys react with positive click when pressed.
* Clear-last-entry feature.
* Automatic ('implied') constant – no need for separate operating button.
* Common-sense ('algebraic') logic – enter calculations just as you write them.
* Calculates to 8 significant digits; fully floating decimal point positions itself automatically.
* Clear, bright 8-digit display.
* Unwanted zeros are suppressed.
* Display flashes to indicate overflow.
* Operates for weeks on four U16-type batteries.

A complete kit!

The kit comes to you packaged in a heavy-duty polystyrene container. It contains all you need to assemble your Sinclair Cambridge.
Assembly time is about 3 hours.

Contents:

1. Coil.
2. Large-scale integrated circuit.
3. Interface chip.
4. Thick-film resistor pack.
5. Case mouldings, with buttons, window and light-up display in position.
6. Printed circuit board.
7. Keyboard panel.
8. Electronic components pack (diodes, resistors, capacitors, transistor).
9. Battery clips and on/off switch.
10. Soft wallet.



This valuable book – free!
If you just use your Sinclair Cambridge for routine arithmetic – for shopping, conversions, percentages, accounting, tallying, and so on – then you'll get more than your money's worth.

But if you want to get even more out of it, you can go one step further and learn how to unlock the full potential of this piece of electronic technology.

How? It's all explained in this unique booklet, written by a leading calculator design consultant. In its fact-packed 32 pages it explains, step by step, how you can use the Sinclair Cambridge to carry out complex calculations like:

Logs	Sines	Cosines
Tangents	Reciprocals	nth roots
Currency conversion	Compound interest	

and many others . . .

sinclair

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St Ives, Huntingdonshire
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Why only Sinclair can make you this offer
The reason's simple: only Sinclair – Europe's largest electronic calculator manufacturer – have the necessary combination of skills and scale.

Sinclair Radionics are the makers of the Executive – the smallest electronic calculator in the world. In spite of being one of the more expensive of the small calculators, it was a runaway best-seller. The experience gained on the Executive has enabled us to design and produce the Cambridge at this remarkably low price.

But that in itself wouldn't be enough. Sinclair also have a very long experience of producing and marketing electronic kits. You may have used one, and you've almost certainly heard of them – the Sinclair Project 60 stereo modules.

It seemed only logical to combine the knowledge of do-it-yourself kits with the knowledge of small calculator technology.
And *you* benefit!

Take advantage of this money-back, no-risks offer today
The Sinclair Cambridge is fully guaranteed. Return your kit within 10 days, and we'll refund your money without question. All parts are tested and checked before despatch – and we guarantee a correctly-assembled calculator for one year.

Simply fill in the preferential order form below and slip it in the post today.

Price in kit form: £24·95 + £2·50 VAT. (Total: £27·45)
Price fully built: £29·95 + £3·00 VAT. (Total: £32·95)

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To: Sinclair Radionics Ltd, London Road,
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Please send me

☐ a Sinclair Cambridge calculator kit at £24·95 + £2·50 VAT (Total: £27·45)

☐ a Sinclair Cambridge calculator ready built at £29·95 + £3·00 VAT (Total: £32·95)

*I enclose cheque for £ ______, made out to Sinclair Radionics Ltd, and crossed.

*Please debit my *Barclaycard/Access account. Account number ______

*Delete as required.

Name ______

Address ______

PLEASE PRINT

everyday electronics

PROJECTS... THEORY....

PLEASE HELP YOURSELF!

It is simple and inexpensive to make a start in the hobby of electronics. The bare essentials in equipment are a soldering iron, screwdriver, wire cutters, pliers, and a modest type of multimeter.

But let us be honest—it is hardly likely to stop just there! After completing a few simple projects the urge to delve progressively further and deeper into the subject comes quite naturally; to conduct experiments and try one's hand at circuit design, for example.

However, visions of the need for additional expensive equipment may cause some enthusiasts to hesitate and ponder over the probable financial outlay involved. Well, we have good and reassuring news in this connection. While many spare time activities do depend upon commercially made equipment that is often expensive, in the case of electronics "do-it-yourself" is doubly true! The most important circuit checks and measurements can be performed with instruments of a kind that the constructor can build himself—provided he is given full design details.

This month EVERYDAY ELECTRONICS introduces the *EE Test Gear Five,* commissioned specially for our readers. Collectively, these five instruments will satisfy all the more usual requirements of the average constructor, experimenter, and designer. While a careful eye has been kept on the budget, these units have been designed to the highest professional standards.

This, then, is an opportunity for every reader to equip himself with a fine set of test gear—instruments he will be proud to own and use and to show to his friends because they will demonstrate his own handiwork as a constructor. These five handsome instruments will transform the appearance of any "den" or private retreat, however modest. Their good looks are incidental however. The instruments are designed for serious work, not just to impress the visitor—though undoubtedly they will. With the *EE Test Gear Five* before him, the least pretentious of constructors will feel confident to tackle more ambitious projects and maybe venture into some experimental and design work in addition.

A word to the wise. All these instruments will have immediate and lasting value. So start building *your* collection this very month, with item number one—the *Power Supply Unit.*

Those more seasoned enthusiasts who already possess some items of test gear may well consider the merits of having a unified set of instruments with a common power supply linkage. Otherwise, one or more items of the *EE Test Gear Five* could be used to make up any deficiency in their existing equipment.

OUR NEW PRICE

Soaring costs of materials, especially paper, have caught up with us. Regrettably we have to advise readers that as from next month the price of EVERYDAY ELECTRONICS will be 20p.

Fred Bennett.

Our March issue will be published on Friday, February 15

Everyday Electronics, Fleetway House, Farringdon Street, London, E.C.4. Phone: *Editorial* 01-634-4452; *Advertisements* 01-634-4202.

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..SIMPLY EXPLAINED

VOL. 3 NO. 2 FEBRUARY 1974

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

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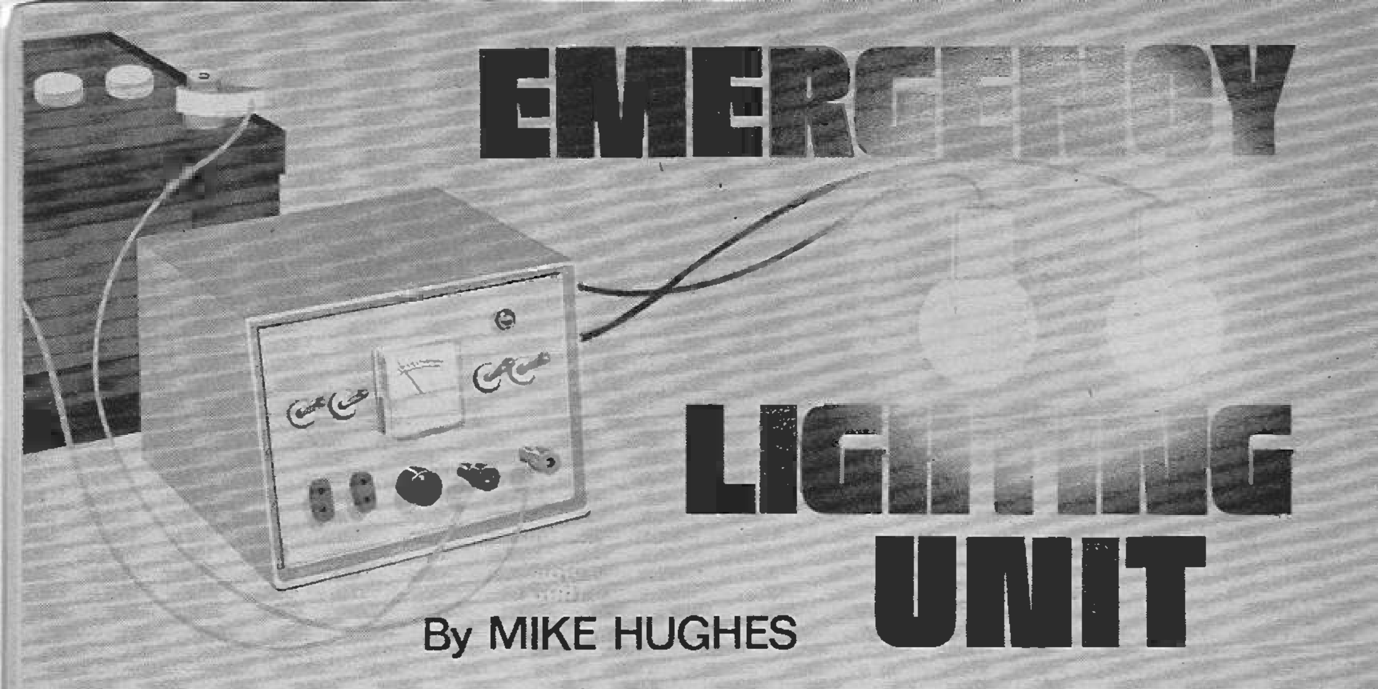


EMERGENCY LIGHTING UNIT

By MIKE HUGHES

Automatically switches on an auxiliary lighting system when mains supply fails

In these days of perpetual electricity failures it is convenient to have an auxiliary source of lighting in the home. It is mandatory that clubs and public areas have an emergency lighting circuit capable of running from a source independent from the mains.

The simple solution, in either case, is to have a circuit, or circuits, running 12 volt bulbs from an accumulator. This, however, requires that the accumulator is in a constant state of charge. This project is basically a battery charger that is used to keep the accumulator "topped up" but wired into it are two switchable output sockets for running auxiliary lighting and facility is built in for automatic change over to the emergency system, should the mains fail.

CIRCUIT

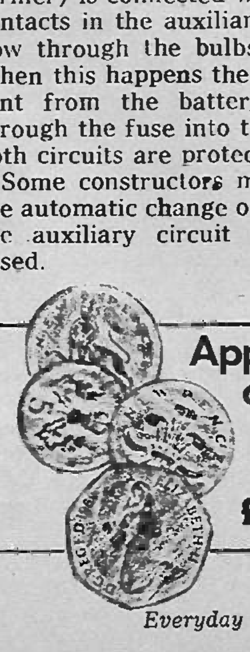
The circuit is shown in Fig. 1. A tapped input mains transformer is used that gives a nominal output of 12V r.m.s. (17V peak) at up to 5A. This is fed to a low voltage, high current bridge rectifier giving a full wave rectified output that is fed via a switchable series limiting resistor R2 and ammeter circuit to the terminals of the unit. The stand-by accumulator would be connected to these terminals.

With the series resistor in circuit charge current is limited to about 0·5 to 1A (for trickle charge purposes) but when shorted out with S2 the circuit current is limited only by the internal resistance of the transformer, the resistance of the ammeter circuit and the state of charge of the accumulator. Current could be up to 5A (and even greater). Should there be some major fault with the accumulator or the output was shorted then current could exceed the 5A (maximum) and a fuse is inserted to prevent overheating etc.

LIGHTING CIRCUITS

The auxiliary lighting circuits are taken from the battery terminals via the relay contacts to switches S3 and S4 to output sockets on the front panel. These circuits are connected on the front side of the same fuse. Because the relay (normally held in by the 12V a.c. from the transformer) is connected with its "normally closed" contacts in the auxiliary circuit, current cannot flow through the bulbs unless the mains fails. When this happens the relay drops out and current from the battery flows the other way through the fuse into the auxiliary circuit. Thus both circuits are protected by the single fuse.

Some constructors may not wish to build in the automatic change over facility; in which case the auxiliary circuit ought to be separately fused.



Approximate cost of components including V.A.T.

£7.00 plus case

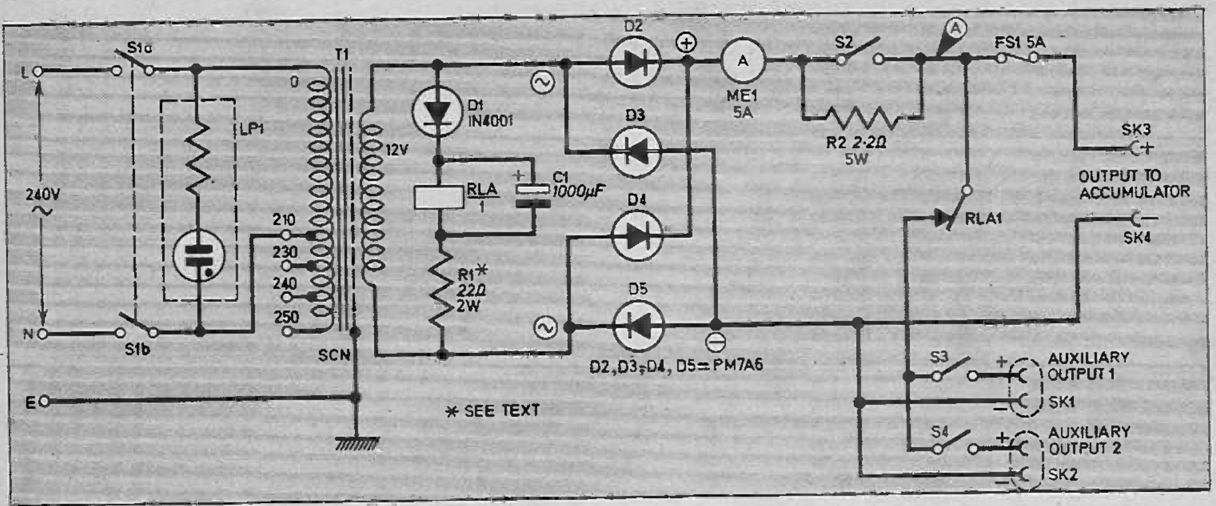


Fig. 1. Complete circuit diagram of the Emergency Lighting Unit.

CURRENT

If the unit is to be run from the mains via a fused 13A plug there is no need for an internal fuse on the mains input but take note that this is essential if the unit is to be run from non-ring main domestic wiring (a 500mA fuse is sufficient).

With this system the maximum output current to the bulbs is 5 amps (not displayed on the meter) thus the total power loading **must not** exceed 60 watts. In a domestic situation this is more than is necessary and in practice two circuits with a loading of 2 amps each is quite sufficient. Switches S3 and S4 allow selection of either or both external circuits in the usual way.

Remember that this unit provides high currents, consequently heavier gauge wire than usual should be used (10 amp rating preferably) for all internal and external connections (Fig. 2). It is particularly important to have this in mind if the equipment is to be permanently wired into a building's structure. If the wire is too light a gauge not only will you get excessive line voltage drops but the conductors could heat up and present a fire risk.

INSTALLATION

When installing the equipment make sure the accumulator is in a well ventilated area because hydrogen and oxygen are liberated during charging—a localised build up of these gases could cause an explosion if exposed to a naked flame. Ideally it should be contained in a wooden (frost protected) box outside.

The charger unit should be as close as possible to the accumulator but for convenience it is more likely that the latter would be indoors, nevertheless keep the leads to the accumulator as short as possible. The longer they are the heavier gauge they ought to be to prevent line drop.

When charging a badly exhausted accumulator it is best to charge at the trickle rate for an hour or two before changing to full rate—other-

Components....

SEE **SHOP TALK**

Resistors
R1 22Ω 2W (see text)
R2 2·2Ω 5W

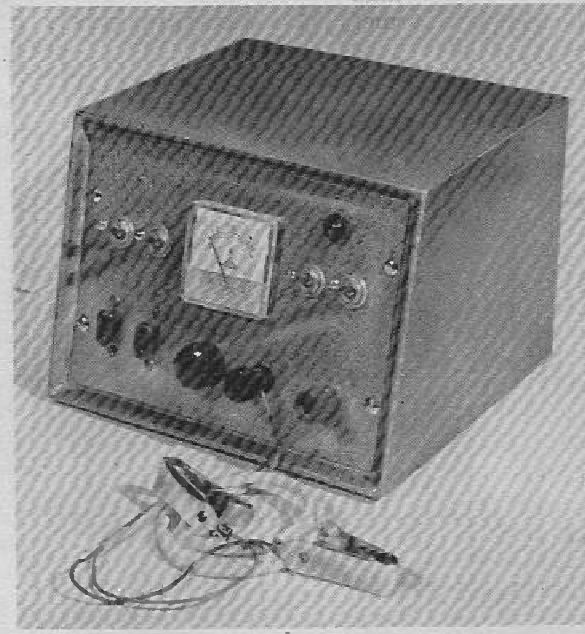
Capacitor
C1 1,000µF elect. 25V

Semiconductors
D1 1N4001
D2, D3, D4, D5 5A, 24V silicon bridge rectifier (AEI type PM7A6) or equivalent wired group of 5A rectifiers (4 off)

Switches
S1, S2, S3, S4 Two pole 3A 240V on/off toggles. (Both poles shorted together for S2, 3 and 4)

Miscellaneous
ME1 5A moving iron meter
RLA1 6V coil, 26ohms with 5A changeover contacts (see text)
LP1 240V neon indicator—incorporating limiting resistor
T1 Mains transformer. Primary 0–210, 230, 240, 250. Secondary 12V at 5A (Douglas type MT 85AT)
FS1 Bulgin panel mounting fuse holder and 5A fuse
SK1/2 2 plug socket pairs for auxiliary circuits (5A capacity)
SK3/4 2 red, 1 black 5A screw terminals
2 large crocodile clips for accumulator. Heavy gauge insulated wire, 3 core mains lead, grommet and cable clamp. Case approx. 200mm x 150mm x 150mm.

EMERGENCY LIGHTING UNIT



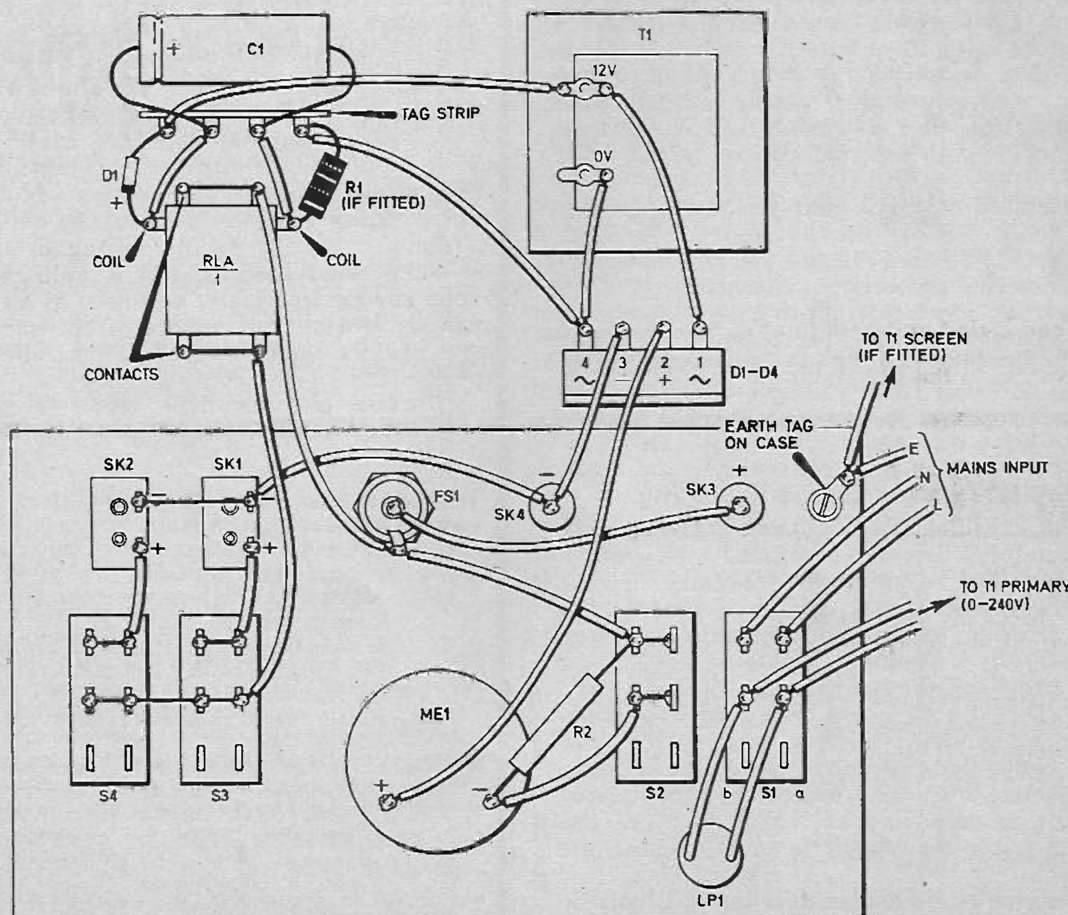
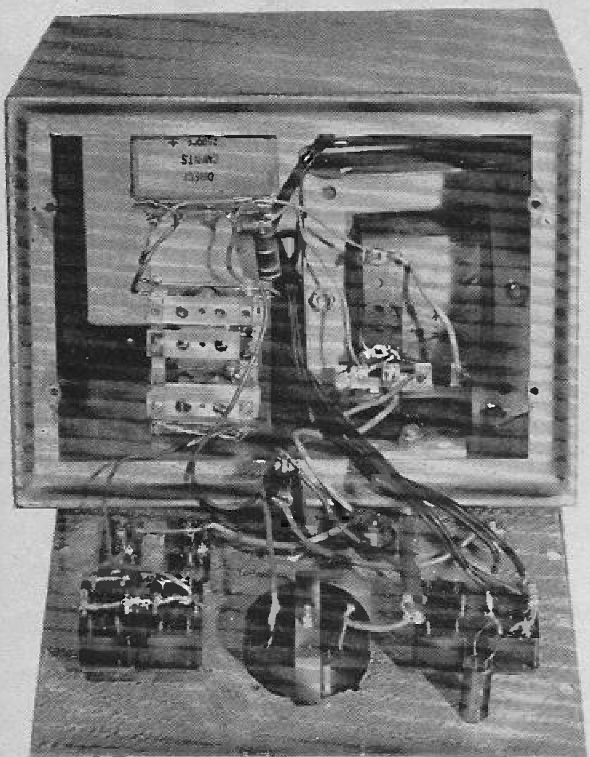


Fig. 2. Layout and wiring of the Emergency Lighting Unit.

wise currents in excess of 5 amps might be drawn. Use can be made of the tapped mains input of the transformer (if such a transformer has been used) to slightly increase or decrease the maximum charging rates. The output of 12V r.m.s. assumes the supply is connected to the input tapping of the same magnitude (e.g. 240V). If, however, you connect 240V across the 210V tappings the output voltage will increase by about 15 per cent. Connecting to higher voltage tappings will reduce the output voltage and hence the charge current. Should the maximum charge current be higher than required a 0·5 or 1 ohm resistor (5 watt) should be inserted between S2 and FS1 at point A (Fig 1).



The completed unit with front panel removed to show construction. Relay types may differ from that shown in the photograph.

COMPONENTS

Finally, some points about the construction and availability of components. The diode bridge must be capable of passing 5 amps. If you cannot obtain the one specified you can make one up using discrete stud rectifiers (of 5 amps rating each) which are easily obtainable. They should, however, be bolted onto a panel of insulating material prior to fixing in the cabinet.

The relay might present some problems but a variety will do here. Ideally an a.c. 12V coil relay with 5 amp low voltage rating contacts should be used straight across the transformer's secondary, but relays with a.c. coils are not very common. The prototype used a 6V d.c. relay that had a coil resistance of 26 ohms. The d.c. drive is provided by rectifier D1 and the current (from the 12V source) is limited by R1 which should be of 2 watts rating, C1 prevents chatter of the relay contacts. If you locate a 12V d.c. coil relay with 5 amp contacts R1 can be omitted.

Because of problems in locating or making low value shunt resistors for a milliameter a 5 amp moving iron meter was used as a current monitor. Moving coil meters of the same full scale reading could be used just as effectively but are likely to be more expensive. ▣

What do you know?

TERMS

Explain the following terms as used when discussing electronic circuits or phenomenon.

1 Direct Coupling
2 Bandwidth (applied to a receiver)
3 Sensitivity
4 Modulation Depth
5 Bias

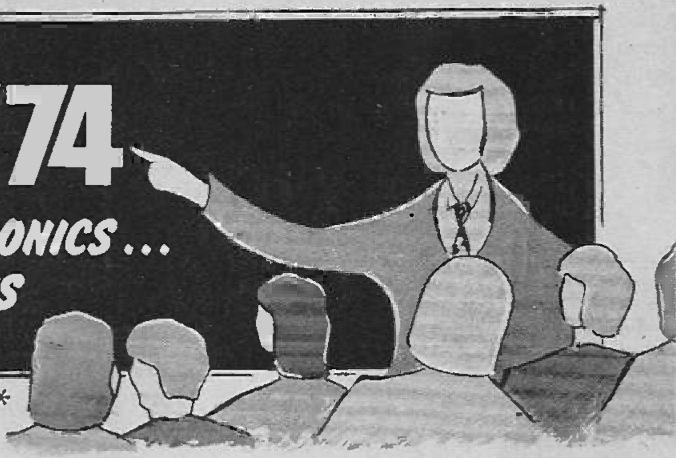
ANSWERS

1 Coupling between two stages of a circuit or two networks where there is a direct current path, i.e. no capacitor is used.
2 The extent of a continuous range of frequencies (a band of frequencies) which the receiver is capable of receiving at a certain specified level.
3 Normally specified as the least input of a receiver or amplifier which produces an output of a certain specified level.
4 A factor which shows the extent to which one signal is modulated by another, usually given as a percentage.
5 A steady direct voltage applied to two terminals of a transistor or other active device to set the working point of the device.

Note. High frequency a.c. bias is used in tape recorders to obtain high quality reproduction from the tape.

TEACH-IN '74

FOR BEGINNERS IN ELECTRONICS ... THEORY AND EXPERIMENTS



TUTOR: PHIL ALLCOCK*

LESSON 5 The Transistor

So far we have mentioned the relationship that exists between the base, collector, and emitter currents of an *npn* transistor and have examined the current/voltage characteristic for the emitter/base junction.

TRANSISTOR CHARACTERISTICS

Manufacturers often publish other characteristics such as the variation of I_c with V_{ce}. Such a characteristic is illustrated in Fig. 5·1. Each curve shows the variation of I_c, as V_{ce} is varied, for a constant value of base current I_b.

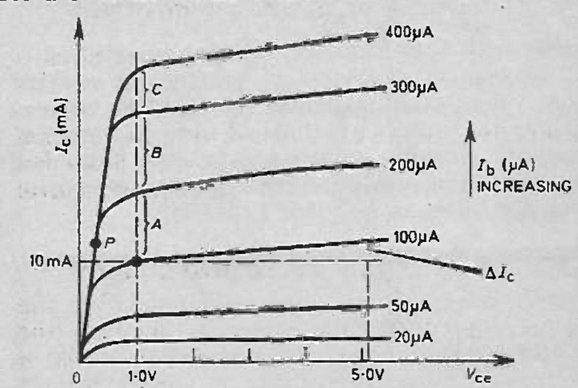


Fig. 5.1. Variation of I_c with V_{ce}.

The curves usually relate to a "typical" device and the values for a particular transistor may differ considerably from the published curves since the parameter β has a wide spread. However, the curves are useful in that they illustrate several important features of the transistor.

The first point is that for V_{ce} values greater than about one volt the collector current is almost constant for a given value of I_b. The collector current does rise slightly as can be seen from the $I_b = 100\mu A$ curve. The current I_c rises by a small amount, shown as ΔI_c, as V_{ce} increases from 1·0 to 5·0 volts. For a typical device this current change might be about 40 to 100µA. Note that the collector current for this curve would be about 10mA, if we assume that β is 100, since we saw last month that $I_c = \beta I_b$.

Although a change of 100µA seems quite large when compared to the base current of 100µA it represents only one per cent of the total collector current. Consequently for most purposes we can assume that I_c is independent of the voltage V_{ce} if V_{ce} is at least one volt. (For power transistors the change in I_c can be much larger and may have to be considered.)

GAIN

The second point which is illustrated by the characteristics is that β does vary somewhat with I_c. If β was constant, each increase of say 100µA in I_b would produce a definite change in I_c, equal to (100 β)µA. The changes in collector current can be read off the characteristics by measuring the spacing of the curves at a given V_{ce}, say 1 volt, whilst noting the corresponding changes in base current for the curves used. For example at $V_{ce} = 1\cdot0$ volt, changes of 100µA in I_b, over the range 100 to 400µA, give collector current changes represented by the lengths *A, B, C*. If these lengths are unequal then β is varying as I_c rises.

Some manufacturers give a separate curve to show this effect and a typical curve would appear as in Fig. 5.2. The parameter plotted is usually h_{fe} which is similar to β and is actually a measure of the *change* in collector current for a *small* change in base current. The curve shows that h_{fe} falls at low and high currents. Since the manufacturing spread for β, and hence h_{fe}, is already large this variation of h_{fe} with collector current is not important uuless a wide variation of I_c occurs in the circuit used. This situation does occur with "large signal" circuits such as power amplifier output stages.

It is worth noting that some transistors are designed to give reasonably high h_{fe} values down to collector currents of 1µA. Others have their

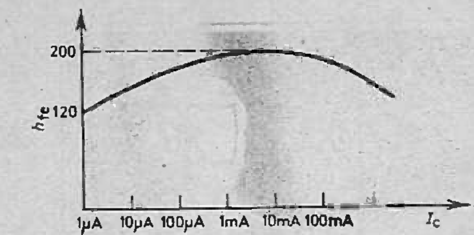


Fig. 5.2. Typical variation of h_{fe} with I_c

best performance at high currents and for power transistors it may be necessary to ensure that reasonable values of h_{fe} are still obtained at currents of several amperes.

SATURATION

A third and very important feature of the transistor is illustrated by considering point P in Fig. 5.1. Notice that at low V_{ce}, less than one volt typically, all the curves tend to merge into one line. This is the *saturation region* of the transistor, so called because at points such as P the collector voltage is almost zero and the current in the colector reaches a saturation level above which it cannot rise.

If the transistor is made to operate at point P any increase in base current above 200μA will have virtually no effect. The collector current has saturated and the additional base current simply flows via the emitter/base junction. Obviously the relation $I_c = \beta I_b$ no longer holds since I_b can have any value above 200μA without I_c changing. To realise the full implications of this situation consider the circuit shown in Fig. 5.3.

If I_c was zero one would have $V_{ce}=9$V (switch S1 open). By closing the switch any base current up to about 1mA can be provided by adjusting VR3. The resistor R1 limits the maximum base current to a safe value. As the base current is increased from zero the collector current, equal to βI_b, also increases and the voltage V_{ce} falls due to the increasing voltage drop across the collector resistor R2. If we could make V_{ce} fall to zero the *maximum* current in R2 would be

$$I_c\,(\text{max}) = \frac{9\ (\text{volts})}{1\ (\text{k}\Omega)} = 9\ \text{mA}.$$

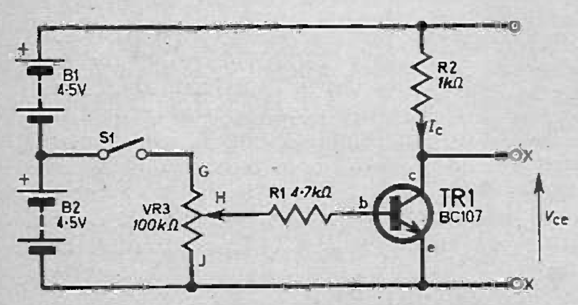


Fig. 5.3. Circuit for testing saturation.

Any attempt to force I_c higher than this must fail. If the transistor has $\beta=100$ the base current corresponding to this maximum collector current will be 9/100**mA**=90μA. If the base current is made larger than this value the "excess" simply flows via the base/emitter junction but does not give rise to any additional collector current. The transistor is said to be saturated.

The collector voltage never falls to zero in practice and so the manufacturer quotes a typical saturation voltage called V_{ce}(sat). The corresponding base and collector currents are usually specified and for the BC107 transistor the specification sheet gives:

V_{ce}(sat) at I_c=10mA, I_b=0·5mA=250mV (max.)
V_{ce}(sat) at I_c=100mA, I_b=5mA=600mV (max.).

These are maximum values for any sample of the BC 107 transistor, typical values for the same current levels are 90mV and 200mV respectively. The variation of V_{ce} as VR3 is rotated clockwise is shown in Fig. 5.4. (The letters J, H, G, identify the connections to the 100 kilohm potentiometer (VR3) as shown in the Tutor Board article [Oct. '73] page 534).

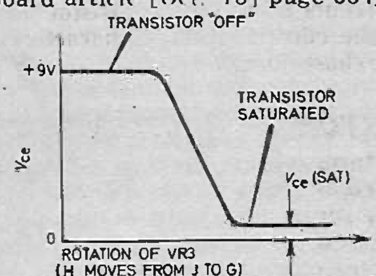


Fig. 5.4. Variation of V_{ce} with setting of VR3.

This lettering will be helpful as our circuits become more complex and is used in this month's tests. The potentiometers can be left permanently fixed to the tutor board with the 100 ohm control on the left hand side, the 5 kilohm control in the centre and the 100 kilohm control adjacent to the switch.

THE COLLECTOR/BASE JUNCTION

The collector/base junction is similar to the emitter/base junction since it involves the transition from the base *p* material to the *n* material of the collector (for an *npn* device). In the circuits so far discussed this junction has been reverse biased since the collector (*n* region) has been made positive with respect to the base. The only exception to this condition is when the transistor is saturated. In this state the voltage V_{ce}(sat) is less than the corresponding base/emitter voltage which is known as V_{be}(sat).

The situation is illustrated in Fig. 5.5 for both (a) saturated and (b) non saturated conditions. Note carefully that the collector base diode is forward biased under saturated conditions but reverse biased under normal conditions. The base/emitter diode is forward biased for both saturated and non saturated states.

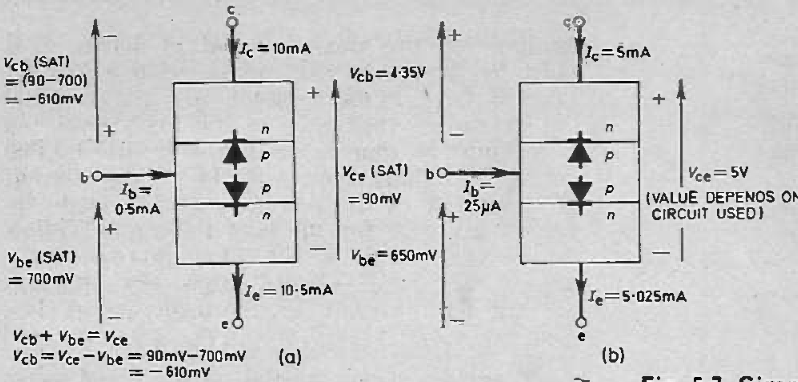


Fig. 5.5. (a) Saturated and (b) non saturated conditions.

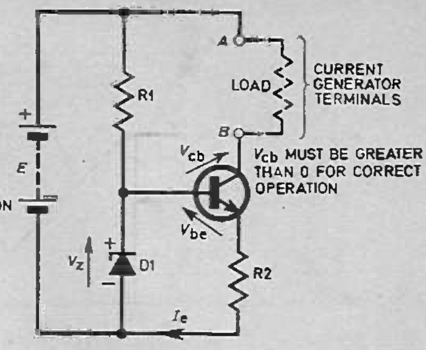


Fig. 5.7. Simple current generator.

TRANSISTOR LEAKAGE CURRENTS

Early germanium transistors had leakage currents which were often significant and these had to be considered when designing circuits. Nowadays the modern silicon planar types have very low leakage and for most general applications the leakage can be neglected. Leakage currents increase with temperature however and silicon power devices can exhibit appreciable leakage if operating at junction temperatures of say 100 degrees Centigrade or more. The two most common leakage currents are I_{cbo} and I_{ceo} and are illustrated in Fig. 5.6.

Current I_{ceo} is always considerably greater than I_{cbo} since the leakage current is forced to flow via the emitter/base junction and this gives rise to extra current by virtue of the basic transistor action. The relationship between I_{cbo} and I_{ceo} is shown in Fig. 5.6 but note that the β value is for *very low* current operation and may be much smaller than the specification value.

JUNCTION VOLTAGE RATINGS

The collector/base junction, like any diode, can only withstand a certain voltage in the reverse-bias condition. The value depends on the external circuit conditions at the base/emitter junction. For the BC107, the absolute maximum voltage between collector and base, with the emitter left open circuit, is 50 volts. The corresponding limit for the emitter/base junction (also with reverse bias and with the collector open circuit) is only 6·0 volts. These ratings are known as V_{cbo}(max) and V_{ebo}(max) respectively. (See table of parameters in last month's Teach-In '74, page 24).

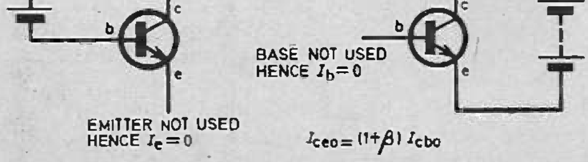


Fig. 5.6. Illustration of leakage currents.

CONSTANT CURRENT GENERATION

The ideal voltage source is easy to understand since present-day batteries approach the ideal very closely. To be ideal the voltage at the battery terminals must be independent of the current taken. An alternative, which can be very useful, is a current generator which has the property of supplying a constant current, independent of the load voltage. A transistor can be used to make a practical current generator which will operate over a restricted voltage range and one possible circuit is shown in Fig. 5.7.

The resistor R1 allows current to flow via the Zener diode D1 which keeps the voltage across R2 constant since V_{be} is almost constant for a given transistor emitter current. The current I_e through R2 must be given by

$$I_e = \frac{V_z - V_{be}}{R2}$$

where V_z is the breakdown voltage of the Zener diode used.

When a load is connected to the terminals *A*, *B* the current flowing will be the collector current of the transistor which is almost exactly equal to I_e (actually αI_e) providing the voltage across *A*, *B* is small enough to avoid saturation of the transistor. To illustrate the action of the circuit it is instructive to calculate the circuit currents and voltages using some of the techniques so far covered in this series. Let us assume that R1 = 1 kilohm, E = 9 volts, R2 = 10 kilohm and V_z = 4·7 volts. The calculations can then proceed as follows:—

(i) Voltage across R1 = (9 − 4·7) = 4·3 volts.
(ii) Current in R1 = 4·3/1000 A = 4·3mA.
(iii) Assume V_{be} = 0·6 volts, then
(iv) Voltage across R2 = (4·7 − 0·6) = 4·1
(v) Current in R2 = 4·1/10,000 A = 410μA.

To prevent saturation occurring (which would give incorrect operation of the current generator) it is necessary to restrict the voltage be-

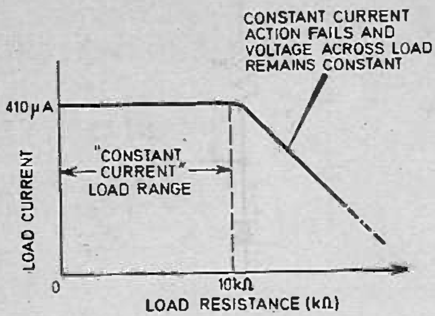


Fig. 5.8. Behaviour of constant current generator.

tween A and B so that the transistor collector base junction never becomes forward biased. Taking $V_{cb}=0$ as the limiting condition this implies that the maximum voltage across A, B must be limited to the voltage drop across R1 i.e. 4·3 volts. Since I_c and I_e are almost equal the maximum resistance of the load connected to A, B must be approximately $4 \cdot 3/I_e(\text{mA}) \times 1{,}000$ i.e. 10·5 kilohms. Consequently a fixed current of about 410 μA will flow through the load connected at A, B for all load resistance values in the range 0 to 10·5 kilohm approximately. Higher resistance values cause the constant current action to fail and the load current then falls below 410μA, as shown in Fig. 5.8.

Next month we shall describe several useful circuit applications using the components covered in Teach-In '74 to date. These circuits will be treated experimentally and use most of the ideas so far presented.

TUTOR BOARD EXPERIMENTS

Test No. 15

This test is based on the circuit shown in Fig. 5.3. Plan a neat layout for the Tutor Board and then wire up the components to match the circuit. Note that the switch only controls the connection of the lower 4·5V battery. Wire up the circuit for the 0-10V voltmeter in the usual way and connect the voltmeter to the points indicated on the diagram as XX. Observing polarity! With this connection the voltmeter will register the voltage V_{ce} for the transistor off.

Set the 100 kilohm control VR3 fully anticlockwise so that the slider H is at end J. Close the switch. Slowly increase the voltage fed to the transistor base by rotating VR3 clockwise whilst observing the meter. Verify that the voltage V_{ce} varies as indicated in Fig. 5.4. Estimate the value V_{ce}(sat) for the transistor used. (The value may be difficult to read accurately since the meter deflection will be very small.)

Switch off the base supply and change the 1 kilohm collector resistor to 10 kilohm. Repeat the test and notice that a smaller rotation of VR3 is now required to give saturation. Why is this so? It is helpful in this test to make pencil marks corresponding to the knob pointer positions at which conduction starts and saturation commences. These marks can be removed with a pencil rubber when the test is complete.

Test No. 16

This test uses two BC107 transistors to produce a very sensitive current detector. The circuit is quite straightforward and is shown in Fig. 5.9. The circuit should be built on the Tutor Board and VR1 set to the mid-point of its rotation to give a resistance of approximately 50 ohms between points B and C. Check the connections of both transistors carefully as an incorrectly wired circuit could cause damage.

The points X, Y can be the test probes normally used for the voltmeter. If the probes are not touching each other, the lamp should be off when the switch is closed. Pick up the probes, one in each hand and make a contact between the metal (nail) and the skin. The lamp should light due to the small current that flows via the "skin resistance" of the user. Experiment to see how many people you can connect "in series" between X and Y whilst still operating the light. With high β transistors the lamp should light even if the resistance between X and Y is as high as 10 million ohms and for transistors with $\beta=500$, resistances of 100 million ohms can be detected.

The sensitivity of this circuit can be reduced if necessary by connecting the 100 kilohm potentiometer as a variable resistor, across the base/emitter connections of transistor TR2 (shown dotted). The lower the setting of this resistance, the lower the sensitivity will be. With zero resistance the lamp may not light at all, since only the collector current of TR1 can now flow via the lamp. (TR2 must now be off since its base-emitter junction is shorted out by the zero resistance and no part of the emitter current of TR1 can flow into TR2 base.) This connection of two transistors, without the 100 kilohm potentiometer, behaves like a single transistor having a very high β of 10,000 or more. Why is this so?

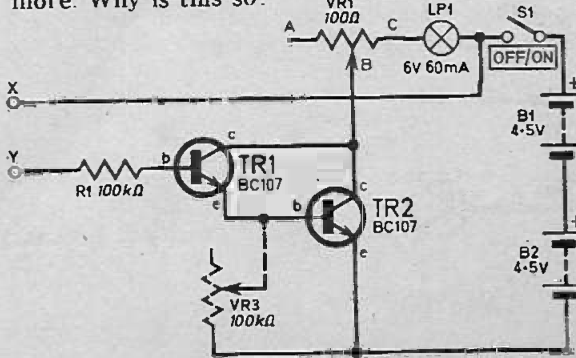
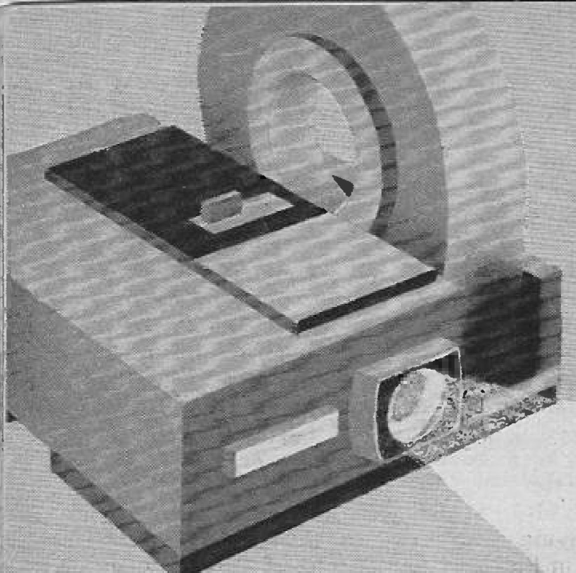


Fig. 5.9. Circuit for Test No. 16.



Approximate cost of components including V.A.T.

£2.00 plus case

Enables continous and automatic slide shows

SLIDE PROJECTOR TIMER

BY C. G. GAMMANS

ANYONE who has tried to produce a continuous slide show for an exhibition or at home, has met the problem that most of the timing devices available on the market are not repetitive but merely time an interval from when the button is pressed after which they operate a set of contacts and they have to be reset before they will go through the cycle again. All of which means that they are not of any use for continuous slide show operation. Fortunately it is not difficult to build a repetitive timer at a reasonable cost.

The circuit described here is very simple, and is one of the many variations of the simple astable multivibrator; no relay driver was found to be needed making the finished design very economic on components.

The projector for which the prototype was designed to be used, was a Kodak Carousel which required to have a set of contacts made together for about a quarter of a second to cause the slide mechanism to operate. This contact is made by means of the relay contacts when the relay is activated in the circuit. The relay needs to be a 6-9V type with a coil resistance of at least 185 ohms and one set of normally open contacts.

CIRCUIT

The complete circuit diagram of the Slide Projector Timer is shown in Fig. 1 and is seen to be a simple astable multivibrator, of variable frequency and mark/space ratio, loaded with relay RLA. Only the "space" part of the periodic time of the cycle is variable.

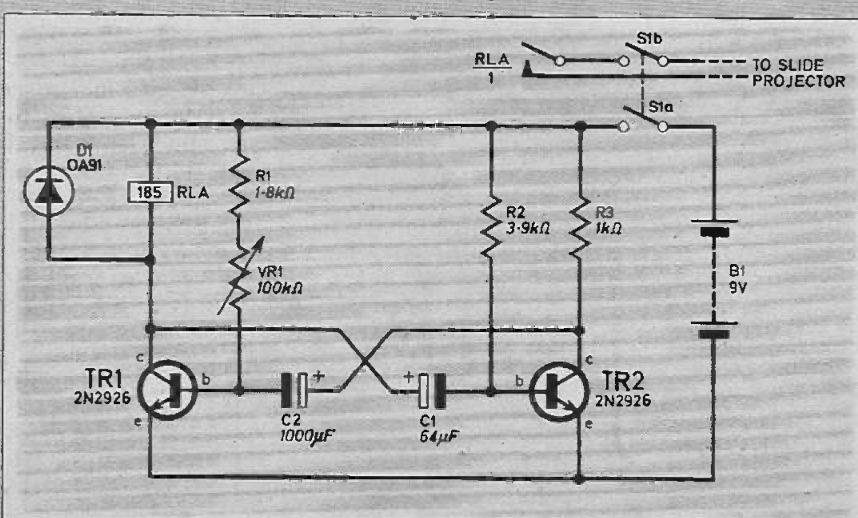


Fig. 1. The complete circuit diagram of the Slide Projector Timer.

The projector, to operate, uses the fixed timing interval ie. the "mark" and this is set at the required 0·25 seconds by the "mark" timing components R2 and C1.

The "space" part of the multivibrator cycle ie. time between relay contact "makes", is variable by adjusting VR1 which, together with C2 and R1 forms the timing components. Adjusting VR1 allows the time between "makes" of the relay contacts to be adjusted from one second to 20 seconds. Increasing VR1 increases the time interval between "makes" and thus between slide changes.

When S1 is switched to the on position, TR1 turns on hard (saturates) with TR2 off (not conducting) and virtually the whole supply appears across the relay coil causing the relay contacts to close for 0·25 seconds. After this time, TR2 switches on and TR1 off—astable action—and the relay contacts open and remain open for a time determined by VR1 setting. After this set time interval the cycle is repeated until turned off at S1.

To hold a slide in position for longer than that available from the unit, S1 should be switched off for as long as required. Longer delays may be obtained by increasing the values of C2 and/or VR1.

The unit will run for many hours powered by a PP3 battery.

Components....

Resistors
R1 1·8kΩ
R2 3·9kΩ
R3 1kΩ
All ¼W carbon ±10%

SEE **SHOP TALK**

Potentiometer
VR1 100kΩ carbon lin.

Capacitors
C1 64μF elect. 9V
C2 1000μF elect. 9V

Semiconductors
TR1 2N2926G *npn* silicon
TR2 2N2926G *npn* silicon
D1 OA91, 1N4148 or similar

Miscellaneous
RLA Any 6–9V relay with coil resistance 185Ω or greater and one set of normally open contacts
B1 9V PP3
S1 d.p.s.t. toggle or slide
Veroboard, 18 holes x 26 strips 0·1in. matrix; battery clip; aluminium for case; two core cable for connecting unit to projector; knob.

CONSTRUCTION

The prototype unit was built on a piece of 0·1in matrix Veroboard size 18 holes by 26 strips. The layout of the components on the top-side of the board is shown in Fig. 2; there are no breaks in the copper strips on the underside.

Commence construction by drilling the fixing hole at location *P11* and then mount and solder the link wires, resistors and capacitors as shown.

Next construct the aluminium case to the dimensions given in Fig 3, and assemble the components VR1, RLA, S1 and B1 as indicated. Now solder flying leads of sufficient length to the component board. The transistors should now be soldered in position and a heatshunt used to prevent thermal damage.

Secure the component board in position in the case with 4BA nut bolt and spacer and then wire up the flying leads to the other components as detailed in Fig. 3. Finally, solder the output lead from one set of normally open contacts and S1b, and pass out through the case via a rubber grommet. The length of this lead will depend on the desired distance of the unit from the projector. If desired, this lead can be made detachable by using a two pin plug and socket.

TESTING

Check out the circuit for wrong/omitted connections, solder bridges between copper strips, transistor connections and diode and capacitor polarities. If satisfied, turn VR1 fully anti-clockwise and switch on with projector not connected. The relay should click over once every second or so. Turning VR1 clockwise should increase the time between clicks; the fully clockwise position should produce one click every 20 seconds or so. If this does not happen, recheck for faults.

If all is well, the lid may be screwed in place. A piece of foam plastic glued to the inside lid will hold B1 in place.

IN USE

Locate the slide change contacts in the remote operating box of the slide projector and connect the two wires from the timer unit in parallel with the slide change contacts.

Switch on the slide projector and set it up as you would normally then switch on the Slide Projector Timer. Set the slide changing speed, then switch off the slide timer and reset the slide cassette to the first slide required. Switch on the Slide Projector Timer when you wish the show to begin. If during a display you want to hold the show at the slide on the screen, then it is necessary to switch off the timer.

If the magazine of the projector is one of the round types, then with the timer running, the show will go on until you switch off. ▣

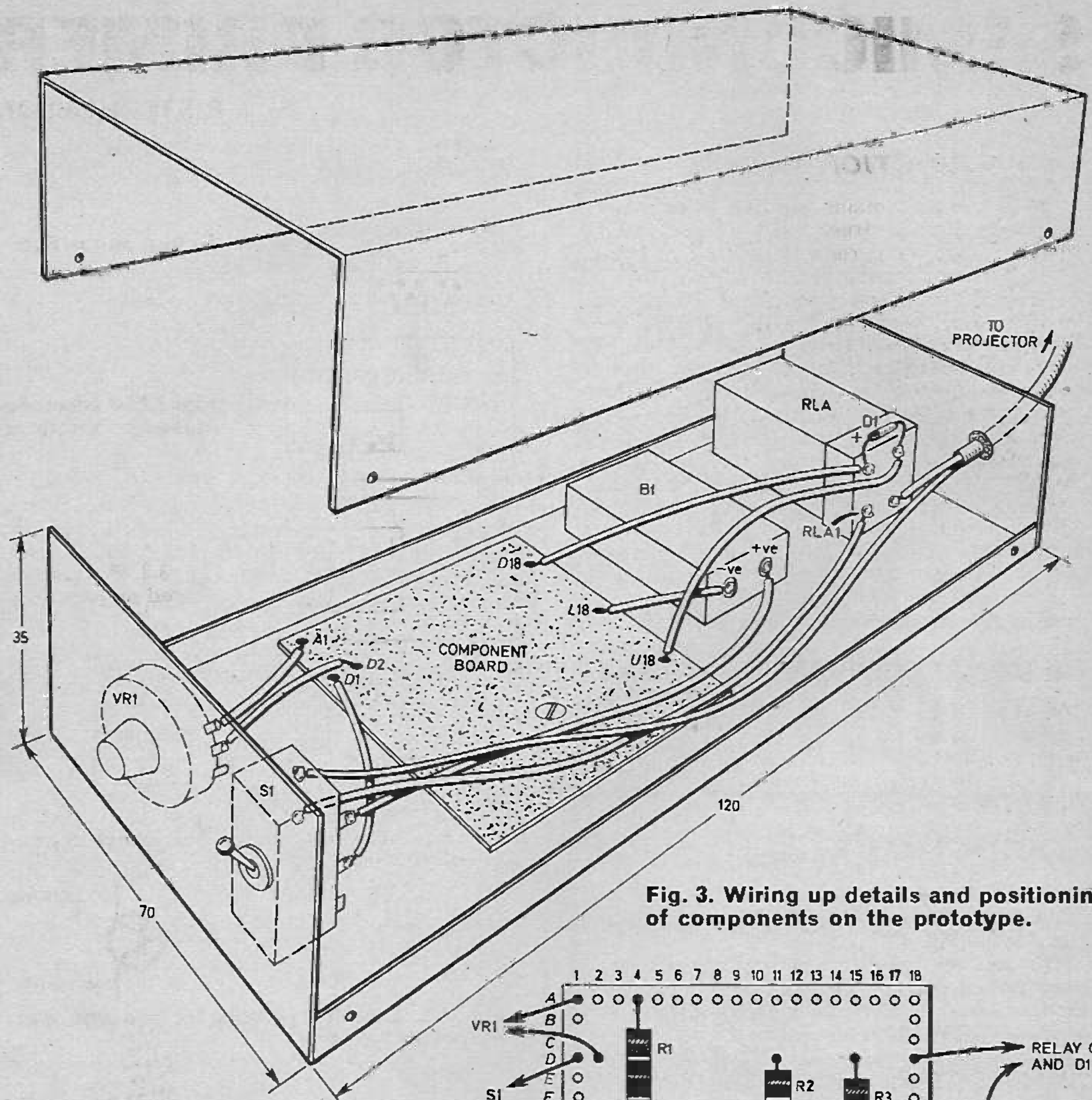


Fig. 3. Wiring up details and positioning of components on the prototype.

SLIDE PROJECTOR TIMER

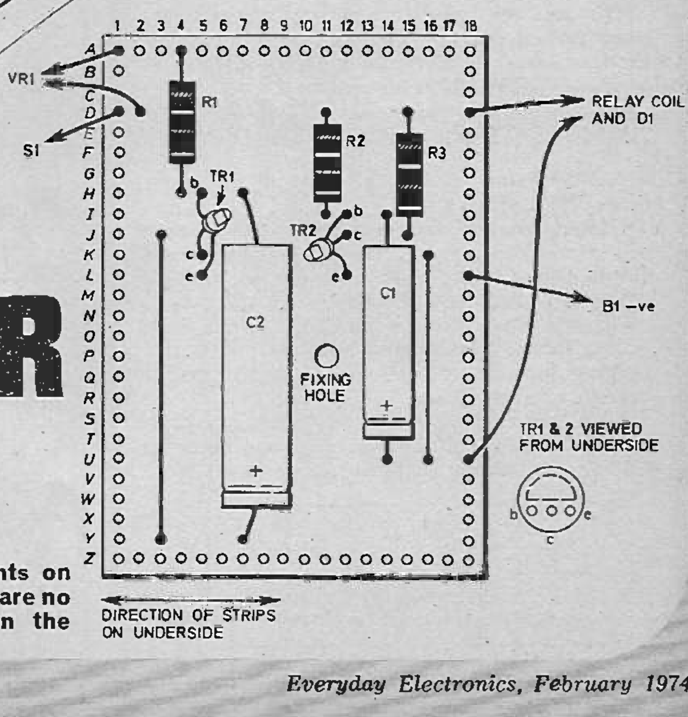


Fig. 2. The layout of the components on the topside of the Veroboard. There are no breaks along the copper strips on the underside.

SEMICONDUCTOR PRIMER

By A.P. STEPHENSON

3 ▪ PN JUNCTION ACTION

"*p*" material contains **positive holes** which can move around freely within the crystal. These can be considered as "little white balls" which possess a **positive** charge.

"*n*" material contains **electrons**, which can be treated as "little black balls". If these two materials are joined (in a special way) a *pn* junction is formed, Fig. 3.1.

Assume a battery is connected as in Fig. 3.2. No current flows because the holes and electrons are simply *pulled away* from the junction, leaving an area in between which is an **insulator** (because there are no charges left).

Now consider Fig. 3.3. This time, the holes and electrons are *pulled across* the junction, and a steady current flows round the circuit. The directional arrows are in opposite *directions* but the effect is *additive* since holes are +ve and electrons −ve.

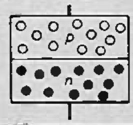


Fig. 3.1. Schematic of a *pn* junction.

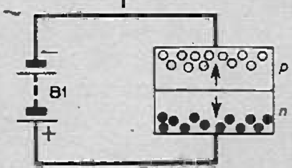


Fig. 3.2. A reversed biased *pn* junction.

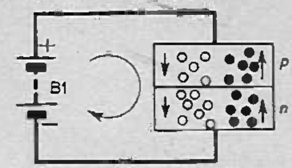


Fig. 3.3. A forward biased *pn* junction.

4 ▪ CONSTRUCTION OF A TRANSISTOR

A transistor comprises two *pn* junctions forming a "sandwich". There are two ways of forming such a sandwich: (a) *pnp* (b) *npn*. These are illustrated in Fig. 4.1.

The three wires connected are named as follows:

The **base** is the middle layer connection.
The **emitter** is one of the ends.
The **collector** is the other end.

The symbols for the two kinds of transistor are given in Fig. 4.2.

The emitter arrow points in direction of *conventional* current, i.e. positive to negative. Emitter arrow is INWARDS for *pnp*. Emitter arrow is OUTWARDS for *npn*.

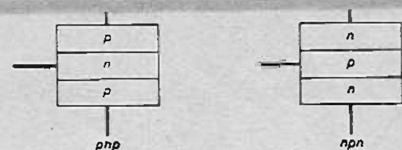


Fig. 4.1. Schematic sandwich construction of transistors.

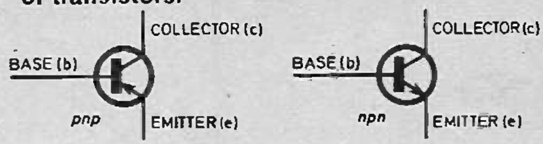


Fig. 4.2. Circuit symbols for *pnp* and *npn* transistor types.

5 ▪ THE "TWO DIODES" CONCEPT

A transistor is basically two *pn*-junction diodes back to back, Fig. 5.1.

Assume the middle connection (the **base**) is left "up in the air", no current can flow due to the *opposing* effect of the two diodes, Fig. 5.2.

Suppose the base is now returned, via a resistor, to the collector rail. **The bottom diode** is now **forward biased** and the top diode is still **reverse biased**, which is the correct way to operate all transistors.

Note that in both cases the *bottom diode* is forward biased and is therefore dropping about 0.6 volts (assuming a **silicon** transistor).

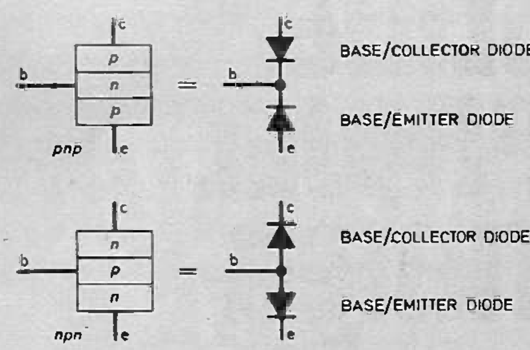


Fig. 5.1 The back to back diode representation of a transistor.

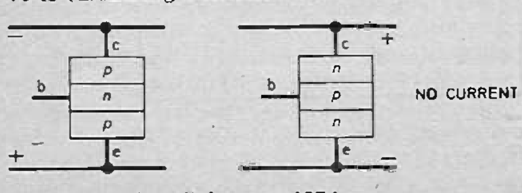
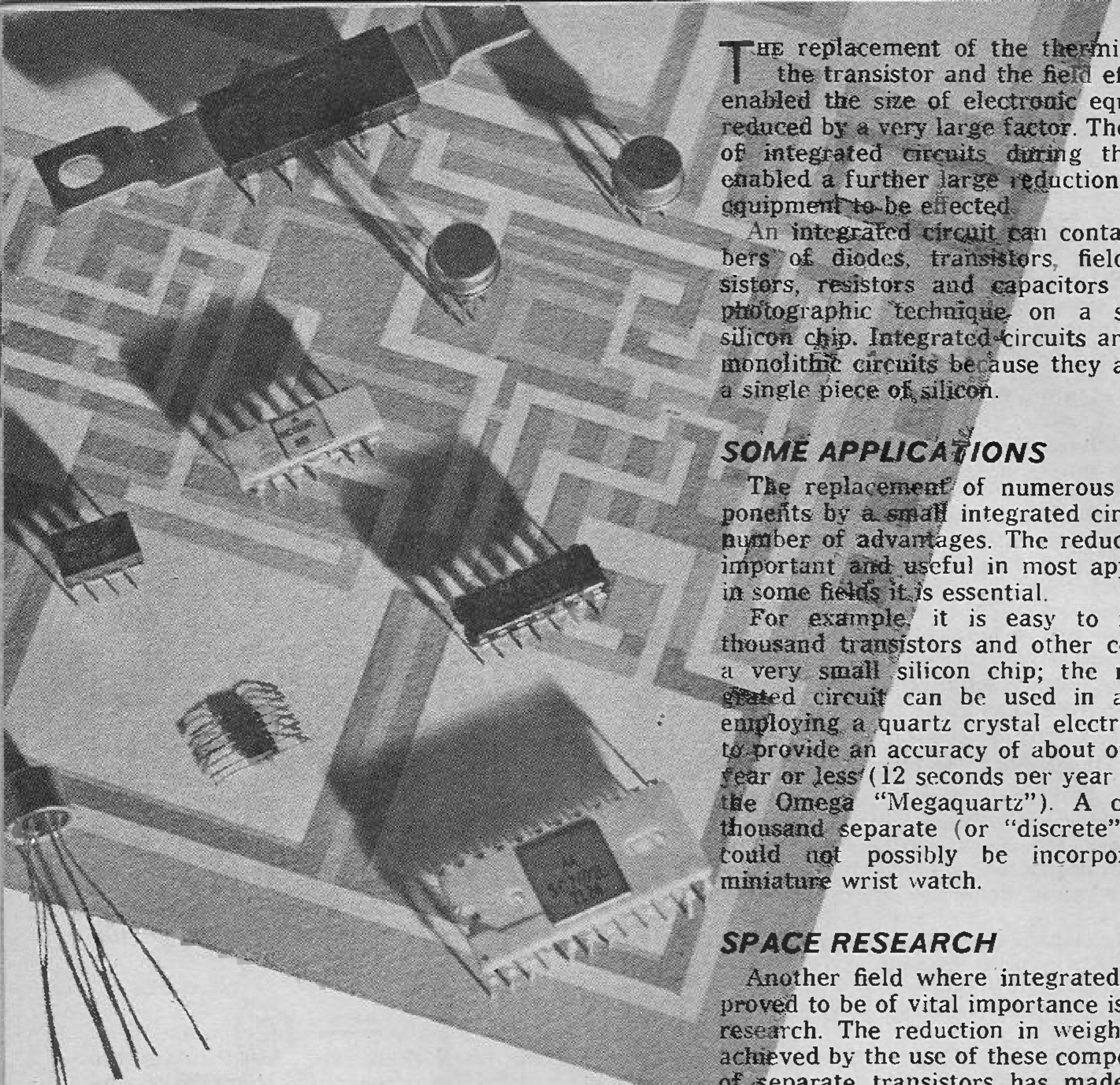


Fig. 5.2 (left). No current flows under these conditions.



Introduction to INTEGRATED CIRCUITS 1

By J. B. DANCE M.Sc.

THE replacement of the thermionic valve by the transistor and the field effect transistor enabled the size of electronic equipment to be reduced by a very large factor. The development of integrated circuits during the 1960's has enabled a further large reduction in the size of equipment to be effected.

An integrated circuit can contain large numbers of diodes, transistors, field effect transistors, resistors and capacitors formed by a photographic technique on a single minute silicon chip. Integrated circuits are often called monolithic circuits because they are formed on a single piece of silicon.

SOME APPLICATIONS

The replacement of numerous discrete components by a small integrated circuit confers a number of advantages. The reduction in size is important and useful in most applications, but in some fields it is essential.

For example, it is easy to incorporate a thousand transistors and other components on a very small silicon chip; the resulting integrated circuit can be used in a wrist watch employing a quartz crystal electronic oscillator to provide an accuracy of about one minute per year or less (12 seconds per year in the case of the Omega "Megaquartz"). A circuit with a thousand separate (or "discrete") components could not possibly be incorporated into a miniature wrist watch.

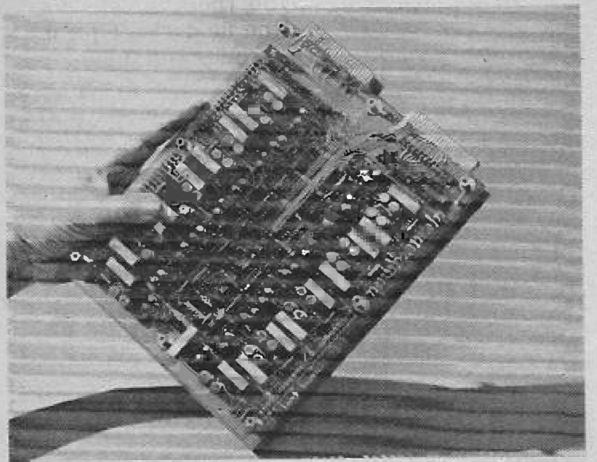
SPACE RESEARCH

Another field where integrated circuits have proved to be of vital importance is that of space research. The reduction in weight and volume achieved by the use of these components instead of separate transistors has made the modern sophisticated signalling and control systems possible. Satellites can now be equipped with miniature computers containing numerous integrated circuits.

The modern computer employs very large numbers of integrated circuits so that an enormous number of components can be connected together in a relatively small space. This has enabled much more powerful computing systems to be made than would have been practicable with discrete components.

ADVANTAGES

The advantages achieved by the use of integrated circuits are not limited to the saving in space thereby obtained. In the manufacture of an integrated circuit all of the internal connections are automatically made by the photographic techniques used in production. In these days of extremely high labour costs, this enables a great saving to be made on the manufacturing costs.



An example of the use of integrated circuits for a computer core memory.

The price of many of the cheaper integrated circuits is about the same as that of about three cheap transistors. Many types of integrated circuits are available for less than £1, even though they contain some hundreds or thousands of separate components. The cost of designing and setting up the equipment used to manufacture integrated circuits is very high, but once the equipment has been set up, the cost of producing each additional component is very low.

The price of any one type of integrated circuit is therefore dependent more on the expected demand for that component rather than on the complexity of the device concerned. Indeed, most integrated circuits employ more components than a similar circuit using discrete devices, partly because additional components can be added with only a very small rise in the manufacturing cost.

DISADVANTAGES

There are two main disadvantages in the use of integrated circuits instead of discrete devices, but these disadvantages tend to apply only in certain specific applications.

In general, circuits which must operate at extremely high frequencies employ discrete components, since it is difficult to manufacture integrated circuits which can operate at some thousands of megahertz.

The other disadvantage is that when one has mass produced, cheap integrated circuits available, one cannot alter the internal design of the integrated circuit to suit one's particular application. In other words, one loses some of the versatility of circuit design when one replaces discrete components with integrated circuits. Nevertheless, this very loss of versatility implies that the circuit designer is relieved of much of the detailed design work of individual stages.

In general, each type of integrated circuit is normally produced for a fairly definite type of application for which it can be sold in large numbers. It is uneconomical to produce integrated circuits which will not be sold in very large numbers. Some types are designed for audio amplification applications, others for use in television receivers and others for the counting of electrical pulses, but some comprise a high gain amplifier which can be used in a fairly wide variety of applications.

EARLY HISTORY

Various attempts were made to miniaturise circuits during the last war, but the first type of device which one might really call an integrated circuit was developed in 1958 by Texas Instruments Ltd. This consisted of a number of resistors and transistors which were produced by diffusing impurity elements into a single chip of silicon.

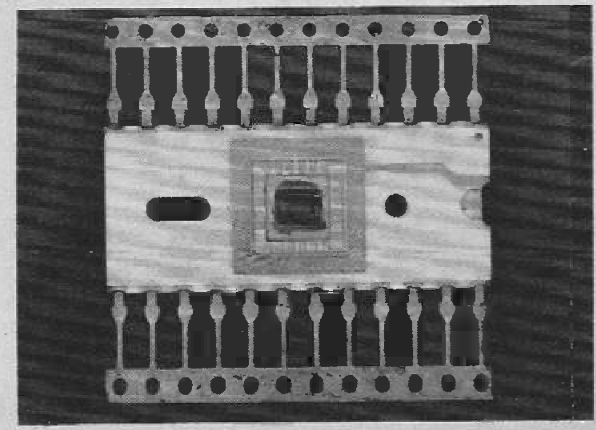
Many types of integrated circuits were developed in the early 1960's. The well known silicon planar process developed by the Fairchild Company in 1960 provided a great boost to the industry, since it is the process by which almost all modern integrated circuits are produced.

The first types of integrated circuits were used mainly in the military and computer fields, but their use has spread and one can now find them in the radio and television fields where costs are most competitive. It is generally cheaper to employ a mass produced miniature integrated circuit than to pay labour charges for people to wire up and test discrete circuits.

APPEARANCE

A transistor normally has three connections, and seldom more than four. Most integrated circuits need more connections than this owing to their complexity. However, the first integrated circuits were produced by various transistor manufacturers and they naturally fitted their products into the type of cases they had been using for transistors.

An integrated circuit before encapsulation.



One type of integrated circuit employs the normal TO-5 type of transistor encapsulation, but there are typically six or eight leads coming out of the base instead of the three or four of the normal transistor. The leads are arranged in a circle. Such integrated circuits can dissipate only about one watt of power. Some high power integrated circuits employ the diamond shaped TO-3 type of encapsulation (as used for many high power transistors), but there may be a number of connecting wires arranged in a circle coming from the base of the device.

One of the most common types of encapsulation used for integrated circuits at the present time is the dual-in-line package (see Fig. 1). This usually consists of a rectangular plastic or ceramic package with two separate rows of connection pins, one row being fitted on each side of the package. Some types of dual-in-line integrated circuits have eight pins (two lines of four pins each), but the most common types of integrated circuit have 14 pins (two lines of 7 pins each). Types with 16 pins are common (for example, certain types of counters), whilst some types of dual-in-line integrated circuits have still more connections.

Some types of integrated circuit are available both in the TO-5 type of encapsulation and as dual-in-line devices. The latter are usually very slightly cheaper than the same devices in a TO-5 type of encapsulation.

A small part of the production area for 7400 I.Cs at ITT Semiconductors.

SOCKETS

A transistor is normally soldered directly into the circuit in which it is to be used. Integrated circuits can also be soldered directly if a suitable circuit board is employed, but it is not easy to unsolder and change devices having a large number of connections. It is therefore common practice to use integrated circuits in suitable sockets. This also avoids possible damage to the integrated circuit by the voltage spikes occurring on an unearthed soldering iron or by overheating during soldering by an inexperienced person.

Sockets are available for integrated circuits having the TO-5 type of encapsulation and also for those employing the dual-in-line encapsulation. In the latter case, sockets are available with 8, 14 and 16 connections and possibly for other numbers also. An integrated circuit with 8 connections, can, incidentally, be fitted into a dual-in-line socket which has 8, 14 or 16 connections.

Great care should be taken when one is inserting and removing dual-in-line integrated circuits into or from their sockets, since the pins can be badly bent (even if reasonable care is taken) when the integrated circuit fits tightly into a new socket. If one attempts to remove an integrated circuit of the dual-in-line type from its socket and it does not come out easily, a thin, small screwdriver slipped under the device will greatly assist in removing it without any damage. If, however, the pins of the device are bent, they should be carefully straightened or "dressed" with pliers and/or forceps.

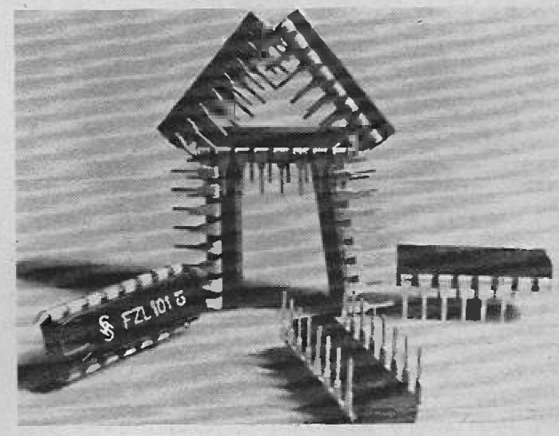


Fig. 1. Dual-in-line packages, these examples have 16 pins.

TYPES

Integrated circuits are employed for so many purposes that it is possible only to give some general indications of some of the more common types of application in this article. Audio amplifiers will be considered in most detail, since they are the type of integrated circuit which is most likely to be of interest to the amateur enthusiast.

The first types of integrated circuit to be developed were digital types which operate by the switching of transistors in them. These transistors are either fully conducting or switched off at any one time; any states of partial conduction do not occur for more than a very short time.

Digital integrated circuits became commercially available in large numbers around 1964. They are widely used in computers and for complex logic applications. They can be used in counting circuits. Metal oxide semiconductor techniques (M.O.S.T.s) are much used in digital applications with integrated circuits, since very economical devices can be produced. However, they are not yet widely used in other types of circuit.

Digital integrated circuits can be employed in industrial logic control. As an extremely simple example, one may employ a digital logic circuit to ensure that a machine will operate only if the cooling water is flowing *or* if an air-blower is switched on *and* if there are enough metal parts at the input *and* if a bath is within certain temperature limits.

The amateur enthusiast may meet digital integrated circuits in calculators, but such projects are fairly complex. In general, the average amateur will be more interested in other types of integrated circuit, so the digital types will not be discussed further here.

LINEAR INTEGRATED CIRCUITS

In linear circuits the currents and voltages can have any values between certain limits, the output being in some way related to the applied input. Suitable linear integrated circuits offer the designer ready made high gain amplifiers, etc.

They were initially rather expensive and designers were not familiar with them; they have therefore been used in large numbers only during the past five years or so. The price of linear integrated circuits has fallen rapidly and they may become cheaper still as time passes and more of them are used.

OPERATIONAL AMPLIFIERS

Operational amplifiers were originally high gain amplifiers using discrete components. They were mainly used to carry out mathematical operations (such as subtraction, integration, etc.) in analogue computers—hence their name. They are coupled so that they can handle steady signals (even signals of zero frequency) as well as alternating inputs.

Operational amplifiers are now produced as integrated circuits. They have a multitude of applications and the properties of the circuits in which they are used can be greatly altered by using various resistors and capacitors in the input and feedback circuits of the amplifiers.

General purpose operational amplifiers form a natural field for the use of integrated circuits.

Pre-testing of integrated circuits at Mullard's. Silicon slices are being electrically checked.

Some thousands of types of operational amplifier are now available.

THE "709"

The first type of general purpose operational amplifier to be produced in quantity was the Fairchild μA709. This type is now available from many manufacturers. For example, Texas Instruments market it under the type number SN72709, Motorola under the number MC1709, National Semiconductor under the number LM709, Newmarket Transistors as LIC709 and Mullard-Philips as the TAA521, etc. Some manufacturers offer two type 709 amplifiers in a single 14 pin dual-in-line package; one example is the Motorola MC1437 and MC1537 dual amplifiers.

A transistor of a certain type number from one manufacturer will satisfactorily replace a transistor of the same number produced by another manufacturer. However, in the case of integrated circuits, one cannot *necessarily* replace one device by an equivalent device of another manufacturer. This is due to the complexity of the circuits and the impossibility of specifying all of the parameters of a device in a data sheet. However, expert circuit designers take such factors into account.

Next month we shall be looking at some particular linear integrated circuits.

SHOP TALK

By Mike Kenward

We are beginning to receive a number of letters from readers complaining about long delays in the supply of components from retailers. Unfortunately these delays are often unavoidable and are due to the manufacturers not being able to supply the retailers. Quite often the retailer can find no alternative supply and cannot obtain a definite commitment on when he will receive the goods.

A recent instance of this problem was experienced in this office. We were trying to obtain some low value, high wattage resistors for a future project and one supplier quoted 63 to 64 weeks delivery—some time in 1975!

Emergency Lighting Unit

The basically very simple *Emergency Lighting Unit* could be very useful indeed both for supplying light and of course for charging car batteries which are bound to be stretched to the limit supplying power during emergencies. If the petrol shortage gets worse it may be worth using the car battery for lighting most of the time—however we will be looking at petrol economy, so watch out for some petrol saving devices.

Getting back to the components needed for the lighting unit, provided a battery is available, most of the components are straightforward with some alternatives being given in the text. The relay may take a bit of looking for, but almost any 12V or less type will work provided the contacts are rated at 5 amps—the coil resistance does not matter too much and there are a number of different types with coils of about 200 ohms that should suit.

Unfortunately the case we show is not available but most suppliers sell a range of cases and any one that is big enough will do.

Power Supply Unit

The first of the *EE Test Gear Five*, the *Power Supply Unit* will be of immediate interest to the more serious constructor and, as with all the instruments in this series is a very useful and "professional" piece of equipment. Most of the parts will be readily available, the transformer and the 10 ohm potentiometer should be available from the larger suppliers. Miniature switches were used on the prototype but these are expensive and normal toggle types are suitable.

The cases used for the Test Gear Five are made by Olsen Electronics Ltd., and are available from them for £3·45 including postage, packing and V.A.T.

The case used is a type 25A with louvres; this case is very well made and very strong, it also gives a good appearance to the finished unit. Cases are available in light green, dark green, blue and silver grey and front panels in light green, cream or white. Our prototypes used dark green cases and cream front panels and look very smart (see front cover). Olsen are at 5 Long Street, London E.2.

The knobs used on the front panel are available from Re-an Products, Burnham Road, Dartford, Kent.

Slide Projector Timer

Relays and cases are items that are often discussed in this article and this once again applies with the *Slide Projector Timer*. In fact the relay can be almost any type that will work on 9 volts and most suppliers should be able to find something to suit. Virtually the same words can be used when referring to the case, there are a number of types available and any that is big enough will do.

Readers' Bright Ideas; any idea that is published will be awarded payment according to its merit. The ideas have not been proved by us.

A handy tool I have made to extract integrated circuits and other components from circuit boards without damage. It is made from 3mm brass rod which will spring back when released, the rod is bent into an inverted "V" shape and about 10mm is bent inwards at each end and then filed down to a taper keeping the bottom as horizontal as possible.

The tapered ends are inserted under each end of the integrated circuit and a slight pressure is applied to the sides of the brass rod, heat is then applied to the pins on the underside of the circuit board and as the solder melts the integrated circuit will lift out because of the tapered prongs.

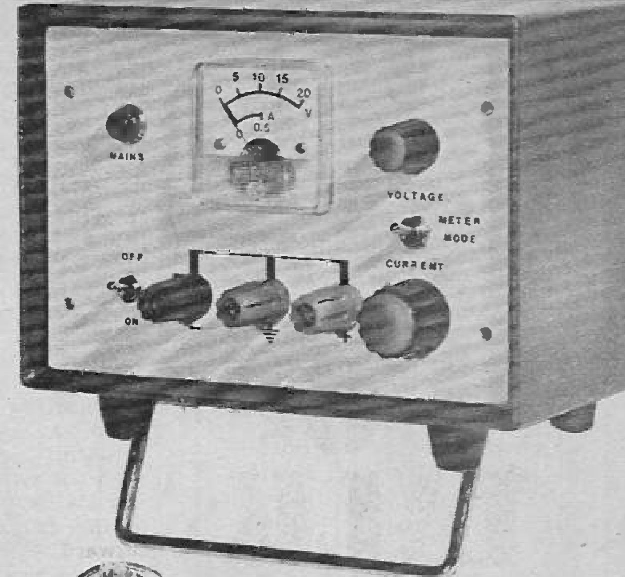
R. Linklater,
Aldershot, Hants.

Instead of using enamel paint as a p.c. board resist I used nail varnish which has several advantages.

(1) It takes less time to dry.
(2) It is difficult to remove the paint while wet if a mistake is made, but with nail varnish it dries quickly and can be removed with the special remover.

S. Bailey,
Leicester.

POWER SUPPLY UNIT



Stabilised variable voltage from 0-20V with current limit control up to 0·5A.

Approximate cost of components including V.A.T.

£7·80 plus case

A POWER supply is a key component in any electronic circuit. Although one may use batteries in a finished project, they are not flexible enough to provide variable voltages needed while designing and testing a new circuit. Additionally, this unit supplies power for other instruments in the *E.E. Test Gear Five* series.

This unit has been designed to satisfy the essential requirements of a home constructor's workshop at a reasonable cost. It provides a stable, well regulated, low ripple output, and incorporates a variable current limit. The voltage may be continually varied from zero to 20V, and the current limit set within the range 50mA to 0·5A. The output current or voltage is indicated on a meter. Limiting the supply current at 0·5A protects the unit from damage arising from a short circuit.

DESIGN PRINCIPLES

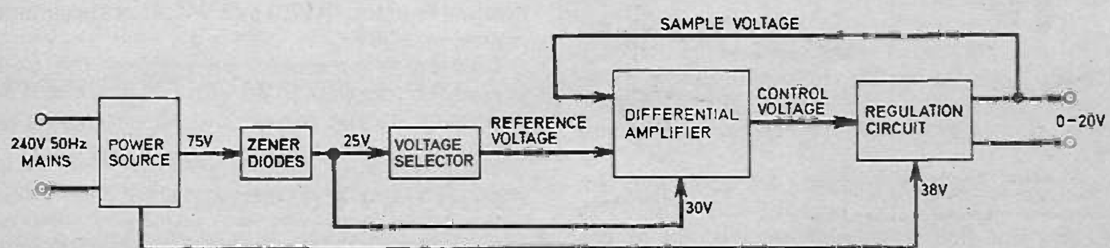
The block diagram, Fig. 1, outlines the basic principles of the circuit.

The power source provides a rectified, smoothed, d.c. voltage to the other circuit blocks. The Zener diodes provide a 30V source for the differential amplifier, and a 25V source for the voltage selector. The 25V source covers the range from −3·3V to +22V to ensure that the output voltage will swing from *zero* to 20V.

The differential amplifier compares the voltage from the voltage selector with the voltage at the output of the supply. The signal which appears at the output of the differential amplifier is proportional to the difference between the two inputs and this signal controls the regulation circuit which in turn controls the output voltage.

This feedback loop will force the output voltage of the supply towards the voltage set at the voltage selector. This circuit arrangement produces a supply having good regulation and low ripple, while allowing the output voltage to be set at any desired level between zero and 20V.

Fig. 1. Block diagram of the Power Supply Unit.



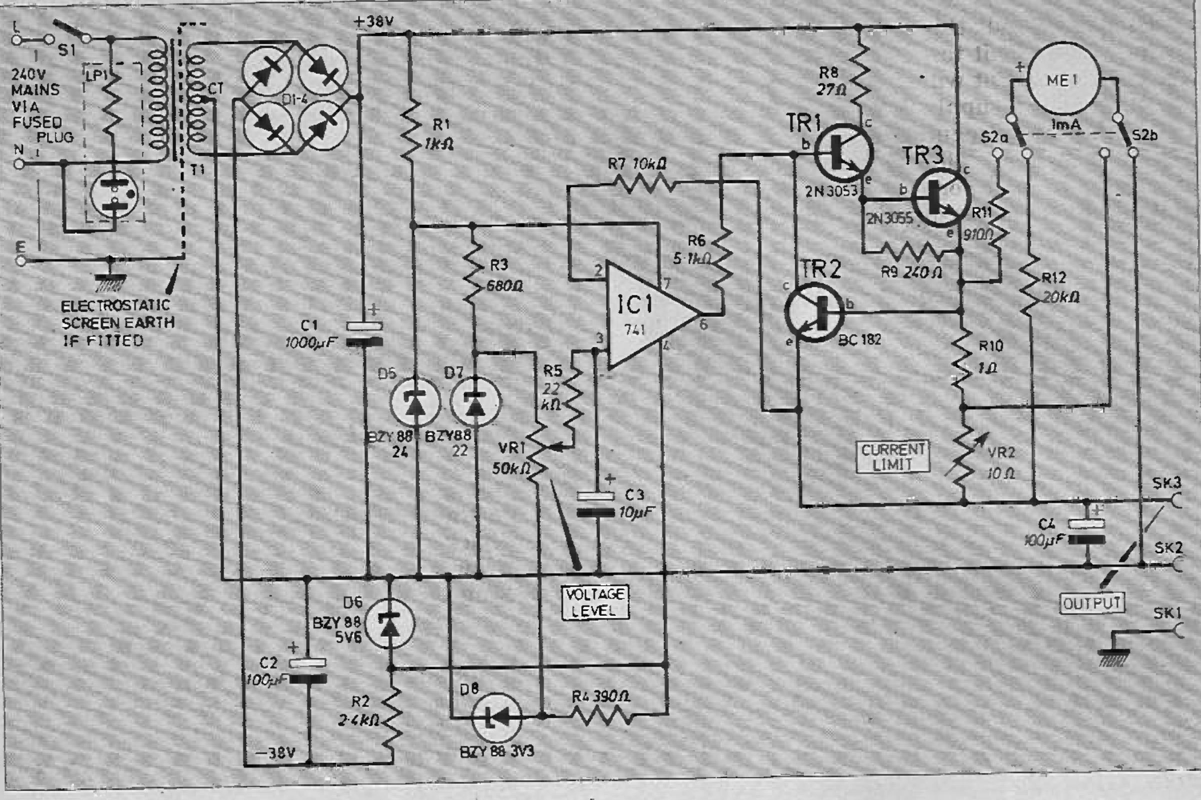


Fig. 2. The complete circuit diagram of the Power Supply Unit.

CIRCUITRY

The circuit diagram for the Power Supply Unit is shown in Fig. 2. The *power source* comprises a 25-0-25V transformer, a diode bridge (D1-D4), and capacitors C1 and C2, an arrangement which gives two voltage sources, 38V being produced across each capacitor.

The Zener diodes give 30V across D5 and D6 to supply the differential amplifier, and a more accurate supply of 25V across D7 and D8 for the voltage selector. Resistors R1 to R4 limit the current through the Zener diodes.

The potentiometer VR1 acts as a *voltage selector*, while the *differential amplifier* IC1 consists of a 741 and ancillary components. Components R5 and C3 form a filter to reduce noise. Resistor R6 increases the output impedance of the 741, which is normally 75 ohms and R7 is a current limiting resistor, through which the output voltage is sampled.

The *regulator* circuit consists of TR1, R8, R9 and TR3 connected as a darlington pair. This may be considered as one transistor with very high gain. Because of this the darlington transistor has a low base current with high collector current, so the arrangement reduces the drain on the 741.

When the sample voltage drops below the reference voltage, the output on the 741 rises, and this increases the base current of the darlington pair. The collector/emitter voltage of TR3 falls and the output voltage increases until the sample voltage is the same as the reference voltage. If the output voltage is greater than the reference voltage, the effect is reversed.

The output voltage will always take up the potential of the reference voltage.

Components TR2, R10 and VR2 form the current control and current limit. With VR2 set to zero ohms, and with 0·5A flowing through R7, the voltage drop across R7 amounts to 0·5V. This is sufficient to turn on transistor TR2 and bring the base of TR1 to the output potential. This cuts off TR1, and hence TR3, so the output current is limited to 0·5A.

By increasing the resistance between base and emitter of TR2, with VR2, the current limit may be reduced to below 50mA.

The meter circuit has been designed for a meter having 1mA full scale deflection and an internal resistance of 105 ohms. Voltage is measured directly across the output via the 20 kilohm resistor, R12, so that full scale deflection represents 20V.

Current is measured by reading the voltage across R11, so that 0·5A current gives half scale deflection on the meter.

CHOOSING COMPONENTS

In the prototype it was decided to use an inexpensive 50V, centre tapped, half-ampere transformer, and this allowed the prototype Power Supply Unit to reach its specified voltage and current output with normal mains supply.

If the mains supply falls appreciably below 240V, the poor regulation of an inexpensive transformer may affect the output. If it is intended to make regular use of the unit near to its limits, a better quality transformer should be considered.

A half-amp diode bridge package with reverse voltage of 100V is used to provide rectification. Four diodes in a bridge arrangement could be used as an alternative, provided that they are each rated at half-amp, and have a reverse voltage of at least 40V.

Transistor TR2 is a BC182, but any small, silicon *npn* transistor having a maximum V_{ce} greater than 50V may be used in this position.

All resistors used are ¼ watt types or greater. The capacitors are all electrolytic and it is important to ensure that you use capacitors with working voltages equal to or greater than the values given.

METER

The meter must give full scale deflection for 10mA or less. If this current is called I_{fsd} and the resistance of the meter is called R_m, then the product, $I_{fsd} \times R_m$ must be less than one volt.

To choose resistors R11 and R12 the formula

$R_s = \frac{V_{fsd}}{I_{fsd}} - R_m$ was used where R_s is the series resistance, see Fig. 3.

Output voltage is measured via R12 and V_{fsd} is 20V. Output current is measured across R10 and via R11, and V_{fsd} is one volt.

So, $R11 = \frac{1}{I_{fsd}} - R_m$ and $R12 = \frac{I_{fsd}}{20} - R_m$

The closest resistance in the list of preferred values should be chosen.

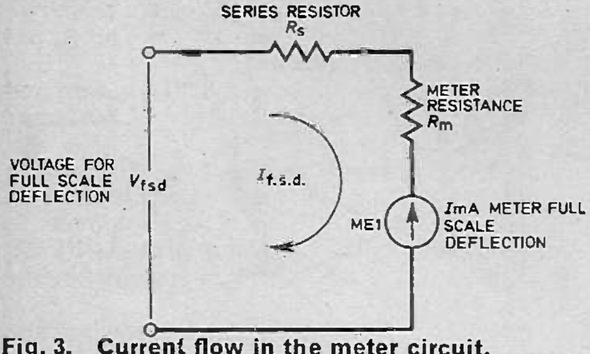


Fig. 3. Current flow in the meter circuit.

CONSTRUCTION

The prototype Power Supply Unit was housed in a commercially available steel cabinet with removeable front and rear panels but any robust case available will do as long as it is metallic.

Components are mounted on the case parts itself and on a piece of 0·1in plain matrix board. Veropins are used to anchor some components on the topside of the board and insulated wire to make the interconnections on the underside of the board.

The top and underside of the component board are shown in Fig. 4. Begin by drilling the four fixing holes near to each corner and then insert the Veropins as indicated.

Next insert the integrated circuit holder and then position and solder the bridge rectifier, resistors and capacitors, paying special attention to polarities, and then wire up the underside as shown keeping the connecting wires as short as possible. The transistors and diodes should be soldered in position next and a heatshunt, such as a pair of pliers, should be used when doing so otherwise heat from the soldering iron may damage these components.

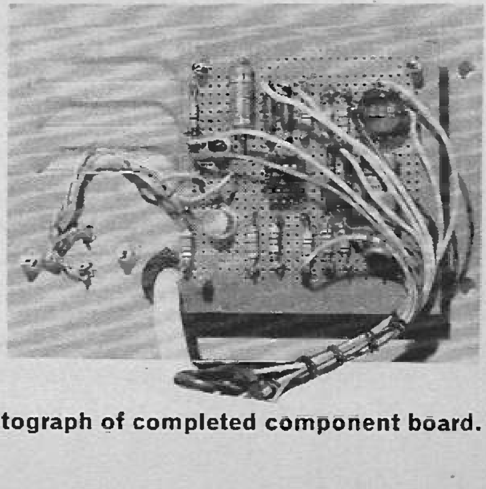
The back panel should be prepared next and the power transistor TR3 mounted in place. Insulating bushes and mica washer **must** be used. Now mount the component board to the back panel with four 4BA nuts, bolts and stand-off spacers and then wire the board to TR3. The back panel acts as a heatsink for TR3.

The next step is to cut and drill the front panel to take the components ME1, VR1, VR2, S1, S2, LP1 and the three terminal connectors SK1, SK2 and SK3 as shown in Fig. 4, and then secure these components in position.

The smoothing capacitor C1 should now be fixed to T1 by means of the capacitor clip as shown in Fig. 6. This assembly should now be placed in position inside the case and suitable holes marked and drilled in the case base through which the transformer can be secured with 4BA nuts and bolts.

Place the front and rear panels on the work bench with T1 between them and wire up according to Figs. 4 and 5. The three core mains cable should be fed in through the panel via a rubber grommet; the other end should terminate in a fused mains plug.

Thoroughly check out your wiring before finally assembling in the metal case.



Photograph of completed component board.

POWER SUPPLY UNIT

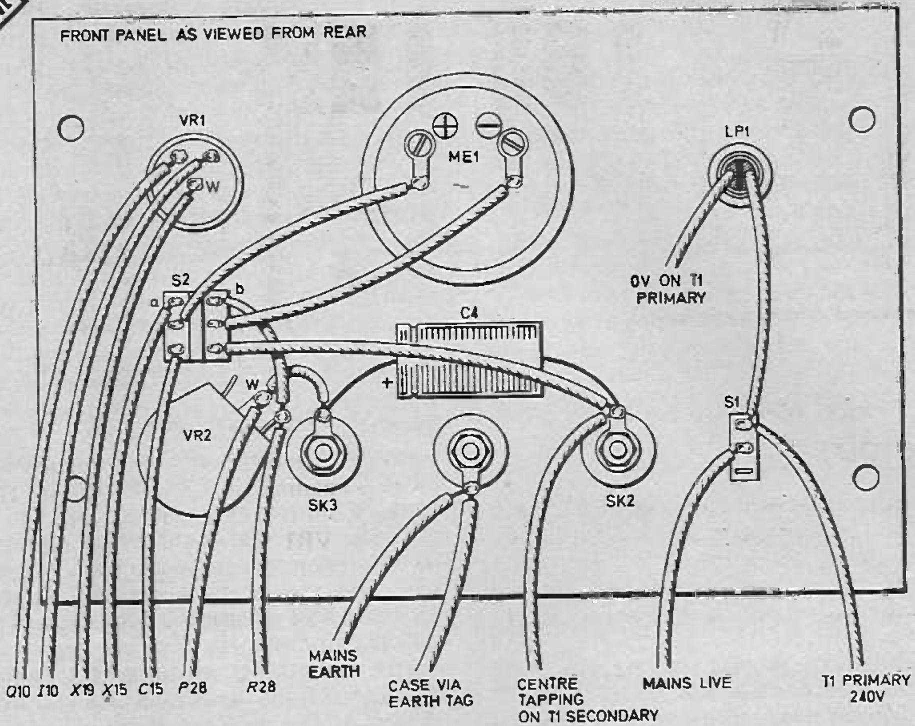


Fig. 5. Component positioning and wiring up on the front panel.

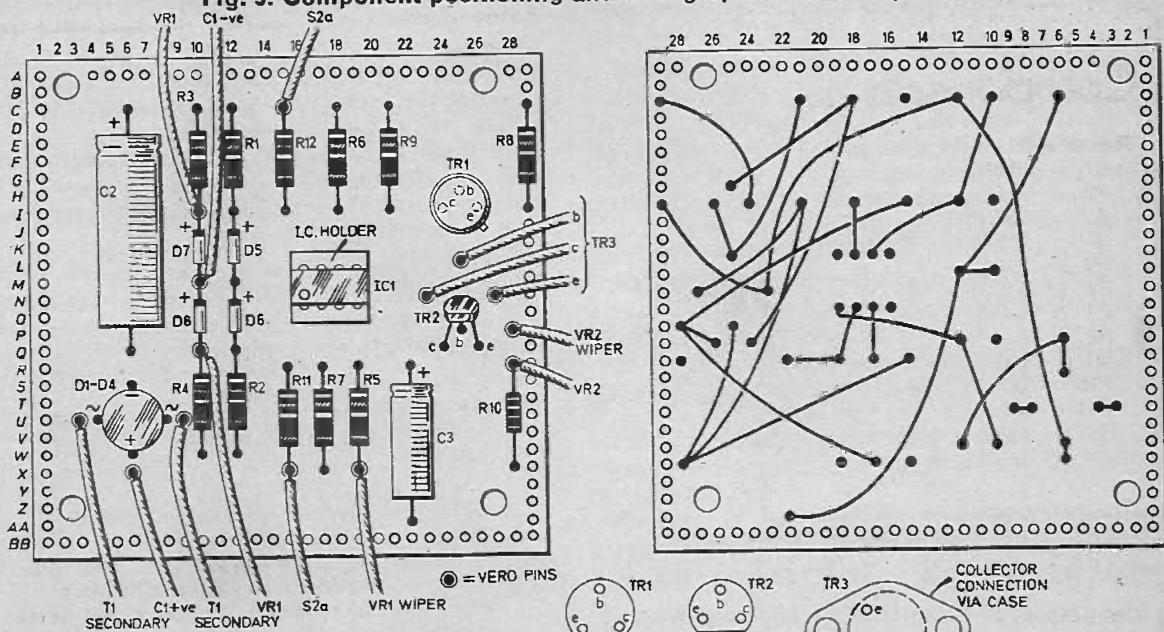


Fig. 4. The layout of the components on the top-side of the board, and interconnections on underside.

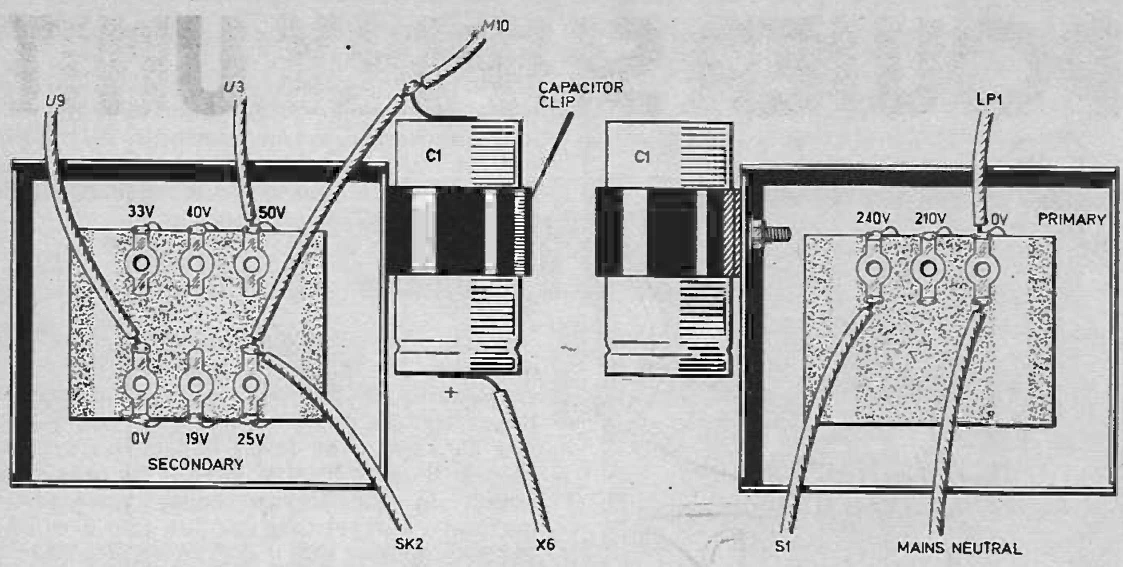


Fig. 6. Wiring up details on primary and secondary windings of T1.

CHECKING OUT

Set VR1 fully anti-clockwise and VR2 fully clockwise, S2 to the voltage mode and then plug into the mains and switch on at S1. The neon indicator lamp should light. Now turn VR1 in a clockwise direction and the meter needle should move across the scale, reading 20 volts with VR1 in the fully clockwise position. Turn VR1 back to read zero volts and switch off.

Connect a 12 volt bulb, six watts or less—i.e. the bulb takes 0·5A or less—across the output terminals SK2 and SK3. Now turn VR1 clockwise until a reading of 12 volts shows; the intensity of the bulb increases from zero.

Leave VR1 set at this level and switch S2 to the current monitoring mode, and take the reading from the *lower* scale, it should be 0·5A. Turn VR2 in an anticlockwise direction and the intensity of the bulb should decrease showing that the current through the bulb is being limited to the value shown on the meter.

With VR2 set to limit at about 250mA (0·25A), switch S2 back to the voltage mode, the meter

Components....

Resistors

R1	680Ω
R2	2·4kΩ
R3	390Ω
R4	390Ω
R5	22kΩ
R6	5·1kΩ
R7	10kΩ
R8	27Ω
R9	240Ω
R10	1Ω
R11	910Ω
R12	20kΩ

All ¼W carbon ± 5%

Potentiometers

VR1	50kΩ linear carbon
VR2	10Ω linear

Capacitors

C1	1000μF	40V	elect.
C2	100μF	40V	elect.
C3	10μF	25V	elect.
C4	100μF	25V	elect.

SEE **SHOP TALK**

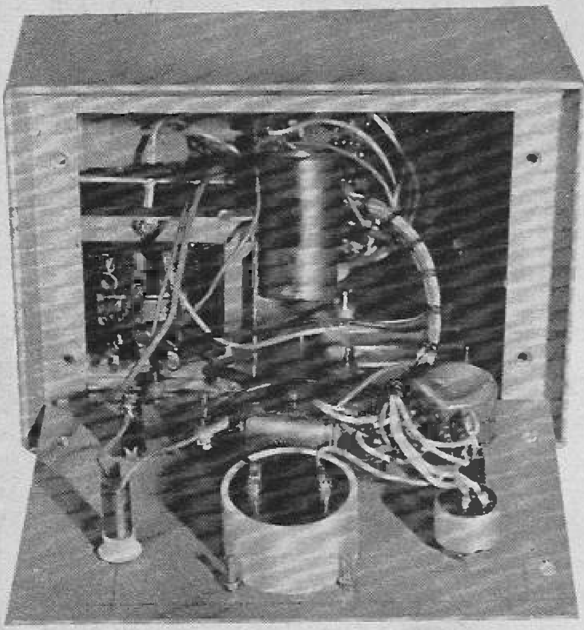
Semiconductors

TR1	2N3053 silicon *npn*
TR2	BC182 silicon *npn* or similar
TR3	2N3055 silicon *npn*
D1-D4	½A 100 P.I.V. bridge rectifier or equivalent
D5	BZY88/24 400mW Zener
D6	BZY88/5V6 400mW Zener
D7	BZY88/22 400mW Zener
D8	BZY88/3V3 400mW Zener
IC1	741 differential operational amplifier, 8-pin d.i.l.

Miscellaneous

T1	240V primary 25-0-25 0·5A secondary
ME1	1mA d.c. meter type S.E.W. MR38P or similar
LP1	panel mounting mains neon with built-in resistor
S1	mains on/off slide or toggle
S2	d.p.d.t. toggle or slide
SK1, 2, 3	insulated screw terminals, black green red (1 off each colour)

Plain matrix board 0·1in. 28 x 28 holes; Veropins; capacitor clip to suit C1; mica washer and insulating bushes for TR3; 4BA nuts bolts and washers and four 4BA stand-off spacers; length of three-cored mains cable. Case, metal approx. 165×115×115mm.



Photograph of completed unit and front panel, removed.

reading, now from the *top* scale, should still be at 12 volts.

If a lower wattage bulb is used, say three watts, ie. current consumption of 0·25A, then in the above test, turning down the current limit control, VR2, would have no effect on the intensity of the bulb until the current is limited to less than 0·25A.

USING

When using the Power Supply Unit to power a device, the maximum current likely to be required by the device should be estimated and the current limit control set to this value. In this way damage to the device is kept to a minimum should there be a fault. Even if there is a short circuit in the device being powered, the maximum current that can flow into it will have been limited by VR2.

There is a third terminal, SK1 connected to earth, so it is possible to earth either side of the power supply output as required.

It is recommended that when in use all connections to the output sockets be made and checked before switching on the unit. ▣

...Counter Intelligence

BY PAUL YOUNG

A retailer discusses component supply matters.

MANY who take up electronics as a hobby, become "hooked on it" if you will forgive the argot. However, when you consider that there are so many less useful or interesting things that could claim your money and attention, this must count in it's favour. If you do reach that stage, you will probably find you are placing regular weekly or monthly orders with your suppliers. In which case, I would suggest that you approach them, with the idea of opening an account. I don't think the mail order firms, would raise any objections.

Of course it would be wisest not to broach the subject, until you have been one of their "cash customers" for a few months. This will give them confidence, and they will also be able to assess your value to them as a client. They may want references, this is usual procedure, but I am sure you will know plenty of people who will vouch for you.

It helps considerably, if your referees have a status, such as, bank manager, doctor, vicar, or school teacher. You may have the payment card of a completed hire purchase transaction, this is often acceptable evidence of your credit worthiness.

Advantages

Consider the advantages of a monthly account. You can order at will, either by post or telephone, and just one cheque or postal order at the end of each month will settle your debt, (this in itself can show quite a saving in the cost of cheques and postal orders). In our company (due perhaps to my enthusiasm) we went overboard for this scheme.

I had an Answerphone installed on a special ex-directory line, (thus enabling our customers to place orders at any time during the 24 hours). Apart from the convenience, it meant that they could use the telephone at the reduced rates. I also provided them with order forms and prepaid envelopes.

'C' for Charlie

For the benefit of the telephone users, I sent them a letter, telling them what to do, and what to avoid. I even sent them a copy of the international air alphabet. I think you know the type of thing. I believe it started in World War 1, with "C for Charlie," "D for Don", "B for beer" etc. Now it is much more sophisticated, and to give you a small sample, "G" "H" "L" "K", would become "golf" "hotel" "Lima" "kilo."

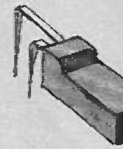
Miss-understanding

When I first introduced it, it led to an amusing incident. The excellent young lady, who runs the whole scheme in her spare time takes the orders off the telephone machine each morning.

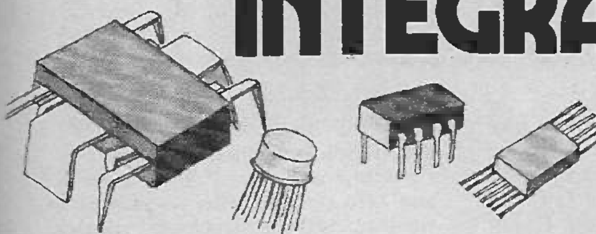
This particular morning, she came to me in great consternation, "Ere this bloke must be orf his chump, 'E wants to order a hotel an' a golf course!" I quickly told the poppett that we were not going into the real estate business, and explained to her, how it came about. Since then all has been plain sailing.

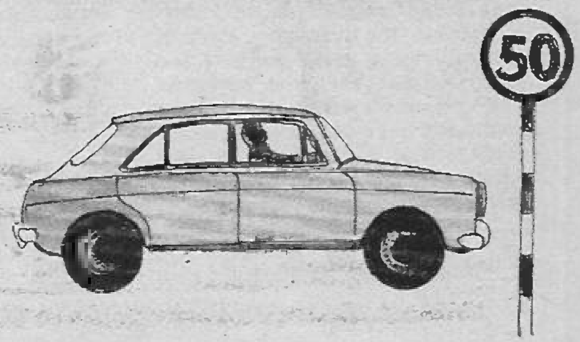
Finally, if any of my fellow sufferers (I mean of course component retailers) would like any advice on running these accounts, just contact me, and, as they say in the *Times* personal column, they will learn something to their advantage, to say nothing of their customers.

FREE *Inside*... NEXT MONTH'S ISSUE



INTEGRATED CIRCUIT DATA CHART

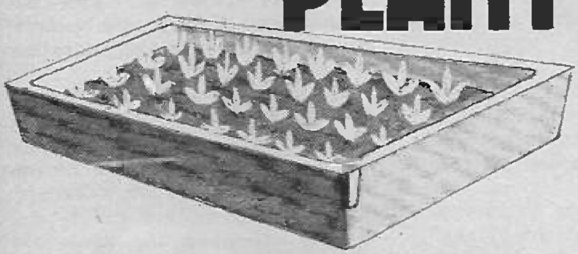




SPEED GUARD

An audible warning is sounded when a pre-set speed is exceeded. An aid to save fuel and to speed limit observance.

PLANT PROPAGATOR



Get your seedlings off to a good start with this temperature controlled soil warmer.

A.F OSCILLATOR

e e
TEST GEAR FIVE

The second unit in our Test Gear Five series provides a sine wave output of up to 4·5 volts r.m.s. between 10Hz and 10kHz.

Subject to the current national industrial situation at the time of going to press

everyday electronics

MARCH ISSUE ON SALE FRIDAY, FEBRUARY 15

NEW PRICE 20p.

Ruminations
By Sensor

Watts to do!

In the midst of the energy crisis there seems little to be cheerful about; the prospect of cold homes, long bus queues in snow filled streets and a bowl of cold gruel for supper, scarcely gladdens the heart.

But the electronics man can feel smug if not snug in the knowledge that the transistor circuits can run on a small battery for many hours. When the power is "on" the whole family can gather round the hot soldering iron while construction of the latest project continues and thus avoid any waste of heat.

I remember warming my hands on the valves of a radar set, during a power crisis many years ago, and a keen fisherman I knew put this waste heat to good use in rather unusual circumstances. One of the women in the factory had bought some bacon during a lunchtime shopping trip and had discovered that it contained some maggots. She was quite justifiably complaining to her workmates about this unhappy state of affairs when the fisherman overheard her remarks. He paid her for the bacon and put it into a piece of equipment for the afternoon where it was kept at an ideal temperature for the maximum production of fat maggots! I felt that this incident represented a variation on the "one man's meat is another man's poison" theme.

Waste Not

The early computers used a considerable amount of power but most of it was dissipated in heat. It was usual to fit refrigeration equipment to all but the smallest computer in order to keep the temperature down to within the operating limits of the components and to avoid the operators having to work stripped to the waist.

Even at a more humble level the domestic radio and television produced an appreciable amount of heat; my father used to raise boxes of tomato seedlings on top of the television very successfully but if you try it be very carefnl when watering them *(see next month's propagator article—ed.)*.

I have often felt that man is guilty of a prodigous waste of heat which is pushed out into the atmosphere, poured into rivers and into the sea with no real attempt to extract the energy which has been put into it at such cost. It has been cheaper to throw away heat than to try to conserve it but the trend towards dearer fuel must change all that. Unfortunately we cannot get back all that has been lost over the years; the best that we can do is to put our house in order now, before it is too late.

Electrolytic Capacitors

Are there any rules that limit the use of electrolytic capacitors in a circuit?

Provided one side of the capacitor is *always* positive with respect to the other then you can use an electrolytic. Even if you have an alternating voltage on one side provided it is set off by a d.c. level so that the peak a.c. levels do not reverse the applied polarity then you can still use an electrolytic but you must make sure that the a.c. component of the signal does not cause the capacitor's "ripple current rating" to be exceeded. With small signal coupling capacitors (between stages) this is not likely to be a problem but it could be in the case of power supply smoothing.

You must however remember that most electrolytics are "leaky" and this would preclude their use in some circuits.

Capacitor Voltage

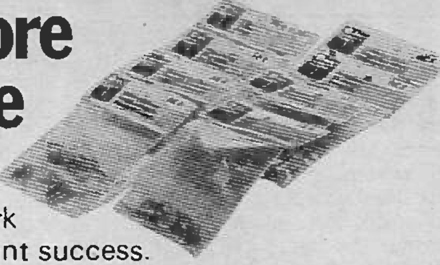
Why do capacitors have a voltage rating? Is it very important and can you use devices having different ratings from those specified?

Any capacitor — when boiled down to its fundamental principle of operation is made up of a number of electrodes separated from each other by a very thin insulator—known as a dielectric. This can be plastic (polyester or polystyrene) ceramic, paper, air or a chemical electrolytic. Any insulating substance can prevent d.c. current flow but only when the voltage across it is limited to below its breakdown voltage; this is dependant on its nature and its thickness. Breakdown occurs by a spark jumping across between the electrodes and through the dielectric. Not only can this permanently damage the capacitor but it can ruin the operation of the circuit.

The voltage rating for a capacitor is the maximum voltage (whether d.c. or peak a.c.) that you can apply across the device before this breakdown occurs. Sometimes there are differences in level between the peak a.c. value and d.c. value for a given capacitor. Obviously is is a *very* important parameter. You can, however, *always* use a capacitor having a *higher* voltage rating than is specified in a components list.

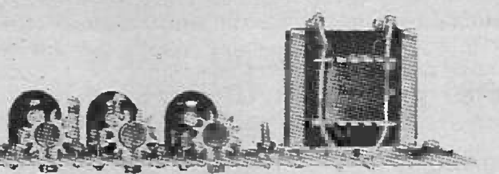
JOSTY KIT

Bags of electronic success from Josty Kit and more and more people stock them!



Josty laboratories in Denmark have worked hard to bring you instant success.

Experienced engineers have produced the wide range of Josty Kits from the finest materials and components. With circuit boards incorporating the latest developments. Assembly of even the complicated circuits has never been simpler. So you put them together quicker and right first time. And now even more people are stocking them. Just look at the list. If there isn't a stockist near you, there are mail order services so nobody gets left out. Every Josty Kit carries a one year guarantee for all parts and for the correct function of the assembled kit.



AT65 Psychedelic Light Control. 400 watts on each of three channels. Treble, medium and bass.

AT30 Photo-cell amplifier.
Use for burglar alarm, counter, door opener, etc.

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AF25	Mixer	3.96
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AF35	Emitter Amplifier	2.50
AF80	Small 0.5 W Amplifier for Microphone	4.65
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AF310	Mono Amplifier (for Stereo use two)	6.50
M160	Multivibrator	1.88
M1302	Transistor Tester	9.30
M191	Vu-Meter	5.01
M192	Stereo Balance Meter	5.47
LF380	Quadrophonic Device	12.50
AT60	Psychedelic Light Control, Single Channel	8.58
AT65	Psychedelic Light Control, 3 Channel	16.00
AT25	Window Wiper Robot	6.40
AT30	Photo Cell Switching Unit	6.27
AT50	400w Triac Light Dimmer Speed Control	5.28
AT56	2,200w Triac Light Dimmer Speed Control	7.59
AT5	Automatic Light Control	2.84
GU330	Tremelo Unit for Guitars, etc.	8.25
HF61	Diode Detector	3.66
HF65	Frequency Modulated FM Transmitter	2.97
HF75	FM Transistor Receiver	3.16
HF310	FM Tuner Unit	17.39
HF325	De-Luxe FM Tuner Unit	26.53
HF330	Stereo Decoder for use with HF310 or HF325	10.95
GP310	Stereo Pre-Amp to use with 2. AF310	23.39
GP312	Basis Circuit Board	12.60
GP304	Basis Circuit Board	5.44
HF380	Aerial Amplifier for LW to VHF	5.54
HF395	Broadband Aerial Amplifier	1.94
NT10	Power Supply 100m/a 9V Stabilised, 12v Unstabilised	6.76
NT300	Professional Stabilised Power Supply	13.76
NT305	Voltage Converter	4.95
NT315	Power Supply 240V a.c. to 4.5 – 15V d.c. 500m/a	10.52
AE1	Output Stage 100mW	1.65
AE2	Pre-amplifier	1.26
AE3	Diode-receiver	2.30
AE4	Flasher	1.09
AE5	Astable Multivibrator	1.05
AE6	Monostable Multivibrator	1.02
AE7	RC Generator	1.06
AE8	Bassfilter	0.99
AE9	Treblefilter	0.99
AE10	CCIR – filter	0.99

List of stockists

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DEMO CIRCUITS

12 By MIKE HUGHES

The AND Gate

THIS month's circuit is shown in Fig. 12.1 and you would be excused if you felt, at first glance, that it was so simple it hardly warranted a special article to describe its function.

However, it is a most important circuit and crops up over and over again—usually hidden away within a more involved system. Because of its simplicity and the fact that it is seldom described in detail when embodied within a more complicated circuit we felt that we had better do the honours to the **diode AND** gate.

To understand its function, imagine you are in a car on a gated mountain road; it is impossible for you to progress along the road unless someone opens the gate—your progress is under the control of a third party!

Conversely, the third party could deliberately impede your passage by refusing to open the gate. This is a direct comparison with this month's circuit which has the same effect on electrical signals as the mountain gate had on the car. This is how the circuit gets its name.

EXPERIMENT

To see this effect wire up the circuit of Fig. 12.1 and connect point *B*, with a temporary lead, to the +4·5V rail. Connect a meter, set to volts, between point *C* and ground and then alternately connect point *A* to +4·5V and then to ground with a flying lead.

By varying the voltage at *A* in this manner you are simulating a square wave and you will see that the voltage measurement at the output, point *C*, follows the waveform you are putting in at *A*. When *A* is connected to ground do not expect to see zero volts at point *C* because you must remember there are forward voltage drops across the diodes to consider. By keeping input *B* connected to +4·5V you are, in effect opening the gate to allow the signals from *A* to pass through.

Now connect point *B* to ground and you will find that the output *C* drops to nearly zero and stays there irrespective of any signal you apply at *A*—grounding point *B* shuts the gate.

You may have noticed that while doing this you can have the gate open by leaving input *B* disconnected; you can therefore consider this to be a "spring loaded" gate which—in the absense of any positive action to keep it closed (grounding point *B*)—will always swing open.

CIRCUIT ACTION

Let's see why this effect takes place. We shall assume that we are using "digital" signals at inputs *A* and *B*; this means that the voltages we supply will be either the full supply voltage (+4·5V) or ground (0V).

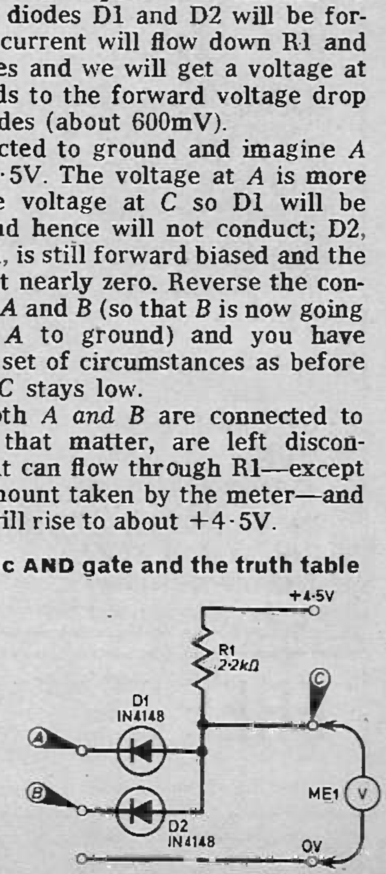
Imagine that both inputs are shorted to ground; both the diodes D1 and D2 will be forward biased and current will flow down R1 and through the diodes and we will get a voltage at *C* that corresponds to the forward voltage drop of the silicon diodes (about 600mV).

Leave *B* connected to ground and imagine *A* connected to +4·5V. The voltage at *A* is more positive than the voltage at *C* so D1 will be reverse biased and hence will not conduct; D2, on the other hand, is still forward biased and the output will stay at nearly zero. Reverse the connections between *A* and *B* (so that *B* is now going to +4·5V with *A* to ground) and you have exactly the same set of circumstances as before —the voltage at *C* stays low.

If, however, both *A and B* are connected to +4·5V (or, for that matter, are left disconnected) no current can flow through R1—except for the minute amount taken by the meter—and the voltage at *C* will rise to about +4·5V.

Fig. 12.1. The basic AND gate and the truth table

INPUTS		OUTPUT
A	*B*	C
OV	OV	OV
+4·5V	OV	OV
OV	+4·5V	OV
+4·5V	+4·5V	+4·5V



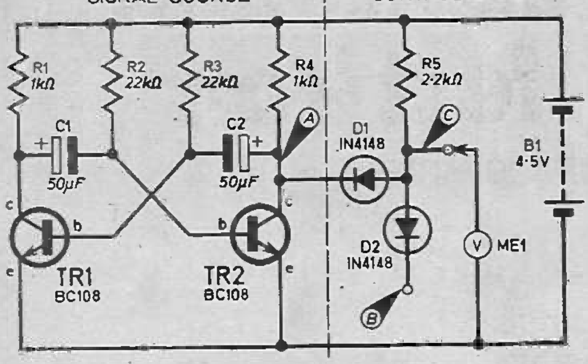


Fig. 12.2. Test circuit for the gate

Notice that we have described every possible permutation of applying either 0V or +4·5V to both inputs—four possibilities in all—and in only one of these possibilities did the output go to +4·5V. This occurred when both *A and B* were connected to +4·5V—strictly speaking we should not consider any cases of the inputs being disconnected.

Because the output will go to a high voltage only when both outputs are connected to a high voltage shows us why the gate is called an AND gate. It takes *A and B* to be at high levels to make *C* go to a high level!

TRUTH TABLE

The combinations of the input conditions and the resulting output conditions can best be seen in the form of a table—Fig. 12.1. This is called a truth table. Imagine column *A* as being a signal and column *B* a control voltage. You can see that the voltages applied to *A* appear at the output when *B* is +4·5V but the input signal is inhibited from appearing at the output when *B* is at 0V; +4·5V at *B* opens the gate while 0V closes it!

DIGITAL GENERATOR

As an extension of the experiment you can generate a real electronic digital waveform for input *A* by using a slow running astable multivibrator as shown in Fig. 12.2. Check with the voltmeter that you are getting a repetitive waveform at point *A* and then measure what you get at output *C* when *B* is firstly connected to +4·5V and then to ground.

You might think that connecting point *B* to ground in some way stops the multivibrator operating; this is not so and you can check this by returning the voltmeter to point *A*. The two diodes are acting as a control gate for the multivibrator's signal.

ALARM

Finally, and to remove the need for mechanical intervention, we can use an electronic signal as the control. A simple circuit is shown in Fig. 12.3. Basically we have a multivibrator operating at an audio frequency and a photocell driving a transistor as a control source.

When the photocell is dark, the voltage at the collector of TR3 is high and this effectively applies +4·5V to input *B*—the signal from the audio source can thus pass through the gate into the loudspeaker driver and we hear an audio tone. When light falls on the cell base current passes into TR3 and the voltage at its collector falls virtually to zero; this closes the gate and the audio tone stops.

If you had this circuit set up with a torch beam illuminating the cell there would be no tone from the loudspeaker until the light beam was interrupted—perhaps by someone walking through a door—and then you get an audible alarm.

Next part: The series resonant filter

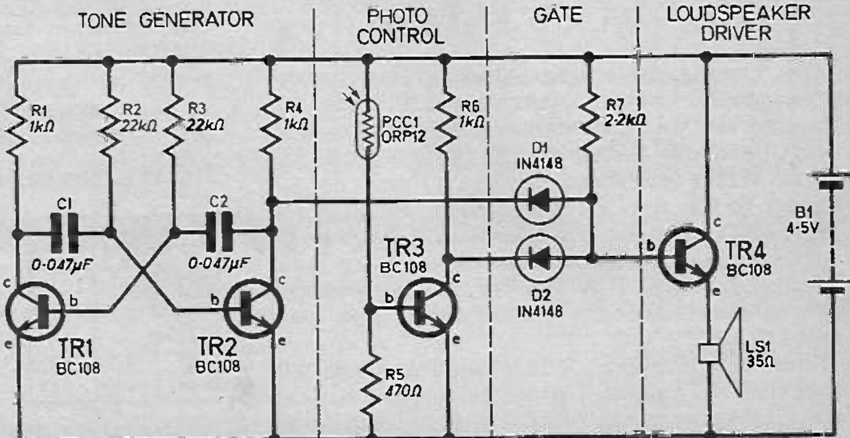
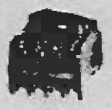


Fig. 12.3. Simple electronic circuit to demonstrate the function of the AND gate

MAINS OPERATED CONTACTOR



220/240v. 50 cycle solenoid with laminated core so very silent in operation. Closes 4 circuits each rated at 10 amps. Extremely well made by a German Electrical Company. Overall size 2¼ × 2 × 2in. £2·20 each.

1 R.P.M. MOTOR+GEAR-BOX

Made by the famous Chamberlain & Hookham Ltd. These could be made to drive clock or similar. Really robust reliable unit. Price £1·10 each.

AUTO—ELECTRIC CAR AERIAL

with dashboard control switch—fully extendable to 40in or fully retractable. Suitable for 12V positive or negative earth. Supplied complete with fitting instructions and ready wired dashboard switch. £6·35 plus 25p post and insurance.

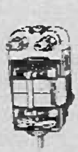
MAINS TRANSISTOR POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only £1·10, plus 20p postage.

MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at 25p each.

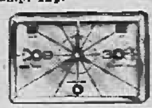
MULTI-SPEED MOTOR



Six speeds are available 500, 850 and 1,100 r.p.m. and 8,000, 12,000 & 15,500 r.p.m. Shaft is ¼ in. diameter and approximately 1 in. long. 230/240v. Its speed may be further controlled with the use of our Thyrister controller. Very powerful and useful motor size approx. 2 in. dia. × 5 in. long. Price 97p plus 23p postage and insurance.

SLIDE SWITCHES

Slide Switch. 2-pole changeover panel mounting by two 6B.A. screws. Size approx. 1in × ⅜in rated 250V lamp. 8p each. 10 for 73p. Ditto as above but for printed circuit 6p each, 10 for 53p Sub Miniature Slide Switch. DPDT 19mm (⅜in approx.) between fixing centres. 20p each or 10 for £1·90. SP Change over spring return 250v 1 amp. 11p.



15A ELECTRICAL PROGRAMMER

Learn in your sleep: Have radio playing and kettle boiling as you awake—switch on lights to ward off intruders—have warm house to come home to. All these and many other things you can do if you invest in an electrical programmer Clock by famous maker with 15 amp. on/off switch. Switch-on time can be set anywhere to stay on up to 6 hours. Independent 60 minute memory jogger. A beautiful unit. Price £2·15 + 20p p & p or with glass front chrome bezel 88p extra.

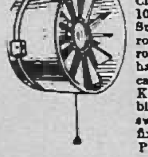
BALANCED ARMATURE UNIT

500 ohm, operates as speaker or microphone, so useful in intercom or similar circuits, 37p each.

12 VOLT 1½ AMP POWER PACK

This comprises double-wound 230/240V mains transformer with full wave rectifier and 2000 m/f/d/ smoothing. Price £2·20 + p. & p. 20p.

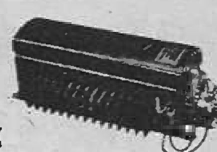
Heavy Duty Mains Power Pack. Output voltage adjustable from 15–40V in steps—maximum load 250W—that is from 6 amp at 40V to 15amp at 15V. This really is a high power heavy duty unit with dozens of workshop uses. Output voltage adjustment is very quick—simply interchange push on leads. Silicon rectifiers and smoothing by 3,000mF. Price £6·33 plus 65p post



EXTRACTOR FAN

Cleans the air at the rate of 10,000 cubic ft. per hour. Suitable for kitchens, bathrooms, factories, changing rooms, etc., it's so quiet it can hardly be heard. Compact, 5¾" casing with 5¼" fan blades. Kit comprises motor, fan blades, sheet steel casing, pull switch, mains connector, and fixing brackets. £2·75 + 20p P. & P.

HONEYWELL PROGRAMMER



This is a drum type timing device, the drum being callibrated in equal divisions for switch setting purposes with trips which are infinitely adjustable for position. They are also arranged to allow 2 operations per switch per rotation. There are 15 changeover micro switches each of 10 amp type operated by the trips thus 15 circuits may be changed per revolution. Drive motor is mains operated 5 revs per min. Some of the many uses of this timer are Machinery control, Boiler firing, Dispensing and Vending machines, Display lighting animated and signs, Signalling, etc. Price from makers probably over £10 each. Special snip price £6·33 plus 25p post and insurance. Don't miss this terrific bargain.

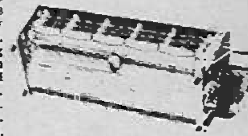
TEACH IN '74

A new beginners series started with the October issue of this magazine, we will be supplying all the parts for this. The initial kit covering all components required for the first 6 months is available post and VAT included—price £7. A special feature about our version of this kit is the 4½" × 3" meter 0–100uA meter. As the author says, a large meter is so much easier to read than a small one.

POWER SUPPLY UNIT
SLIDE PROJECTOR TIMER
EMERGENCY LIGHTING UNIT

To receive parts for these and other feature projects, send the quoted approximate amounts and any cash adjustment can be made later.

TANGENTIAL HEATER UNIT



This heater unit is the very latest type, most efficient, and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. We have a few only. Comprises motor, impeller, 2kW. element and 1kW. element allowing switching 1, 2 and 3kW. and with thermal safety cut-out. Can be fitted into any metal line case or cabinet. Only needs control switch, £3·85. 2kW. Model as above except 2kW. £2·75. Don't miss this. Control Switch, 44p plus VAT P. & P. 40p.

PORTABLE RADIO CASE DE-LUXE

A similar size to the above but a more expensive design. Used with the Good Companion de-luxe model. £2·20 plus 50p post and insurance.

KETTLE ELEMENTS

Made by the famous A.E.I. Co. Complete with washers and combined fixing ring and plug shroud. Normal 2 round pin and flat pin earth connection and overload reset push button. 2 Models—1¼in (approx.) suitable for Swan and other similar models—1⅝in (approx.) suitable for G.E.C., Hotpoint, etc. All quick-boil 2¼kW elements at 240V. Price £1·38.

SWITCH TRIGGER MATS

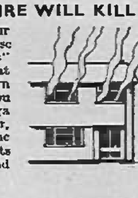
So thin is undetectable under carpet but will switch on with slightest pressure. For burglar alarms, shop doors, etc. 24in × 18in £1·69. 13in × 10in £1·21.

HORSTMANN "TIME & SET" SWITCH

(A30 Amp Switch.) Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc. up to 14 hours from setting time or you can use the switch to give a boost on period of up to 3 hours. Equally suitable to control processing. Regular price probably around £5. Special snip price £1·65 Post and ins. 23p.

OUR 1974 CATALOGUE LISTING HUNDREDS OF BARGAINS. NOW AVAILABLE. PRICE 30p POST PAID.

SMOKE WILL KILL—GAS WILL KILL—FIRE WILL KILL

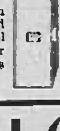


But, if you install SAGA (our smoke and gas alarm) your family will have the latest electronic protection, against these killers. Saga uses a fantastic electronic sensor which "smells" smoke and gas and sounds the alarm immediately, in a neat case measuring approx. 5in × 3½in × 2¼in, it has its own internal alarm, also a connector for additional bells. You just plug it in to the mains and hang it near the ceiling. Saga uses so little electricity that it will hardly move the meter, leave it on always to give night and day protection. One year's guarantee, also 7-day cash return offer, (or kit of parts £5·99. Battery model kit only £4·99), £6·99 plus 30p post and service.

SOIL HEATER

Or could be used on bench for seed trays. Comprising mains transformer to reduce to safe voltage also heater wire. £1·50 plus 20p p. & p.

WALL THERMOSTATS



Made by the famous Smiths Instrument Co. called Colourstat. Wall mounting and in a handsome plastic case. (Cream and beige) Adjustable by slider (lockable) and may be set to control temperatures from around freezing through to 50°C. The slide panel is engraved and indicates (frost) (warm) (very warm) etc. The thermostat will control heaters etc. up to 15 amp at normal mains voltage and is ideal for living room, bedroom and greenhouses etc. Price £1·65. Don't miss this.

EDUCATIONAL KITS — all with pictorial instructions

THIS BALANCE KIT FREE. Eagle educational kits. Japanese made, these are excellent value for money. We do not expect to be able to repeat this offer once stocks are sold. Brief description of each kit is given below and with 3 kits or more we give FREE an accurate 11 piece balance kit. Price of kits 44p each post paid. Special price for all 7 kits £3·00 with free balance kit.

KA2 Lens Kit. Eleven parts, including candle, one concave lens, one convex lens, stage and slit frame, etc. Watch light rays bend as they pass through different lenses.

KA3 Water Pump Kit. Thirteen parts. Top of pump is transparent so that operating parts may be observed. Small parts are brightly coloured to be seen easily while working. Three types of pump may be made: Lift Pump, Force Pump and Force Pump with reservoir and nozzle.

KA4 Buzzer Kit. Eleven parts. Transparent covers allow the operation of buzzer to be seen. Illustrates and teaches how electromagnetism with an automatic switch results in an operating buzzer.

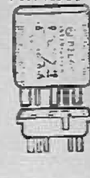
KA7 Electro-Magnet Kit. Fifteen parts, includes compass. Makes two electro-magnets, one with one layer of wire and one with several layers of wire. Picks up tacks, nails and any small parts showing how magnetism works.

KA8 Current and Resistance Kit. Twenty-nine parts, including bench and light bulb. Conduct interesting and educational projects to learn the application of "OHMS LAW" and see the difference in current and resistance with different types and lengths of wire.

KA9 Bell Kit. Eight parts, including bell and push button switch. Build a complete electric bell and see how the hammer is triggered to make the bell ring.

KA10 Morse Key Buzzer and Bell Kit. 25 part kit, easy to construct, simple to operate.

MINIATURE SEALED RELAY



American made. Our Ref. No. REL A1. Measures only ⅞" wide × ½" thick and ⅞" high and it's a double change over, we don't know the contact rating but estimate this at 3/5 amps. The coil resistance is 600 ohms and 9–12 volt will close it. Ideal for models and miniaturised equipment. It's a plug in relay but we supply complete with base. Price 28p including base.

TELESCOPIC AERIAL

for portable, car radio or transmitter. Chrome plated—six sections, extends from 7¼ to 47in. Hole in bottom for 6BA screw. 42p. KNUCKLED MODEL FOR F.M. 55p

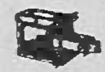
TREASURE TRACER

Complete Kit (except wooden battens) to make the metal detector as the circuit in Practical Wireless, August issue. £3·30 plus 20p post and insurance

IMMERSION HEATERS BY REMPLOY

Standard fitting for domestic water tanks, made by the famous Remploy Company. Complete with sealing washers suitable for 200–240 volts A.C. Depth into tank 11". 2kw or 3kw £1·65 plus 20p each post and insurance.

MAINS OPERATED SOLENOIDS



Model TT2—small but powerful 1" pull—approx. size 1½" x 1⅛" x 1¼". 66p. Model 400/1 ½" pull. Size 2¼" x 2" x 1¾". 83p. Model TT10 1½" pull. Size 3" x 2½" x 2¼". £1·93 plus 20p post and insurance.

MACLAREN THERMOSTAT

Make and break 20 amp A.C. with the sensor probe coupled by 2 feet capillary covering range of 10—100°C—complete with large engraved control knob. Price 83p.

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Make and break 20A a.c. with the sensor probe coupled by a 2 feet capillary covering range of 10-100°C—complete with large engraved control knob. Price 83p.

12 WAY SUB-MINIATURE MULTI-CORE CABLE

7·0076 copper cores each core P.V.C. insulated and of different colour. P.V.C. covered overall and approx. 3/16in thick. Price 22p per yard.

TERMS:—10% discount if ten of an item ordered, postage where quoted—other items, post free if order for these over £6·00 otherwise add 25p.

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DOWN TO EARTH

By GEORGE HYLTON

"Why is it that you don't get a shock if you touch the neutral terminal of the mains? After all, this terminal is negative half the time and positive half the time, so if you don't get a shock when it's negative then you should get one when it's positive. Also, why is it that if you connect a voltmeter between the neutral and earth terminals you get a small voltage reading?"

An enquiring mind is a great thing, and can lead to important discoveries. Benjamin Franklin, flying his kite in a thunderstorm, proved that thunderclouds are electrically charged and so gained evidence that lightning is electrical.

The next chap to try the experiment discovered that it could be dangerous. He was electrocuted. Which is by way of saying, please, **please don't play about with the mains.**

Even if what you do *should* be safe, in theory, as in this case, there's no guarantee that it *will* be safe in practice. Electrical wiring in the house has been known to have the polarities reversed, the earth connection omitted, and so on.

BRITISH SYSTEM

For the benefit of foreign readers whose mains system may be different from ours, the standard British house wiring system provides 240V, 50Hz outlets at sockets which take three-pin plugs.

One pin is connected to the local, domestic earth (often a metal water pipe where it enters the ground). Another is the neutral side of the mains, earthed at the power station or distribution transformer. The third is the live or non-earthy side of the mains. The system is shown in Fig 1, which is simplified in that it glosses over the fact that the distribution cables are usually made to carry more than one "phase" and so have more than two conductors, but the general idea is correct.

In order to receive a shock from the mains, it is necessary to connect your body between the live and neutral terminals, directly or *indirectly*.

DIRECT AND INDIRECT

A direct connection is what you get if you touch the "live" terminal with, say, one finger and the "neutral" with another. This is not pleasant. In particular, if the two fingers are on different hands, the resulting arm-to-arm current passes through your heart, which is a pretty good way of killing yourself.

The indirect connection is nearly as bad. It happens when you touch the "live" terminal only, but when your body is also in some way connected to the earth.

Since the mains "neutral" is also connected to earth, the circuit is complete and you get a shock. With 240V to drive the current, the earth connection to your body needn't be very good. Standing on a concrete floor in leather-soled shoes may provide a low enough resistance for a lethal shock, while most homes contain a wealth of earthed objects such as water pipes, taps, gas pipes, central heating radiators and so on.

NO SHOCK

I know: I haven't answered the questions yet. Well, the answer to the first one can be seen from Fig. 1. Touching the "neutral" *alone*, even if you are earthed, doesn't permit current to flow between "live" and "neutral", via your body, so, no shock. The polarity of the voltage at the neutral terminal swings positive and negative with respect to the live terminal but it's always the same as that of the earth terminal, since both neutral and earth are connected to the earth, one at the power station and the other at the local water pipe or whatever.

Since both these terminals are earthed, there can be no voltage difference between them, Or can there? Yes, there can, because they are not connected to the earth at the same place: the earth connections may be miles apart.

VOLTAGE DROP

This leads to the answer to the other question, which is, really: how can there be a voltage difference between two terminals, each earthed? In Fig. 1, the cable between power station and home is shown as having no resistance. But real cables, however thick, do have some resistance. Since a mains distribution cable may be carrying thousands of amperes even a few thousandths of an ohm resistance can cause an appreciable voltage drop.

In the case of the neutral side of the cable, this voltage drop is earthed at the power station but not at the home end. The home end can therefore be a few volts above local earth potential, and this is one cause of the small voltage which our reader measured between local earth and neutral terminals.

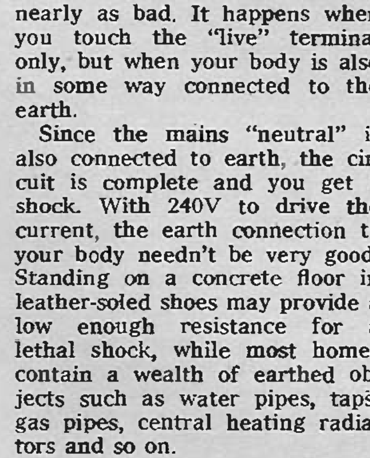
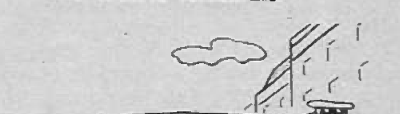
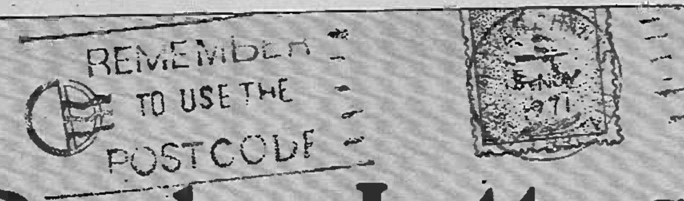


Fig. 1 Domestic mains supply from power station.



"Better check your construction of that indicator audible warning—it's just failed the noise test."



Readers Letters

P.C. Construction

Wishing to construct the *Train Controller* as described in EVERYDAY ELECTRONICS Vol. 2 No. 9 September, '73, I decided to have a go at making my own printed circuit as per instructions in Vol. 2 No. 6. June '73. I'm afraid that I have lost count of the number of chemists that I called on to try and get the ferric chloride and have come to the conclusion that there must be an easier way to carry out this project. One chemist told me that there was no such animal as ferric chloride in powder or crystal form and that it existed only in liquid form. In the end I managed to purchase a do-it-yourself kit (in which the f.c. was a liquid) but as I would like to be able to purchase the necessary chemicals separately I would welcome your comments generally.

I note that in the process of etching on copper that nitric acid is used. Although more care would have to be exercised when using acids it might prove easier to obtain and I would enquire if this is a suitable alternative.

By the way, I feel that the estimated cost of £3·15 for the cost of parts for the controller was a bit conservative. I purchased most of the bits and pieces from Henry's Radio, and the balance from a component shop in Brighton, and they came to a lot more than £3·15. If A. J. Dunn managed to build his for £3·15 then he was very lucky.

I look forward to receiving your reply and thank you for providing such an interesting mag. each month.

N. C. Langridge,
Littlehampton, Surrey

G. F. Milward of 369 Alum Rock Road, Birmingham B8 3DR can supply ½lb packs of ferric chloride (in crystal form) for 50p including post and packing. A dilute solution of nitric acid can be used provided the resist can withstand it—nail varnish is quite good!

The price for the controller was obtained by pricing components from suppliers catalogues. One of our advertisers is supplying a kit of parts for the same price.

Soldering Competition

Many thanks for your letter dated September, 1973 and your kind congratulations accompanying a most attractive and useful runner-up prize

The competition has given me great pleasure and I would like to say that I whole-heartedly agree with the final order selected by the judges for the first prize. They obviously gave the competition considerable thought.

May I also take this opportunity to congratulate you on your very fine publication, which I always find most interesting, stimulating and educational.

J. W. Berry,
Bury St. Edmunds.

Many thanks for the safe receipt of my prize from the recent soldering competition in EVERYDAY ELECTRONICS.

Congratulations are really all due to EVERYDAY ELECTRONICS which I have taken ever since the first issue. Before this, I did not have the vaguest idea about electronics or soldering.

Being a middle aged spinster with no male friends or relatives connected in any way with electronics I have learned all I do know on the subject through your pages. It is the lucid way in which processes are explained, together with the detailed diagrams and clear photographs, which I have found so easy to follow, which has enabled me to learn as much as I have. (To my wondering surprise.)

The excellent book about soldering is just what I needed and is going to be so useful. I didn't have a wire stripper either, so that also will be very acceptable, even though I have acquired the knack of stripping with side cutters!

Incidentally, I have never ever won any kind of prize in my life before. Maybe electronics has brought some luck at last!

Thank you again for the gifts and for an excellent magazine, and for the happy hours that will ensue from both.

Connie Wade
Leeds.

Price

As a schoolboy I am rather annoyed at the letter in the December E.E. which said that your projects are within the scope of the pocket money of the schoolboy enthusiast. This is not true. the average schoolboy only gets at the least 30p pocket money which is hardly enough for your projects. I have made one of your projects which the approximate cost was 45p (*Neon Novelty* with two lamps). It cost me a total of 105p which I could only afford because it was Easter.

David Hooton,
Rushden, Northants.

Spiders At Work

Re. your December issue *Ruminations*, spiders are used by man to spin their webs to suit our purposes. Selected spiders are made to spin a thread onto special frames, which are then stored until needed to be used as graticules (crosswires) in certain optical instruments. An example of this application was shown on BBC's "Animal Magic" some weeks ago, when a spider was shown working for man at the York factory of Vickers Instruments, the "end" result being used in the repair of a theodolite.

C. Long,
Leeds.

Please note: we can only answer readers letters concerning published articles, not commercial equipment or modifications to circuits. Please include an s.a.e. for a reply.

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SPECIAL RESISTOR KITS (¼W 5% or ½W 5% CARBON FILM)
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400V: (μF) 0·001, 0·0015, 0·0022, 0·0033, 0·0047, 2½p; 0·0068, 0·01, 0·015, 0·022, 0·033, 3½p; 0·047, 0·068, 0·1, 4½p. 0·15, 6½p. 0·22, 8½p. 0·33, 12p. 0·47, 14p.

MINIATURE MULLARD ELECTRONICS 015 016 017 SERIES
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ELECTROLYTIC CAPACITORS, Tubular and large can
(μF/V): 2·2/25, 2·2/63, 4·7/10, 4·7/25, 4·7/63, 22/10, 22/25, 22/63, 5p; 2/10, 10/10, 50/10, 100/10, 10/25, 50/25, 10/50, 5½p; 200/10, 100/25, 50/50, 6½p; 500/10, 200/25, 100/50, 9p; 1000/10, 500/25, 200/50, 11p; 2000/10, 1000/25, 500/50, 16½p; 1000/50, 39p; 1000/100, 66p; 2000/25, 27p; 2500/12, 17p; 2500/25, 33p; 2500/50, 62p; 3000/50, 72p; 5000/25, 66p; 5000/50, 94p.
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Veroboard	0·1	0·15
2½ x 5in	28p	28p
2½ x 3¾in	26p	19p
3¾ x 5in	32p	33p
3¾ x 3¾in	28p	28p
2½ x 1in	7p	7p
2½ x 5in (plain)	—	14p
2½ x 3¾in (plain)	—	12p
5 x 3¾in (plain)	—	22p
Insertion tool	59p	59p
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Pins, pkt. 25	10p	10p

2 pin DIN Plug, 12p; Skt., 10p. 3 pin DIN Plug, 13p; Skt., 10p. 5 pin DIN Plug, 180°, 15p; Skt., 12p. Transistor Equiv. Book, 40p. Carbon pots 5K–2M log. & lin. single 16½p, single with switch 26p, dual 46p.

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1N914	7p
μL914	35p
OC71	13p
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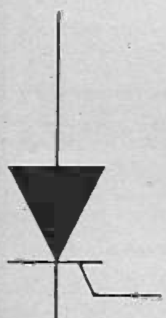

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in Electrical and Electronic Engineering with the possibility of transfer at the end of the first year to the second year of the Hons. Degree Course in Electrical Engineering

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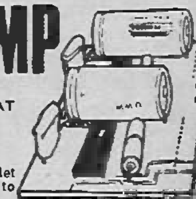
A ready built unit, ready for connection to the I.F. stages of existing F.M. Radio or Tuner. A tell tale light can be connected. The unit is a small printed circuit, no further alignment necessary. A L.E.D. is recommended as the indicating light, suitable device available from us at 36½p. Instructions included

3W R.M.S. I.C. AMP



only £1.65 Incl. P. & P. and VAT
Order Code I.C.A. 1
on P.C. Board with all components
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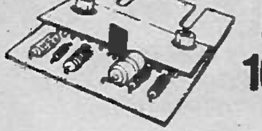
These amps. are supplied with a free booklet on connecting up, specifications and easy to build projects using the I.C.A.1

5W & 10W AMPS



5W ONLY £1.98
10W ONLY £2.49

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These matchbox size amplifiers have an exceptionally good tone and quality for the price. They are only 2½" x 1¾". The 5W amp will run from a 12V car battery making it very suitable for portable voice reinforcement such as public functions. Two amplifiers are ideal for stereo. Complete connection details and treble, bass, volume and balance control circuit diagrams are supplied with each unit. Discounts are available for quantity orders. More details on request. **Cheapest in the UK. Built and tested.**

Now available for 5 & 10W AMPS

Pre-assembled printed circuit boards 2" x 3" available in stereo only, will fit ·15 edge connector.

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Instruction leaflet supplied with all units. Post and packing and VAT included in prices.

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the U.K.'s two leading audio retailers through Audiotronic Holdings Ltd. the final phase of the integration has now been completed. One retail company trading under the name of "Laskys" has been formed to bring you a wider choice of equipment, highly competitive prices and a better than ever service.

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LASKYS PRICES—Our enormous purchasing power together with reduced administration costs enables us to offer you the most competitive prices to be found in the U.K.

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AUDIOTRONIC Model ATM1

Top value 10,000 opv pocket multimeter. Ranges:— 0/10/50/250/1,000 volt AC and DC. DC current 0-1mA/100mA. Resistance 0/150k ohms. Decibels —10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.
OUR PRICE £2.95 P&P 15p

MODEL TE200

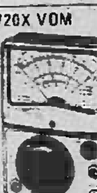
20,000opv. Mirror scale, overload protection. 0/5/25/125/1000V DC. 0/10/50/250/1000V AC. 0/50uA/250mA. 0/60k/6 Meg ohms. —20 to +62dB.
OUR PRICE £4.95 P&P 15p

MODEL U437 MULTIMETER

10,000opv. A first class, instrument manufactured in USSR to the highest standards. Ranges: 2.5/10/50/250/500/1000V DC. 2.5/10/50/250/500/1000V AC. DC current 100uA/1/10/100mA/1A. Resistence 300 ohms/3/30/300k/3 Meg. ohms. Complete with batteries, test leads, instructions and a sturdy steel carrying case.
OUR PRICE £4.95 P&P 25p

MODEL TH12

20,000 opv. Overload protection. Slide switch selector. 0/0.25/2.5/10/50/150/1000V DC. 0/10/50/250/1000V AC. 0/50uA/25/250mA DC. 0/3k/30k/300k/3 Megohms. —20 to +50dB.
OUR PRICE £5.97 P&P 15p

HIOKI Model 720X VOM

A versatile, accurate measuring instrument. 20,000 opv. 0/5/25/100/500/1000V DC. 0/10/50/250/1000V AC. 0—50uA/250mA. 0—20k/2 Megohms.
OUR PRICE £5.97 P&P 20p

U4323 MULTIMETER

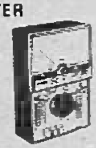
20,000opv. Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/500/1000V DC. 2.5/10/15/250/500/1000V AC. 0.05/0.5/5/50/500mA DC. Resistence 5/50/500 ohms/5/10/100k ohms/1Meg. Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.
OUR PRICE £7.00 P&P 20p

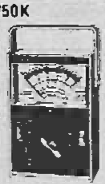
U4312 MULTIMETER

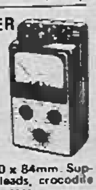
extremely sturdy instrument for general electrical use. 667opv. 0/0.3/1.5/7.5/30/60/150/300/600/900V DC & 75mV. 0/0.3/1.5/7.5/30/60/150/300/600/900V AC. 0/300uA/1.5/6/15/150/60/600mA/1/1.5/6A DC. 0/1.5/6/15/60/150/600mA/1.5/6A AC. 0/200/3k/30k ohms. DC accuracy 1%. AC 1.5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions.
OUR PRICE £9.75 P&P 25p

MODEL TE300

30,000opv. Mirror scale. Overload protection. 0/0.6/3/15/60/300/1200V DC 0/6/30/120/600/1200V AC. 0/30uA/6mA/60mA/300mA/600mA. 0/8k/80k/800k/8 Meg ohms. —20 to +63dB.
OUR PRICE £7.50 P&P 15p

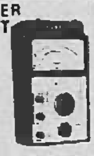
U4324 MULTIMETER

High sensitivity, overload protected. 20,000opv. Ranges: 0.6/1.2/3/12/30/60/120/600/1200V DC. 3/6/15/60/150/300/600/900V AC. Current: 0.06/0.6/6/60/600mA/3A DC 0.3/3/30/300mA/3A AC. Resistence: 25/500 ohms/0.5/5/50/500k ohms/5 Mohms. Decibels: —10 to +12dB. Size 167 x 98 x 63mm. Supplied complete with test leads, spare diode and instructions.
OUR PRICE £8.00 P&P 20p

TMK MODEL TW50K

46 ranges, mirror scale. 50k/V DC 50k/V AC. DC Volts: 0.125/0.25/1.25/2.5/5/10/25/50/125/250/500/1000. AC Volts 1.5/3/5/10/25/50/125/250/500/1000. DC current 25/50uA/2.5/5/25/50/250/500mA/5/10A. Resistence: 10k/100k/1 Meg/10 Meg ohms. —20 to +81 5dB
OUR PRICE £8.50 P&P 17p

U435 MULTIMETER

20,000opv. Overload protected. Ranges: 75mV/2.5/10/25/100/250/500/1000V DC. 2.5/10/25/100/250/500/1000V AC. Current: 50uA/1/5/25/100mA/0.5/2.5A DC. 5/25/100mA/0.5/2.5A AC. Resistance: 0.3/3/30/300k ohms. Size: 205 x 110 x 84mm. Supplied complete with leads, crocodile clips and steel carrying case.
OUR PRICE £8.75 P&P 20p

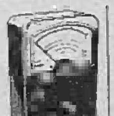
U91 Clamp VOLT AMMETER

For measuring AC voltage and current without breaking circuit. Ranges 300/600V AC. Current: 10/25/100/250/500A. Accuracy 4%. Size 283 x 94 x 35mm. Complete with carrying case, leads and fuses.
OUR PRICE £10.50 P&P 20p

U4341 MULTIMETER TRANSISTOR TEST

27 ranges. 16,700opv. Overload protected. Ranges: 0.3/1.5/6/30/60/150/300/900V DC. 1.5/7.5/30/150/300/750V AC. Current: 0.06/0.6/6/60/600mA DC. 0.3/3/30/300mA AC. Resistance: 0.06/0.6/2/6/20/60/200k ohms/2 Mohms. Battery operated. Supplied complete with probes, leads and steel carrying case. Size: 115 x 215 x 90mm.
OUR PRICE £10.50 P&P 20p

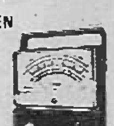
Model 449A In Circuit TRANSISTOR TESTER

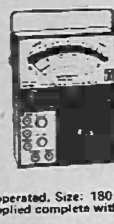
Checks true AC, Beta in/out. Checks ICO. Checks diodes in/out. Checks SCR etc. Beta HI 10—500 LO 2—50. ICO 0—5000uA. 220/240 V AC operation.
OUR PRICE £17.50 P&P 25p

MODEL 500

30,000 opv with overload protection. Mirror scale. 0/0.5/2.5/10/25/100/250/500/1000V DC. 0/2.5/10/25/100/250/500/1000V AC. 0/50uA/5/50/500mA. 12A DC. 0/60k/6 meg/60 megohms.
OUR PRICE £10.50 Carr. paid
Leather case for above £1.75

KAMODEN HM350 TRANSISTOR TESTER

High quality instrument to test reverse leak current and DC current. Amplification factor of NPN, PNP, diodes, transistors, SCR's etc. 4" square clear scale meter. Operates from internal batteries. Complete with instructions, leads carrying handle.
OUR PRICE £12.50 P&P 30p

MODEL C7080EN

Giant 6" mirror scale. 20,000 opv. 0/0.25/1/2.5/10/50/250/1000/5000V DC. 0/2.5/10/50/250/1000/5000V AC. 0/50uA/1/10/100/500mA/10A DC. 0/2k/200k/20 Meg. —20 to +50dB.
OUR PRICE £13.95 P&P 35p

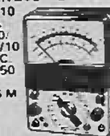
KAMODEN 360 MULTIMETER

High sensitivity. DC 100kohm/V AC 10kohm/V 5" mirror scale, overload protected. Ranges: 0.5/2.5/10/50/250/1000V DC. 5/10/50/250/1000V AC. Current: 0.01mA/0.5/5/50/500mA/10A. Resistance: 0.1/1/10/100 ohms/1/10/100k ohms/10/100M ohms. Decibels —20 to +62dB. Battery operated. Size: 180 x 140 x 80mm. Supplied complete with, test leads etc.
OUR PRICE £13.95 P&P 25p

HIOKI MODEL 700X

100,000opv. Overload protection. Mirror scale 0.3/0.6/1.2/1.5/3/6/12/30/60/120/300/600/1200V DC. 1.5/3/6/12/30/60/150/300/500/1200V AC. 15/30uA/3/6/30/60/150/500mA/6/12A DC. 2k/200k/2M/20MOhms —20 to +63dB.
OUR PRICE £14.95 P&P 20p

S100TR MULTIMETER—TRANSISTOR TESTER

100,000opv. Mirror scale. Overload protection. 0/0.12/0.6/3/12/30/120/600V DC. 0/6/30/120/600V AC. 0/12/600uA/12/300mA/12A DC. 0/10k/1 Meg/100 Meg. —20 to +50dB. 0.01—0.2 MFD. Transistor tester measures Alpha, Beta and ICO. Complete with instructions, batteries and leads.
OUR PRICE £14.95 P&P 25p

KAMODEN HM720B FET VOM

Input impedence 10 Megohms. Ranges 0/.25/1/2.5/10/50/1000V DC. 0/2.5/10/50/250/1000V AC. 0/25uA/2.5/25/250 mA DC. 0/5k/50k/500k/5 M 500 Megohms
OUR PRICE £14.95 P&P 30p

MODEL TE15 GRID DIP METER

Transistorised. Operates as Grid Dip, Oscillator, Absorbtion Wave Meter and Oscillating Detector. Frequency range 440kHz—280MHz in six coils. 500uA meter. 9V battery operation. Size: 180 x 80 x 40mm.
OUR PRICE £15.00 P&P 20p

U4317 MULTIMETER

High sensitivity instrument for field and laboratory work Knife edge pointer, 86mm. mirror scale. Ranges: 100mV/0.5/2.5/10/25/50/100/250/500/1000 V DC. 0.5/2.5/10/25/50/100/250/500/1000V AC. Current: 50uA/0.5/1/5/10/50/250mA/1/5A DC. 0.25/0.5/1/5/10/50/250mA/1/5A AC. Resistance: 0.5/10/100/200 ohms/1/3/30/300k ohms. Decibels: —5 to +10dB Battery operated. Size: 210 x 115 x 90mm. Supplied in carrying case complete with leads.
OUR PRICE £15.00 P&P 20p

KAMODEN 72200 Multitester

High sensitivity tester. 200,000 opv Overload protected Mirror scale. Ranges:—0/.06/.3/3/30/120/600/1200V DC. 0/3/12/60/300/11200 V AC. 0/6uA/1.2mA/120mA/600mA/12A DC 0/12A AC. —20 to +63dB. 0/2k/200k/2 Meg/200 Megohms.
OUR PRICE £16.95 P&P 30p

370WTR MULTIMETER

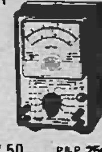
Features AC current ranges. 20,000opv. 0/0.5/2.5/10/50/250/500/1000V DC 0/2.5/10/50/250/500/1000V AC. 0/50uA/1/10/100 mA/1/10A DC. 0/100mA/1/10A AC. 0/5k/50k/500k/5 Meg/50 Meg. Decibels: —20 to +62dB.
OUR PRICE £17.50 P&P 25p

TMK MODEL 117 FET ELECTRONIC VOLTMETER

Battery operated. 11 Meg input, 26 ranges. Large 4½" mirror scale. Size: 149 x 117 x 60mm. 0.3—1200V DC. 3—300V RMS AC. 8—800V P-P. DC current 0.12—12mA. Resistence up to 2000MOhms. Decibels: —20 to +51dB. Supplied complete with leads and instructions.
OUR PRICE £17.50 P&P 20p

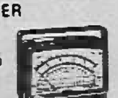
TE65 VALVE VOLTMETER

28 ranges. DC volts 1.5—1500V. AC volts 1.5—1500V. Resistance up to 1000 Megohms. 200/240V AC operation. Complete with probe and instructions.
OUR PRICE £17.50 P&P 30p
Additional probes available: RF £2.12, HV £2.50

TE40 HIGH SENSITIVITY AC VOLTMETER

10 Meg input. 10 ranges: 0.001/0.03/0.1/0.3/1/3/11/30/100/300V RMS. 5cps—1.2MHz. —40 to +50dB supplied brand new complete with leads and instructions.
OUR PRICE £17.50 P&P 25p

KAMODEN HMG500 insulation resistance tester

Range 0—1,000 Megohms, 500V. Battery operated Wide range clear meter 4" x 4¾". Complete with deluxe carrying case, batteries and instructions.
OUR PRICE £19.95 P&P 30p

TMK LAB TESTER

100,000opv. 6½" scale. Buzzer short circuit check. Sensitivity 100,000 opv DC. 5k/V AC DC Volts: 0.5/2.5/10/50/250/1000V AC. 3/10/50/250/500/1000V DC. current 10/100uA/10/10/100/500mA/2.5/10A. Resistance: 1k/10k/100k/10 Meg/100 Meg ohms. Decibels: —10 to +49dB. Plastic case with carrying handle. Size: 190 x 172 x 99mm.
OUR PRICE £19.95 P&P 25p

MODEL U4311 Sub-standard Multi-range Volt-Ammeter

Sensitivity 330 Ohms/Volt AC and DC. Accuracy 0.5% DC. 1% AC. Scale length: 165mm. 0/300/750uA/1.5/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A DC. 0/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A AC. 0/75/150/300/750mV/1.5/3/7.5/15/30/75/150/300/750V DC. 0/750mV/1.5/3 /7.5/15/30/75/150/300/750V AC. Automatic cut out device. Supplied complete with test leads, manual and test certificates.
OUR PRICE £49.00 P&P 50p

AT201 Decade ATTENUATOR

Frequency range 0—200kHz. Attenuator 0—111dB. 0.1dB steps. Impedence 600 ohms. Input power maximum 30dBm. Size: 180 x 90 x 55mm.
OUR PRICE £12.50 P&P 37p

TE16A TRANSISTORISED SIGNAL GENERATOR

5 ranges, 400kHz to 30 MHz. An inexpensive instrument for the handy-man. Operates on 9V battery. Wide easy to read scale. 800kHz modulation. Size: 149 x 149 x 92mm. Complete with instructions and leads.
OUR PRICE £8.97 P&P 25p

TE22 SINE SQUARE WAVE AUDIO GENERATOR

Sine 20cps to 200kHz on 4 bands. Square 20 cps to 30 kHz. Output impedence 5000 Ohms. 200/250V AC operation. Supplied brand new guaranteed, with instruction manual and leads.
OUR PRICE £17.50 P&P 37p

ARF 300 AF/RF SIGNAL GENERATOR

All transistorised compact fully portable. AF sine wave 18Hz to 220 kHz. AF square wave 18Hz to 100k Hz. Output Square/Sine wave 10V. P.P RF 100kHz to 200MHz. Output 1V maximum. 220/240V AC operation. Complete with instructions and leads.
OUR PRICE £29.95 P&P 50p

LASKYS

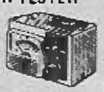
ALL PRICES EXCLUDE VAT

INCORPORATING LASKYS RADIO LTD. & G. W. SMITH & CO. (RADIO) LTD

WALKIE TALKIES

SKYFON 100mW
OUR PRICE £24.95 per pair
P302 Two Channel 300mW
OUR PRICE £52.50 per pair
P1003 Three Channel 1 Watt
OUR PRICE £71.25 per pair
P&P 50p per pair

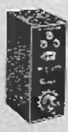
LB3 TRANSISTOR TESTER



Tests ICO and B. PNP/NPN. Operates from 9V battery. Complete with all instructions etc.

OUR PRICE £3.95 P&P 20p

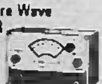
LB4 TRANSISTOR TESTER



Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with instructions etc.

OUR PRICE £4.50 P&P 20p

BELCO Sine Square Wave CR OSCILLATOR



Sine 18 x 200,000Hz Square 18 x 20,000 Hz. Maximum output +10dB (10k ohms) Operates from internal batteries. Attractive two tone case. Size: 196 x 127 x 50mm.

OUR PRICE £17.50 P&P 17p

POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range available ex-stock. Single hole fixing. ¼" diameter shafts. Bulk quantities available.

25 WATT 10/25/50/100/250/500/1000 Ohms. £1.15 P&P 10p

50 WATT 10/25/50/100/250/500/1000/2500/5000 Ohms. £1.62 P&P 10p

100 WATT 1/5/10/25/50/100/250/500/1000/2500 Ohms. £2.34 P&P 15p

YAMABISHI VARIABLE VOLTAGE TRANSFORMERS

Excellent quality at low cost.
All models—Input 230V 50/60Hz.
Variable output 0—260V
MODEL S260 GENERAL PURPOSE BENCH MOUNTING

		P&P
1A	£8.75	30p
2.5A	£10.00	35p
5A	£14.70	37p
8A	£25.50	50p
10A	£28.10	75p
12A	£29.50	100p
20A	£72.50	125p
25A	£72.50	130p
40A	£103.10	150p

MODEL S260B

2.5A	£8.75	30p
1A	£10.00	35p

AUTO TRANSFORMERS

0/115/250V. Step up or step down. Fully shrouded.

80W	£2.75	P&P 18p
150W	£3.50	P&P 18p
300W	£4.50	P&P 23p
500W	£6.95	P&P 33p
1000W	£9.50	P&P 38p
1500W	£12.50	P&P 43p
2250W	£20.95	P&P 60p
5000W	£44.95	P&P £1.

SWR METER Model SWR3

Handy SWR meter for transmitter antenna alignment, with built-in field strength meter. Accuracy 5%. Impedence 52' Indicator 100uA DC. Full scale 5 section collapsible antenna. Size 145 x 50 x 60mm.

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SEW

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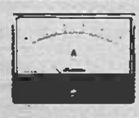
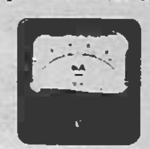
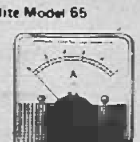


Clear Plastic Model SD830

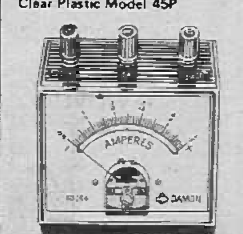
Enlarged Window Model S80



Bakelite Model 65



Clear Plastic Model 45P



Model ED107

RANGE	MR 38P	MR 45P	MR 52P	MR 65P	MR 85P	MR 65	S 80	SW 100	SD 460	SD 640	SD 830	PE 70	ED 107
25uA	–	–	–	–	–	£4.60	–	–	–	–	–	–	–
50uA	£2.55	£2.70	£3.50	£3.70	£4.40	£3.55	£3.50	£4.15	£2.80	£3.05	£3.40	£3.75	£6.90
100uA	£2.45	£2.60	£3.00	£3.15	£4.25	£3.00	£3.40	£3.95	£2.75	£3.00	£3.35	£3.60	£6.40
200uA	£2.40	£2.50	–	£3.05	£4.05	–	–	–	£2.70	£3.00	£3.30	£3.40	–
500uA	£2.25	£2.45	£2.65	£2.75	£3.90	£2.70	£3.05	£3.70	£2.55	£2.95	£3.15	£3.20	–
50-0-50uA	£2.50	£2.85	£3.05	£3.15	£4.25	£3.05	£3.40	£3.95	£2.80	£3.05	£3.40	£3.60	£6.40
100-0-100uA	£2.40	£2.50	£2.95	£3.10	£4.05	£3.00	£3.30	£3.90	£2.75	£3.00	£3.35	£3.50	–
500-0-500uA	£2.25	£2.40	–	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
1mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	£3.20	–
1-0-1mA	£2.25	–	–	–	£3.90	£2.60	–	–	–	–	–	–	–
2mA	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
5mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	£2.60	£2.90	£3.10	–	–
10mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	£2.60	£2.90	£3.10	–	–
20mA	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
50mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	£2.60	£2.90	£3.10	–	–
100mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	£2.60	£2.90	£3.10	–	–
150mA	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
200mA	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
300mA	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
500mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	£2.60	£2.90	£3.10	–	–
750mA	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
1A DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	–	£5.95
2A DC	£2.25	–	–	–	–	£2.60	–	–	–	–	–	–	–
5A DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	–	£5.95
10A DC	£2.25	–	–	£2.60	–	–	–	–	£2.60	£2.90	£3.10	–	–
15A DC	£2.25	–	–	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
20A DC	£2.25	–	–	£2.60	–	–	–	–	–	–	–	–	–
30A DC	–	–	–	£2.80	£3.95	£2.60	–	–	–	–	–	–	–
50A DC	–	–	–	£2.90	–	£2.60	–	–	–	–	–	–	–
3V DC	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
5V DC	–	–	–	£2.60	–	£2.60	–	–	£2.60	£2.90	£3.10	–	£5.95
10V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	£2.60	–	£3.10	–	£5.95
15V DC	£2.25	–	–	–	–	–	–	–	–	–	–	–	£5.95
20V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	–	£2.90	£3,10	–	£5.95
50V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	–	£5.95
100V DC	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
150V DC	£2.25	–	–	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
300V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	–	£5.95
500V DC	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
750V DC	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
15V AC	£2.30	£2.45	£2.60	£2.80	£3.95	–	–	–	£2.70	£3.00	£3.30	–	–
30V AC	–	–	–	–	–	£2.65	–	–	–	–	–	–	–
50V AC	£2.30	–	–	£2.80	–	£2.65	–	–	–	–	–	–	–
150V AC	£2.30	–	–	£2.80	–	£2.65	–	–	–	–	–	–	–
300V AC	£2.30	£2.45	£2.60	£2.80	£3.95	£2.65	£3.00	£3.70	£2.70	£3.00	£3.30	£3.25	–
500V AC.	£2.30	–	–	£2.80	–	£2.65	–	–	–	–	–	–	–
S Meter 1mA	£2.30	£2.50	£2.60	£2.85	£3.90	–	–	–	–	–	–	–	–
VU Meter	£2.65	£2.70	£3.60	£3.70	£4.55	£3.65	£3.70	£4.30	£2.90	£3.15	£3.50	£3.85	–
1A AC	–	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
5A AC	–	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
10A AC	–	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
20A AC	–	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
30A AC	–	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
50A AC	–	–	–	–	–	£2.60	–	–	–	–	–	–	–
50mA AC	–	–	–	£2.60	–	–	–	–	–	–	–	–	–
100mA AC	–	–	–	£2.60	–	–	–	–	–	–	–	–	–
200mA AC	–	–	–	£2.60	–	–	–	–	–	–	–	–	–
500mA AC	–	–	–	£2.60	–	£2.60	–	–	–	–	–	–	–
50mV DC	–	–	–	–	–	£2.90	–	–	–	–	–	–	–
100mV DC	–	–	–	–	–	£2.90	–	–	–	–	–	–	–
500mA/5A DC	–	–	–	–	–	–	–	–	–	–	–	–	£7.00
1/15A DC	–	–	–	–	–	–	–	–	–	–	–	–	£7.00
5/15V DC	–	–	–	–	–	–	–	–	–	–	–	–	£7.00
5/50V DC	–	–	–	–	–	–	–	–	–	–	–	–	£7.00

SEW PANEL METERS—SIZES AND FIXING INFORMATION

	Front	Panel Hole	Fixing
Model 38P	42 x 42mm	32mm dia.	4 studs
Model 45P	50 x 50mm	38mm dia.	4 studs
Model 52P	60 x 60mm	48mm dia.	4 studs
Model 65P	86 x 78mm	57mm dia.	4 studs
Model 85P	120 x 110mm	98mm dia.	4 studs
Model 65	80 x 80mm	64mm dia	4 studs
Model S80	80 x 80mm	65mm dia.	4 studs

	Front	Panel Hole	Fixing
Model SW100	100 x 80mm	65mm dia.	4 studs
Model SD460	59 x 46mm	38mm dia.	4 studs
Model SD640	85 x 64mm	45mm dia.	4 studs
Model SD830	110 x 83mm	58mm dia.	4 studs
Model PE70	90 x 34mm	70 x 31mm	2 holes

Model ED107 Size: 100 x 90 x 150mm high including terminals.

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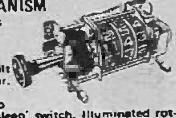

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Reduce tape hiss by 3dB at 600Hz, 6dB at 1200Hz and 10dB for all frequencies above 3000Hz. Size: 460 x 203 x 79mm. AC 220/240V

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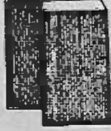

Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size: 368 x 229 x 190mm. 8 ohms. 8 watts RMS, 16 watts peak. Complete with Din lead.

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A beautifully styled four track stereo deck with an outstanding specification offered at a remarkably low price. Incorporates a host of features including switchable noise filter, normal/chrome tape selector, twin VU meter slider record/playback level controls, front panel headphone socket, recording indicator lamp, phono/Din line input sockets, 3.5mm microphone in sockets etc, etc. Frequency response: 40–12kHz (40–16kHz CrO2), S/N: –45dB. Crosstalk 45dB. Separation: –35dB. Noise limiter –6dB at 10kHz. Complete with connecting leads.

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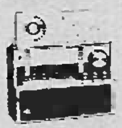
Global AM/FM Portable Radio



10 wave-bands covering AM: 535–1605kHz. LW: 150–380 kHz. MB 1.6–4MHz. SW1: 4–8MHz. SW2: 8–1.6 MHz. SW3: 16–24MHz. PSB1: 30–50 MHz. PSB2: 148–174MHz. FM: 88–108MHz. Air: 108–136MHz. Feature time zone map and timing dial. Large clear scale. Telescopic aerial and built in aerial. AFC on FM. 6"x4" speaker and personal earpiece. Battery/mains operation. Size: 345 x 133 x 305mm.

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LSH30 Open back type. Individual tone and volume controls. 8 ohms. 30–20,000Hz

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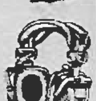

LSH40 Two way speaker system Individual volume controls. 8 ohms. 20–20,000Hz

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LSH60 3" speaker units. 8 ohms. Complete with zipped carrying case. 20–20,000Hz.

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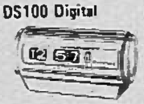

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610/TPD1	£13.90
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MP60/ADC K8	£10.90
MP60/TPD1	£13.20
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HT70/ADC K7E	£14.25
HT70/TPD1	£16.55
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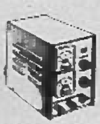
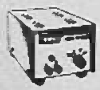
PS200 Regulated POWER SUPPLY UNIT



Solid state. Variable output 5–20V DC up to 2 Amp. Independent meters to monitor voltage and current. Output 220/240V AC. Size: 190 x 136 x 98mm.

OUR PRICE £19.95 P&P 25p

PS100B Regulated POWER SUPPLY UNIT



Solid state. Output 6, 9 or 12V DC up to 3 Amp. Meter to monitor current. Input 220/240V AC. Size: 100 x 82 x 159mm.

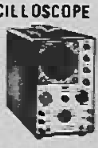
OUR PRICE £11.97 P&P 25p

MCA220 Automatic Voltage Stabiliser

Input 88–125V AC or 176–250 V AC. Output 120V AC or 240V AC. 200V A rating.

OUR PRICE £11.97 P&P 50p

TO3 Portable OSCILLOSCOPE



3" tube. Y amp sensitivity 0.1Vp-p/CM. Bandwidth: 1.5Hz–1.5MHz. Input Impedence: 2MOhms, 25pF. X amp. sensitivity: 0.9Vp-p/CM. Bandwidth 1.5Hz–800kHz. Input impedence 2 Meg Ohms, 20pF. Time base, five ranges 10Hz to 300kHz. Synchronisation, Internal or external. Illuminated scale 140 x 215 x 330mm. Weight 15½lbs. 220/240V AC. Supplied brand new with handbook.

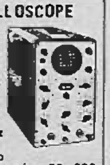
OUR PRICE £52.50 P&P 50p

RUSSIAN CI16 Double Beam OSCILLOSCOPE

5 MHz pass band. Separate Y1 and Y2 amplifiers. Rectangular 5" x 4" CRT. Calibrated triggered sweep from 0.2usec. to 100 milli-sec/cm. Free running time base, 50Hz–1MHz. Built-in time base Calibrator and amplitude Calibrator. Supplied complete with all accessories and instruction manual.

OUR PRICE £87.00 Carr. paid

CI5 PULSE OSCILLOSCOPE



For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP Bandwidth: 10MHz. Sensitivity at 100kHz VRMS/mm: 0.1–25 HOR. AMP. Bandwidth: 500kHz. Sensitivity ay 100kHz VRMS/mm: 0.3–25 Preset triggered sweep 1–3000usec. Free running 20–200 kHz in nine ranges. Calibrator pips. 220 x 360 x 430mm. 115–230V AC.

OUR PRICE £39.00 Carr. paid

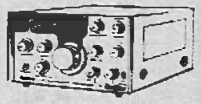
LAFAYETTE HA600 Receiver

General coverage 150–400kHz, 550 kHz–30MHz. FET front end 2 mechanical filters, product detector. Noise limiter, variable BFO, S Meter, Bandspread and RF gain. 220/240V AC or 12V DC. Brand new with instructions.

OUR PRICE £50.00 P&P 50p

SUPER VALUE TOP QUALITY TRIO communications equipment

TRIO JR599 RECEIVER



Nine wave-bands covering 1.8–29.7 MHz, 144–146MHz and 10MHz WWV SSB, CW, AM and FM. AF output is more than 1 watt. S Meter. Squelch control. BFO. Variable AF and RF controls. 4–16 ohm output and jack for phones. Power requirement 100/240V AC, 12/14V DC. Size: 270 x 140 x 310mm.

OUR PRICE £132.50 Carr. paid

TRIO 9R59DS RECEIVER

Four bands covering 550kHz to 30 MHz continuous and electrical bandspread on 10, 15, 20, 40, and 80 mtrs. 8 valve plus 7 diode circuit. 4 to 8 ohm output and phone jack. SSB–CW, ANL, variable BFO, S Meter and separate band spread dial. (F frequency 445kHz, audio output 1½ watt. Variable RF and AF gain controls. 115/250V AC, with instructions.

OUR PRICE £42.50 Carr. paid

TRIO JR310 SSB RECEIVER

Covers 3.5, 7, 14, 21, 28, 28.5 and 29.1MHz bands and WWV 15MHz. SSB, AM and CW. AF output more than 1W. Crystal controlled BFO for SSB. S Meter, ANL etc. AC 110/120–220/240V. Size: 330 x 179 x 310mm.

OUR PRICE £75.00 Carr. paid

TRIO TR2200 RECEIVER

Fully transistorised portable VHF transceiver Will transmit and receive on six channels between 144–146MHz. 1 watt transmitter. 12V DC Internal or external supply. Built-in charger for Ni-Cad cells. Power/volume switch, squelch control, channel selector, mic. socket, earphone/external speaker socket. Complete with microphone and 144.48, 144.72 & 145.32 crystals. Size: 134 x 58 x 180mm.

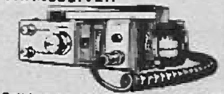
OUR PRICE £79.50 Carr. paid

UNR30 RECEIVER

Four bands covering 580 KHz/30MHz BFO. Built-in speaker. Operates from 220/240V AC. Brand new with instructions.

OUR PRICE £15.75 P&P 37p

BELTEK W5400 CAR TRANSCEIVER



Solid state mobile transceiver for 12 volt DC neg. Transmits and receives on any 12 of 28 channels between 144 and 146MHz. Power output 10W and 1W switchable. Controls: On/off/volume, squelch and channel selector. Internal 3" speaker. Complete with dynamic mic. PTT switch, three sets of crystals for 144.48, 144.6 and 145MHz, mounting bracket and instructions. Size: 150 x 70 x 220mm.

OUR PRICE £75.00 P&P 50p

RUH6 Reflex Horn Speaker

Built-in driver unit. Impedence 16 ohms. Power rating 10W. Response 380–7000Hz. Size app. 8" x 6". Weather and shock protected.

OUR PRICE £4.97 P&P 30p

TE1018 Deluxe Mono High Impedence Headset.

Sensitive magnetic headset with soft ear pads. Impedence 2,600 ohms (600 ohms DC). Frequency response: 200–4,000Hz.

OUR PRICE £2.25 P&P 30p

DH02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head band. Impedence 8 ohms 20–12,000Hz. Complete with lead and plug.

OUR PRICE £2.25 P&P 30p

LH02S STEREO HEADPHONES

Light weight headphones with padded ear pieces. 4/16 ohms 20–20,000Hz. Complete with 6' lead and plug.

OUR PRICE £1.97 P&P 30p

BH001 HEADSET and Boom Microphone

Moving coil. Ideal for language teaching, communications etc. Headphone impedence 16 ohms. Microphone impedence 200 ohms.

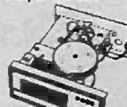
OUR PRICE £5.95 P&P 30p

SH628 STEREO HEADPHONES

Outstanding value. With soft ear pads and adjustable headband. 8–16 ohms. 20–20,000Hz. Complete with lead and stereo plug.

OUR PRICE £1.87 P&P 30p

SPECIAL PURCHASE!! BSR 8 Track Player Chassis



Famous BSR 8track chassis as used in model TD8S complete with silver and black escutcheon, ready to fit into cabinet. Output 125mV. 240V AC. Overall size app. 185 x 215 x 80mm.

OUR PRICE £8.95 P&P 60p

JOSTY KIT

HIGH QUALITY CONSTRUCTION KITS

WE ARE APPOINTED STOCKISTS AT ALL BRANCHES

All kits are complete with comprehensive easy to follow instructions and covered by full guarantee.

Post and Packing 15p per kit.

AF20 Mono amplifier	£4.80
AF30 Mono pre-amplifier	£2.61
AF310 Mono amplifier	£5.91
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AT30 Photo cell switch unit	£5.70
AT50 400W Light dimmer/speed control	£4.80
AT55 1,300W Light control/speed control	£6.70
AT56 2,200W Light dimmer/speed control	£6.90
AT60 1 channel light control	£7.80
AT65 3 channel light control	£14.55
HF61 MW transistor radio	£3.33
HF75 FM transistor radio	£2.88
HF310 FM tuner unit	£15.81
HF325 Deluxe FM tuner unit	£24.12
HF330 FM stereo decoder	£9.96
HF396 Aerial amplifier for AM/FM bands I, II, & III	£1.77
GP310 Stereo pre-amplifier	£21.27
GU330 Tremolo unit	£7.50
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NT300 Professional stabilised PSU, 2 x 30V, 2.2A	£12.51
NT305 Transistor converter 12/15V AC/DC to 6V, 7.5V or 9V DC	£4.50
NT310 PSU 240V AC to 2 x 18V DC at 2A	£4.80
NT315 PSU 240V AC to 4.5–15V DC at 500mA	£9.57
AE1 100mW output stage	£1.65
AE2 Pre-amplifier	£1.26
AE3 Diode receiver	£2.00
AE4 Flasher	£1.09
AE5 Astable multivibrator	£1.05
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NEW FROM JOSTY-KIT 'Amateur Electronics'

The professional book for the amateur—covers the subject from basic principles to advanced electronic techniques. Complete with circuit board for making ten of the kits listed above.

OUR PRICE £3.30 (No VAT) P & P 25p plus VAT

FRUSTRATED EXPORT ORDER !!

Philco Ford 5245 Mains Tape Recorder.

2 track BSR deck with push button controls for easy operation. Tape counter and volume control. Complete with hand microphone, direct recording lead, 1,200' reel of tape and spare reel. 200/250V AC. Fully guaranteed.

OUR PRICE £17.50 P&P 75p

Philco Ford 5248 Mains Tape Recorder.

Four track, two speeds. Piano key type controls, tape counter, recording level meter, volume and tone controls etc. Complete with hand, microphone lead for direct recording 1,800' of tape and spare reel. 200/250V AC. Fully guaranteed.

OUR PRICE £27.50 P&P 75p

BVO5 Vernier TUNING DIAL

App. 7:1 ratio planetary drive vernier dial. Log scale 0–180 degrees. Blank scales 1–5. Dial size 128 x 76mm. Overall size 190 x 117 x 41mm, deep including knob and coupling. ¼" diam. shaft

OUR PRICE £1.62 P&P 15p

SINCLAIR CAMBRIDGE CALCULATOR

To build yourself. Complete kit of parts with step by step instructions to build a full specification pocket sized calculator.

OUR PRICE £24.95 P&P free

ALSO AVAILABLE READY BUILT Recommended Price £29.95

OUR PRICE £27.20 P&P 25p

MINUTEMAN MM3 POCKET CALCULATOR

Size only 103 x 77 x 25mm. 8 digit display with overflow and error indicators. Floating decimal. Adds, subtracts, multiplies and divides. Chain and mixed calculations. Constant factor for series multiplication or division. Complete with batteries, instructions and case.

OUR PRICE £23.95 P&P 25p

Also available—

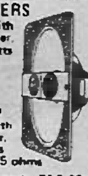
SINCLAIR EXECUTIVE Recommended Price £39.00

OUR PRICE £35.45

SINCLAIR EXECUTIVE with MEMORY Recommended Price £49.00

OUR PRICE £40.75

EMI LOUDSPEAKERS



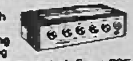
Model 350 13 x 8" with single tweeter/crossover. 20–20,000Hz. 15 watts RMS. Available 8 or 15 ohms.

OUR PRICE £7.25 each P&P 37p

Model 450 13 x 8" with twin tweeter/crossover. 55–13,000Hz. 8 watts RMS. Available 8 or 15 ohms

OUR PRICE £3.62 each P&P 25p

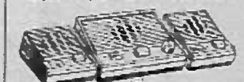
MP7 MIXER-PREAMPLIFIER



5 Microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. Size: 235 x 127 x 76mm. Inputs: Mics. 3 x 3mV 50k; 2 x 3mV 600 ohms. Phono. Mag. 4mV 50k; Phono Ceramic 100mV 1 Meg. Output 250mV 100k.

OUR PRICE £8.97 P&P 20p

KE630 3 Station INTERCOM



Master and two sub-stations. Can be used on desk or wall mounted. Complete with cable and batteries

OUR PRICE £5.25 P&P 50p

1021 Stereo Listening Station

For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. Two gain controls, speakers on–off slide switch, stereo headphone socket.

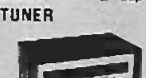
OUR PRICE £2.25 P&P 15p

FM TUNER CHASSIS

6 transistor high quality tuner. Size only 153 x 101 x 63mm 3 IF stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Covers 88–108MHz. Ready built, ready for use. Fantastic value for money.

OUR PRICE £5.95 P&P 20p

A1018 FM TUNER



Specification as above FM chassis but complete in cabinet with on/off switch. Size: 184 x 86 x 127mm.

OUR PRICE £9.65 P&P 30p

Stereo multiplex adapter £4.97

The largest selection

EX COMPUTER BOARDS

Packed with transistors, diodes, capacitors and resistors—COMPONENT VALUE £1·50. 3 for ONLY 55p + p & p 30p

SPECIAL ONE. As above PLUS Power Transistors ONLY 55p each + p & p 15p

STABILISED POWER MODULES Complete with circuit diagrams, etc. 99p each + p & p 15p

PAXOLINE BOARDS 7½ × 9" approx. 4 for 30p + p & p 20p.

FIBRE-GLASS PRINTED CIRCUIT BOARDS

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Etch resistant printed circuit marker pen 90p each

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Packs containing approx., 50sq. ins. various sizes, all ·1 matric 55p

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RF Chokes
CH1. 2·5mH 25p CH2. 5·0mH 25p
CH3. 7·5mH 25p CH4. 10mH 25p
CH5. 1·5mH 25p

COILS
DRX1 Crystal set 31p DRR2 Dual range 45p

COIL FORMERS & CORES

NORMAN ¼" Cores & Formers 7p
⅜" Cores & Formers 8p

SWITCHES

DP/DT Toggle 25p SP/ST Toggle 18p

FUSES

1¼" and 20mm. 100mA. 200mA. 250mA. 500mA, 1A, 1·5A, 2A
QUICK-BLOW 4p ea. ANTI-SURGE 5p ea.

EARPHONES

Crystal 2·5mm plug 33p
Crystal 3·5mm plug 33p
8 ohms 2·5mm plug 22p
8 ohms 3·5mm plug 22p

DYNAMIC MICROPHONES

B1223. 200 ohms plus on/off switch and 2·5mm and 3·5mm plugs £1·60

3-WAY STEREO HEAD-PHONE JUNCTION BOX

H1012 £1·87

2-WAY CROSSOVER NETWORK

K4007. 80 ohms Imp. Insertion loss 3dB £1·21

CAR STEREO SPEAKERS

(Angled) £3·85 per pair.

BI-PAK

CATALOGUE AND LISTS

Send S.A.E. and 10p.

INSTRUMENT CASES

(Black Vinyl covered)

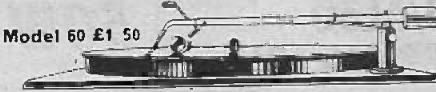
No.	Length		Width		Height	Price
BV1	8"	×	5¼"	×	2"	90p
BV2	11"	×	6"	×	3"	£1·20

ALUMINIUM BOXES

BA1	5¼"	×	2¼"	×	1½"	42p
BA2	4"	×	4"	×	1½"	41p
BA3	4"	×	2¼"	×	1½"	41p
BA4	5¼"	×	4"	×	1½"	47p
BA5	4"	×	2½"	×	2"	41p
BA6	3"	×	2"	×	1"	34p
BA7	7"	×	5"	×	2½"	66p
BA8	8"	×	6"	×	3"	84p
BA9	6"	×	4"	×	2"	54p

BIB HI-FI ACCESSORIES

De Luxe Groov-Kleen
Model 42 £1·84
Chrome Finish Model 60 £1 50



Ref. 36A. Record/Stylus Cleaning Kit 28p
Ref. 43. Record Care Kit £2·35
Ref. 31. Cassette Head Cleaner 54p
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Model 9. Wire Stripper/Cutter 88p
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Ref. 32A. Stylus Balance £1·36
Ref. J. Tape Head Cleaning Kit 51p
Ref. 34. Cassette Case £1·27
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ANTEX SOLDERING IRONS

X25. 25 watt £1·93
CCN 240. 15 watt £2·15
Model G. 18 watt £2·15
SK2. Soldering Kit £2·86
STANDS: ST1 £1·21. ST2 77p
SOLDER: 18SWG Multicore 7oz 82p
22SWG 7oz 82p. 18SWG 22ft 28p
22SWG Tube 22p

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Bits No.		
102	For model CN240 3/32"	38p
104	For model CN240 3/16"	38p
1100	For model CCN240 3/32"	38p
1101	For model CCN240 3/8"	38p
1102	For model CCN240 ¼"	38p
1020	For model G240 3/32"	38p
1021	For model G240 1/8"	38p
1022	For model G240 3/16"	38p
50	For model X25 3/32"	38p
51	For model X25 1/8"	38p
52	For model X25 3/16"	38p

ELEMENTS
ECN 240 £1·16 ECCN 240 £1·32
EG 240 £1·16 EX 25 £1·16

ANTEX HEAT SINKS 10p

V.A.T. included in all prices. Please add 10p P. & P. (U.K. only). Overseas orders—please add extra for postage.

NEW COMPONENT PAK BARGAINS

Pack No.	Qty.	Description	Price
C1	250	Resistors mixed values approx. count by weight	0·55
C2	200	Capacitors mixed values approx. count by weight	0·55
C3	50	Precision Resistors 1%. 2% mixed values	0·55
C4	75	⅛th W Resistors mixed preferred values	0·55
C5	5	Pieces assorted Ferrite Rods	0·55
C6	2	Tuning Gangs. MW/LW VHF	0·55
C7	1	Pack Wire 50 metres assorted colours	0·55
C 8	10	Reed Switches	0·55
C 9	3	Micro Switches	0·55
C10	15	Assorted Pots & Pre-Sets	0·55
C11	5	Jack Sockets 3 × 3·5m 2 × Standard Switch Type	0·55
C12	40	Paper Condensers preferred types mixed values	0·55
C13	20	Electrolytics Trans. types	0·55
C14	1	Pack assorted Hardware—Nuts/Bolts, Grommets etc.	0·55
C15	4	Mains Slide Switches	0·55
C16	20	Assorted Tag strips & Panels	0·55
C17	10	Assorted Control Knobs	0·55
C18	4	Rotary Wave Change Switches	0·55
C19	3	Relays 6—24V Operating	0·55
C20	4	Sheets Copper Laminate approx. 10" × 7"	0·55

PLUGS AND SOCKETS

SOCKETS

PS 35 DIN	2 Pin (Speaker)	0·06
PS 36 DIN	3 Pin	0·10
PS 37 DIN	5 Pin 180°	0·10
PS 38 DIN	5 Pin 240°	0·10
PS 39	Jack 2·5mm Switched	0·09
PS 40	Jack 3·5mm Switched	0·10
PS 41	Jack ¼" Switched	0·17
PS 42	Jack Stereo Switched	0·26
PS 43	Phono Single	0·06
PS 44	Phono Double	0·10
PS 45	Car Aerial	0·09
PS 46	Co-Axial Surface	0·09
PS 47	Co-Axial Flush	0·14

INLINE SOCKETS

PS 21	D.I.N. 2 Pin (Speaker)	0·13
PS 22	D.I.N. 3 Pin	0·17
PS 23	D.I.N. 5 Pin 180°	0·17
PS 24	D.I.N. 5 Pin 240°	0·17
PS 25	Jack 2·5mm Plastic	0·10
PS 26	Jack 3·5mm Plastic	0·12
PS 27	Jack ¼" Plastic	0·24
PS 28	Jack ¼" Screened	0·28
PS 29	Jack Stereo Plastic	0·22
PS 30	Jack Stereo Screened	0·32
PS 31	Phono Screened	0·14
PS 32	Car Aerial	0·15
PS 33	Co-Axial	0·17

PLUGS

PS 1	D.I.N. 2 Pin (Speaker)	0·11
PS 2	D.I.N. 3 Pin	0·12
PS 3	D.I.N. 4 Pin	0·15
PS 4	D.I.N. 5 Pin 180°	0·14
PS 5	D.I.N. 5 Pin 240°	0·15
PS 6	D.I.N. 6 Pin	0·15
PS 7	S.I.N. 7 Pin	0·15
PS 8	Jack 2·5mm Screened	0·10
PS 9	Jack 3·5mm Plastic	0·09
PS 10	Jack 3·5mm Screened	0·12
PS 11	Jack ¼" Plastic	0·13
PS 12	Jack ¼" Screened	0·18
PS 13	Jack Stereo Screened	0·29
PS 14	Phono	0·06
PS 15	Car Aerial	0·15
PS 16	Co-Axial	0·10

CABLES

CP 1	Single Lapped Screen	0·06
CP 2	Twin Common Screen	0·08
CP 3	Stereo Screened	0·08
CP 4	Four Core Common Screen	0·23
CP 5	Four Core Individually Screened	0·30
CP 6	Microphone Fully Braided Cable	0·10
CP 7	Three Core Mains Cable	0·07
CP 8	Twin Oval Mains Cable	0·06
CP 9	Speaker Cable	0·04
CP 10	Low Loss Co-Axial	0·10

CARBON POTENTIOMETERS

Log and Lin
4·7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M

VC 1	Single less Switch	0·14
VC 2	Single D.P. Switch	0·26
VC 3	Tandem Less Switch	0·44
VC 4	1K Lin Less Switch	0·14
VC 5	100K Log anti-Log	0·44

HORIZONTAL CARBON PRESETS

0·1 watt 0·06 each
100, 220, 470, 1K, 2·2K, 4·7K, 10K, 22K, 4K7, 100K, 220K, 470K, 1M, 2M, 4·7M

BOOK BARGAIN BUNDLE

8 Books comprising
2 Transistor Equivalent Books
1 Radio and Electronic Colour Code and Data Chart
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Value £3 Our Price £2 10p p & p

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BP9	38 Practical Tested Diode Circuits for the Home Constructor	35p
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	Resistor Colour Code Disc Calculator	10p

CARTRIDGES

ACOS GP91-1SC. 200mV at 1·2cms/sec £1·16
ACOS GP93-1. 280mV at 1cm/sec £1·65
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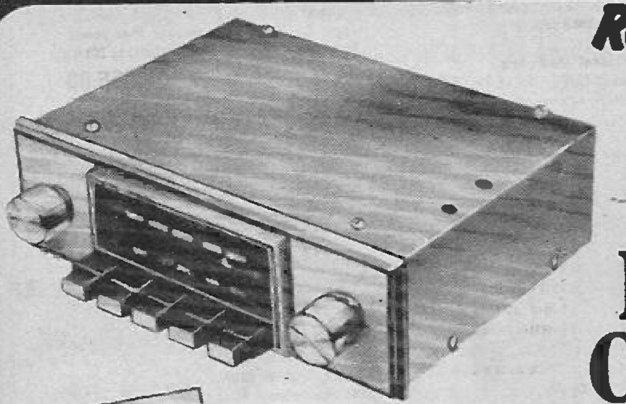


PUSH BUTTON CAR RADIO KIT

BUILD YOUR OWN TOURIST PUSH BUTTON CAR RADIO

Technical specification:

1.) Output 2.5 watts R.M.S. into 8 ohms. For 12 volt operation on negative or positive earth.

2.) Integrated circuit output stage, pre built three stage IF Module.

Controls Volume, manual tuning and five push buttons for station selection, illuminated tuning scale covering full medium and long wave bands.

Size Chassis 7 ins. wide, 2 ins. high and $4\frac{5}{16}$ ins. deep approx.

NOTE: The ability to solder on a printed circuitboard is necessary to complete this kit successfully. Circuit diagram and comprehensive instructions 55p. free with kit.

Car Radio Kit

£6.60 + 55p. postage & packing.

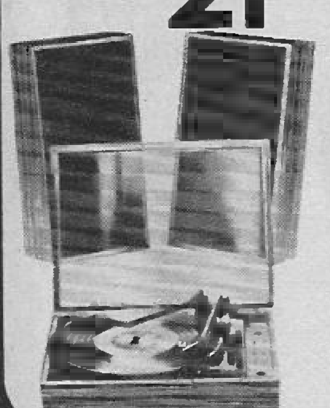
Speaker including baffle and fixing strips

£1.65 + 23p. postage & packing.

Recommended Car Aerial - fully retractable and locking.

£1.35 post paid.

STEREO 21



QUALITY SOUND FOR LESS THAN £19·00

Stereo 21 easy to assemble audio system kit. - no soldering required. Includes:—

BSR 3 speed deck, automatic, manual facilities together with ceramic cartridge.

Two 8" × 5" speakers with cabinets.

Amplifier module. Ready built with control panel, speaker leads and full, easy to follow assembly instructions.

For the technically minded:—

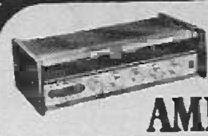
Specifications:

Input sensitivity 600mV; Aux. input sensitivity 120mV: Power output 2.7 watts per channel: Output impedance 8-15 ohms. Stereo headphone socket with automatic speaker cutout. Provision for auxiliary inputs - radio, tape, etc., and outputs for taping discs. Overall Dimensions. Speakers approx. $15\frac{1}{2}" \times 8" \times 4"$. Complete deck and cover in closed position approx. $15\frac{3}{4}" \times 12" \times 6"$. Complete only **£18.45.**

Extras if required.

Optional Diamond Styli **£1.37**

Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance. **£3.85.**



DISCO AMPLIFIER

Reliant Mk IV Mono Amplifier, ideal for the small disco or house parties.

Outputs 20 watts R.M.S. into 8 ohms (suitable for 15 ohms).

Inputs •5 Electrically Mixed Inputs. •3 Individual Mixing controls. •Separate bass and treble controls common to all 5 inputs. •Mixer employing F.E.T. (Field Effect Transistors). •Solid State Circuitry. •Attractive Styling.

1) Crystal Mic or Guitar 9mV. 2) Moving coil Mic or Guitar 8mV. 3), 4), 5) Medium output equipment (Gram. Tuner, Monitor, Organ, etc.) - all 250mV sensitivity.

Size approx. $2\frac{1}{2}$ ins × 6 ins × $3\frac{1}{2}$ ins

£13.50 + 60p. postage & packing.

8 TRACK CARTRIDGE PLAYER

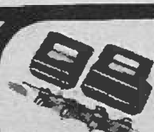
Elegant self selector push button player for use with your own stereo system. Compatible with Viscount III system, the Stereo 21 and the Unisound module.

Technical specification.

Mains input, 240V, Output sensitivity 125mV

Comparable unit sold elsewhere at £24·00 approx.

Yours for only £10·60 + 90p. p & p



BUILD YOUR OWN STEREO AMPLIFIER

For the man who wants to design his own stereo —here's your chance to start, with Unisound— pre-amp, power amplifier and control panel. No soldering—just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips which ensure very low distortion over the audio spectrum.

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£49·00

40 Watt Amplifier.
Viscount III – R102 now 20 watts per channel.
System I includes.
Viscount III amplifier – volume, bass, treble and balance controls, plus switches for mono/stereo on/off function and bass and treble filters. Plus headphone socket.

Specification
20 watts per channel into 8 ohms.
Total distortion @ 10W @ 1kHz 0 1%. *P.U.1* (for ceramic cartridges) 150mV into 3 Meg. *P.U.2* (for magnetic cartridges) 4mV @ 1kHz into 47K, equalised within 1dB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power). Tape out facilities: headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: · 12dB to –17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble 12dB to –12dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max.) –58dB.
Crosstalk better than 35dB on all inputs.
Overload characteristics better than 26dB on all inputs. Size approx. 13¾" × 9" × 3¾".
Garrard SP. 25 Mk III deck with magnetic cartridge, plinth and cover.
Two Duo Type II matched speakers – Enclosure size approx. 17" × 10½" × 6½" in simulated teak. Drive unit 13" × 8" with parasitic tweeter. **Complete System £49·00**

£65·00

System II
Viscount III amplifier (As System I)
Garrard SP. 25 Mk III deck (As System I)
Two Duo Type III matched speakers – Enclosure size approx. 23½" × 11½" × 9½". Finished in teak veneer. Drive units approx. 13½" × 8¼" with 3¼" HF speaker. Max. power 20 watts, 8 ohms. Freq. range 20Hz to 20kHz.

Complete System £65·00

PRICES: SYSTEM 1

Viscount III R 102 amplifier	£24·20	£1 p & p
2 Duo Type II speakers	£14 00	£2·20 p & p
Garrard SP25 Mk. III with MAG. cartridge plinth & cover	£18·00	£1·75 p & p
total	£56·20	

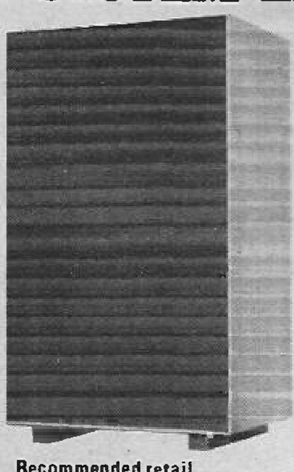
Available complete for only £49·00 · £3.50 p. & p.

PRICES: SYSTEM 2

Viscount R 102 amplifier	£24·20	£1 p & p
2 Duo Type III speakers	£32 00	£3 30 p & p
Garrard SP25 Mk III with MAG. cartridge plinth & cover	£18·00	£1·75 p & p
total	£74·20	

Available complete for £65 00 · £4 p. & p.

THE ULTIMATE COMPLETE SPEAKER SYSTEM EMI LE 315



A professional standard five way speaker system with enclosure giving top quality performance.
Enclosure Dimensions
approx. (3 ft. × 2 ft. × 1 ft.).
Drive Units
Hand built – 15" diameter bass with 3" voice coil,
– two 5" diameter Mid Range units,
– two 3¼" HF. units,
plus matching crossover panel with two variable potentiometers for mid and high frequency adjustment.
Powder Handling
Continuous rating
35 W rms., Peak power rating 70 W.
Frequency Response
20 Hz 20,000 Hz.

Recommended retail selling price, £86·00.
Our price £45·00 + £3.50 postage & packing.

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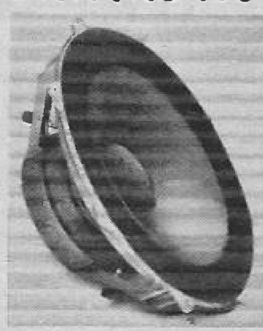
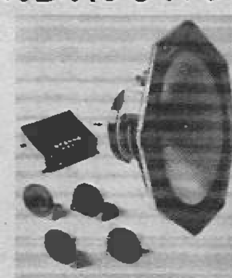
FANTASTIC REDUCTION



15" 14A/780. Bass unit on a rigid diecast chassis. Superior cone material handles up to 50 watts RMS. and is treated to give a smooth frequency response. Resonance 30 Hz. flux density 360,000 Maxwells: Impedance at 1 kHz is 8 ohms. 3" voice coil.

Recommended retail price £40·80.
OUR PRICE £18·70 + £1·50 p & p



950 Kit – Five matched speakers and crossover unit for handling up to 45 watts, frequency response from 20 to 20,000 Hz.
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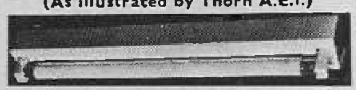

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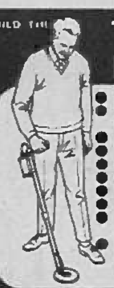

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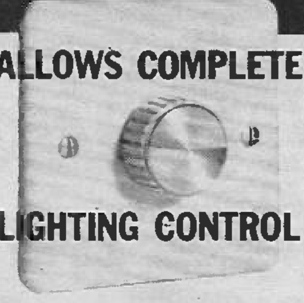

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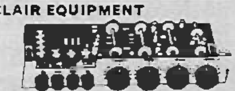

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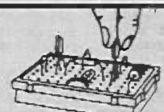

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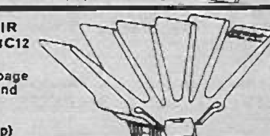

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