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RADIO & ELECTRONICS CONSTRUCTOR

JANUARY 1981
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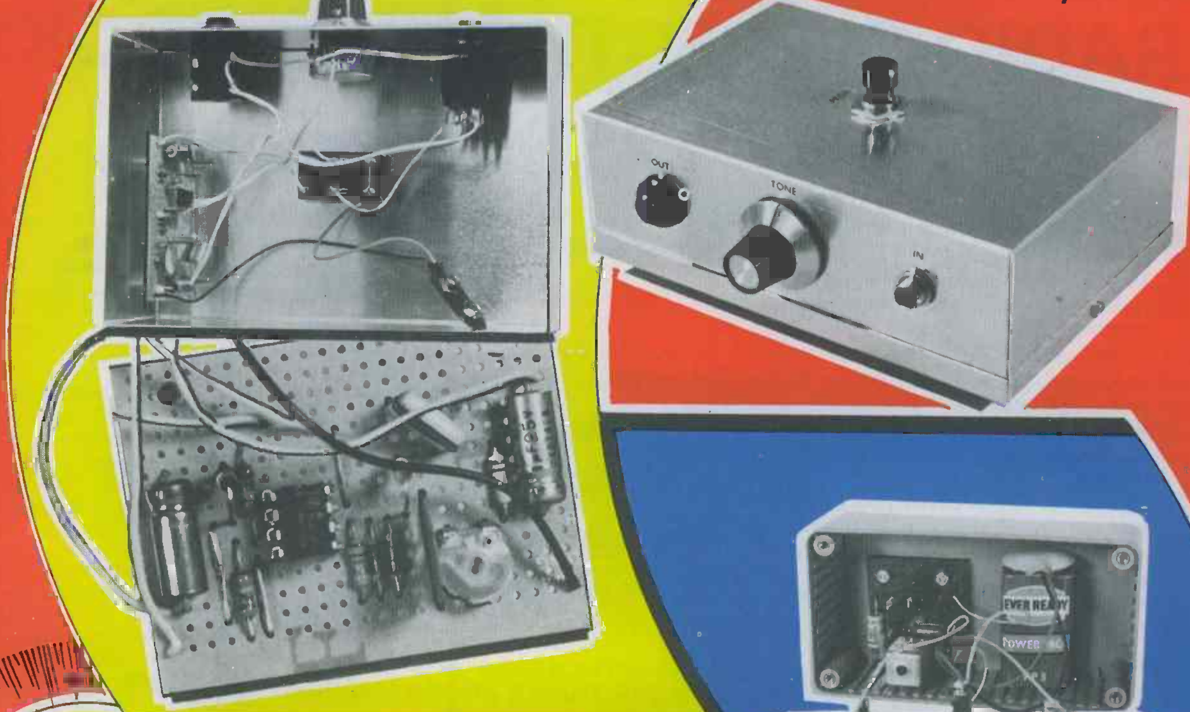

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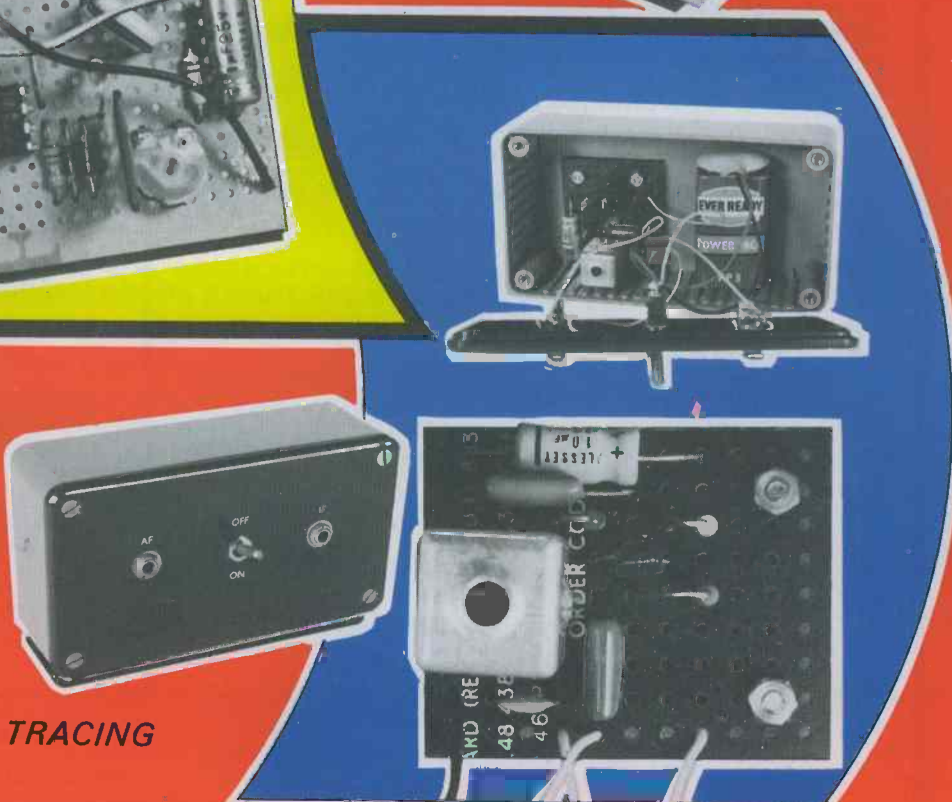

IDEAL FOR SIGNAL TRACING

DOUBLE OUTPUT TEST OSCILLATOR

RADIO & ELECTRONICS CONSTRUCTOR

JANUARY 1981
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Technical Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. We regret that queries cannot be answered over the telephone, they must be submitted in writing and accompanied by a stamped addressed envelope for reply.

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BOOKS BY BABANI

BOOK NO	DESCRIPTION	£ p
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BP24	52 Projects Using IC741 (or equiv)	0.95
BP26	Radio Antenna Book Long Distance Reception & Transmission	1.00
BP27	Giant Chart of Radio Electronic Semi-conductor & Logic Symbols	0.60
BP32	Build Metal & Treasure Locators	1.00
BP34	Practical Repair & Renovation of Colour TVs	1.25
BP35	Handbook of IC Audio Preamplifier	1.25
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BP46	Radio Circuits using ICs	1.35
BP47	Mobile Discotheque Handbook	1.35
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BP53	Practical Electronic Calculations & Formulae	2.25
BP55	Radio Stations Guide	1.45
BP56	Electronic Security Devices	1.45
BP57	How to Build Your Own Solid State Oscilloscope	1.50
BP58	50 Circuits using 7400 Series ICs	1.35
BP59	Second Book of CMOS IC Projects	1.50
BP60	Practical Construction of Pre-amps/Tone Controls/Filters & Attn	1.45
BP61	Beginners Guide to Digital Techniques	0.95
BP62	Elements of Electronics — Book I	2.25
BP63	Elements of Electronics — Book II	2.25
BP64	Elements of Electronics — Book III	2.25
BP65	Single IC Projects	1.50
BP66	Beginners Guide to Microprocessors & Computing	1.75
BP67	Counter driver & numeral Display projects	1.75
BP68	Choosing & Using your Hi-Fi	1.65
BP69	Electronic Games	1.75
BP70	Transistor Radio Fault-Finding Chart	0.50
BP160	Coil Design & Construction Manual	0.75
BP202	Handbook of Integrated Circuits Equivs & Substitutes	1.00
BP211	First Book of Diode Characteristics & Equivalents & Substitutes	1.25
BP213	Electronic Circuits for Model Railways	1.00
BP215	Shortwave Circuits & Gear for Experimenters & Radio Hams	0.85
BP221	28 Tested Transistor Projects	1.25
BP224	50 CMOS IC Projects	0.95
BP226	Build Advanced Short wave receivers	1.20
BP227	Beginners Guide to Building Electronic Projects	1.25
RCC	Resistor Colour Code Disc	0.20

BRACKETS

Right-angle mounting brackets. Ideal for mounting, PCB, panels et cetera into boxes and cases.
18SWG — Mild steel — short face has slotted hole 6.5cm x 3 7cm long face has 3 7cm diam hole

O/NO 1726	Height 15cm, length 15cm, width 10cm	£0.06
O/NO.1727	Height 25cm, length 15cm, width 10cm	£0.07

SWITCHES

Description	No.	Price
DPDT miniature slide	1973	£0.18
DPDT standard slide	1974	£0.17
Toggle switch SPST 1½ amp 250V ac	1975	£0.38
Toggle switch DPDT 1 amp 250V ac	1976	£0.48
Rotary on-off mains switch	1977	£0.58
Push switch — Push to make	1978	£0.16
Push switch — Push to break	1979	£0.21

ROCKER SWITCH	Colour	No.	Price
A range of rocker	RED	1980	£0.35
switches SPST — moulded	BLACK	1981	£0.35
in high insulation	WHITE	1982	£0.35
material available in a	BLUE	1983	£0.35
choice of colours ideal	YELLOW	1984	£0.35
for small apparatus	LUMINOUS	1985	£0.35

Description	No.	Price
Miniature SPST toggle 2 amp 250V ac	1958	£0.81
Miniature SPST toggle 2 amp 250V ac	1959	£0.86
Miniature DPDT toggle 2 amp 250V ac	1960	£0.92
Miniature DPDT toggle centre off 2 amp 250V ac	1961	£1.09
Push-button SPST 2 amp 250V ac	1962	£1.04
Push-button SPST 2 amp 250V ac	1963	£1.09
Push-button DPDT 2 amp 250V ac	1964	£1.38

MIDGET WAFER SWITCHES
Single bank wafer type — suitable for switching at 250V ac 100mA or 150V dc in non-reactive loads make before-break contacts These switches have a spindle 0 25 in dia and 30 indexing

Description		No.	Price
1 pole	12 way	1965	£0.55
2 pole	6 way	1966	£0.55
3 pole	4 way	1967	£0.55
4 pole	3 way	1968	£0.55

MICRO SWITCHES	No.	Price
Plastic button gives simple 1 pole change over action Rating 10 amp 250V ac	1970	£0.29

ANTEX IRONS

1943	15 watt iron element ceramic fitted with 3/32" bit	£5.12
1947	Replacement element for 1943 iron	£2.33
1944	Iron coated bit 3/32" for 1943 iron	£0.58
1945	Iron coated bit ⅛" for 1943 iron	£0.58
1946	Iron coated bit 3/16" for 1943 iron	£0.58
1948	General purpose 18 watt iron fitted with iron coated bit	£5.12
1952	Replacement element for 1948 iron	£2.22
1949	Iron coated bit 3/32" for 1948 iron	£0.58
1958	Iron coated bit ⅛" for 1948 iron	£0.58
1951	Iron coated bit 3/16" for 1948 iron	£0.58
1931	Highly popular x 25 25 watt quality iron ceramic shafts to provide near perfect insulation breakdown voltage of 1500 volts AC and a leakage current of only 3·5uA and another shaft of stainless steel to ensure strength	£5.12
1935	Replacement element for 1931 iron	£2.00
1932	Iron coated bit ⅛" for 1931 iron	£0.58
1933	Iron coated bit ⅛" for 1931 iron	£0.58
1934	Iron coated bit 3/32" for 1931 iron	£0.58
1953	SK1 kit contains 15 watt iron with a 3/16" bit plus two spare solder, heat-sink and a booklet 'How to solder', in presentation display box	£7.28

VEROBOARD

2201	2.5"×5" .1 Copper	£0.71	2211	2.5"×2.5" .15 Copper	£0.63
2201	2.5"×3.75" .1 Copper	£0.81	2212	3.75"×17" .15 Copper	£2.30
2203	2.5"×17" .1 Copper	£2.14	2213	3.75"×5" .15 Copper	£0.90
2205	3.75"×3.75" .1 Copper	£0.71	2217	3.75"×17.0" .1 Plain	£1.79
2206	3.75"×17" .1 Copper	£2.76	2218	3.75"×2.5" .1 Plain	£0.44
2207	4.75"×17.9" .1 Copper	£3.61	2219	5"×3.75" .1 Plain	£0.68
2208	2.5"×1", 5 in pack	£0.85	2223	2.5"×5" .15 Plain	£0.37
2204	3.75"×5" .1 Copper	£0.79	2225	5"×3.75" .15 Plain	£0.56
2210	2.5"×5" .15 Copper	£0.64			

BIB HI-FI ACCESSORIES

806	J	Compact tape head cleaning kit	£1.22
810	23	Tape Editing kit	£2.85
811	24	Cassette Tape editing and joining kit	£2.76
813	29A	Salvage cassette	£0.51
814	31	Cassette Head cleaning tape	£0.71
817	36A	Record & Stylus cleaning kit	£0.48
818	41	8-track Cartridge tape head cleaner	£1.24
819	42	Groove Kleen auto metal record cleaner	£2.65
826	52A	Cassette storage tray (holds 10)	£0.82
827	53	Hi-Fi stereo test cassette	£3.17
829	60	Chrome finish Groove Kleen (plastic)	£2.12
834	69	Anti-static Hi-Fi cleaning liquid	£0.35
838	78	Cassette hand tape winder	£1.50

WIRE CONNECTORS

Entirely new range of connectors for Discrete wire Uniquely designed Wirepost is soldered to the P C Board A pre-stripped wire is inserted into the connector and easily locked by pressing the housing down The wire is alternatively removed by lifting the housing Tin alloy plated contacts ensure good as gold performance

Housing consists of Thermo plastic polyster

1728	Single connector in red/black or white	£0.12 inc VAT
1729	Threeway connector black ONLY	£0.23 inc VAT
1730	Fourway connector black ONLY	£0.28 inc VAT

FUSE HOLDERS AND FUSES

Description	No.	Price
20mm x 5mm chassis mounting	506	£0.18
1¼in x ¼in chassis mounting	507	£0.14
1¼in car inline type	508	£0.18
Panel mounting 20mm	509	£0.23
Panel mounting 1¼in	510	£0.37

QUICK BLOW 20mm

Type	No.		Type	No.		Type	No.	
150mA	611	7p	1A	615	6p	3A	619	6p
250mA	612	6p	1 5A	616	7p	4A	620	10p
550mA	613	6p	2A	617	6p	5A	621	6p
800mA	614	8p	2 5A	618	7p			

ANTI-SURGE 20mm

Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2 5A	628
250mA	623	2A	626	3 15A	629
500mA	624	1 6A	627	5A	630

All 8p each

QUICK-BLOW 1¼in

Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634

All 8p each

Type	No.	Type	No.	Type	No.
1A	635	2 5A	638	4A	641
2A	637	3A	639	5A	642

All 7p each

NUTS AND BOLTS

BA BOLTS — packs of BA threaded cadmium plated screws slotted cheese head Supplied in multiples of 50

Type	No.	Price	Type	No.	Price
1in 0BA	839	£1.38	½in 4BA	846	£0.37
½in 0BA	840	£0.86	¼in 4BA	847	£0.29
1in 2BA	842	£0.75	1in 6BA	848	£0.46
½in 2BA	843	£0.52	½in 6BA	849	£0.24
¼in 2BA	844	£0.60	¼in 6BA	850	£0.29
1in 4BA	845	£0.51			

BA NUTS — packs of cadmium plated full nuts in multiples of 50

Type	No.	Price	Type	No.	Price
0BA	855	£0.83	4BA	857	£0.35
2BA	856	£0.55	6BA	858	£0.28

BA WASHERS — flat cadmium plated plain stamped washers supplied in multiples of 50

Type	No.	Price	Type	No.	Price
0BA	859	£0.16	4BA	861	£0.14
2BA	860	£0.14	6BA	862	£0.14

SOLDER TAGS — Hot tinned supplied in multiples of 50

Type	No.	Price	Type	No.	Price
0BA	851	£0.48	4BA	853	£0.25
2BA	852	£0.32	6BA	854	£0.25

AUDIO LEADS

No.	Type	Price
107	FM indoor Ribbon Aerial	£0.69
113	3 5mm Jack plug to 3 5mm Jack plug Length 1 5m	£0.86
114	5 pin DIN plug to 3 5mm Jack connected to pins 3 & 5 Length 1 5m	£0.98
115	5 pin DIN plug to 3 5mm Jack connected to pins 1 & 4 Length 1 5m	£0.98
116	Car aerial extension Screened insulated lead Fitted plug and socket	£1.44
117	AC mains connecting lead for cassette recorders and radios 2 metres	£0.78
118	5 pin DIN phono plug to stereo headphone Jack socket	£1.21
119	2 + 2 pin DIN plugs to stereo Jack socket with attenuation network for stereo headphones Length 0 2m	£1.04
120	Car stereo connector Variable geometry plug to fit most car cassettes 8-track cartridge and combination units Supplied with inlined fuse power lead and instructions	£0.69
123	6 6m Coded Guitar Lead Mono Jack plug to Mono Jack plug Black	£1.73
124	3 pin DIN plug to 3 pin DIN plug Length 1 5m	£0.86
125	5 pin DIN plug to 5 pin DIN plug Length 1 5m	£0.88
126	5 pin DIN plug to Tinned open end Length 1 5m	£0.88
127	5 pin DIN plug to 4 Phono Plugs All colour coded Length 1 5m	£1.50
128	5 pin DIN plug to 5 pin DIN socket Length 1 5m	£0.92
129	5 pin DIN plug to 5 pin DIN plug mirror image Length 1 5m	£1.21
130	2 pin DIN plug to 2 pin DIN inline socket Length 5m	£0.78
131	5 pin DIN plug to 3 pin DIN plug 1 & 4 and 3 & 5 Length 1 5m	£0.95
132	2 pin DIN plug to 2 pin DIN socket Length 10m	£1.13
133	5 pin DIN plug to 2 Phono plugs Connected pins 3 & 5 Length 1 5m	£0.88
134	5 pin DIN plug to 2 Phono sockets Connected pins 3 & 5 Length 23cm	£0.78
135	5 pin DIN socket to 2 Phono plugs Connected pins 3 & 5 Length 23cm	£0.78
136	Coded stereo headphone extension lead Black Length 6m	£2.01
178	AC mains lead for calculators, etc	£0.52

TRANSFORMERS

MINIATURE MAINS Primary 240V

No.	Secondary	Price
2021	6V-0-6V 100mA	£1.04
2022	9v-0-9v 75mA	£1.04
2023	12V-0-12V 100mA	£1.29

MINIATURE MAINS Primary 240V
with two independent secondary windings

No.	Type	Price
2024	MT280 0-6V 0-6V RMS	£1.84
2025	MT150-0 12V 0-12V RMS	£1.84

1 AMP MAINS Primary 240V

No.	Secondary	Price	
2026	6V-0-6V 1 amp	£2.88	P &P 45p
2027	9V-0-9V 1 amp	£2.30	P &P 45p
2028	12V-0-12V 1 amp	£2.99	P &P 55p
2029	15V-0-15V 1 amp	£3.16	P &P 66p
2030	30V-0-30V 1 amp	£3.97	P &P 86p

STANDARD MAINS Primary 240V
Multi tapped secondary mains transformers available in ½ amp 1 amp and 2 amp current rating Secondary taps are 0 19 25-33 40-50V Voltages available by use of taps. 7 8 10 14 15 17 19, 25 31 33, 40 25-0-25V

No.	Rating	Price	
2031	½ amp	£3.91	P &P 86p
2032	1 amp	£5.06	P &P 86p
2033	2 amp	£6.27	P &P £1
2035	240V Primary 0 55V @ 2A Secondary	£7.30	P &P £1

CASES AND BOXES

INSTRUMENT CASES. In two sections, vinyl covered and sides, aluminium bottom, front and sides.

No.	Length	Width	Height	Price
155	8in	5½	2in	£2.01
156	11in	6in	3in	£3.10
157	6in	4½	1¾	£1.93
158	9in	5¼	2½	£2.59

ALUMINIUM BOXES. Made from bright alloy, folded construction each box complete with half-inch deep lid and screws.

No.	Length	Width	Height	Price
159	5¼in	2¼in	1½in	£0.98
160	4in	4in	1½in	£0.98
161	4in	2¼in	1½in	£0.98
162	5¼in	4in	1½in	£1.10
163	4in	2½in	2in	£0.98
164	3in	2in	1in	£0.67
165	7in	5in	2½in	£1.54
166	8in	6in	3in	£1.98
167	6in	4in	2in	£1.32

SLOPE front aluminium boxes with black vinyl base and sides & aluminium back top & front – strong construction easily accessible.

169	2¹/₈	5¹/₈	2½	12in	3½	8in	£8.21
168	2³/₈	7½	4in	16in	4½	11in	£5.45

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AND THERE'S MORE WHERE THIS CAME FROM

It's a long time since one of our adverts was presented in 'list' form - but simply because we do not try to squeeze this lot in every time doesn't mean that it's not available. Our new style price list (now some 40 pages long) includes all this and more, including quantity prices and a brief description. The kits, modules and specialized RF components - such as TOKO coils, filters etc. are covered in the general price list - so send now for a free copy (with an SAE please). Part 4 of the catalogue is due out now (incorporating a revised version of pt.1).

LINEAR ICs - NUMERIC LISTINGS

TBA120S	1.00
L200	1.95
U237B	1.28
U247B	1.28
U257B	1.28
U267B	1.28
LM301H	0.67
LM301N	0.30
LM308H	0.96
LM308N	0.65
LM339N	0.66
LM348N	1.86
LF351N	0.38
LF353N	0.76
LM374N	3.75
LM380N-14	1.00
LM380N-8	1.00
LM381N	1.81
ZN419CE	1.95
NE544N	1.80
NE555N	0.30
NE556N	0.50
NE560N	3.50
NE562N	4.05
NE564N	4.29
NE565N	1.00
NE566N	1.60
NE570N	3.85
SL624	3.28
TBA651	1.81
uA709HC	0.64
uA709PC	0.36
uA710HC	0.65
uA710PC	0.59
uA741CH	0.66
uA741CN	0.27
uA747CN	0.70
uA748CN	0.36
uA753	2.44
uA758	2.35
TBA810AS	1.09
TBA820M	0.75
TCA940E	1.80
TDA1028	2.11
TDA1029	2.11
TDA1054	1.45
TDA1062	1.95
TDA1072	2.69
TDA1074A	5.04
TDA1083	1.95
TDA1090	3.05
HA1137	1.20
HA1196	2.00
HA1197	1.00
TDA1220	1.40
LM1303	0.99
LM1307	1.55
MC1310P	1.90
MC1330	1.20
MC1350	1.20
HA1370	1.90
HA1388	2.75
TDA1490	1.86
MC1496P	1.25
SL1610P	1.60
SL1611P	1.60
SL1612P	1.60
SL1613P	1.89
SL1620P	2.17
SL1621P	2.17
SL1623P	2.24
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SL1630P	1.62
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CA3080E	0.70
CA3089E	1.84
CA3090AQ	3.35
CA3123E	1.40
CA3130E	0.80
CA3130T	0.90
CA3140E	0.46
CA3189E	2.20
MC3357P	2.35
LM3900N	0.60
LM3909N	0.68
LM3914N	2.80
LM3915N	2.80
KB4400	0.80
KB4406	0.60
KB4412	1.95
KB4413	1.95
KB4417	1.80
TDA4420	2.25
KB4420B	1.09
KB4423	2.30
KB4424	1.65
KB4431	1.95
KB4432	1.95
KB4433	1.52
KB4436	2.53
KB4437	1.75
KB4438	2.22
KB4441	1.35
KB4445	1.29
KB4446	2.75
KB4448	1.65
NE5044N	2.26
NE5532N	1.85
SD6000	3.75
SL6270	2.03
SL6310	2.03
SL6600	3.75
SL6640	2.75
SL6690	3.20
SL6700	2.35
ICL8038CC	4.50
MSL9362	1.75
MSL9363	1.75
HA11211	1.95
HA11223	2.15
HA11225	1.45
HA12002	1.45
HA12017	0.80
HA12402	1.95
HA12411	1.20
HA12412	1.55
LF13741	0.33
SN76660N	0.80

FREQUENCY DISPLAY & SYNTHESISER ICs

SAA1056	3.75
SAA1058	3.35
SAA1059	3.35
11C90DC	14.00
LM1232	19.00
LM1242	19.00
MSL2318	3.84
MSM5523	11.30
MSM5524	11.30
MSM5525	7.85
MSM5526	7.85
MSM5527	9.75
MSM55271	9.75
ICM7106CP	9.55
ICM7107CP	9.55
ICM7216B	19.25
ICM7217A	9.50
SP8629	3.85
SP8647	6.00
95H90PC	6.00
HD10551	2.45
HD44015	4.45
HD12009	6.00
HD44752	8.00

CMOS 4000 SERIES

4001	0.17
4000	0.17
4002	0.23
4008	0.80
4009	0.58
4010B	0.58
4011AE	0.20
4011B	0.20
4012	0.55
4013	0.55
4015	0.95
4016	0.52
4017	0.80
4019	0.60
4020B	0.93
4021	0.82
4022	0.90
4023	0.17
4024	0.76
4025	0.17
4026	1.80
4028	0.72
4029	1.00
4030	0.58
4035	1.20
4040	0.83
4042	0.85
4043	0.85
4044	0.80
4046	1.30
4047	0.99
4049	0.52
4050	0.55
4051	0.65
4052	0.65
4053	0.65
4063	1.09
4066	0.56
4068	0.25
4069	0.20
4070	0.20
4071	0.20
4072	0.20
4073	0.20
4075	0.20
4076	0.90
4077	0.20
4078	0.20
4082	0.20
4093	0.78
4175	0.95
4503	0.69
4506	0.51
4510	0.99
4511	1.49
4512	0.98
4514	2.55
4518	1.03
4520	1.09
4521	2.36
4522	1.49
4529	1.41
4539	1.10
4549	3.50
4554	1.53
4560	2.18
4566	1.59
4568	2.18
4569	3.03
4572	0.30
4585	1.10

TTL N and LSN

7400N	0.13
74LS00	0.20
7401N	0.13
74LS01	0.20
7402N	0.14
74LS02	0.20
7403N	0.14
74LS03	0.20
7404N	0.14
74LS04	0.24
7405N	0.18
74LS05	0.26
7406N	0.28
7407N	0.38
7408N	0.17
74LS08	0.24
7409N	0.17
74LS09	0.24
7410N	0.15
74LS10	0.24
7411N	0.20
74LS11	0.24
7412N	0.17
7413N	0.30
7414N	0.51
74LS15	0.24
7416N	0.30
7417N	0.30
7420N	0.16
74LS20	0.24
7421N	0.29
74LS21	0.24
7423N	0.27
7425N	0.27
7427N	0.27
74LS27	0.44
7428N	0.35
74LS28	0.32
7430N	0.17
74LS30	0.24
7432N	0.25
74LS32	0.24
7437N	0.40
7438N	0.33
74LS38	0.24
7440N	0.17
74LS40	0.24
7441N	0.74
7442N	0.70
74LS42	0.99
7443N	1.15
7444N	1.12
7445N	0.94
7446N	0.94
74LS47	0.89
7448N	0.56
74LS48	0.99
74LS49	0.99
7451N	0.17
74LS51	0.24
7453N	0.17
7454N	0.17
74LS54	0.24
74LS55	0.24
7460N	0.17
74LS63	1.24
7470N	0.28
7472N	0.28
7473N	0.32
74LS73	0.38
7474N	0.27
74LS74	0.28
7475N	0.38
7476N	0.37
74LS76	0.38
74LS78	0.38
7480N	0.48
7481N	0.86
7482N	0.69
7485N	1.04
74LS85	0.99
74LS86	0.40
7489N	2.05
7490N	0.33
74LS90	0.90
7491N	0.76
74LS91	1.10
7492N	0.38
74LS92	0.78
7493N	0.32
74LS93	0.99
7494N	0.78
7495N	0.65
74LS95	1.14
7496N	0.58
74LS96	1.20
7497N	1.85
74LS107	0.38
74109N	0.63
74LS109	0.70
74110N	0.54
74111N	0.68
74LS112	0.38
74LS113	0.38
74LS114	0.38
74118N	0.83
74120N	1.15
74121N	0.42
74122N	0.46
74123N	0.73
74LS124	1.75
74125N	0.38
74LS125	0.44
74126N	0.57
74LS126	0.44
74128N	0.74
74132N	0.73
74LS132	0.78
74LS136	0.40
74LS138	0.60
74141N	0.56
74142N	2.65
74143N	3.12
74144N	3.12
74LS145	0.97
74147N	1.75
74148N	1.09
74LS148	1.19
74150N	0.99
74151N	0.55
74LS151	0.84
74153N	0.64
74LS153	0.54
74154N	0.96
74155N	0.54
74LS155	1.10
74156N	0.80
74157N	0.67
74LS157	0.55
74LS158	0.60
74159N	2.10
74160N	0.82
74LS160	1.30
74161N	0.92
74LS161	0.78
74LS162	1.30
74163N	0.92
74LS163	0.78
74164N	1.04
74LS164	1.30
74165N	1.05
74LS165	1.04
74167N	2.50
74LS169	2.00
74170N	2.30
74LS170	2.00
74LS174	1.20
74175N	0.87
74LS175	1.10
74176N	0.75
74177N	0.78
74181N	1.65
74LS181	3.50
74LS183	2.10
74184N	1.35
74185N	1.34
74LS190	0.92
74192N	1.05
74LS192	1.80
74193N	1.05
74LS193	1.80
74194N	1.05
74196N	0.99
74LS196	1.10
74LS197	1.10
74198N	1.50
74199N	1.60
74LS247	0.93
74LS257	1.08
74LS260	1.53
74LS279	0.52
74LS283	1.20
74LS293	0.95
74LS365	0.49
74LS366	0.49
74LS367	0.43
74LS368	0.49
74LS374	1.80
74LS377	1.95
74LS379	1.30
74LS393	1.40

VOLTAGE REGULATORS

78series	0.95
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78Mseries	0.65
78Lseries	0.35
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78MGT2C	1.75
79MGT2C	1.75
723CN	0.65
L200	1.95
TDA1412	0.75
NE5553N	1.25
LM317MP	1.48
LM337MP	1.48

MICROMARKET

8080A/2	7.50
8212	2.30
8214	3.50
8216	1.95
8224	3.50
8251	6.25
8255	5.40
6800P	7.50
6810	5.95
6820	7.45
6850	4.90
6852	4.85
MC2708	7.50
2114	6.50
4027	5.78
2102	1.70
2112	3.40
2513	7.54
HM4716	4.50
81LS97	1.25

VARICAP TUNING DIODES

BA102	0.30
BA121	0.30
ITT210	0.30
BB204B	0.36
BB105B	0.36
BB109	0.27
MVM125	1.05
BB212	1.95
KV1210	2.45
KV1211	1.75
KV1226	1.95
KV1225	2.75
KV1215	2.55
KV1225	2.75

SWITCHING AND PIN DIODES

SHOTTKY DIODES

1N6263	0.62
BA182	0.19
BA244	0.17
BA379	0.35
TDA1061	0.95

SIGNAL DIODES & RECTIFIERS

1N4148	0.06
1N4001	0.06
1N4002	0.07
1N5402	0.15
OA91	0.07
AA112	0.25
BRIDGES:	
1A/50V	0.35
6A/200V	0.75

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LF/HF FIXED INDUCTORS —FULL E12 RANGE

7BA series 1uH-1mH	0.16
8RB series 100uH-33mH	0.19
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10RBH series 120mH-1.5H	0.55
PIEZO SOUNDER PB2720	0.44

CRYSTAL FILTER PRODUCTS

10.7MHZ 2 POLE TYPES:	
10M15A 15KHZ BW	2.49
10.7MHZ 8 POLE TYPES:	
10M4B1 15kHz BW	14.50
H4402 7.5KHZ BW	15.50
10M22D 2.4KHZ SSB	17.20
HF FIRST FILTER:	
B34F8A 34.5MHz HF	32.00

RADIO CONTROL CRYSTALS

(No splits available)

AM TX:-	
3rd OT 30pF HC25U	1.65
AM/FM RX:-	
3rd OT 30pF HC25U	1.65
FM TX :-	
Fund 20pF HC25U	1.85
Pairs FM	3.25
Pairs AM	3.10

CRYSTALS

32.768 kHz	2.70
100kHZ	3.85
455kHZ	5.00
1.0MHz	3.00
3.2768MHz	2.70
4.000MHz	2.00
4.19439MHz	2.30
6.5536MHz	2.10
10.0MHz	2.50
10.6985MHz	2.50
10.7015MHz	2.50
10.245MHz	2.50
10.7MHz	3.00
11.52MHz	2.50
100MHz	3.00

LEDs

5MM RED	0.12
3MM RED CLEAR	0.15
3MM RED	0.15
2.5 X 5MM RED	0.17
5MM GREEN	0.15
3MM GN CLEAR	0.16
3MM GREEN	0.16
2.5 X 5MM GN	0.20
5MM YELLOW	0.15
3MM YELLOW CL	0.16
3MM YELLOW	0.18
2.5 X 5MM YE	0.20
5MM ORANGERED	0.20
5MM ORA CL	0.29
3MM ORANGERED	0.19
2.5 X 5MM ORA	0.24
5MM INFRA RED	0.56
BPW41 IR DET	1.51
IR OPT CPLR	1.44
5MM CLIP	0.04

LCDs

3.5 digit	9.45
4 digit	8.95
5 digit	8.95

SCHOTTKY DIODE BAL MIXERS (SBL1=MD108)

SBL1 1-500MHz	4.25
SBL1-8 .1-200MHz	4.55
SBL1-X 10-1000MHZ	5.75
SRA1 .5-500MHz	8.45
SRA1-1 .1-500MHz	9.25
SRA1H .5-500MHz	13.35
SRA3 .025-200MHz	10.25

LCD Module

CM161.
Miniature clock, 12/24 hr., alarm, day, date, backlight.
All for......9.95

TRANSISTORS AUDIO DEVICES

BC237	0.08
BC238	0.08
BC239	0.08
BC307	0.08
BC308	0.08
BC309	0.08
BC413	0.10
BC414	0.11
BC415	0.07
BC416	0.08
BC546	0.12
BC556	0.12
BC550	0.12
BC560	0.12
BC639	0.22
BC640	0.23
2SC1775	0.18
2SA872A	0.14
2SD666A	0.30
2SB646A	0.30
2SD668A	0.40
2SB648A	0.40
2SD760	0.45
2SB720	0.45
2SC2546	0.19
2SA1084	0.20
2SC2547	0.19
2SA1085	0.20

AUDIO POWER DEVICES

2SB753	2.34
2SB723	2.34
2SK133	3.00
2SJ 48	3.00
2SK134	3.10
2SK135	3.75
2SJ 50	3.75
BD535	0.52
BD536	0.52
BD377	0.33
BD378	0.33
BD165	0.30
BD166	0.31

SMALL SIGNAL RF DEVICES

BF194	0.18
BF195	0.18
BF224	0.22
BF241	0.18
BF274	0.18
BF440	0.21
BF441	0.21
BF362	0.49
BF395	0.18
BF479	0.66
BF679S	0.55
BFR91	1.33
BFW92	0.60
BFT95	0.99
BFY90	0.90
40238	0.85

RF POWER DEVICES

VN66AF	0.95
2N3866	0.85

SMALL SIGNAL RF FET/MOSFET

BF256	0.38
2SK55	0.28
2SK168	0.35
J310	0.69
J176	0.65
40823	0.65
40673	3SK51
3SK45	0.49
3SK51	0.54
3SK60	0.58
MEM680	0.75
BF961	0.70
BF960	1.24
3SK48	1.64

CAPACITORS

All 5mm or less spacing

CERAMIC 50v
2P2,3P3,4P7,6P8
8P2,10P,15P,18P..0.04
22P,27P,33P,47P
56P,68P,82P,100P.0.05
150P,220P,270P
330P,390P,470P...0.055
1N0,2N2,3N3,4N7..0.06
10N (0.01uF)....0.05
22N,47N.........0.06
100N,220N.......0.09
MONOLITHIC CERAMIC
10N,100N........0.16

FEEDTHRU
1NO SOLDER IN....0.09

POLYESTER (SIEMENS)
10mm LEAD SPACING
10N,22N,33N......0.17
47N,68N,100N.....0.19
220N,470N.......0.22
1uF.............0.29

POLYESTER (GENERAL)
10mm LEAD SPACING
10N,15N,22N,33N..0.06
47N,68N,100N.....0.08
220N............0.11
20mm LEAD SPACING
220N,330N,470N...0.18

MYLAR
5mm LEAD SPACING
1NO,10N,22N,33N..0.08
100N............0.09
20mm LEAD SPACING
220N,470N....... 0.17

POLYSTYRENE
10P,15P,18P,22P,
27P,47P,56P,68P..0.08
100P,180P,220P,
270P,330P,390P...0.09
470P,680P,820P...0.10
1N0,1N2,1N5,1N8..0.11
2N2,2N7,3N3,3N9..0.12
4N7,5N6,6N8,10N..0.13

TANTALUM BEAD CAPS
16v: 0.22,0.33,
0.68,1.0........0.18
16v: 2.2,4.7,10..0.19
6v3: 22,47......0.30
10v: 22,100......0.35

ALUMIN ELECTROLYTICS RADIAL (VERT. MOUNT)

(uF/voltage)
1/63,2.2/50,4.7/35
10/16,15/16,22/10
33/6.3..........0.08
22/16,33/10,
47/10...........0.09
10/63,22/50,33/50,
47/16,100/16.....0.10
47/63,100/25,220/16
470/6.3.........0.12
100/63,470/16,
1000/10.........0.18
1000/16,470/63...0.23
1000/63,2200/16..0.30
3300/25.........0.69
1000/100........0.88
10000/70........3.00

AXIAL (HORIZ. MOUNT)
1/25,4.7/16,6.4/25
10/16............0.08
4.7/63,22/10,22/16
33/16...........0.09
47/25,100/16.....0.10
100/25..........0.11
100/16..........0.25
2200/16,1000/25..0.36
1000/35,4700/16..0.45
1000/50.........0.58

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0.25W, 5% E12 CARBON
1ohm-10M........0.02
0.25W 1% E12 METAL FILM
1.1ohm-1M.......0.05

HORIZ CARBON PRESETS
10mm TYPE
100ohms-2M5......0.12
HORIZ CERMET PRESETS
1k, 10k.........0.27

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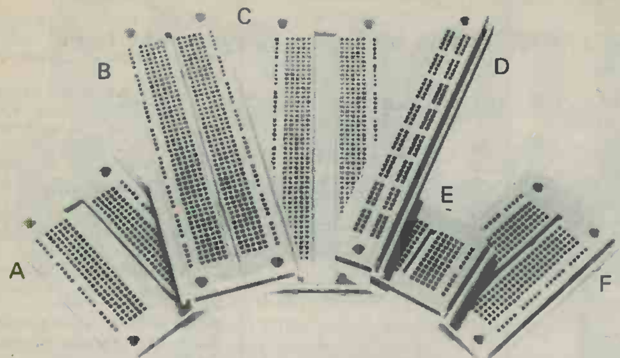

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BC328	6p
BC337	6p
BC338	5p
BC382L	7½p
BC384B	7½p
BC546	5p
BC547/A/B	5p
BC548/A/B/C	5p
BC549C	5p
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BF137	11p
BF167	18p
BF173	18p
BF178	23p
BF179	23p
BF180	12p
BF181	8p
BF182	18p
BF183	18p
BF184	18p
BF185	18p
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BF195/C/D	5p
BF196	5p
BF197	5p
BF198	5p
BF200	13p
BF224	4p
BF244C FET	7½p
BF245	6p
BF256FET	4p
BF256LB/LC FET	3P
BF257	20p
BF262	29p
BF263	29p
BF274	8p
BF324	3½p
BF336	16p
BF355	15p
BF394B	3p
BF451	6p
BF494	10p
BF495	5p
BF595c FM/AM/GP	9½p
BF615	27p
BF617	27p
BFZ35	15p
BFQ35	15p
BFQ85	15p
BFR34A	36p
BFR38	68p
BFR86	19p
BFS21 FET pair	£3
BFS28 Dual MOS	50p
BFT30	15p
BFT31	15p
BFT39	15p
BFT41	15p
BFT60	6p
BFT61	15p
BFT70	15p
BFT71	15p
BFW10 FET	46p
BFW11 FET	46p
BFW30	15p
BFW31	15p
BFW57	18p
BFW58	18p
BFX12	23p
BFX29	11p
BFX30	16p
BFX37	16p
BFX84	20p
BFX85	14p
BFX88	20p
BFX89	20p
BFY39	20p
BFY50	15p
BFY51	15p
BFY52	15p
BFY75	15p
BFY90	40p
BLY10	23p
BR101 Prog.	20p
BRY39 Uni-	29p
BRY56 Junct	29p
BSV64	36p
BSV79	50p
BSV80	50p
BSV81	75p
BSX19	15p
BSX20 VHF Osc.	7p
BSX21	10p
BSX78	8p
BSY40	30p
BSY95A	10p
BU105	64p
BU105/04	78p
BU204	50p
BU208	£1
BUX 66P, 150v. 35w.	54p
D45C2 40v. 30w 220HFE 50MHz	50p
GET102	46p
GET111	45p
GET120	30p
M103G MOSFET	30p
MA393	25p
MD7000	£2.25
ME2	13p
ME0412	14p
ME8003	20p
MJ481 BDY23)	23p
MJE371	40p
MJE2371	80p
MJE2901T (Higain 2955)	50p
MJE2955 70v 90w	45p
MΩ15 Russian	25p
MΩ41 Russian	25p
MPF131 Dual MOSFET	15p
MPU131 Prog. Uni J.	15p
MRF502 Improved BFY90	90p
Ω16A Russian	25p
Ω42A Russian	25p
NKT49	23p
NKTA52	20p
NKTB54	30p
NKT152	38p
NKT153	24p
NKT154	26p
NKT251	18p
NKT775	16p
NKTME2	13p
OC41	4p
OC42	21p
OC43	55p
OC44	4p
OC45	13p
OC71	4p
OC72 (XK 120)	4p
OC76	15p
OC77	46p
OC81 (XK 122)	4p
OC84	30p
OC200	41p
OC201	66p
OC202	66p
OC603	50p
OC701	50p
ON222	23p
P346A	24p
P7029	30p
PXB103	25p
RCP701A/B/D 10wT	3p
R1039 (2010)	54p
R2008B	£1.18
R2010B	£1.18
R2306 100v 40w	26p
R2540	£1.70
S3017	25p
SB240	26p
SFT357	26p
SJE5039	8p
SL102	40p
TE886	£1
TIP29 40v 30w	22p
TIP30	22p
TIP30C 100v 30w	26p
TIP31C 100v 40w	26p
TIP32A 60v 40w	22p
TIP32C 100v 40w	26p
TIP41 40v 65w	15p
TIP42C 100v 65w	33p
TIP48	33p
TIP 110 60v 50w Darl.	30p
TIP112 100v 50w	45
TIP117 Pwr Darl	45p
TIS44 VHF switch	9½p
TIS60GY	3p
TIS61	3p
TIS73L	3p
TIS90	4p
TIS91 UNI Junc.	3p
TIS92GY	14p
TIS98	3p
TK24	20p
V435	20p
U14710	20p
ZT403P	30p
ZT1486	£1.10
ZTX300	9p
ZTX327	18p
ZTX341	9p
2G103	33p
2G302	12p
2G309	30p
2G339A	20p
2G371	18p
2N456A	71p
2N597	16p
2N598	16p
2N601	£1.50
2N644	22p
2N706A	10½p
2N708	9p
2N914	15p
2N918	12p
2N929	16p
2N984	28p
2N987	45p
2N1091	16p
2N1132	14p
2N1302	16p
2N1303	16p
2N1395	25p
2N1484	36p
2N1485 60v 25w	36p
2N1487	90p
2N1490	£3
2N1500	30p
2N1507	18p
2N1711	13p
2N1716	15p
2N1748	28p
2N2192A	15P
2N2221/A	9P
2N2222A	8p
2N2369	10p
2N2401	7½p
2N2412	27p
2N2483	28p
2N2484	10p
2N2586	15p
2N2614	4p
2N2887	£2
2N2894	11p
2N2904	9p
2N2905	15p
2N2906	9p
2N2907/A	9p
2N2926	4p
2N3020	25p
2N3053	16p
2N3054	35p
2N3055RCA	68p
2N3133	24p
2N3283	25p
2N3418	15p
2N3553	56p
2N3583	18p
2N3645	3p
2N3703	3p
2N3704	4p
2N3707	3p
2N3711	3p
2N3714 80v 150w	54p
2N3794	14p
2N3799	18p
2N3823 FET	25p
2N3906	8p
2N4000	15p
2N4026	15p
2N4031	15p
2N4062	4p
2N4285	17p
2N4891	30p
2N4918	15p
2N5058 (BF259)	11p
2N5147	15p
2N5293 80v 36w	30p
2N5294 80v 36w	30p
2N5295 60v 36w	30p
2N5296 60v 36w	30p
2N5297 80v 36w	36p
2N5449	3p
2N5484	37p
2N5492 75v 50w	36p
2N5494 60v 50w	36p
2N5915 (16068) 450Mhz 6WT R.F. 12v	£2.50
2N5954 P. 80v 40w.	36p
2N6028 PUJT	3p
2N6101 80v 75w	55p
2N6106 80v 40w	44p
2N6109 60v 40w	44p
2N6111 40v 40w	36p
2N6124	24p
2N6178 100v 25w	30p
2N6181 75v 25w	30p
2N6254	36p
2N6288 30v 40w	36p
2N6290 60v 40w	30p
2N6292 80v 40w	30p
2N6486 40v 75w	36p
2N6488 90v 75w	36p
2S701	18p
2SA12	42p
2SA50	36p
2SA80	36p
2SA83	36p
2SA141	36p
2SA142	36p
2SA234	50p
2SA236	50p
2SA354	38p
2SA360	34p
2SA367	56p
2SA518	38p
2SA634	80p
2SB75	25p
2SB77	25p
2SB135	25p
2SB136	25p
2SB156	60p
2SB175	20p
2SB176	20p
2SB187	25p
2SB457	25p
2SC1061 50v 25w	50p
2SD234 60v 25w	50p
2SD315D	80p
16120 (MPSU55/ BD238)	19p
40235	50p
40250	36p
40250VI (2N3054 + Ht. sink)	40p
40316 40v. 50w	36p
40372 (2N3054 + Ht. sink)	40p
40349v2 160v 1w	30p
40394 60v 1w	30p
40602 VHF Mosfet	36p
40633 NPN 40w	36p
40911 (2N6261 + Ht. sink)	40p

RELAYS

CONTINENTAL SERIES. 700Ω 24v 4pco 62p: 700Ω 12v 4pco 75p. 52Ω 3/6v 2pco 75p: 52Ω 3/6v 4pco 75p. 125Ω 12v 2pco 75p: 900Ω2pco 75p: 1250Ω4pco 1,250Ω 12v 2pco 75p: 900Ω2pco 75p: 1250Ω4pco 2pco 75p. 1250Ω 24v 2pco 75p: 700Ω 11/31v 2pco 75p. 1000Ω 12v 2pco 95p:

REED RELAYS. Alma DR1. 1" x ⅛" diam. 1250Ω S.P. 12volt 50p. D.I.L. 500Ω 3.7/10volt S.P. £1. ALMA 38mn x 11mm x 13mm 1KΩ 6/12v S.P. 36p, 3KΩ 18/30v S.P. 36p, 2K7Ω 12/24v S.P.C.O. 65p. Reed switches normally open 28mm 5p. Coils 6-12-24volt 28p. 6/12v 2pco £1.45: 12v 3pco £2.

HEAVY DUTY SERIES. 650Ω 12/24V 4pco 75p 670Ω24v 4pco 75p. 110v 4pco 62p: 325Ω 12v 3pole £1.15p. 110/130vac spco 75p. 6/12vdc/24vac 3pco 10amp 75p. 280Ω 12v D.P. 95p.

OPEN STYLE. 240vac 3pco, 2pco or 1pco £1.20, 110vac. 3pco or 4pco 75p. 115vac 1pco 75p.

MINIATURE OPEN STYLE HI-SPEED. 5400Ω S.P.C.O. 24v 60p: 4500Ω 20v S.P.C.O. 60p.

HIGH SPEED OPEN STYLE DUAL COIL. Wire as 625, 1250 or 2500Ω 1½-12v coil S.P.C.O. Heavy Duty contacts 75p.

G.P.O. 1000/3000 series. 12v 2pco 81p: 12v S.P.C.O. £1.05. 3K8Ω centre tapped 4pco 63p. 1700Ω 3pco + 2p. 80p. Clare 11kΩ 4pco 63p: 4K5Ω + 5KΩ 4pco 63p.

PLUG IN 8/11 PIN. 336Ω 12v S.P.C.O. 80p: 5330Ω S.P.C.O. 80p. 10,250Ω S.P.C.O. 80p: 110Ω 12v 2pco £1. 475Ω 24v 2pco 80p: 40/52v 2pco 80p. 36v 2pco 60p: 24v 3pco 89p. 50vac (1MFD series for mains) 3pco 80p. 6v. 288Ω S.P. 75p.

COAXIAL 700Ω 14/30v 50Ω Impedance S.P.C.O. £2.

SEALED METAL CASED HEAVY DUTY MULTI CONTACT. 12v £1.40: 18/24v £1.30: 8pco 12v £1.30p. 48v 1700Ω + 1700Ω S.P.C.O. 66p.

THERMAL DELAY. Amperite 115 no2, 26c5, 1CC10T, 26 no5, 6 no2. 60p each. Silic-o-netic 36v 90 second 2pco 90p.

LOW PROFILE. 4pco 24v 1200Ω 95p.

Continental series CONTINENTAL SERIES SOCKETS 2 or 4pco 10p. 11 pin ex-equipment 18p.

TRIACS

Amp	Volt	Type	Price
0.1	40	7W84	3p
2.5	600	2N5757	44p
3.5	400	T2710D	58p
4	400	T2716D/40730	74p
6	200	T2500B/41014	54p
6	400	T2500D	72p
8	400	T2850D	72p
8	500	BT137-500	72p
12	500	BT138-500	90p
25	100	BTX94-100	£2.25
25	1200	BTX94-1200	£5

HUGHES

MICRO ELECTRONICS 400MW ZENER DIODES 200 IN CLEAR PLASTIC HINGED LID COMPONENT BOX £2.30

3V, 3.6V, 3.9V, 4.3V, 4.7V, 11V, or 13V.

END OF LINE STOCK ITEMS AND COMPUTER & AUDIO BOARDS/ASSEMBLIES WITH VARYING CONTENTS INCLUDE ZENER, GOLD BOND, SILICON, GERMANIUM, LOW AND HIGH POWER TRANSISTORS AND DIODES, HI STAB RESISTORS, CAPACITORS, ELECTROLYTICS, TRIMPOTS, POT CORES, CHOKES, INTEGRATED CIRCUITS, ETC.

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7 MILLION CARBON FILM RESISTORS PURCHASED

1/4 – 1/3 – 1/2 – 3/4 – 1 – 1 1/2 Wt. Iskra and Piher, mainly 5%, few 2%. Lucky Dip as the packs come (will not duplicate under 20 packs) due to cartons-packed tight and on top of each other to ceiling of warehouse.

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OPTO ELECTRONICS

Photo Diodes: BPX40, BPX42, BPY10, CQY77, CQY17, BPY68, BPY69, BPY77 36p
Wire end neons 4p.
Photo transistors: BPX43, BP103, 2N5777, Darlington, 36p. LED's (Mullard Selmans) Red 2" 8p, 125" 9p; Green 2" 11p; 125" 12½p; Micro Yellow LD481 7½p.
PHOTO SILICON CONTROLLED SWITCH BPX66 PNPN 10 amp 36p.
CA3062 Photo Detector and power amp. £1

7 SEGMENT L.E.D. DISPLAYS

3" Red com. anode 81p
6" Green R.S.C.A. £1.77
5082-7650 Red com. anode.
5082-7653 Red com. cath
5082-7600 Yellow com. anode.
H.P. Highbrilliance 43" 72p

HEWLIT PACKARD MULTIPLEXED 12" 7 SEGMENT LED DISPLAYS

3 Digit HP5082 7413 45p
4 Digit HP 5082 7414 45p
5 Digit HP 5082 7415 45p
Infra red transmit diodes CQY11B or LD27 High power 1.6-2v or 3-3.5v Pulse 32p
LD242 36p
H15B Photon coupled isolator I.R. diode and NPN Photo-Darlington amp 26p
CNY17/1 opto coupler 70p
Cold cathode tubes I.T.T. G517A or 5870L 60p

SPECIAL OFFER

IN4004 or IN4006 Sealed manufacturers carton of 300.
£6.75

BULGIN 5amp 240vac in line 3 pin plug and socket 75p pair.

T.V. DROPPERS

266+ 14+ 193Ω
15+ 23+ 26Ω
108+ 24+ 9Ω
66+ 66+ 137Ω
66+ 66+ 158Ω
285+ 575+ 148+ 35Ω
25+ 35+ 97+ +59 30Ω
30+ 60Ω
all 11p each plus 59p

UNISELECTOR

5 pole 25 way 24v coil £3.50

TOGGLE SWITCHES

Double Pole 40p. Bulgin 3 amp 250v S.P. 42p with free panel plate 13amp 250v S.P. 36p. 13amp 250v S.P.C.O. centre off 39p. 3amp 250v S.P. Biased 50p. S.P.C.O. biased 50p. D.P. biased 3amp 250v 60p. S.P.C.O. centre off 10a 250v biased 75p. 10/15amp 4 pole C.O. centre off £1.20. 10/15amp 3 pole C.O. centre off 98p. Sub miniature S.P.C.O. 53p.

ROTARY MAINS SWITCH

¼" or 4mm Spindle D.P.S.T. 20p. Bulgin 5amp S.P. 35p.

Rada + SLR EMERGENCY LIGHT 8" diam x 5" deep. 4 hour unit fit and forget. Auto switch on if mains fail. switches off and recharges when mains restored complete – Boxed – £26.50.

DIODES

AA119	7p	MPN3401	30p
AA133	9p	OA5	25p
AAZ15	15p	OA7	25p
B1	11p	OA10	25p
BA116	30p	OA47	7p
BA128	2½p	OA70	10p
BA145	2½p	OA75	11p
BA148	12p	OA79	11p
BA182 Varicap	6p	OA81	3½p
BAX14	2½p	OA95	8p
BAX54	8p	OA200	2½p
BAY36P	2½p	OA202	2½p
BB103 Varicap	6p	IGP7	11p
BB104 Varicap	16p	IGP10	11p
BB109 Varicap	24p	IN662	2½p
BB110B Varicap	24p	IN914	1½p
BB113 Triple Varicap	43p	IN916	2½p
		IN935B	7½p
BB139	£1	IN936B	7½p
BR100 Diac.	15p	IN937B	7½p
BY206	7½p	IN941B	7½p
BY207	23p	IN942B	7½p
BY402	2½p	IN943B	7½p
BY403	2½p	IN3064	2½p
Centercell	3p	IN4009	2½p
CG651	9p	IN4148	1p
CR HG/3	10p	IN4150	2½p
CSD117YLZ	40p	IN4151	2½p
CV7095	2½p	IN4146	2½p
CV7098	2½p	IN4449	2½p
D3202Y Diac.	11p	IN5456	15p
DC2845 Microwave	20p	5082 2900 RF Schotky Barrier	20p
DOG53	11p		
FSY28A	40p		
HG1012	10p		
HS2091	11p		

RECTIFIERS

Type	Volt	Amp	Price
BY126	650	1	5p
BY127	1250	1	4p
BY212	15kv	500ma	6p
BY235	600	1½	7½p
BY236	900	1½	7½p
BY264	300	3	9p
BY265	600	3	11½p
BY266	900	3	15p
BY274	300	5	14½p
BY275	600	5	17½p
BY277	1200	5	27p
BY299	800	2	4p
BY1202	2kV	10mA	6p
BYX20-200	200	25	72p
BYX22-200	300	1½	25p
BYX38 300R	300	2½	48p
BYX38 600	600	2½	52p
BYX38 900	900	2½	60p
BYX38 1200	1200	2½	65p
BYX42 300	300	10	36p
BYX42 600	600	10	46p
BYX42 900	900	10	92p
BYX42 1200	1200	10	£1.07
BYX46 300R	300	15 Avalanche	£1.19
BYX46 400R	400	15 Avalanche	£1.75
BYX46 500R	500	15 Avalanche	£2.00
BYX46 600	600	15 Avalanche	£2.30
BYX48 300R	300	6	47p
BYX48 600	600	6	60p
BYX48 900	900	6	70p
BYX48 1200R	1200	6	92p
BYX49 300R	300	3	35p
BYX49 600	600	3	42p
BYX49 900R	900	3	47p
BYX49 1200	1200	3	60p
BYX52 300	300	40	£2.05
BYX52 1200	1200	40	£2.90
BYX72 150R	150	10	42p
BYX72 300R	300	10	52p
BYX72 500R	500	10	65p
BYX94	1250	1	6p
E250C50	250	½	14p
KS11394	800	3	23p
LT102	30	2	15p
M1	68	1	5p
MR856	600	3	24p
OA210	400	5	33p
RAS3 10AF Avalanche	1250	1½	48p
REC53A	1250	1½	16p
S10BR30	1000	30	£2.00
SKE4G	200	6	30p
SR100	100	1½	9p
SR400	400	1½	10p
IN3254	400	1	4p
IN4002	100	1	3p
IN4004	400	1	4½p
IN4005	600	1	6p
IN4006	800	1	6p
IN4007	1250	1	6p
IN5059	200	1½	10p
IN5401	100	3	10p
IS138	800	½	2½p
IS921	100	¼	8p
25G100	100	60	£4.35
3052	200	3	11p
16094P	900	3	15p
16492	700	1½	9½p

24 MEG 1 watt 5% High Voltage resistor 10 for 25p.

BRIDGE RECTIFIERS

½	60V	BC30 C350	23p
½	1,600	BYX10	34p
0.6	110	EC433	20p
1	50V	WO05	19p
1	140	OSH01-200	25p
1	200V	WO2 Ex Equip	15p
1	400V	WO4	28p
1	400V	MDA104	29p
1	800V	WO8	27p
1	1000	W10	36p
1½	75V	IBIBY234	11½p
1½	150V	IBIBY235	15p
2½	100	I.R.	40p
2½	350V	9F2	70p
2½	500V	9E4	85p
3	50	KBS005	30p
3	100	KBS01	30p
3	200	KBS02	30p
3	400	KBS04	30p
3	600	KBS06	30p
3½	100	B40C 3200	58p
5	400	Texas	85p
Miniature	Meter	Type	34p

THYRISTORS

Amp	Volt	Type	Price
0.8	200	2N5064	18p
1.	240	BTX18-200	35p
1	240	BTX30-200	35p
1	400	BTX18-300	41p
2	400	S2710D with heatsink	40p
3	600	T3N06C00	53p
3	100	T3N1C00	36p
4	50	S107F Sensitive Gate	36p
4	50	S2060F Sensitive Gate	36p
4	400	S2061D Sensitive Gate	38p
4	500	40506 with heatsink	58p
4	600	C106M Sensitive Gate	36p
4	600	2N3228	36p
4	600	GAK	36p
5	400	S3700D	44p
5	400	S5800D/R	36p
5	600	S5800M	44p
6.5	500	BT109/SCR957	71p
7	400	S2620D	45p
7	600	S2620M	45p
8	100	S2800A	36p
8	600	S122M	54p
12	1000	CR121103-RB	£8
15	800	BTX95-800 Pulse Modulated	£1
20	600	BTW92-600RM	£3.40
75	800	71CG80	£6
110	20	72RC2A	£3
150	1000	151RA100	£10
150	1200	151RA120	£11
BT106		70p	
BT121		70p	
BT107		£1	

ZENER DIODES

4/500MW. BZY88, BZX97, etc. 5p
2v. 2v7. 3v. 3v3. 3v6. 3v9. 4v3. 4v7. 5v1. 5v6. 6v2. 6v8. 7v5. 8v2. 9v1. 10v. 11v. 12v. 13v. 13v5. 15v. 18v. 20v. 22v. 24v. 27v. 30v. 33v. 43v.
BZY61 Laboratory Standard 400MW 7v5. Voltage Regulator Diode 12p
1.3/1.5WT BZX61, BZY97, etc. 11p
2v4. 2v7. 3v. 3v6. 3v9. 4v3. 4v7. 5v6. 6v2. 6v8. 8v2. 10v. 11v. 12v. 15v. 18v. 27v. 33v.
2.5WT BZX70, etc. 13p
v75. 1v. 2v4. 3v6. 3v9. 5v6. 6v2. 7v. 7v5. 8v. 9v. 10v. 11v. 14v. 15v. (8p). 20v. 22v. 24v. 26v.
5WT BZV40, etc. 15p
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10WT Z5D, ZX. etc. 20p
4v3. 4v7. 5v1. 5v6. 6v2. 6v8. 7v5. 8v2. 11v. 12v. 13v. 16v. 18v. 21v. 22v. 33v. 36v. 39v. 68v. 150v.
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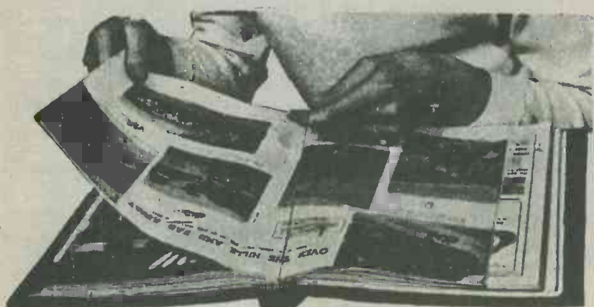

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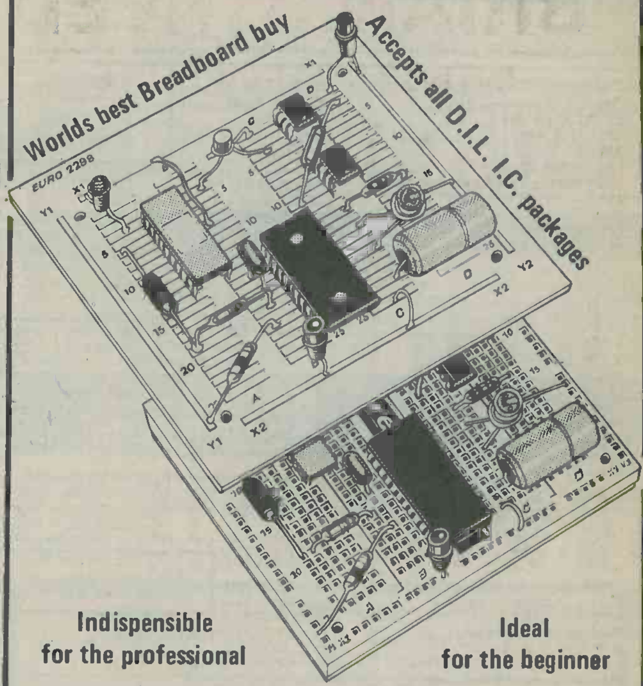

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50.	.022/250v	10	3p	58.	.68/100v	15	15p	61.	2.2/100	22	25p
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70.	BAX13	75mA 50v	1p	78.	0A90	10mA 30v	5p	86.	IN4151	150mA 75v	2p
71.	BAX16	200mA 150v	4p	79.	0A91	50mA 115v	7p	87.	IN5404	3A 400v	10p
72.	BAY38	115mA 50v	4p	80.	0A200	80mA 50v	6p	88.	IN5407	3A 800v	12p
73.	BY126	1A 650v	7p	81.	IN914	75mA 100v	2p	89.	IS923	200mA 200v	2p
74.	BY127	2A1250v	11p	82.	IN916	75mA 100v	2p				
75.	BY206	400mA350v	20p	83	IN4002	1A 100v	2p				

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BZX61/85C IW3 5%

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ICs CMOS DIL 40 – – N BUFF / MROLA. NATIONAL, RCA AND TEXAS

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122	01		141	23	
123	02		142		24
124		06	143	25	
125	07		144		26
126		08	145	27	
127		09	146		28
128		10	147		29
129	11		148	30	
130	12		149		35
131		13	150		41
132		14	151		42
133		15	152		43
134		16	153		44
135		17	154		46
136		18	155		47
137		19	156	49	
138		20	157	50	
139		21	158	99	
			159	TAA550C 10p	

ICs dual DIL: 118 556 (14) 60p; 119 747 (14) 30p
QUAD DIL: 120 324 (14) 60p

ICs TTL DIL 74 – – N / FCHILD NAT SIGNETICS

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161	01		185			41
162	02		186		42	
163	03		187			45
164	04		188		46	
165	05		189			47
166		06	190			48
167		07	191	50		
168	08		192	51		
169	09		193	53		
170	10		194	54		
171	11		195		60	
172		13	196		70	
173		14	197	72		
174		16	198		73	
175		17	199	H74T only		
176	20		200		76	
177		23	201			83
178		25	202			85
179		27	203		86	
180	30		204			90
181		32	205		93	
182		37	206			157
183		38	207			157

ICs 74LS – – N

ITEM	16p
208	00
209	01
210	02
211	03
212	04
213	08
214	10
215	15
216	27
217	51
218	73

74S – – N

ITEM	24p
219	00
220	02
221	04
222	08
223	10

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228 BT106	1	700	70p	230 2N4444	5	600	90p	232 2N5062	.25	100	18p
229 C106D	2.4	400	35p	231 2N5061	.25	60	12p				

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TRANSISTORS

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	Case	VC EO	POL	IC Max mA	P Tot mW	FT Min MHz
234 BC134	TO106	45	N	200	200	200
235 BC147	SOT26	45	N	200	350	150
236 BC148	SOT25	30	N	200	350	150
237 BC149	SOT25	30	N	200	350	150
238 BC157A	SOT25	45	P	200	350	130
239 BC158A	SOT25	30	P	200	350	100
240 BC159A	SOT25	30	P	200	350	100
241 BC171B	TO92	45	N	200	300	100
242 BC172B	TO92	25	N	200	300	100
243 BC182A	TO92	50	N	200	300	150
244 BC183A	TO92	30	N	200	300	150
245 BC184	TO92	30	N	200	300	150
246 BC212B	TO92	50	P	200	300	200
247 BC213B	TO92	30	P	200	300	200
248 BC214B	TO92	30	P	200	300	200
249 BC237A	TO92	45	N	100	625	150
250 BC337	TO92	45	N	800	625	60
251 BC447	TO92	80	N	200	625	100
252 BF393	TO92	300	N	500	625	50
253 TIS90	TO92	40	N	800	625	100
254 TIS91	TO92	40	P	800	625	100
255 2N3702	TO92	25	P	200	360	100
256 2N3704	TO92	30	N	800	360	100
257 2N3706	TO92	20	N	800	625	100
258 2N3711	TO92	30	N	30	360	100

all at 9p each

	Case	VC EO	POL	IC Max mA	P Tot mW	FT Min MHz
259 BC107	TO18	45	N	100	300	150
260 BC107B	TO18	45	N	100	300	150
261 BC108	TO18	20	N	100	300	150
262 BC108B	TO18	20	N	100	300	150
263 BC109	TO18	20	N	100	300	150
264 BC109C	TO18	20	N	100	300	150
265 BC177	TO18	45	P	150	300	130
266 BC178	TO18	25	P	150	300	100
267 BC261A	TO18	45	P	100	300	100
268 BC477	TO18	80	P	150	360	100
269 BC478	TO18	50	P	150	360	100
270 BC479	TO18	40	P	150	360	100
271 70B	TO18	40	P	200	350	250
272 71C	TO18	45	P	200	350	300
273 72Y	TO18	25	P	200	350	200
274 2N706	TO18	15	N	200	300	200
275 2N3903	TO92	40	N	200	310	250
276 2N3904	TO92	40	N	200	310	250
277 2N3905	TO92	40	P	200	310	
278 2N3906	TO92	40	P	200	310	250

all at 19p each

	Case	VC EO	POL	IC Max mA	P Tot mW	FT Min MHz
279 AC107		15	P	10	80	1
280 AC127	TO1	12	N	500	340	1.5
281 AC128	TO1	16	P	1A	267	1
282 AC141B	TO1	15	N	1A2	1W	1
283 AC142	TO1	20	P	1A2	720	1
284 AC153	TO1A	18	P	2A	1W	1.5
285 AC176	TO1	20	N	1A	1W	1
286 AC187	TO1	15	N	2A	1W	1
287 AC188	TO1	15	P	2A	1W	1
288 BC140	TO39	40	N	1A	3W7	50
289 BC141	TO39	60	N	1A	3W7	50
290 BC142	TO39	60	N	1A	800	40
291 BC143	TO39	60	P	1A	800	100
292 BC300	TO39	80	N	1A	850	60
293 BC461	TO39	60	P	2A	1W	50
294 BD135	TO126	45	N	1A	12W	50
295 BD136	TO126	45	P	1A	12W	50
296 BF258	TO39	250	N	100	800	65
297 BF337	TO39	226	N	100	800	80
298 BFX29	TO5	60	P	600	600	100
299 BFX85	TO39	60	N	1A	800	50
300 BFY50	TO5	35	N	1A	800	60
301 BFY51	TO6	30	N	1A	800	50
302 BFY52	TO5	20	N	1A	800	50
303 BSX20	TO18	15	N	500	360	500
304 OC71	– –	20	P	10	125	.3
305 OC76	– –	32	P	125	125	.1
306 TIP29A	TO220	60	N	1A	30W	3
307 TIP31A	TO220	60	N	3A	40W	3
308 TIP32A	TO220	60	P	3A	40W	3

all at 19p each

	Case	VC EO	POL	IC Mac mA	P Tot mW	FT Min MHz
309 2N696	TO5	40	N	500	500	40
310 2N698	TO5	60	N	500	800	40
311 2N930	TO18	45	N	30	300	30
312 2N1613	TO5	50	N	600	800	80
313 2N1711	TO5	50	N	600	800	70
314 2N1890	TO5	60	N	600	800	60
315 2N2218	TO5	30	N	800	800	250
316 2N2219	TO5	30	N	800	800	250
317 2N2221	TO18	30	N	800	500	250
318 2N2222	TO18	30	N	800	500	250
319 2N2905	TO5	40	P	600	600	200
320 2N2906	TO18	40	P	600	400	200
321 2N2907	TO18	40	P	600	400-	200
322 2N3011	TO18	12	N	200	360	400
323 2N3053	TO5	40	N	700	1W	100
324 2N3638	TO105	25	P	500	300	100
325 2N3947	TO18	40	N	200	360	300
326 2N5550	TO92	140	N	600	310	100

all at 29p each

	Case	VC EO	POL	IC Mac mA	P Tot mW	FT Min MHz
327 AC153K		18	P	2A	1W	1
328 AD161	SO55	20	N	1A	4W	1
329 AD162	SO55	20	P	1A	6W	1
330 AF139	TO72	15	P	10	60	275
331 BD115	TO39	180	N	150	6W	80
332 BD116	TO3	60	N	3A	10W	–
333 BD131	TO126	45	N	3A	11W	60
334 BD132	TO126	45	P	3A	11W	60
335 BD176	TO126	45	P	3A	30W	3
336 BD232	TO126	300	N	150	11W	10
337 BD236	TO126	60	P	2A	25W	3
338 BD238	TO126	100	N	2A	25W	3
339 BF459	TO126	300	N	100	6W	40
340 BSX29	TO18	12	P	200	360	
341 OC45		15	P	10	83	4
342 TIP41A	TO220	60	N	6A	65W	3
343 TIP42A	TO220	60	P	6A	66W	3
344 TIP3055	TOP3	70	N	15A	90W	3
345 2N3019	TO3	80	N	1A	800	100
346 2N5320	TO39	75	N	2A	1W	50
347 2N5322	TO39	75	P	2A	1W	50

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	Case	VC EO	POL	IC Mac mA	P Tot mW	FT Min MHz
348 ACY17	TO5	32	P	500	260	1
349 ACY18	TO5	30	P	500	260	1
350 ACY22	TO5	15	P	500	260	1
351 ASY27	TO5	15	P	200	150	6
352 BCY33	TO5	25	P	100	250	.25
353 BD112	TO3	60	N	12A	20W	3
354 TIP47	TO220	250	N	1A	40W	10
355 TIP110	– –	60	N	2A	50W	–
356 TIP115	– –	60	P	2A	50W	–
367 TIP2955	TOP3	60	P	15A	90W	3
358 2N1304	TO5	20	N	300	150	4
359 2N1305	TO5	20	P	300	150	4
360 2N1308	TO5	15	N	300	150	12
361 2N1309	TO5	15	P	300	150	12
362 2N3054	TO66	60	N	4A	25W	.75
363 2N3055	TO3	60	N	15A	115W	.2
364 2N3440	TO5	250	N	1A	1W	15

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	Case	VC EO	POL	IC Mac mA	P Tot mW	FT Min MHz
366 BCY34	TO5	25	P	100	250	.25
367 BCY39	TO39	60	P	250	410	.45
368 BDY55	TO3	60	N	15A	115W	10
369 BSW67	TO39	120	N	1A	800	40
370 BSW68	TO39	150	N	1A	800	40
371 BU126	TO3	300	N	5A	30W	4
372 BU208	TO3	700	N	7.5A	12W	3
373 BUY87	TO3	150	N	7A	82W	45
374 OC28	TO3	60	P	8A	30W	.2
375 2N3442	TO3	140	N	10A	117W	.5
376 2N6385	TO3	80	N	10A	100W	20

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	Case	VC EO	POL	IC Mac mA	P Tot mW	FT Min MHz
377 BU102	TO3	150	N	7A	50W	
378 BU113	TO3	–	N	10A	63W	3
379 2N3773	TO3	140	N	30A	150W	.2
380 2N4358	TO5	240	P	100	700	40

FETS: 381 2N5457 18p; 382 2n5459 18p
PUTs: 383 BRY39 36p; 384 2n6028 12p
TRIODES: 385 MCR106-8 24p; 386 2n4991 72p
UJTs: 387 2n2646 54p; 388 2n2647 72p
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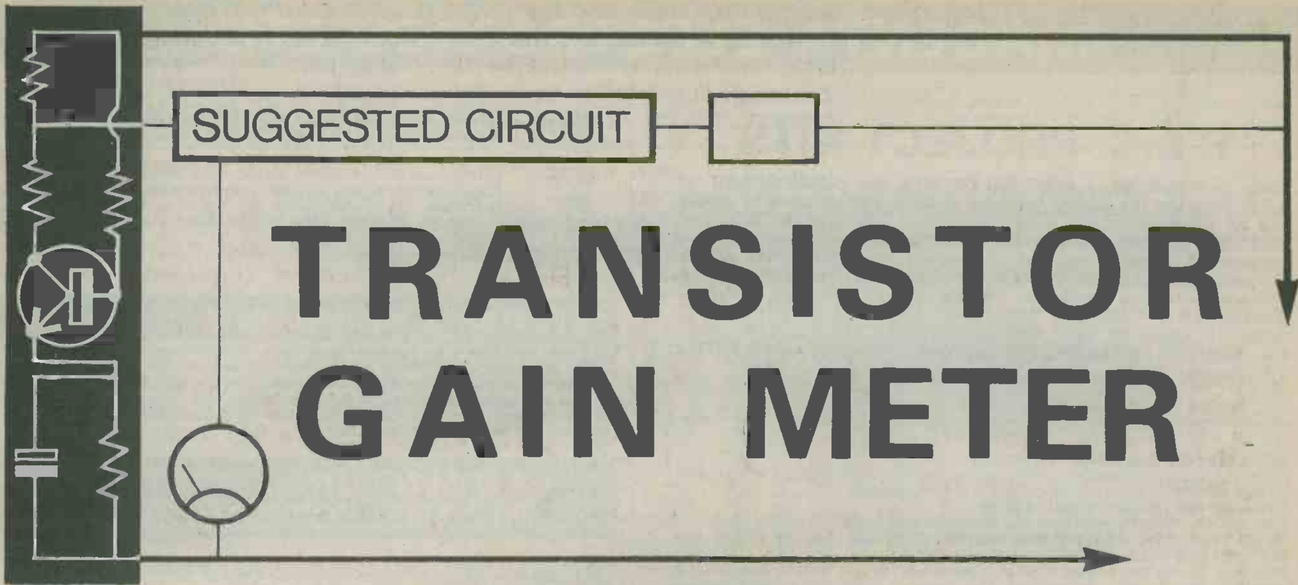


TRANSISTOR GAIN METER

By G. A. French

The instrument described in this article is intended to measure the hFE, or d.c. current gain, of n.p.n. or p.n.p. transistors. The measurement range is from 30 to 1,000 times, and readings are taken at a collector current of slightly more than 10mA. Since a transistor gain meter is not normally used extensively in the amateur workshop, care has been taken to keep the component count low without sacrificing accuracy. The circuit requires one voltmeter for transistor gain evaluation, and this can be any multimeter, set to a low d.c. volts range, which is connected to the gain meter when required. Thus, no expensive meter movement is permanently tied up with the instrument.

The gain meter is primarily intended for checking silicon transistors, although it can also be employed with the now obsolescent germanium types. The description of the circuit assumes that it is silicon transistors which are being checked.

BASIC CONFIGURATIONS

To understand how the meter functions, let us first examine the circuit of Fig. 1 (a). In this a p.n.p. silicon transistor is connected as an emitter follower, with the emitter current flowing through resistor RA. The voltmeter monitors the voltage across this resistor. Base bias for the transistor is applied via the variable resistor RB, and the circuit is powered by a 5 volt stabilized supply.

As the resistance inserted into circuit by RB is reduced, the transistor base current increases as also does the amplified emitter current and the voltage dropped across RA. If RB is adjusted so that the voltage across RA (as indicated by the voltmeter) is equal to 2.2 volts, the situation shown in Fig. 1(b) is set up. Here, 2.2 volts appear across RA with approximately 0.6 volt being dropped across the base-emitter junction of the transistor. The remaining 2.2 volts must then appear across RB. Since the same voltage appears across RA and RB, the currents flowing in them are inversely proportional to their values. Thus, if RB inserts a resistance which is 100 times the value of RA, the current flowing in RA is 100 times the current flowing in RB and the transistor has a base-to-emitter current gain of 100 times.

The circuit of Fig. 1(b) makes it possible to measure the base-to-emitter current gain of any small p.n.p. silicon transistor. After the transistor has been connected into the circuit, RB is adjusted until the voltmeter reads 2.2 volts. The gain is then found from a previously calibrated scale fitted behind the control knob of RB.

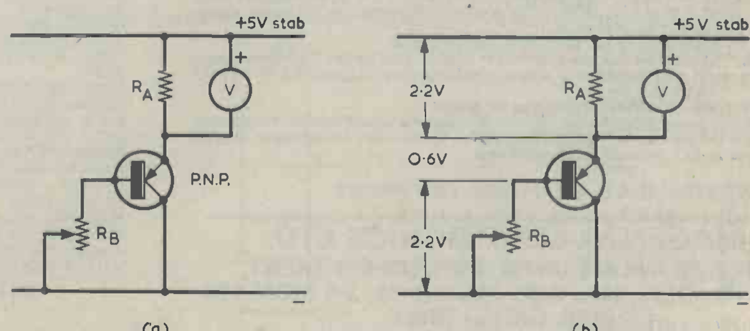


Fig. 1(a). A circuit which is capable of evaluating the base-to-emitter current gain of a p.n.p. silicon transistor.
(b). If RB is ajusted for a reading of 2.2 volts in the voltimeter, the voltage distribution in the circuit is as shown here.

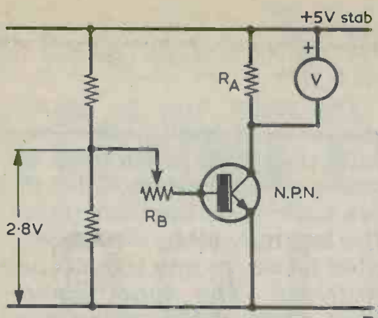


Fig. 2. This circuit can be used to measure the base-to-collector gain of a silicon n.p.n. transistor. RB is adjusted for an indication of 2.2 volts in the voltmeter, and this voltage also appears across RB.

The base-to-emitter current gain is not precisely the same as hFE, which is the base-to-collector current gain, because the emitter current is the sum of the collector and the base currents. However, the base current is very much smaller than the collector current and little error is introduced, particularly at the higher gain figures, if its presence is ignored. The circuit of Fig 1(b) can in consequence be looked upon as a practical arrangement capable of assessing the hFE of a p.n.p. transistor.

To ease polarity switching requirements, it is desirable to have a basic circuit very similar to that of Fig 1(b) for the evaluation of n.p.n. transistors. This circuit is shown in Fig. 2, where the emitter of the n.p.n. transistor is connected to the negative rail and the collector is connected to RA. RB is not now returned to the negative rail but connects instead to a potential divider which offers a voltage which is 2.8 volts positive of the negative rail. The standing current flowing through the two potential divider resistors is very much higher than any current which is likely to be drawn by RB, and so the 2.8 volt point may be considered as having virtually the same level of voltage stabilization as has the 5 volt positive rail.

As with Fig. 1(a), RB is again adjusted so that the voltage across RA is 2.2 volts. Since about 0.6 volt is dropped across the base-emitter junction of the transistor, the voltage across RB will then also be 2.2 volts. The base-to-collector current gain will be equal to the resistance inserted by RB divided by the resistance of RA, and the gain calibration given to RB for Fig. 1(b) will be equally applicable to the gain measuring circuit of Fig. 2.

COMPLETE CIRCUIT

The two basic circuits of Fig. 1(b) and Fig. 2 are combined in the complete working circuit of Fig. 3. RA now appears as the 200Ω resistor, R4, and the voltmeter connected across it is a multimeter plugged into sockets SK4 and SK5. RB is replaced by R3 in series with VR1 or VR2 according to the position of switch S2. When S2 is in position "1", VR1 is in circuit and provides current gain readings from 30 to 100 times. A gain of 30 is indicated when R3 plus the resistance inserted by VR1 is equal to 30 times 200Ω, or 6kΩ. A transistor current gain of 100 is indicated when R3 and VR1 insert 100 times 200Ω, or 20kΩ. Setting S2 to position "2" allows gain measurements from 100 to 1,000, these figures corresponding to resistances in R3 plus VR2 of 20kΩ and 200kΩ respectively.

The potential divider of Fig. 2 is given by R1 and R2. These are connected in series when S1 is set to "N.P.N." and the voltage at their junction calculates at almost exactly 2.8 volts positive of the negative rail. The standing current in the potential divider is 18.5mA.

Putting S1 to "P.N.P." opens the potential divider circuit and returns R3 to the negative rail, to give the same circuit conditions as existed in Fig. 1(b). S1 provides the only polarity switching required. Further polarity changes are automatically given at the three test sockets. An n.p.n. test transistor has its collector connected to SKI and its emitter to SK3, whilst a p.n.p. test transmitter has its emitter connected to SK1 and its collector to SK3. With both transistor types, the base connects to SK2.

Since R4 has a value of 200Ω, the collector or emitter current which flows in this resistor after VR1 or VR2 has been adjusted for the voltage reading of 2.2 volts is 11mA.

R3 is a current limiting resistor. With S1 in the "P.N.P." position, a combination of possible short-circuits in the test connections at SK1 and SK2, and at SK4 and SK5, could cause the full 5 volts of the supply to appear across R3 and VR1 or R3 and VR2. The more vulnerable component here is VR2. This is a standard ½ watt potentiometer, and the current which flows through its track must not exceed 1.5mA. R3 ensures that the maximum possible current which can flow is 5 volts divided by 3.9Ω, or 1.3mA.

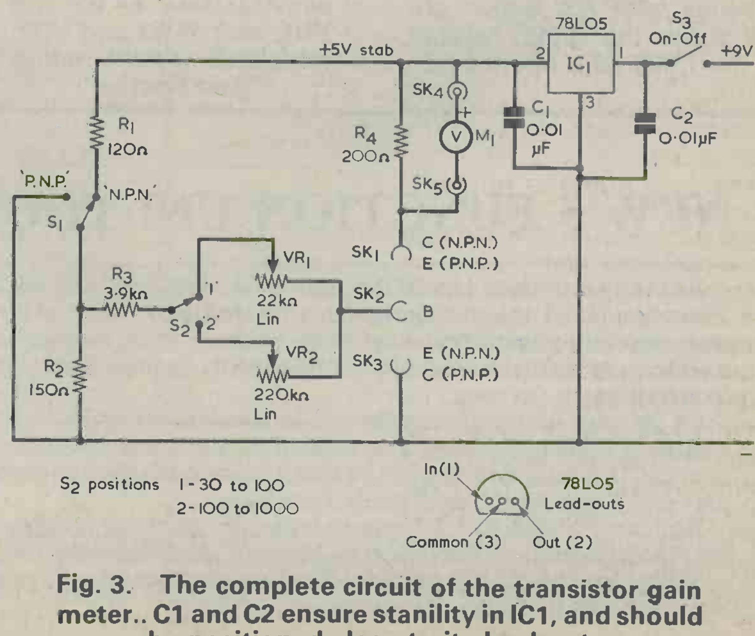


Fig. 3. The complete circuit of the transistor gain meter.. C1 and C2 ensure stanility in IC1, and should be positioned close to its lead-outs.

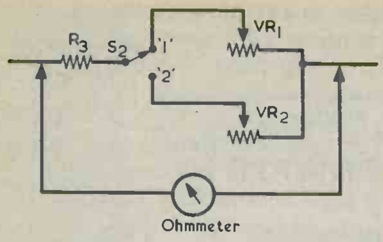


Fig. 4. VR1 and VR2 are calibrated for gain figures by connecting an ohmmeter into the circuit in the manner illustrated here.

CALIBRATION

VR1 and VR2 are calibrated by connecting an ohmmeter as shown in Fig. 4, and setting S2 to position "1" or position "2" for each range. No power is applied to the gain meter and no connection is made to SK2. Temporary scales are fitted behind the potentiometer knobs, which must of course be pointer types, and these are marked up with gain figures corresponding to the resistances indicated by the charts in Fig. 5. VR2 will normally have a tolerance on value of 20% and if it is at or very close to the minimum value within tolerance it may not be possible to obtain a calibration for gain figures above 900. However the probability, in practice, will be that most potentiometers likely to be encountered will provide resistances, in series with R3, which are well above the 200kΩ needed for the 1,000 gain figure calibration.

COMPONENTS

All the components are readily obtainable. As already mentioned, VR2 is a standard sized potentiometer rated at ½ watt. VR1 is a similar type of potentiometer. All three switches are toggle types. The fixed resistors are ¼ watt 5% components. A slight increase in accuracy will, however, be given if R4 is 2% or 1%, rather than 5%. IC1 is a standard 78LO5 voltage regulator with a maximum rating of 100mA. In the inset view of its lead-outs in Fig. 3 the lead-outs are pointing towards the reader.

The current consumption from the 9 volt supply is equal to the emitter current of the test transistor when S1 is set to "P.N.P.". To this current is

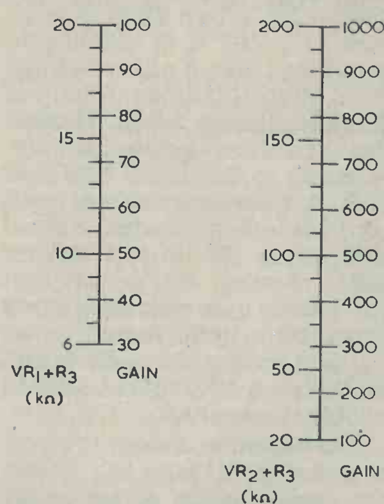


Fig. 5. Charts showing resistance in the series combinations of R3 and VR1, and of R3 and VR2, with the corresponding gain figures.

added the 18.5mA flowing in R1 and R2 when S1 is put to "N.P.N.".

The tester may be assembled in any small plastic case with the three switches, the two potentiometers and the five sockets on the front panel. The last may all be 4mm. insulated types, or any other types preferred. The most convenient method of making connections to the test transistors will be given by three short flexible leads, plugging into SK1, SK2 and SK3, these leads being terminated in miniature crocodile clips with vinyl sleeves.

When the gain meter is to be used, a multimeter is connected to SK4 and SK5 and is switched to a suitable low d.c. volts range. The test transistor is connected to SK1, SK2 and SK3, and S1 is put to the transistor polarity applicable. Both VR1 and VR2 should be at their maximum gain figure settings. S2 is set to position "2" and S3 is then closed to apply power. The resistance inserted by VR2 is slowly reduced until the multimeter indicates 2.2 volts, whereupon the transistor gain figure is read from the scale at VR2. If the gain is lower than 100 times, S2 is put to position "1" and the process repeated with VR1.

The gain meter is primarily intended for silicon transistors. It can give results which are nearly as accurate with germanium transistors but, in this case, VR1 and VR2 are adjusted for a reading of 2.5 volts in the meter. ■

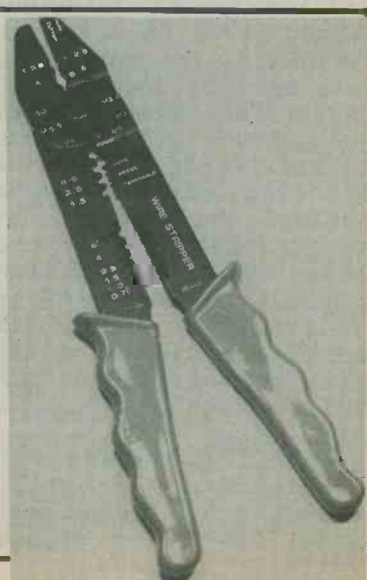
NEW 5 FUNCTION UNI-TOOL

Recently introduced by BOSS Industrial Mouldings Ltd is a new 5 function Uni-Tool which although orintated to the needs of power and automotive electrical engineers working both in-house and on-site is, nevertheless, equally useful to most engineers and 'Do It Yourselfers.

Of primary importance is the spade terminal crimping facilities where, by utilising 2 separate sections of the tool both the conductor wire and the outer sleeving can be firmly crimped to the appropriate part of all commonly used spade terminals.

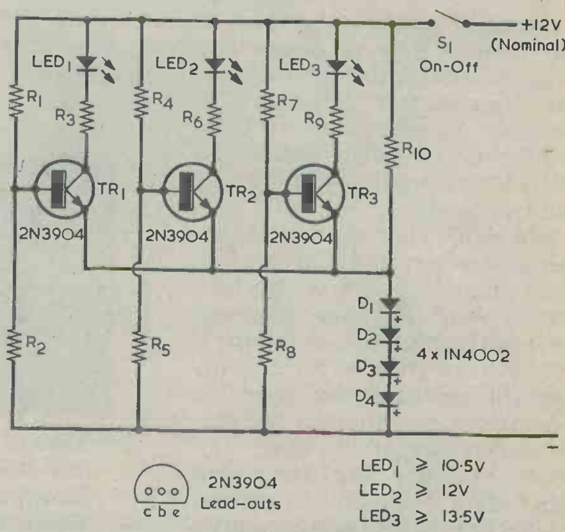
Both wire cutting and 0.75mm to 6mm wire stripping facilities are also incorporated, as are M2.6 to M5 bolt shearing capabilities.

Selling for only £2 this new Uni-Tool is a must for all self respecting engineers tool kits.



CAR VOLTAGE MONITOR By I. Peterson

This low cost unit has simple and robust circuitry, and is thereby well fitted for installation in a car. Its function is to monitor the battery voltage in 12 volt systems and it does this by means of three light-emitting diodes. When no diode is illuminated, the battery voltage is below 10.5 volts. One diode lit up indicates a voltage of 10.5 volts or more, two diodes a voltage of 12 volts or more and three diodes a voltage of 13.5 volts or more. As a result, the car driver can tell at a glance whether his battery is fully charged, whether it is running at nominal voltage and whether its voltage is at or below the discharged level.



The circuit of the battery voltage monitor. Voltage is indicated by the number of l.e.d.'s which are alight.

CIRCUIT OPERATION

The circuit appears in the accompanying diagram, in which the light-emitting diodes are LED1, LED2 and LED3. These diodes are fed by TR1, TR2 and TR3 respectively, the emitters of which are all returned to the stabilized voltage appearing across the forward biased silicon diodes, D1 to D4. The voltage across these diodes under low forward voltage conditions is almost exactly 2.4 volts.

The voltage being monitored is applied to the potential dividers coupling to the transistor bases. Roughly one-quarter of the nominal 12 volts is applied to each base, whereupon the transistors turn on much more abruptly as battery voltage rises than would occur if their emitters were returned direct to the negative rail. In the latter case each potential divider would need to apply approximately 0.6 volt to the base it connects to in order to turn the transistor on. Such a voltage is only one-twentieth of the nominal 12 volts.

VOLTAGE LEVELS

When the battery voltage is below 10.5 volts all of the three transistors are turned off and no l.e.d. is alight. If the battery voltage rises to 10.5 volts the voltage applied to TR1 base by way of R1 and R2 is just sufficient to turn on the transistor, and LED1 commences to glow. It stays illuminated at all higher voltages. The values of R4 and R5 allow TR2 to turn on at a battery voltage of 12 volts, whereupon LED2 lights up at this and higher voltages. R7 and R8 cause TR3 to turn on at 13.5 volts, with the result that all three l.e.d.'s are then alight.

The voltage across D1 to D4 increases by about 0.2 volt as each l.e.d. is turned fully on, and this fact is reflected in the resistor values specified for the potential dividers. With the prototype circuit each l.e.d. becomes illuminated at precisely the voltage ascribed to it, as accurately as can be judged with an analogue voltmeter.

All the components are standard types. Resistors with a tolerance of 5% will be accurate enough for practical requirements. The 7.5kΩ resistor required for R4 may only be available in ½ watt from some suppliers, and it is, of course, perfectly in order to use the higher wattage resistor. The three l.e.d.'s should be red or "extra bright" types.

COMPONENTS

Resistors
(All ¼ watt 5%)

R1	6.8kΩ	R6	1.5kΩ
R2	2.7kΩ	R7	6.8kΩ
R3	1.5kΩ	R8	2.2kΩ
R4	7.5kΩ	R9	1.5kΩ
R5	2.7kΩ	R10	4.7kΩ

Semiconductors
TR1–TR3 2N3904
D1–D4 1N4002
LED1–LED3 see text

Switch
S1 s.p.s.t. toggle

The unit couples into the car electrical system at any convenient point. With no l.e.d. alight the standing current is of the order of 4 to 6mA, and it increases by about 5mA as each l.e.d. becomes illuminated. Such currents are negligible when compared with those normally provided by a car battery.

To prevent short-circuits to the car metalwork the unit should be completely enclosed in a small plastic case, this being situated at a convenient point in front of the car driver. On its front panel are mounted the three l.e.d.'s and the on-off switch. When not in use, the monitor can be turned off by means of the switch.

NEWS . . . AND

TELETEXT ADAPTOR RECEIVES DEPARTMENT OF INDUSTRY SUPPORT

Actual production samples of the Teletext Adaptor shown and demonstrated at the Viewdata 80 exhibition by Ayr Viewdata Ltd, Surbiton, Surrey, have now been produced for distribution to selected organisations in the UK and overseas.

Mr. H. O. Thomas, Ayr's Managing Director, said that this had been made possible by the enthusiastic support received from the Department of Industry. "They have given every encouragement and assistance in getting this British invention to the pre-production stage," he said.

Mr. Thomas explained that although a reduction in picture quality is expected when using an adaptor, this has been shown to be of a very minor, hardly discernible degree when using the Ayr adaptor.

The unit is compatible with most modern television receivers, which are automatically converted to remote control operation by means of the hand held infra-red key pad used for remote operation of the adaptor. It will enable viewers with standard TV sets to take full advantage of the written-word information services provided by the BBC1 and BBC2 Ceefax and ITV Oracle systems. Of particular help to the hard of hearing, these systems will give general news, stock exchange prices, financial information, weather forecasts, travel and other special interests.

When in production, the Ayr Teletext Adaptor is expected to have a retail price tag of not more than £150, including VAT.

One of the production samples of the Ayr Teletex Adaptor being demonstrated to Mr. I. Sibbick (centre) of the Computer Systems & Electronics Division of the Department of Industry, AT Ayr Viewdata's factory in Dartford. With him are (left) Mr. H. O. Thomas, Managing Director and (right) Mr. Peter Kidd, the well-known electronic consultant, who has been responsible for the basic engineering of the unit.

HIPFI – THE HI-FI AT YOUR HIP

Selfridges at their Oxford Street Store have the exclusive selling rights for a new product from Binatone International. As far as is known there is only one other such product on the market.

While you can carry around a portable radio or stereo it is very difficult to get true hi-fi reproduction. The problem is resolved with Hipfi, which can be worn as shown in the photograph.

The unit includes a leatherette carrying case, shoulderstrap, spare cassette pouch, batteries, featherlight hi-fi stereo headphones and even a pre-recorded demonstration tape for instant music.

Full facilities including separate volume controls for each channel, a tone control, facility for add-on second headphones (optional extra), fast forward and rewind with cueing and reviewing facility for locating the required piece of music.

The entire unit weighs 390 grms and while 3 alkaline pencil batteries will provide approximately 8 hours of music – it has facilities for an add-on mains adaptor (optional extra) for use at home.

It has a talk-line whereby simply pressing a button switches the listener to the outside world so he can converse with others without having to remove the headphones.

. . . COMMENT

IBA's small-dish digital-video satellite first

The first successful transmission of digital-video colour television pictures through a European space satellite using compact small-dish terminals at both ends of the link has been achieved at the IBA Engineering Centre at Crawley Court, Winchester.

This follows experiments earlier this year in which the IBA small-dish receive terminal was used to receive digital video signals transmitted from British Telecom's large 14 GHz space terminal at Goonhilly Downs, Cornwall.

The new series of experiments, again carried out with the co-operation of British Telecom and the European EUTEL-SAT organisation, passed digital signals through the 120-MHz-bandwidth transponder on the OTS satellite launched in May 1978.

The digital test signals, using the IBA-developed experimental 60Mbit/s digital encoder-decoder, were sent and received at Crawley Court, using the 14 GHz 2.5-metre dish 'up-link' terminal (about 1.5 kW transmitter power) and the 3-metre dish receive-terminal.

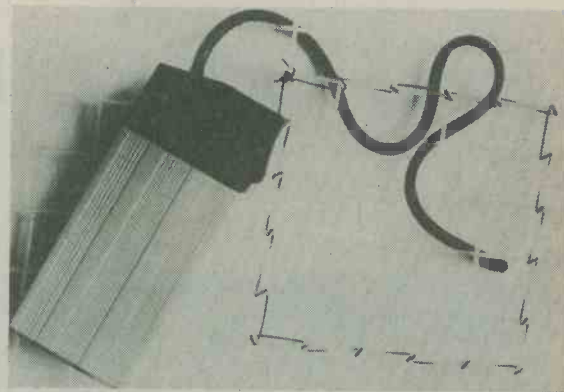
During preliminary tests using pseudo-random digital signals error rates of the order of only one error in each 10-million bits were recorded. When 625-line colour television pictures were transmitted through the system no degradations, other than those inherent in the experimental 60Mbit/s digital system, could be observed.

For these experiments, a conventional 625-line analogue television picture was encoded and transmitted through the 120MHz-bandwidth OTS transponder using a bandwidth of some 40MHz and modulated by means of quadrature phase-shift keying. The pictures were initially sampled at four times the frequency of the colour sub-carrier (142Mbit/s) and then digitally converted to the equivalent of twice sub-carrier frequency sampling (71 Mbit/s). This data rate is then further reduced by means of bit-reduction techniques including the use of differential pulse code modulation and, when error-protection and 'house-keeping' bits are added the system has a bit rate of 60Mbit/s.

The digital sampling rate and techniques used in these trials are for experimental purposes only and are not being proposed as an international standard. The IBA work however is showing that digital-video transmission would have useful advantages for news-gathering and national and international distribution links via space satellites.

SEASONAL GREETINGS TO ALL OUR READERS

FIBRE OPTIC LIGHT 'SEES' ROUND CORNERS



Edward Fletcher and Partners have announced a new, British-made, Light Probe.

Comprising a small hand-held torch and a 9" long, 3mm. diameter, flexible Fibre Optic Light Guide, the Light Probe can be used for illumination and inspection in inaccessible areas, or wherever a direct light source will not penetrate. By using Fibre Optics, the light from the torch is transmitted along the fibres and can be 'bent' round corners as required. If necessary, the Fibre Optic Light Guide can be detached and the torch used in the conventional manner.

The Light Probe also makes an ideal gift or novelty item for Christmas for adults, or children, as an introduction to the new technology of Fibre Optics. A small magnet can be attached to the end of the Light Guide for retrieval of metal objects in hard-to-reach places.

Only available from the manufacturers:-

Edward Fletcher & Partners, 25 West Park Road, Kew, Richmond, Surrey TW9 4DB. The price of the Light Probe is under £2.00.

Broadcast Training and Services Ltd of 2 Hills Road, Cambridge, have recently completed Sound Reinforcement Systems for both the Chapel and Hall of St John's College, Cambridge and for Chelmsford Cathedral.

In St John's, loudspeakers were successfully camouflaged so that they are virtually invisible in the context of the gilded and panelled 16th Century Hall, without impairing the high quality reproduction. Mixing facilities for several microphones and other sources were provided with provision also to record from the system.

The system installed in the very reverberant Chapel makes use of highly directional BTS loudspeakers with three circuits so that the sound always appears to come from the person speaking even when the speaking points are widely separated. The directional properties are important to prevent the excitation of unwanted reverberation and the sound coverage achieved varies by less than 2 dB throughout the listening areas.

A similar approach has been adopted in Chelmsford Cathedral.

EXPERIMENTAL ELECTRONICS

By R. J. Caborn

Tips for the venturesome

Many constructors obtain their pleasure in the successful assembly of projects, following the instructions which are given in this magazine. A growing number like to design their own projects as well, using their knowledge to work out the project circuits, checking out the circuits experimentally and, when a circuit has been proven in practice, assembling it in its final permanent form. The intermediate expermental stage is almost mandatory for all but the simplest circuits; a circuit diagram may look great in theory but there are many pitfalls between that theory and actual practical working. In the theoretical circuit a transistor may be biased incorrectly, there may be a hidden positive feedback route which will cause instability, component values may not be at their optimum and some could even be downright wrong. The list of possible snags which can beset a seemingly perfect theoretical circuit is a long and sorry one.

So the experimental electronic hobbyist (and, incidentally, the professional engineer) carries out the following procedure. First, he works out the initial circuit of the project; second, he checks it out in a quick experimental test mock-up; third, he builds it in its properly constructed permanent form.

EXPERIMENTAL APPROACH

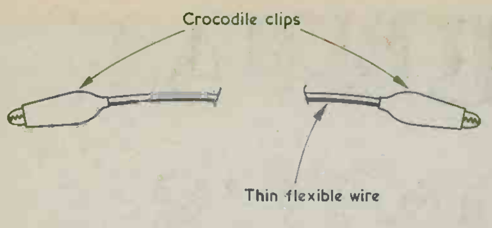
Here are some hints gleamed from those who test new circuits, either professionally or as a hobby.

First, choose the method of experimental assembly. There are two basic approaches here: either use a breadboard having rows of holes with internal contact springs, or use tagboards, tagstrips or other forms of terminal, and solder all connections. With the breadboard most (but not all) soldering processes are eliminated, whilst the second approach means soldering all the way. Assembly with breadboards is 2-dimensoonal, whilst with all-soldering it is 3-dimensional. Veteran experimenters can solder up test circuits very quickly. Provided you don't cut the leads too short, resistors and capacitors can be used over and over in all-soldered hook-ups, just as they can be used over and over again in breadboard layouts.

What are the essentials for experimental working? The first and most obvious is a multimeter. You **have** to know what voltages and currents exist in the experimental hook-up. In many cases we don't insert a meter into circuit to measure current. If the current flows through a known resistance it is usually much quicker to measure the voltage across the resistance and deduce the current from Ohm's Law. With electronics we nearly always have to think in terms of milliamps and microamps. 9 volts across $1k\Omega$ means a current of 9mA; 9 volts across $1M\Omega$ indicates a current of $9\mu A$.

Not essential but very, very useful are crocodile clip leads. The best clips to use are the miniature ones with a clip length of about 35mm. and a flexible vinyl sleeve, as are retailed by Maplin Electronic Supplies and others. Make up some ten of these leads with varying lengths, as in Fig. 1(a). If you are going in for breadboard have half a dozen of the leads with one end of the wire tinned to form a single strand which will plug into one of the breadboard holes. See Fig. 1(b). (**Never** push stranded wire into breadboard holes; there is too great a risk of the strands separating, whereupon they can upset the spring contact action and cause short-circuits.)

It is best to draw your initial circuit on a **large** (*8 by* 10in. or more) notepad or sheet of paper. Use both a blue and a red ball-point pen. The initial circuit is drawn in blue. If it is amended during the experiments, scribble over the unwanted circuit section with red and then draw in the new section in blue. The final, tested, circuit will then be all-blue. Unless you're very familiar with the transistors and other multi-lead devices you are using, draw their pin layouts on the same paper as the initial circuit.



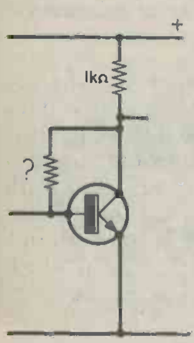
(a)

(b)

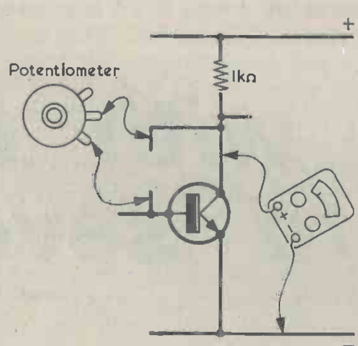
Fig. 1(a). Very useful for experimental work are crocodile clip leads. A range can be made up with wire lengths varying from some 4 to 7in.
(b). One end of the lead can be tinned to form a single strand which can be inserted in a breadboard hole.

FINDING RESISTANCE VALUES

Some component values may have to be finalised in the experimental mock-up. The base bias resistor required in Fig. 2(a) to make the transistor collector sit at exactly half-supply voltage may not be known. One simple way of finding the required value is to use two of the crocodile clip leads to connect to a potentiometer, and adjust this for the required collector voltage, as in Fig. 2(b). The potentiometer is then removed, its resistance measured, and a fixed resistor of that value inserted in the circuit. The collector load in our example is 1kΩ, and a suitable potentiometer value would be 470kΩ linear. A word of caution here: always start with the potentiometer inserting maximum resistance and then reduce that resistance slowly. If the potentiometer inserts too low a resistance an excessive current can flow in its track and it will be damaged. Remember that a potentiometer wattage rating applies to its whole track. The accompanying Table shows maximum permitted track currents for potentiometers of different values and wattage ratings.



(a)



(b)

Fig. 2(a). In an experimental circuit the bias resistor, whose value is unknown, is required to have a value which causes the transistor collector to be at mid-supply potential.
(b). The collector voltage is monitored by a testmeter switched to a volts range, and a potentiometer is coupled into the circuit by two crocodile clip leads. The potentiometer is adjusted for the required collector voltage.

TABLE
Maximum permitted potentiometer track currents (mA)

Resistance	0.25W	0.5W	1W
100Ω	50	70	100
220kΩ	33	47	67
470kΩ	23	32	46
1kΩ	15	22	31
2.2kΩ	10	15	21
4.7kΩ	7.0	10	14
10kΩ	5.0	7.0	10
22kΩ	3.3	4.7	6.7
47kΩ	2.3	3.2	4.6
100kΩ	1.5	2.2	3.1
220kΩ	1.0	1.5	2.1
470kΩ	0.72	1.0	1.4
1MΩ	0.50	0.70	1.0

A pocket calculator can be very useful, and this can be an inexpensive model with the four arithmetic functions, a reciprocal function (1/x), a square function (x^2) and a square root function ($\sqrt{x}$). We tend to get into the habit of using calculators for solving ridiculously simple problems, but this is not all bad as it gets us calculator-oriented for the more complicated ones. Tastes vary, but a good choice is a calculator with a nice bright l.e.d. display and rechargeable facilities, i.e. a socket in the side into which the mains "adaptor" for the calculator can be plugged. L.E.D. display calculators burn up a lot of current but this is no problem when their batteries can be readily recharged from the mains.

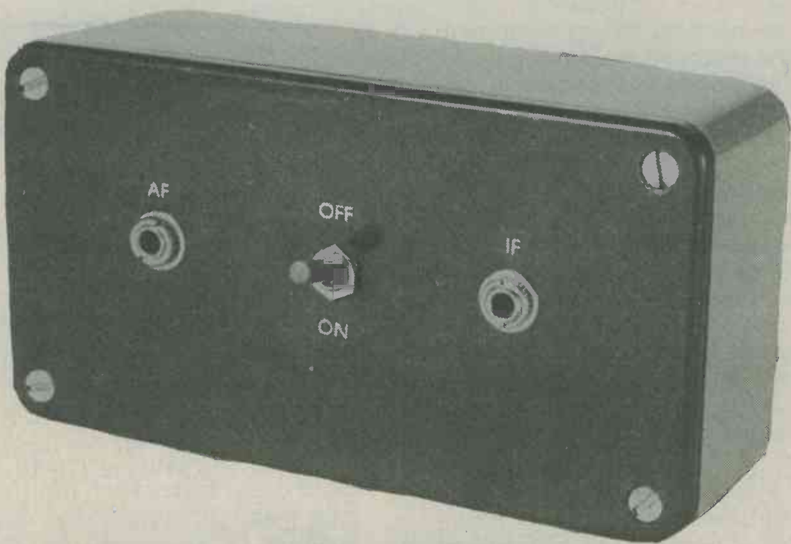
Whether the breadboard or all-soldering approach is used, the resulting experimental assembly will almost certainly look untidy, to say the least. This doesn't matter if it proves the circuit. Longish leads are not normally liable to cause trouble in a.f. or logic circuits but it pays to keep wiring to op-amp non-inverting inputs short and to keep compensating and bypass capacitors close to op-amps, voltage regulators and other i.c.'s.

Even with an experimental circuit there can be hidden snags. You may get a circuit to work fine when it's supplied by a mains power supply, after which it does horrible things when connected to a battery of the same voltage. Reason? The power supply had a fat electrolytic across its output terminals which acted as a supply bypass for the experimental circuit!

There are, of course, many other aspects to be considered when undertaking experimental electronic work, but those which have been covered in this short article make up the basic essentials. There's a lot of fun to be had with expermenting and, once you catch the bug, you'll find yourself learning all the way as you advance in this fascinating branch of electronics. ■

DOUBLE OUTPUT TEST OSCILLATOR

By R. A. Penfold



The test oscillator can be housed in any small plastic case which can accommodate the components

1kHz output with harmonics up to several MHz.

Peaked i.f. output at 470kHz.

Ideal for signal tracing.

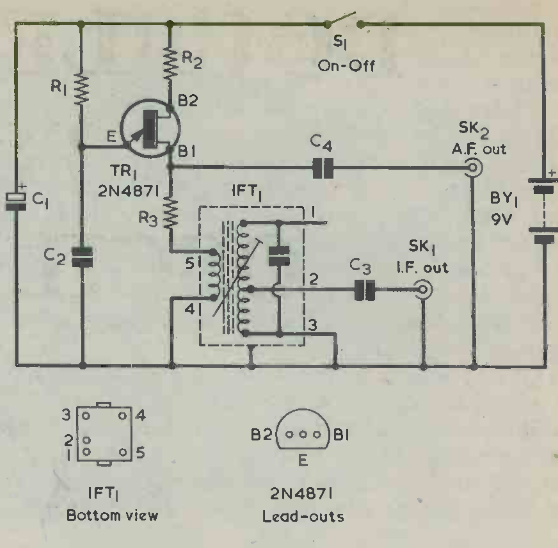


Fig. 1 The circuit of the test oscillator. Despite its simplicity this produces an a.f. output with modulated harmonics up to several MHz as well as a modulated i.f. signal peaked at 470kHz

This very inexpensive item of test equipment can be very useful when troubleshooting audio or radio equipment. It can be used as a wide band signal injector providing an audio tone which is rich in harmonics up to frequencies of a few MHz. It is therefore suitable for checking the r.f. and i.f. stages of a.m. radios as well as audio equipment. It also has an i.f. output at the normal a.m. intermediate frequency of 470 kHz and can be used as an i.f. alignment oscillator for newly constructed a.m. radios or for commercially made radios having this intermediate frequency.

The circuit is very simple and employs only one active device (a unijunction transistor) together with a few passive components. Power is obtained from an internal 9 volt battery, and running costs are low since the current drain is only about 1.5mA.

THE CIRCUIT

In the circuit diagram of Fig. 1, TR1 is the unijunction transistor. This functions in the following manner. At switch-on, capacitor C2 is discharged, and it begins to charge via R1. The transistor presents a resistance between its base 2 and base 1 which allows a small current to flow in R2 and R3. (The winding of IFT1 between R3 and the negative rail has a low resistance, and has little effect on oscillator operation.) When the voltage across the capacitor reaches the triggering level for the transistor a regenerative effect takes place which causes a very low impedance to be given between the emitter and the base 1. The capacitor rapidly discharges into R3. It then commences to charge again via R1 and the voltage across it increases until it once more reaches triggering level and discharges into R3. The circuit continues to oscillate in this manner and causes the appearance of positive-going spikes at the base 1 of the transistor. These spikes are coupled to the a.f. output socket via C4.

The component values in the circuit cause the spikes to have a fundamental frequency of about 1kHz, although this may vary slightly with different unijunction transistors. The a.f. output is very rich in harmonics and produces signals, spaced at the 1kHz fundamental frequency, up to several MHz. If these signals are applied to an a.m. detector, the fundamental frequency is given in the detector output. Thus, the a.f. output can be used for r.f. and i.f. signal injection as well as for audio checking.

COMPONENTS

Resistors
(All ¼ watt 5%)
R1 33kΩ
R2 120Ω
R3 100Ω

Capacitors
C1 10μF electrolytic, 10V. Wkg.
C2 0.022μF type C280
C3 47pF ceramic plate
C4 0.1μF type C280

Inductor
IFT1 i.f. transformer type IFT13-470kHz (Denco)

Semiconductor
TR1 2N4871

Switch
S1 s.p.s.t. sub-miniature toggle

Sockets
SK1 3.5mm jack socket
SK2 3.5mm jack socket

Battery
BY1 9-volt battery type PP3

Miscellaneous
Plastic case (see text)
Veroboard. 0.15 in. matrix
Veropins, single ended, for 0.15in. Veroboard
Battery connector
Test prod
Crocodile clip
3.5mm jack plug
Nuts. bolts. wire. etc.

Although the winding of IFT1 between R3 and the negative rail has little effect on oscillator operation it still allows the current spikes at 1kHz to be coupled into the second winding, which is tuned to 470kHz by the parallel capacitor. This capacitor is an integral part of the i.f. transformer and the tuned circuit filters out the fundamental and harmonics other than those which are at or very close to its resonant frequency. An output is taken from a tap in the tuned winding, to ensure that there is little loading on the resonant circuit, and is coupled to the i.f. output socket via C3. This output can be used for i.f. alignment purposes.

There is only one control in the circuit, this being the on-off switch, S1.

If difficulty is experienced in obtaining the component specified for IFT1, it may be purchased direct from the maker at Denco (Clacton) Limited, 357/9 Old Road, Clacton-on Sea, Essex, CO15 3RH.

ASSEMBLY

Any small plastic case capable of taking the parts may be used to house the oscillator, and that employed by the author had approximate dimensions of 118 by 84 by 38mm. Switch S1 is mounted centrally on the lid, which now becomes the front panel, with SK2 mounted on its left and SK1 on its right. The two sockets are positioned symmetrically on each side of the switch.

Apart from the battery, the remaining components are assembled on a Veroboard of 0.15in. matrix having 11 copper strips by 9 holes. This has to be cut out from a larger board by means of a small hacksaw. The single break in the strips and the two 6BA clear holes are then made at the points indicated in Fig. 2, which shows the component and copper sides.

The first item to be soldered in place is IFT1. This is not mounted directly in the Veroboard holes but has its tags soldered to single-ended Veropins which are first soldered in at holes C6, B4, A5 and A6. Tags 5, 2, 3 and 4, and the can mounting lug between tags 3 and 4 are then generously tinned with solder, after which it will be found they can be easily soldered to the Veropin heads. Note that no connections are

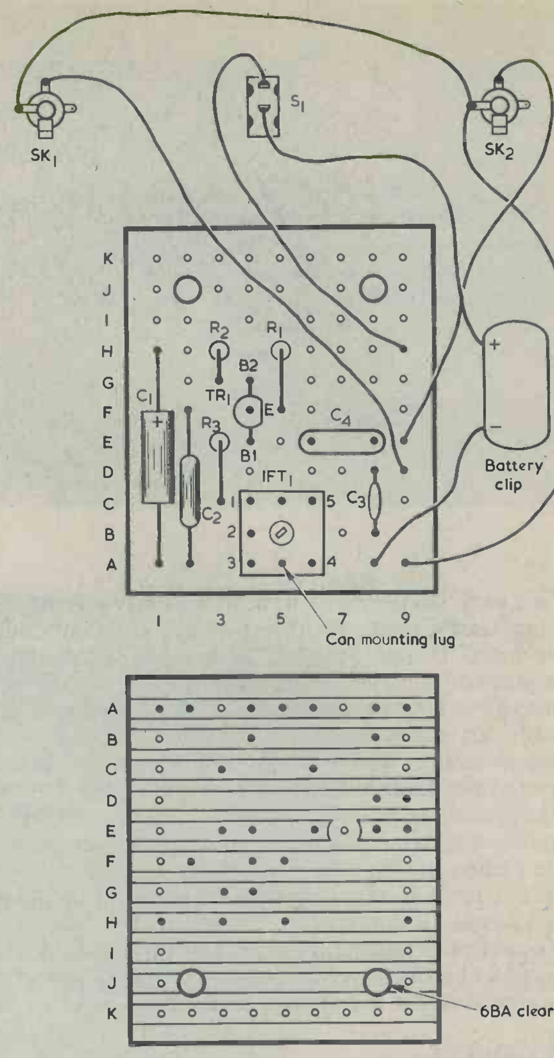
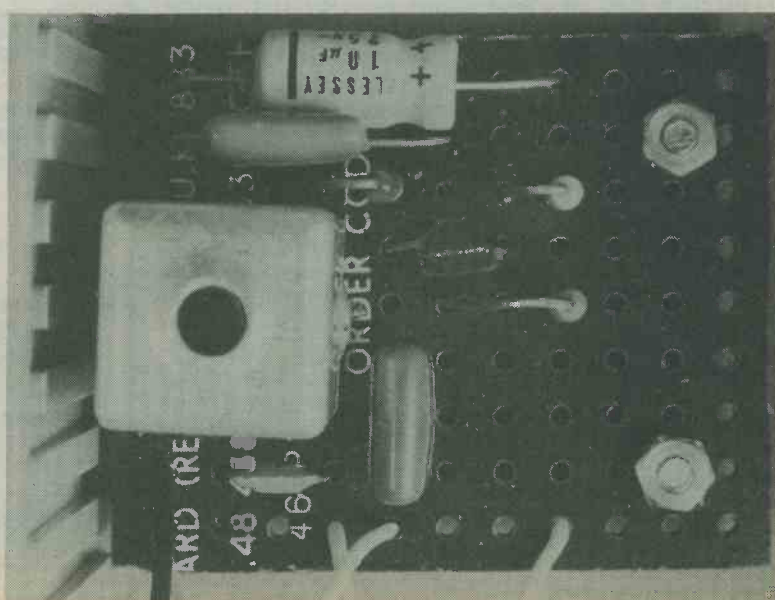
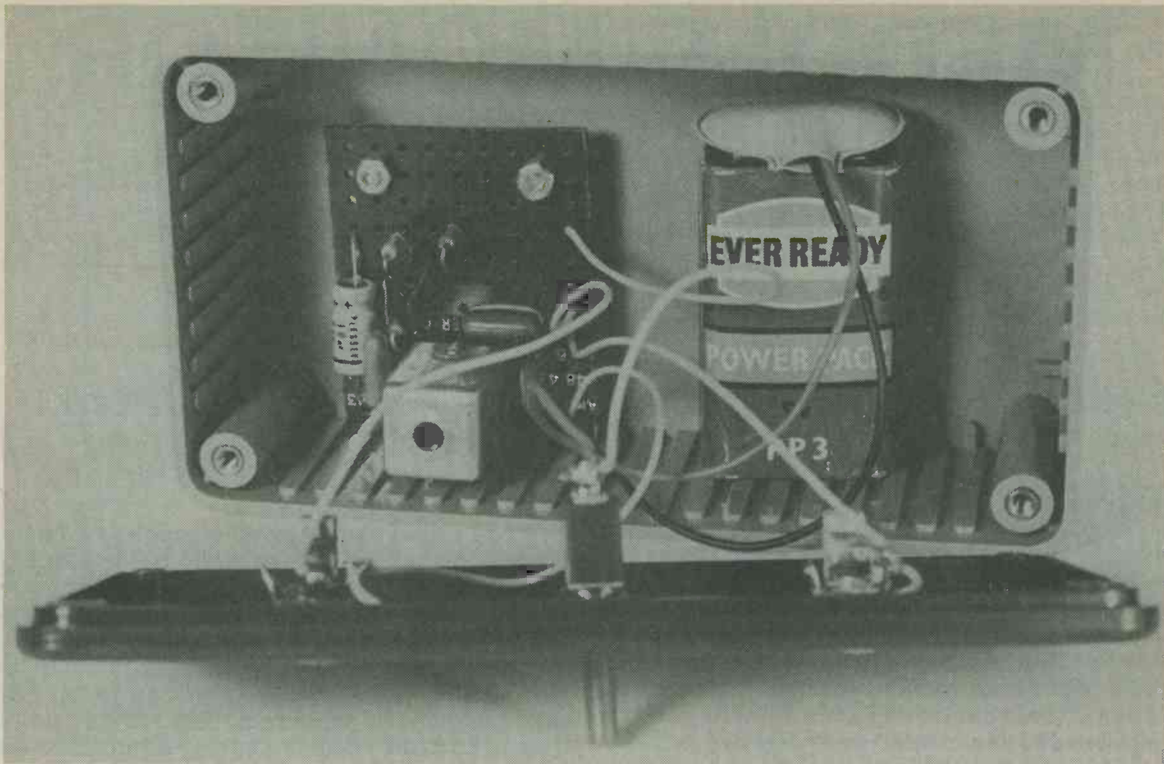


Fig. 2. The wiring on and around the Veroboard. IFT1 is soldered in place first, using a procedure which is described in the text

Close-up view of the Veroboard and its components





The Veroboard assembly is secured to the rear panel at the left, with the battery to the right

made to tag 1 and the remaining can mounting lug of the component.

After IFT1 has been soldered into circuit the remaining components are mounted and soldered to the board. So also are the leads which connect to S1, the two sockets and the battery clip. All wiring external to the board is shown in Fig. 2.

The board is secured to the left hand side of the rear panel, as indicated in the photograph of the interior, using two 6BA bolts and nuts with spacing washers. There should be adequate clearance with the backs of the sockets and on-off switch when the front panel is screwed in place. The 9 volt battery is positioned to the right of the board and it can be held in place by a home-made clamp or, more simply, by a piece of plastic foam sandwiched between the front panel and the battery.

USING THE OSCILLATOR

When completed the oscillator is ready for use. If suitable test gear is available, IFT1 can if desired be peaked up to 470kHz, whereupon it is essential that a proper trimming tool (such as the Denco TT5) be used. The core can easily break if an attempt is made to adjust it with an incorrect tool such as a small screwdriver. However, no adjustment is really necessary because the transformer is pre-aligned at the factory and will provide an output frequency of adequate accuracy.

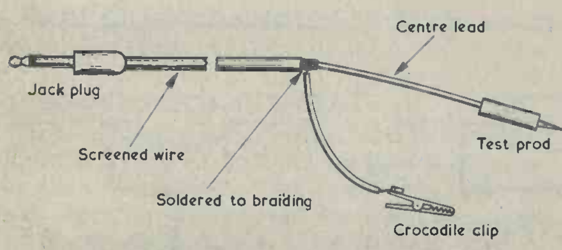


Fig. 3. Making up the test lead. This is plugged into SK1 or SK2 according to the function required

A short screened test lead is required and this can consist of flexible audio cable connected to a 3.5mm jack plug. At the other end the braiding is connected to a wire terminated in a crocodile clip and the centre conductor to a test prod, as shown in Fig. 3.

For a.m. receiver i.f. alignment purposes the test prod can be applied to the collector of the mixer transistor and the i.f. transformers can then be adjusted, working backwards from the last i.f. transformer. In this case there should be no necessity to connect the test clip to the receiver chassis, and sufficient signal will be given simply by connecting the test prod on its own. For this purpose the test lead is plugged into SK1.

For signal injection purposes with an a.m. receiver the test lead is plugged into SK2, and it will be necessary to connect the test clip to the receiver chassis. The test prod is then first applied to the non-earthy tag of the speaker, and this should produce a low volume tone from the speaker if this is functioning. (Try out the oscillator initially with one or more serviceable speakers to gain an idea of the performance to be expected here.) The prod is next applied to the output transistor bases, the driver transistor base, the base of the a.f. amplifier input stage, the i.f. amplifier bases and so on, working back towards the mixer base. The approximate location of the fault is found when the audio tone fails to be produced by the speaker, and it lies either in the immediate circuitry at the last test point, or between that test point and the previous one. The same working-back technique can be used when fault-finding on audio equipment. ■

MEDDLE MONITOR

By

F. Bowden

Security device incorporates AND gate latch.

We have become used, over recent years, to CMOS latches employing two inverters. A typical instance is given in Fig. 1(a), where two 2-input NAND gates are connected as inverters. If the input of the latch is taken momentarily to the positive rail the output goes positive as well, whereupon it holds the input positive via resistor R when the temporary connection is removed. The circuit remains latched in this condition. Should the input be momentarily connected to the negative rail the output goes negative and the circuit latches in this alternative state.

The resistor between input and output limits the current drawn from the output of the second gate during a transition and, in most practical applications, may have a value lying between some 10 kΩ and 1MΩ. Two 2-input NOR gates could be employed instead of the two NAND gates shown.

AND GATE

AND gates can also be employed as latches. In Fig. 1(b) a 2-input AND gate is used in a latch circuit having the same performance as the latch of Fig. 1(a). When the input goes positive, so also does the output, and when the input goes negative the output similarly becomes negative. Again, the circuit can latch into either of these two stable states.

The fact that a single AND gate carries out the same function as two NAND gates or two NOR gates can represent an advantage in some circuit applications. A particularly useful i.c. here is the 4081 quad 2-input AND gate which contains four gates. This is a readily available and inexpensive i.c., and has the internal circuitry shown in Fig. 2.

To give an idea of the manner in which AND gates may be employed, the remainder of this article is devoted to the security device indicated by its title.

SWITCHING MONITOR

When prized mains-driven equipment is left unattended for relatively long periods the owner frequently wishes to assure himself that it has not been switched on and meddled with during his absences. A similar situation can arise with unoccupied premises, and it is comforting if a check can be made to ascertain whether an intruder has switched on any electrical equipment or appliances. The security device is connected to the mains circuitry to be monitored after its on-off switch, and will indicate at any later time whether or not that switch has been closed.

The circuit of the monitor appears in Fig. 3. Here, the latching gate is the gate associated with pins 1, 2 and 3 of IC1, which is a 4081. The 240 volt primary of transformer T1 is connected to the mains circuit being monitored, and it has a 6 volt secondary. To set up the monitor, S3 is closed to switch on the 9 volt supply with the 240 volt a.c. mains connected to T1 primary switched off. The "Reset" button, S1, is then pressed to ensure that the input and output of the latching gate are negative.

If at any subsequent time the 240 volt a.c. mains is switched on, even if momentarily only, the voltage across T1 secondary is applied to TR1 base via R1, causing TR1 to turn on for part of the alternate a.c. half-cycles when the lower end of T1 secondary is negative. The upper end of R2 is then taken positive and causes the AND gate latch input and output to go positive also. The gate latches in this state during the periods when TR1 is non-conductive because current from the gate input to R2 is blocked by D1. Thus, a momentary, or continuous, application of the a.c. mains to T1 primary causes the gate input and output to go positive and stay positive. The function of C1 is to prevent possible switching transients in the mains

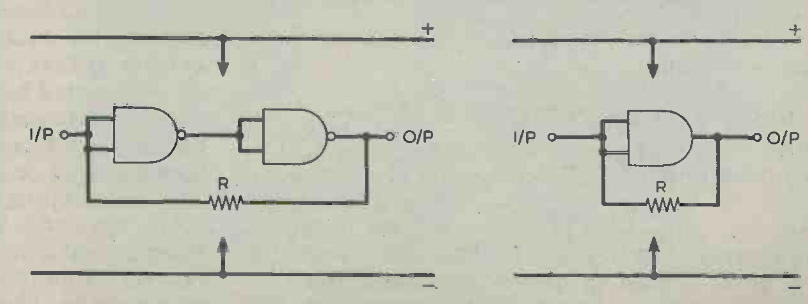


Fig. 1(a). Two NAND gates connected to form a latch (b). A single AND gate provides the same latching function.

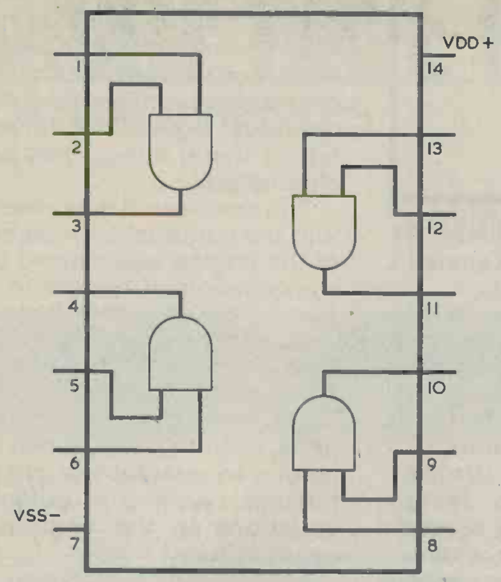


Fig. 2. Internal circuitry of the 4081 quad 2-input AND gate

6.3mA. The l.e.d. is thus illuminated much more brightly than it would be by the output current offered by a single gate.

To sum up, the unit is set up before leaving the mains circuit being monitored by switching on at S3 and pressing the "Reset" button with the mains circuit switched off. On returning later, the "Check" button is pressed. Should the l.e.d. remain extinguished this indicates that the mains circuit has not been switched on during the intervening period. If on the other hand the l.e.d. lights up, this means that the mains circuit has, at some time, been turned on.

The current drawn from the 9 volt supply when the l.e.d. lights up on pressing the "Check" button is the 6.3mA l.e.d. current. For all other quiescent conditions, the battery current is too low to be indicated with normal test equipment.

Should the "Reset" button be pressed whilst the a.c. mains supply is present at T1 primary the input and output of the latching gate goes negative, and current in the D1 circuit is then limited by R3. The gate input and output revert to the positive condition as soon as the "Reset" button is released.

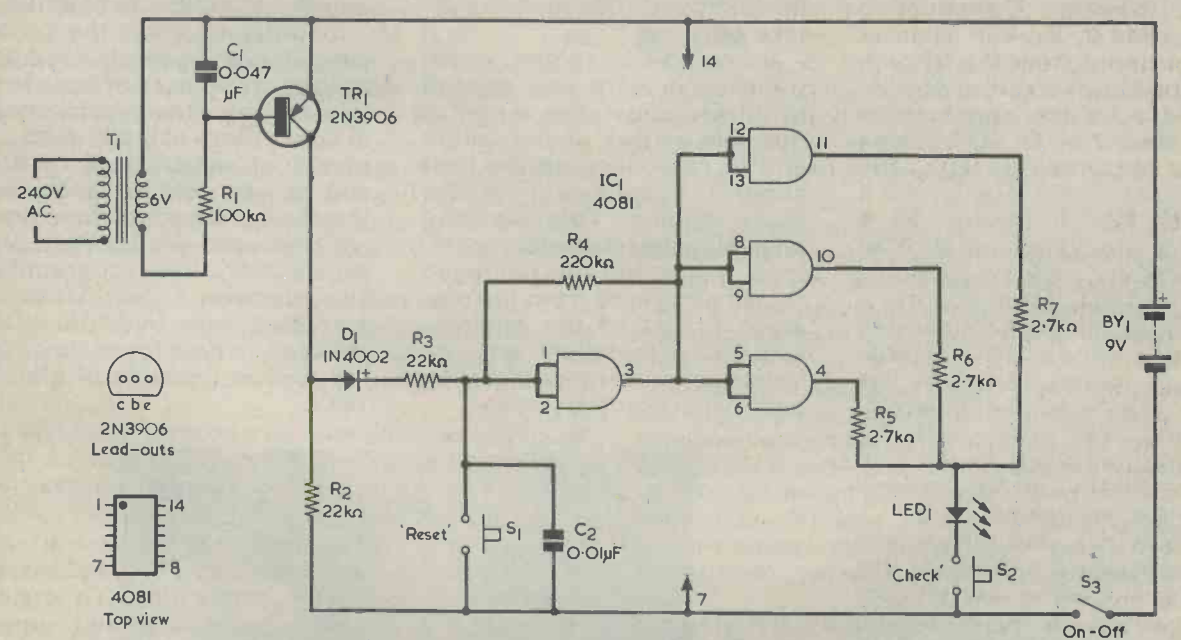


Fig. 3. The Meddle Monitor. If the a.c. mains is applied, even momentarily, to the primary of T1 the latching gate goes to the positive state. The l.e.d. will then light if the "Check" button is pressed later.

supply being passed to TR1 base. C2 also stabilizes circuit operation.

INCREASED L.E.D. CURRENT

Three remaining gates are all used to drive LED1. When the output of the latching gate is negative, so also are the outputs of the remaining three gates. These three outputs go positive when the output of the first gate goes positive. If the "Check" button, S2, is then pressed the l.e.d. lights up. A current slightly in excess of 2mA flows in each of the three resistors R5, R6 and R7, giving a total l.e.d. current of about 6.3mA.

As already mentioned, T1 is a mains transformer with a secondary voltage of 6 volts. The secondary current rating is quite unimportant because the current drawn via R1 and the base-emitter junction of TR1 is very low. All the resistors are ¼ watt 5% types. The l.e.d. can be any small red type. The 9 volt battery may be a PP3. Since no significant current is drawn from it under quiescent conditions, its useful life will be very nearly as long as its shelf life. ■

AMATEUR RADIO SATELLITES

Report by Arthur C. Gee

Readers will know from the note in 'News and Comment' June 1980 issue, that the satellite Oscar 9 was lost at launching; the only failure in ten years of amateur orbiting satellites.

Hopes were expressed then, that it might be possible to build a replacement and find a launching opportunity in the not too distance future. Doubts were also expressed that, due to the heavy expenditure of time and money that would be involved in creating a replacement, it might not be possible.

It is pleasing to report that the West German Amateur Radio Satellite Construction Group, led by Dr. Karl Meinzer who in conjunction with Jan King of Amsat was responsible for much of the construction and design of Oscar 9, have been negotiating with the European Space Agency for a further launch facility. As a result it is reported that such an opportunity may be available early in 1982. If this opportunity is to be taken up much work has to be done and a very large sum of money raised. It has been estimated that approximately £80,000 will be required, and it is hoped that half of the amount required will be raised in Europe.

AMSAT-UK has undertaken to spearhead the drive for this fund raising effort, and readers who would like to contribute should contact the AMSAT-UK Secretary, Ron Broadbent, 94 Herongate Road, Wanstead Park, London E12 5EQ.

The failure of the Ariane LO2 launched on 23rd May last, was due to combustion instability which occurred in one of the four first stage engines about six seconds after ignition.

This extremely violent phenomenon which lasted only three tenths of a second, abruptly altered the characteristics of the injector, which promptly led to the destruction of that engine. The fire that then broke out in the propulsion bay caused the vehicle to be destroyed 108 seconds after take off.

As can be imagined, much meticulous work was needed to narrow down the range of possible causes of the failure and to reproduce on the test-stand the behaviour of the faulty engine. This involved analysing the telemetry recordings, inspecting the damaged rocket recovered from the sea, static firings of the engines, acoustic simulation and an investigation of manufacturing and inspection processes.

In particular, it has been proved that the cause of the engine failure could not have been external to the engine itself, and the hypothesis of the presence at ignition of a foreign body, e.g. an identification tag or metal filings, has been eliminated.

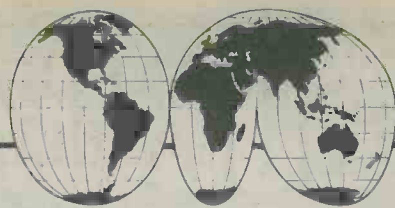
The conclusion was reached that the combustion instability of the engine was caused by a combination of factors in the system for injecting fuel into the combustion chamber. These most probably resulted from slight variations in the manufacture of successive units, such that very small variations in geometrical characteristics resulted in sufficient variations in the engines to cause failure.

The engine injectors are extremely complex, some 1000 injection orifices are provided in order to deliver 250 Kgs of fuel and oxidant per second into the combustion chamber.

In order to solve the problem, it has been decided to adjust the manufacturing tolerances for the injectors and to select those actually used by means of static firings on the engine test stand. Provided that the test schedules from now until the end of the year are satisfactory, this programme should enable Ariane LO3 to be equipped with injectors thus selected, in time for a launch in the second fortnight of March 1982.

OSCAR 9, before its completion, being wired up by Marie Marr, AMSAT'S Aerospace Technician. The replacement will be almost identical to that shown with just a few modifications resulting from the experience gained during the construction of the first model.

SHORT WAVE NEWS
FOR DX LISTENERS



By Frank A. Baldwin

Times = GMT *Frequencies = kHz*

A lot to report this month, so without more ado – and less verbiage – your attention is drawn to the following loggings, presented here for guidance. Select your item and 'have a go'.

●INDONESIA

RRI (Radio Republik Indonesia) Jakarta on a measured **11791.2** at 1430, OM (OM = male announcer) with station identification in English after a musical interlude in the English programme for South East Asia and the Pacific, scheduled from 1400 to 1500.

RRI Yogyakarta on 5046 at 1514, OM in Indonesian, orchestral music slow and rhythmic in the local style. This one operates from 0100 to 0300, 0455 to 0800 and from 0955 to 1700. The power is 5kW.

RRI Padang on a measured **4002** at 1536, YL's (YL = Young Lady - female) with a soft lilting song and guitar-type music. The schedule here is from 2230 to 0100 and from 1000 to 1600. The power is 10kW.

RRI Bukittinggi on a measured **4827** at 1525, OM with a song in Indonesian, local-type music. The schedule is from 2300 to 0300, 0500 to 0715 and from 0930 to 1600. The power is just 1kW.

●BURMA

BBS Rangoon on 4725 at 1524, YL with a talk – presumably in Burmese. Rangoon is scheduled on this channel from 1030 to 1545 but the signing-off time can vary from as early as 1445. The power is 50kW.

MALAYSIA

Kuala Lumpur on **4845** at 1520, OM and YL in Malay at termination of transmission. National Anthem and off at 1532. The schedule is from 2130 to 0130 and from 0545 to 1530 Mondays to Fridays; Saturdays from 2130 to 0330 and from 0545 to 1530; Sundays from 2130 to 1530. The power is 50kW and the programme languages are Indian.

Kuching, Sarawak, on **4950** at 1533, plaintive tune on a local wind instrument, weird and wailing! Fair signal under a running teletype transmitter. The schedule is from 2200 to 0100 and from 0800 to 1600. The power is 10kW.

●NEPAL

Jawalakhal on **5005** at 1520, OM in Nepalese, OM song, music in Indian-style. This is the Home Service radiated from 0020 to 0350; from 0720 to 0950 and from 1150 to 1720. The power is 100kW. This one can also be logged in parallel on **3425**.

●CHINA

Wuhan, Hubei, on **3940** at 2214, OM and YL in Chinese, logged under severe CW (Morse) interference. The schedule is from 2100 to 0100; from 0300 to 0740 and from 0855 to 1605.

Xizang, Tibet, on **4750** at 0046, OM AND YL alternate in Chinese. This one is scheduled from 2230 to 0645 (March to September from 2300) and from 1000 to 1545. Ensure you are listening to this one by tuning to the channel after 0000 for the reason that Hailaer, Heilongjiang is on this frequency from 2120 to 2400; also from 0355 to 0600 and from 0925 to 1500.

Wulumqi, Xinjiang, on **5060** at 0058, Chinese classical music, 5 pips time-check at 0100, OM station identification in Mongolian. Wulumqi is on the air from 2330 (from February to September from 0000) to 0555 and from 1100 to 1625.

Kumming, Yunnan, on **4760** at 2348, OM with a talk in Chinese. This is Yunnan 1, on the air from 2150 to 0600 (Tuesdays until 0800) and from 0920 to 1600.

Xizang, Tibet, on **4035** at 2342, Chinese classical music then YL with songs in the Tibetan Service, scheduled here from 2230 to 0645 and from 1000 to 1545.

Xining, Qinghai, on **3950** at 0003, OM with a talk in Chinese. Xining is scheduled from 2150 to 0100 and from 0930 to 1525.

●ITALY

Rome on **7275** at 1950, YL and OM announcers with the programme in English for the U.K., scheduled on this channel from 1935 to 1955.

●NIGERIA

Lagos on **15120** at 0651, OM with a newscast in English, all about local affairs in a programme directed to North Africa and "Overseas", scheduled from 0600 to 0800.

● **MALTA**

Radio Mediterranean on **5960** at 1840, YL with a newscast in English, followed by station identification in English.

● **AUSTRALIA**

Melbourne on **17890** at 0112, OM with a talk in English about foreign affairs as represented in the Australian press in a programme entitled 'Editorial Opinion'.

● **TAIWAN**

CBS Taipei on **11905** at 1410, YL with songs in Chinese, light music local-style in a broadcast presumably for South East Asia.

● **SINGAPORE**

BBC Kranji on **11955** at 1615, OM with comments on USSR domestic affairs followed be a reading from 'The Invisible Man' by H. G. Wells.

● **NEW ZEALAND**

Wellington on **15485** at 0700, 6 pips time-check, station identification in English after a programme of soft-sounding Polynesian melodies from 0655 tune-in.

● **MALAYSIA – 2**

Kuala Lumpur on **15295** at 0713, OM with station identification, frequencies and times announcement in English.

● **NEW CALEDONIA**

Radio Noumea on **11710** at 0732, choral song to a Polynesian drum-beat, OM with announcements in French. A weak signal but audible on a clear channel.

● **PHILIPPINES**

Tinang (VOA) on **11965** at 1350, OM and YL with an English language lesson in a programme intended for China.

● **CLANDESTINE**

Voice of the Malayan Revolution on **15789** at 1403, military music, OM with a harangue in (presumably) Tamil. This station follows a pro-Peking line and is anti-Malaysia and Singapore Governments. The transmitter is thought to be located near Changsha in the Hunan Province of China.

● **ECUADOR**

HCJB Quito on **9535** at 0300, YL with station identification follwed by a programme in Russian for Europe, scheduled from 0230 to 0400.

● **MONGOLIA**

Ulan Bator on **4830** at 2355, OM and YL in Mongolian followed by a programme of folk music. Also logged on the parallel channel of **4763** at 2210 on a differing occasion, OM in Mongolian. This is the Home Service, scheduled from 2200 to 0100 and from 1030 to 1500.

● **UGANDA**

Soroti on a measured **5026.5** at 0331. OM with news of African affairs in Swahili in the National Programme scheduled from 1300 to 2100 weekdays and from 0300 to 0545 and from 1400 to 2100 on Saturdays and Sundays. The power is 250kW.

● **TANZANIA**

Dar-es-Salaam on **5050** at 0325, African drums interval signal, OM with announcements in Swahili at 0330 when opening transmission. The schedule is from 0300 to 0700 and from 1500 to 2015 weekdays. Presumably they commence later on Sundays! The power is 10kW.

● **SWAZILAND**

TWR (Trans-World Radio) Mpangela on **4790** at 0319, YL's with an Afircan song in the Afrikaans programme, radiated at this time of the year from 0300 to 0345. The power is 30kW.

● **INDIA**

AIR (All India Radio) Bombay on **4840** at 1549, OM in Hindi in the Domestic programme, scheduled on this channel from 0230 to 0400 and from 1230 to 1740. The power is 10kW.

AIR Delhi on **3925** at 1541, OM with a newscast in English in the Home Service, scheduled from 1300 to 1600 and from 1730 to 1740 (Tuesdays, Saturdays and Sundays continuous until 1735). The English newscasts are as follows – from 0030 to 0035; 1430 to 1435; 1530 to 1545 and from 1730 to 1735. The power is 10kW.

● **CAPE VERDE**

Voz de Sao Vicente on a measured **3931** at 2359, OM with announcements in Portuguese, the National Anthem and sign-off. This station is on the air irregularly and when transmitting is scheduled from 2000 to 2400 (Saturdays from 1630, Sundays from 1600). The power is 10kW.

● **NAMIBIA**

Windhoek on **4965** at 1721, OM in vernacular. The schedule is from 1515 to 0615. Power unknown.

● **ANGOLA**

Luanda on **4820** at 1815, OM with a long harangue in vernacular (not Portuguese) all about Angola and UNITA. The schedule is from 0430 to 0630 and from 1500 to 2400. The power is 10kW.

● **SAO TOME**

Radio Nacional de Sao Tome on a measured **4807** at 1755, choral songs then OM with announcements in Portuguese. The schedule is from 0530 to 2300 and the power is 10kW.

● **AFGHANISTAN**

Kabul on **4740** at 0138, OM with announcements in Pashto, 3 long pips at 0130 then OM with religious chants, all in the Home Service 1, scheduled from 0125 to 0330 and from 1340 to 1920. The power is unkown.

● **COLOMBIA**

Radio Super, Medillin, on **4875** at 0509, OM with a newscast in Spanish with many mentions of Colombian place-names. Full station identification as "Radio Super" at 0517. The schedule is around the clock and the power is 2kW.

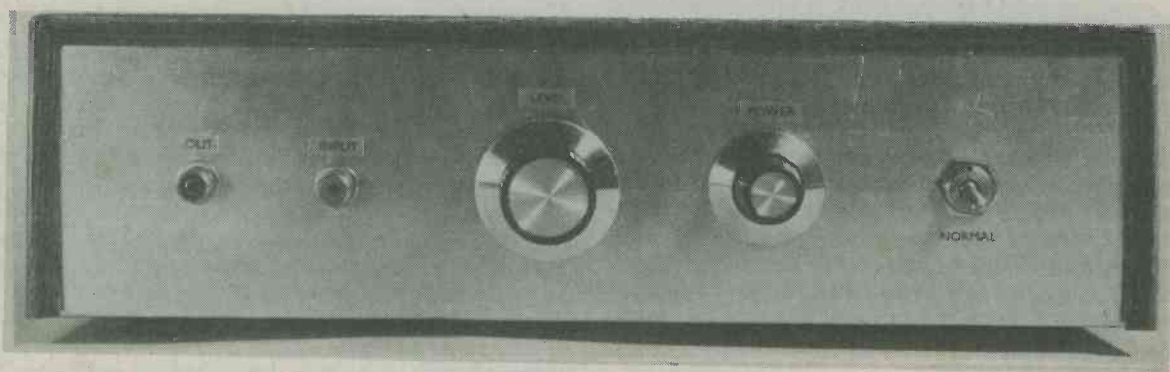
Radio Neiva, Neiva, on **4855** at 0456, OM with announcements in Spanish then the National Anthem and off. Radio Neiva operates irregularly and is reported to be on the air at times from 2300 to 0530 and the power is 1 kW.

RADIO & ELECTRONICS CONSTRUCTOR

FEBRUARY 1981

IN NEXT MONTH'S ISSUE

REVERBERATION UNIT



★SELF-CONTAINED SELF-POWERED UNIT

★REVERBERATION AMPLITUDE CONTROL

★SWITCHING OPTION FOR REVERBERATION ONLY. The unit is powered by a PP6 size 9 volt battery.

ELECTRONIC DOOR BUZZER

LOW CONSUMPTION UNIT PRODUCES DISTINCTIVE TWO-NOTE TONE.

"OWIZZEE"

HOW TO PLAY CRICKET IN COMFORT

PLUS MANY OTHER ARTICLES

FUZZ BOX

Silicon diode clipping action.

Very low noise level. Variable

Although it has been in use for many years now the "fuzz" musical effect is still one of the most popular. It is primarily employed with electric guitars (although of course it can be used with electronic organs and other instruments) and consists of distorting the processes signal to produce strong harmonics of the signal frequency. These harmonics are multiples of the input frequency, so that a 500Hz signal would have added to it signals at 1kHz, 1.5kHz, 2kHz and so on. Thus, the output signal tends to have a much higher treble content that the input signal, giving a "sharper" and more "brilliant" sound than would otherwise be obtained.

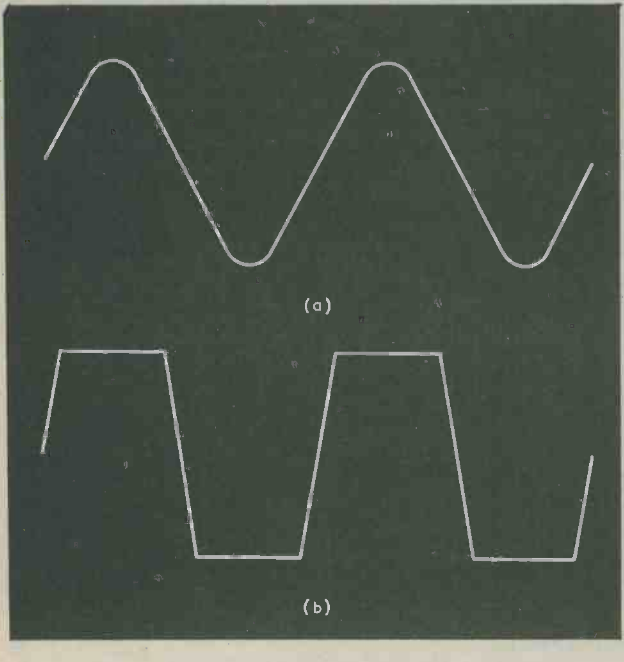


Fig. 1(a). The input waveform before clipping
(b). After amplification and clipping, the waveform is converted to a nearly square wave.

CLIPPING

There are several ways in which the fuzz effect can be given, but by far the most common method is to use a clipping circuit. With this type of circuit a sine wave input, as in Fig. 1(a), is greatly amplified and then fed to a diode clipping circuit which, if silicon diodes are used, limits the maximum peak signal level to plus and minus 0.6 volt. Since the input signal would normally have a peak-to-peak amplitude of several volts, the clipping considerably flattens the signal peaks, so that the sine wave of Fig. 1(a) would be changed to the near square wave of Fig. 1(b). A square wave signal is rich in harmonics, and the fuzz effect is thereby given.

When used with a guitar the clipping circuit can also produce a "sustain" effect. The output from the guitar initially has a high amplitude which rapidly decays. When there is a high level of amplification before the clipping diodes the decaying signal can still reach clipping level, so that the clipped output is maintained at full amplitude for several seconds.

Although a fuzz unit can sustain a note, it has the obvious disadvantage of producing distortion products as well. This problem can be overcome to some extent by using a low pass filter at the output, thereby giving the signal a more rounded waveform. The filter can give quite good results, but it will not greatly reduce intermodulation distortion products as many of these occur at middle and low audio frequencies. In practice dissonant results are much less noticeable if only one note is played at a time.

The fuzz box described here is designed to connect between an electric guitar and a guitar amplifier, and by employing a low noise bifet operational amplifier it has an excellent signal-to-noise ratio. An adjustable low pass filter is included at the output so that the fuzz effect can be varied to suit individual tastes. The unit is self-contained, being powered by its own PP3 9 volt battery. This will give many hours of operation before a replacement is required, as the circuit has a current consumption of only about 3mA.

By I. M. Attrill

output filter.

The completed fuzz unit in its aluminium case. The successional action foot operated switch on the top panel switches the fuzz effect in and out.

THE CIRCUIT

The full circuit of the fuzz box is shown in Fig. 2. IC1 is a Texas Instruments operational amplifier which is designed to give minimal audio frequency noise at its output. The i.c. also has an excellent distortion performance, although this is obviously of no great importance in the present application!

The non-inverting input of the i.c. is biased to half the supply voltage by R2 and R3, and the input signal passes through C2 and R1 to the inverting input. R4 and R1 form a standard negative feedback circuit and allow the i.c. to have a voltage gain, for very low level signals, equal to R4 divided by R1, or approximately 47 times. If, however, an input signal causes the peak i.c. output to exceed 0.6 volt the two diodes commence to conduct. Their forward resistance is very much lower than the resistance of R4, with the result that the amplifier gain is considerably reduced. As signal amplitude increases a point is reached where the diodes cause the amplifier to have a gain which is less than unity. This gives the desired clipping effect, with the amplifier output being limited to about 1.2 volts peak-to-peak.

The low pass filter is given by R5, C3 and VR1. The filter has no significant effect when VR1 inserts maximum resistance into circuit and gives its full high frequency cut when VR1 inserts minimum resistance. VR1 can be set up to give the level of filtering which is desired. R6 and R7 form an output attenuator, and the output signal level can be adjusted by means of R7. This potentiometer is set up so that the output levels with or without fuzz are comparable, whereupon the switching in or out of the fuzz effect can be reasonably unobtrusive. This switching is achieved by S1(a)(b), which is a successional action push-button switch intended for foot

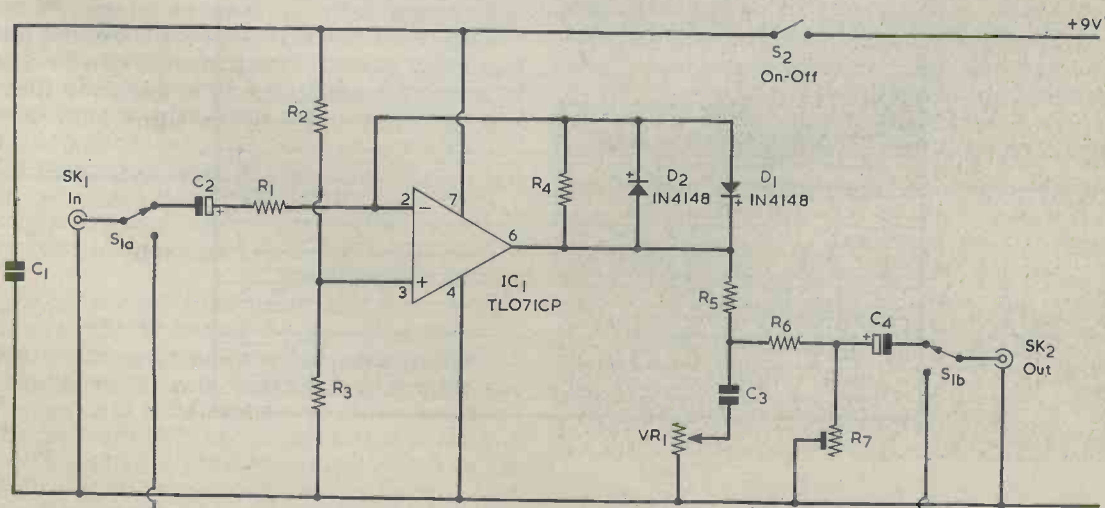
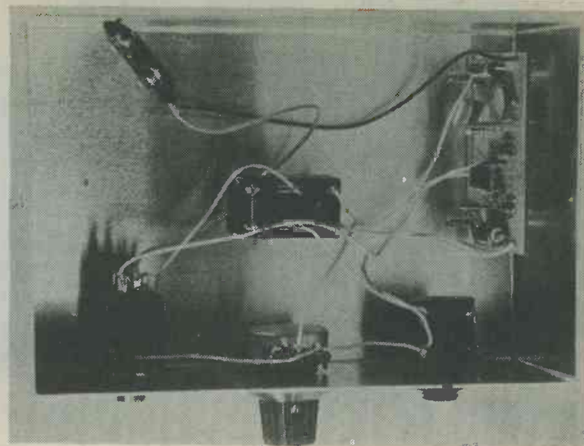


Fig. 2. The circuit of the fuzz box. Clipping is achieved by the two diodes in the feedback loop around IC1.

The Veroboard assembly is mounted on one of the side panels of the case



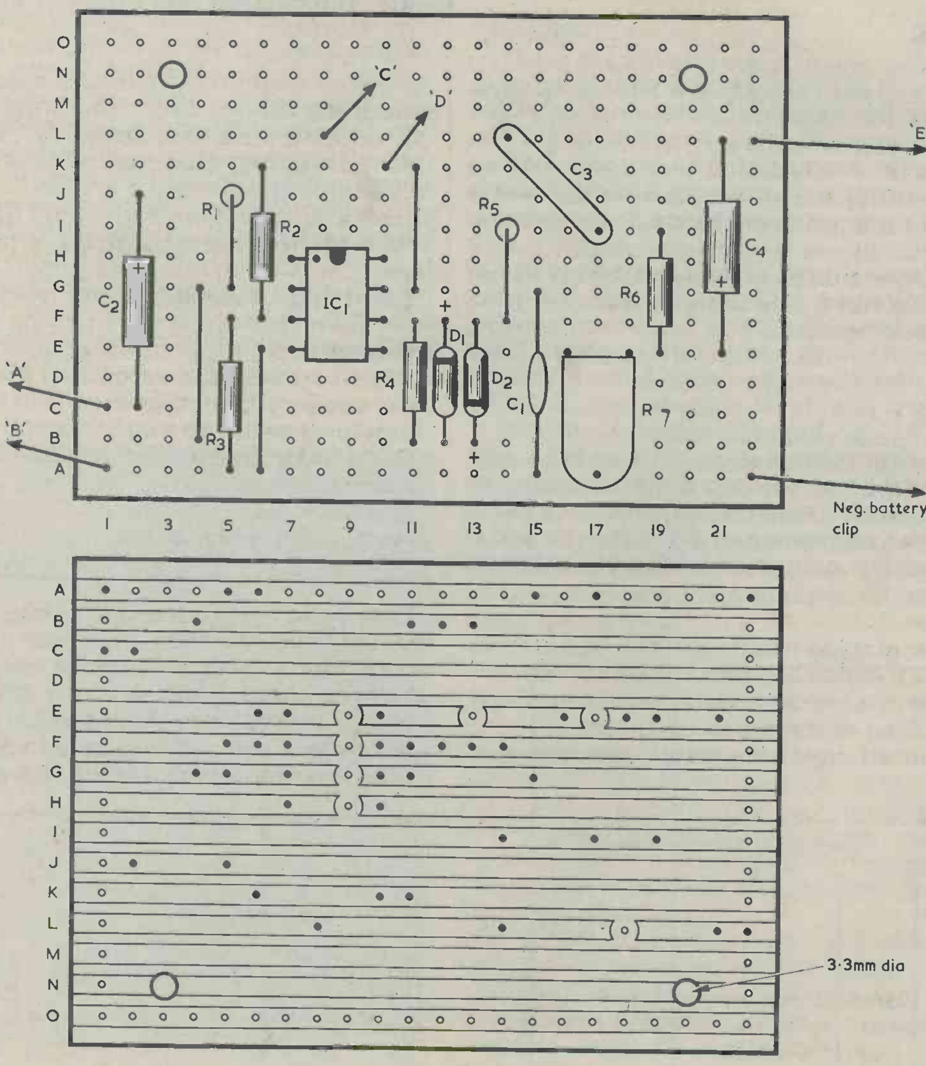


Fig. 3. The component and copper sides of the Veroboard panel. The wires designated "A" to "E" connect to the similarly identified points in Fig. 4.

operation. A suitable switch is available from Maplin Electronic Supplies.

The only other control is the on-off switch S2. In the prototype this is part of the input socket SK1, which has d.p.d.t. contacts, insulated from the jack contacts, which are operated when the jack plug is inserted. This socket is also available from Maplin Electronic Supplies. A separate on-off switch can be alternatively employed, if desired.

The TL071CP specified for IC1 is available from several suppliers. The two electrolytic capacitors are specified as having a working coltage of 10 bolts. It will be perfectly in order to use capacitors having a much higher working voltage than this, and it can be as high as 100 volts.

CONSTRUCTION

The fuzz unit must be housed in a robust metal box, which provides screening and which also has to withstand rough handling. A diecast aluminium box would be ideal, but these are relatively expensive. It was found that a simple aluminium box measuring about 152 by 102 by 51 mm. (6 by4 by 2ins.) was quite adequate, and cases of this type are readily available at reasonably low cost.

The box is used inverted so that the lid is at the bottom. This lid is fitted with four large cabinet feet near the corners. S1 is mounted at the centre of what is now the top of the box, so that it can be foot operated. VR1 is mounted at the centre of one of the larger side panels, with SK2 on its left and SK1 on its right. The general layout can be seen in the photographs.

VEROBOARD PANEL

The majority of the components are assembled on a piece of Veroboard of 0.1 in. matrix having 22 holes by 15 copper strips. This is shown in Fig 3. The board has to be cut down from a larger piece, after which the two mounting holes are drilled and the seven breaks in the copper strips made. The components and link wires are then soldered in place. Finally to be fitted are the negative battery lead and five flexible insulated leads for connection to the components external to the board. These can all be around 8 in. long, being cut to their final length when the other ends are connected.

COMPONENTS

Resistors
(All fixed values ¼ watt 5% unless otherwise stated)
R1 47kΩ
R2 22kΩ
R3 22kΩ
R4 2.2MΩ 10%
R5 5.6kΩ
R6 100kΩ
R7 47kΩ pre-set potentiometer, 0.1 watt horizontal
VR1 22kΩ potentiometer, linear

Capacitors
C1 0.047μF ceramic plate or type C280
C2 1μF electrolytic, 10V. Wkg. (see text)
C3 0.047μF type C280
C4 1μF electrolytic, 10V Wkg. (see text)

Semiconductors
IC1 TL071CP
D1 IN4148
D2 IN4148

Switches
S1(a)(b) d.p.d.t. (see text)
S2 part of SK1 (see tect)

Sockets
SK1 ¼in. jack socket with d.p.d.t. contacts (see text)
SK2 ¼in. jack socket

Miscellaneous
Aluminium case (see text)
Veroboard, 0.1in. matrix
9 volt battery type PP3
Battery connector
Control knob
4 cabinet feet
Nuts, bolts, wire etc.

The completed Veroboard panel is mounted to the side panel at the SK2 end of the case by means of two 6BA or M3 bolts and nuts. Spacing washers about 12.5mm. long are used on the bolts to ensure that the underside of the board is well clear of the metal case panel.

The point-to-point wiring shown in Fig. 4 is

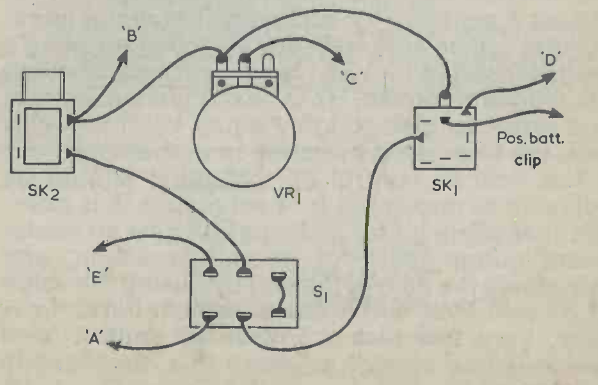
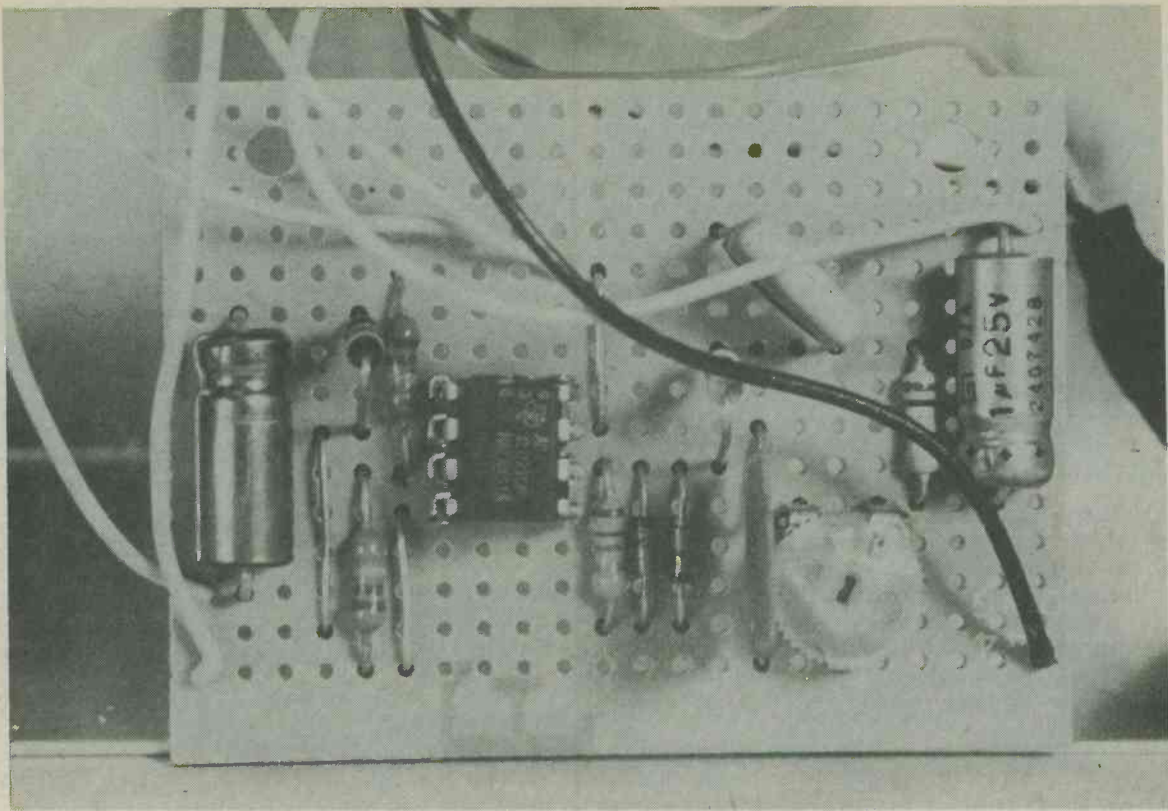


Fig. 4. Connections to the front panel components and the foot operated switch.



Component layout on the Veroboard panel

then carried out. Confirm with an ohmmeter or continuity tester the tags on the SK1 assembly which connect to S1 before wiring to these tags. A jack socket with an insulated housing was used in the prototype for SK2. If an open type of socket is used here (or in the SK1 position) the connections to it will be obvious form the circuit of Fig. 2.

There is plenty of space for the PP3 battery. This can be held on place with a simple clip or can be secured by sponge plastic when the case lid is screwed on.

TESTING

After a final and thorough visual check of the wiring, the fuzz box is ready for testing. A screened lead must be used for the connection between its output and the guitar amplifier to prevent pick-up of hum and other electrical noise. Unless a separate on-off switch has been fitted, the unit will be automatically switched on when a plug is inserted into SK1, and switched off when the plug is removed. R7 is next adjusted, by trial and error, to give roughly equal volume levels with the fuzz effect switched in and out.

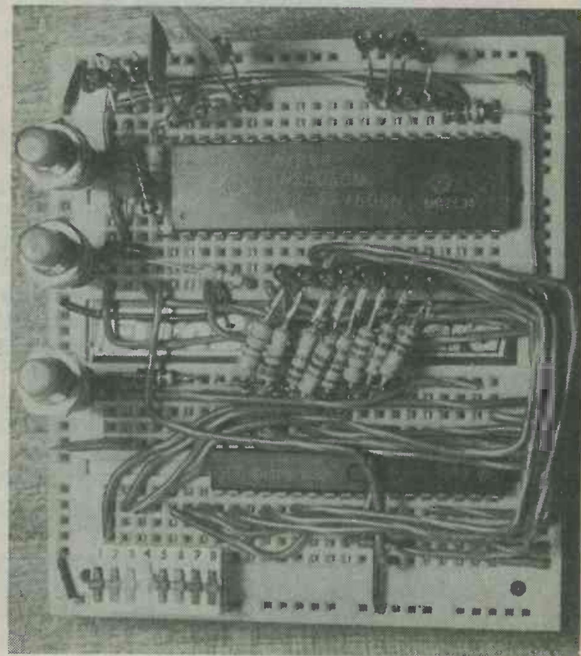
The volume control on the guitar should be adjusted to maximum for best results. It is possible that some guitar pick-ups will give an inadequate output level for good fuzz action, and increasing the gain of the unit by raising the value of R4 to 4.7MΩ should be of benefit here. However, very few pick-ups have an output level which is low enough to make this modification necessary. ■

"Coo Mister! Have you come to fix our tele?"

The INStructor

Part 6

By Ian Sinclair



A PRACTICAL INTRODUCTION TO MICROPROCESSORS

Shifting, Rotating and Serial input/output

The next family of single-bye instructions we're going to look at carries out the usual action of a shift register, and allows us to program for multiplication among other things. The shift right (SR) instruction acts on the byte in the accumulator and has the effect of shifting each bit into the next place on the right. What happens to the D7 position of the register, and the DO bit? Try it and see, using the program in Fig. 1. We start with the byte 10010001, and end with the displaced byte 01001000. What's happened is that a zero has been shifted into the D7 place, and the 1 has dropped out of the DO place in the register. Each shift instruction causes one more shift, so that if the G0 button is pressed twice with the SR instruction set up on the data switches, the byte in the accumulator will be shifted right, twice – try it.

WITH LINK

There's a variation on this theme which causes the carry/link bit to be fed into the D7 position of the accumulator. This is the shift-right-with-link step (SRL), and it's this use of the carry bit to link into the shift operation which is responsible for the name "link" appearing along with "carry". A program which makes use of the link is shown in Fig 2. The carry/link is set using SCL, and the byte 01100100 is loaded into the accumulator. This is shifted right twice, with the link fed in, by setting up the SRL code 00011101 and pressing GO twice. What do you end up with? Has the carry/link been cleared by the first shift?

The shift-right instruction, with or without link, is sometimes useful, but the rotate right (RR) is even more so. In a rotate instruction, the bits in

RESET	
LDI	11000100
BYTE	10010001
SR	00011100
DISPLAY	

Fig. 1

RESET	
SCL	00000011
LDI	11000100
BYTE	01100100
SRL	00011101
DISPLAY	

Fig. 2

RESET	
LDI	11000100
BYTE	01100101
RR	00011110
DISPLAY	

Fig. 3

RESET	
LDI	11000100
BYTE	00010101
XAE	00000001
SIO	00011001

(Observe the l.e.d. – see text)

Fig. 4.

the register are shifted right as before, but the bit which drops out of the D0 position is shifted into the D7 position. Practically speaking, what has happened is that the serial output of the register is connected to its serial input. Fig 3 shows a program example, setting up 01100101 and rotating right so as to produce 10110010 in one rotation.

We can also bring the carry/link into this operation, using the RRL instruction (00011111). When this is done, the D0 bit shifts into the carry/link bit, and the bit which was in the carry/link shifts into D7, with the rest of the bits shifted right one place as before.

One example of the use of the rotate right instruction is the entry of a four bit number from a keyboard. The circuit of the microprocessor system will be arranged so that the four bit number appears in the lower half byte of the accumulator. Before the next number is loaded in, the accumulator must be rotated four times, so that the first number is now in the upper four bits, and the second number can be loaded into the lower four bits.

Shift and rotate instructions are used on all microprocessors, but the next instruction, SIO is another one which is peculiar to the INS8060. SIO means Serial Input/Output, and this means shifting bits into or out of the microprocessor one at a time, rather than in eights. If, for example, you want to record a program or a set of data bytes on a cassette, the eight data lines are not of much use to you because you don't have an eight-track recorder! What is done is to shift the bits, one by one, in a series, to the recorder. When we want to replay the procedure is the same – we shift the bits in one by one and assemble them into bunches of eight for use. This is a simple system which, as it stands, offers no protection against a bit which goes astray – it's left to the program which controls the serial input and output to identify the bits correctly and to feed them out and in at the correct speed. Once again, most other microprocessors need another i.c. connected to the data lines to carry out this action.

In the 8060, the serial input and output acts on the extension register, and does not affect the accumulator. The serial output is taken from a flip-flop fed from the E0 end of the extension register to the START pin and the input is taken at the SIN (Serial IN) pin on the microprocessor. On our board, there's a push-button switch at the SIN input, and an l.e.d. hooked to the output, so we can put information in and read it out. The switch earths the serial input when the button is pushed, so that the arrangement is that the input will be 1 unless the switch is pushed. Remember, though, that there are no serial inputs or outputs unless the SIO program instruction is being carried out.

XAE INSTRUCTION

Take a look at the output first, using the program in Fig. 4. This loads the byte 00010101 into the accumulator, and then uses the XAE instruction to exchange the accumulator and extension registers. With the byte in the extension register, the SIO instruction (00011001) can be set up on the data switches, and we're ready for serial outputs. Watch the serial output l.e.d. and press the GO switch once. This should shift the lowest order bit of the accumulator (A1) to the serial output, causing the l.e.d. to light. At the same time, a 1 will be shifted into the E7 position of the extension register, because the SIN switch is open, allowing the serial input to stay at logic 1. The next press of GO (without altering the settings on the data switches) will cause the next bit to be shifted out. Since this is zero, the l.e.d. will extinguish. The next press of GO will light the l.e.d. again, because of the 1 which started in the E2 position, and so on. After the GO button has been pushed eight times, the l.e.d. will remain lit continually, because the extension register is full of 1s, which were fed in from the SIN switch. Without resetting, hold the SIN switch pressed, and push the GO switch eight times. This should load the extension register with 0s, so that the l.e.d. goes out and will stay out for the next eight presses of the GO button. Try alternately pushing and releasing the SIN switch as you push GO, and then see the effect on the l.e.d.

There are a number of single byte instructions which act on the accumulator, but use the extension register as the source of the bytes. These were listed in Fig. 9 of Part 5 of this series. In each case the numbers which are processed are the bytes in the extension and in the accumulator, and the result is stored in the accumulator. For example, the AND-extension (ANE) will AND the byte in the extension with the byte in the accumulator and store the result in the accumulator. In this way, numbers which have been assembled for the serial input, or which have been taken from the accumulator at an earlier stage, can be fed back into the main accumulator register.

DOUBLE-BYTE INSTRUCTIONS

Now we have to pop back to look at some more double-byte instructions again, and it's an important group. So far, each load, add, AND or similar instruction which we've used has been immediate – the byte to be processed has followed the instruction. If we'd been following address numbers, for example, we would find that a LDI (load immediate) instruction at address 0001 was followed by the number to be loaded at address 0010. This can be useful, but it's much more likely

RESET

LD	11000000	Note the address number.
DISP	00000011	Note the address number.

The number displayed by the data l.e.d.'s is not important in this example, what we are looking for are the address changes. In the examples which follow the address changes are also the important point.

Fig. 5

that we'll want to load a number which appears at some quite different address – how do we do that? The most common method of loading from a different address is ***program-relative displacement,*** and we can most easily illustrate what happens by a program example which you can try out. In this example and the ones which follow ignore what the data l.e.d.'s are doing, and concentrate entirely on the address l.e.d.'s. Fig. 5 shows the routine. Remember that the address l.e.d.'s always show the address of the step which you are about to make, so that when we read the l.e.d.'s we're actually reading the address for the next instruction. We start off with the address l.e.d.'s at 0001, and we set the data switches to a load instruction – not load immediate this time, but a PC relative load. PC means program counter, and relative means that the address of the number we want to load is given by adding a byte to the value of the program count. The binary code of this one is 11000000, so when GO is pressed the next address is 0010. We now set up the displacement byte – in this example 00000011 (decimal 3) and press GO again. Now in the programs we've been stepping through up to now, this would result in the address shifting to the next number, 0011 – but that's not what the address l.e.d.'s are reading now! What has happened is that this second byte has been added to the program counter address, to produce the new address 0101 (decimal 5). In a fully-fledged system, then, the number which is to be loaded in is fetched from memory position 0101 instead of being loaded immediately after the load instruction. We wouldn't usually, of course, make such a small jump forward to find a number in memory, because if we had 1024 steps of program in a read-only memory, then we might want to start loading the numbers from a read/write memory which started with its first address at 1025.

Wait a moment, though. How far can we "displace" from the program address? One byte can be a number as large as 11111111, which is 255 – or is it? Try it out as in Fig. 6. Reset and, with the address 0001 shown, set the data switches to load 11000000 and push GO. Then set to 11111111, check that the address which is showing is 0010, and push GO again. The normal step forward would bring the address to 0011. What does it actually show? Whatever it does, 11111111 doesn't put the program 255 steps on. Can it be that the microprocessor is arranged to read this as a signed number? To check this, repeat the load operation, but this time use 11111110 as the displacement. What address does this cause?

These displacements are limited, then, to seven bit numbers, with the highest order bit indicating sign. We can displace only 127 steps on, or 128 steps back. Now that may not sound very much and it certainly doesn't solve the problem of getting to a memory location which is several thousand steps away, but for a lot of programming it's quite enough. The reason is that most programs are written as short "blocks" of only a few steps, and so the displacements that are needed are only of a few steps. For larger displacements – stay with us.

LARGE DISPLACEMENTS

All the functions which are available as "immediate" or as "extension" are also available as PC relative displacements, so that we can load AND, OR, XOR, DECIMAL ADD, ADD, complement-and-add numbers which are taken from an address given by the program count plus a signed displacement. Next question is: what happens after that? The program of Fig. 7 answers that in a practical way. We've set up to load, specified a displacement of 00000101 and then, having got there, loaded the number 00000001. What is the address showing now? It is, as we might suspect, the next address that the microprocessor would have gone to if we had **not** used the displacement. That, in fact, is one of the very useful features of this method of loading a byte from another address – you don't have to do anything special to be sure of returning to your normal address afterwards. As well as loading into the accumulator there is an instruction, STORE (ST), which is found only in this displacement form (there's no store immediate, for example). We've used this to display numbers, and we can now clear up a mystery which has been with us since Part 3. When we display, the routine we've used has been to set the store code

RESET

LD	11000000	Note address.
BYTE	11111111	Note address.

What address is caused by this displacement number? Try 11111110 as a displacement also.

Fig. 6.

RESET		
LD	11000000	
DISP	00000101	Note address.
BYTE	00000001	Note address.

Note the final address.

Fig. 7.

RESET		Address
LDI	11000100	000000000001
BYTE	11000100	000000000010
ST	11001000	000000000011
READ	11001000	000000000100

The resulting address is 111111001100

WHY? The last address in the program counter before the "READ" part of the store instruction was completed was 000000000100, which is decimal 4. The displacement byte was 11001000, which is in decimal –56. The resulting address should be 4 –56 = –52 in decimal. Because 12 address lines are used, this causes all the higher lines to be set – the reason can be seen if we work out the sum in binary, using twelve bits:

–52 in decimal becomes	000000110100
Complemented, this is	111111001011
Add 1 to get	111111001100,

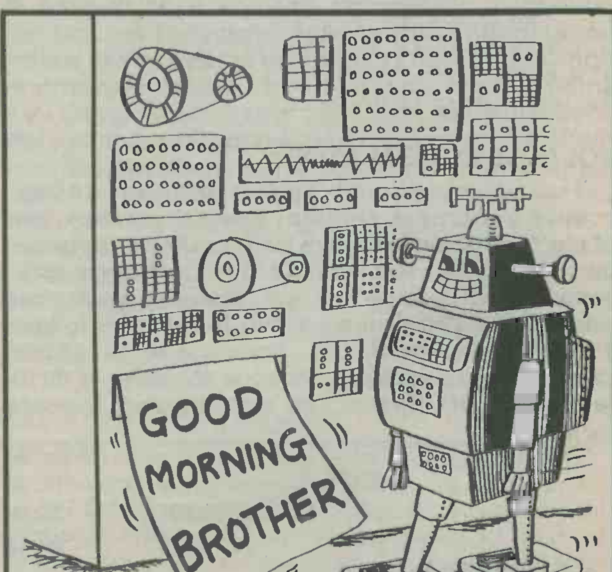
which is the address put out on the lines.

Fig. 8.

11001000 and press GO twice. Now the first press of GO loads in the instruction to store, and the second loads in 11001000, which is taken by the microprocessor as a negative number (decimal –56). This subtracts 56 (decimal) from the address, causing the odd effects which manifest themselves as the A11 l.e.d. lighting. This is because the 8060 uses 12 address lines, which can address 2^{12}, equal to 4096, memory locations. The normal number of address lines is 16, and the 8060 has the other four but they have to be gated and latched, they're not available on pins. This type of arrangement is called paging–the 8060 has an address page of 4096 bytes, and the numberof pages is 24 (the four higher order bits), equal to 16, making a grand total of 65536 bytes which can be addressed. Now these upper few bits aren't affected by anything that happens to the 12 lower address lines, so that one lot of 4096 addresses is separate from another lot. When we use a negative displacement number which is greater than the program address, we run backwards "across the page". Fig. 8 helps to explain this.

The result is that the high order address lines set to 1, causing an address number which we wouldn't normally expect, since it seems to be much larger than we could get from a displacement of +127. This, incidentally, is one way of getting displacements greater than +127 relative to the program counter, but it's not mentioned in any of the manufacturer's data books!

(To be continued)



MEASURING ELECTROLYTICS

By T. H. Reynolds

Inexpensive capacitance measuring circuit

In Fig. 1(a) a resistor R and capacitor C are in series, and are connected to a source of supply via a switch. The switch is open and the capacitor is discharged. When the switch is closed the capacitor charges via the resistor and the voltage across it increases. After a period of time equal to the time constant of the resistor and the capacitor, the voltage across the capacitor will have reached 63% of the supply voltage. The time constant, in seconds, is equal to the value of C in microfarads multiplied by the value of R in megohms. The capacitor still continues to charge after the time constant level, of course, and the voltage across its plates eventually becomes equal to the supply voltage.

In Fig. 1(b) the positions of the capacitor and resistor are reversed. If the capacitor is discharged and the switch is closed the voltage across the capacitor increases as before, but this time its lower plate is going negative with respect to the positive rail. The voltage across the capacitor will once again equal 63% of the supply voltage after the time constant of the resistor and capacitor has elapsed.

VOLTAGE COMPARATOR

The circuit of Fig. 1(b) forms the basis of an inexpensive instrument, capable of measuring the values of electrolytic capacitors, which forms the subject of this article. As used normally the instrument gives approximate indications, but these are more than adequate for components having the very wide tolerances on value which are common with electrolytic capacitors. In any case, quite accurate measurements can be obtained if extra time is employed in carrying them out.

The full circuit of the capacitance measuring instrument is given in Fig. 2, and it will be seen that this incorporates an ICM7555. The ICM7555 is the CMOS version of the 555 and offers very high input impedances at the trigger and threshold inputs, at pins 2 and 6 respectively.

When S2 is in the Off position the capacitor being measured is short-circuited via the current limiting resistor R8, and has zero voltage across it. Putting S2 to On takes the short-circuit off the capacitor and applies power to the circuit. The test capacitor then begins to charge via whatever resistor is brought into circuit by the Range switch S1. At the instant of putting S2 to the On position, pins 2 and 6 of IC1 are held at the same potential as the positive rail by the discharged test capacitor and the output at pin 3 is low. LED1, in consequence, lights up. The l.e.d. remains alight until the voltage on the lower plate of the test capacitor falls to one-third of the supply voltage. At this voltage the pin 3 output of IC1 goes abruptly high, and the l.e.d. extinguishes. It stays extinguished as the voltage across the charging capacitor continues to increase. The ICM7555 is therefore employed as a voltage comparator.

The length of time during which the l.e.d. is alight is equal to the time needed for the voltage across the test capacitor to reach two-thirds, or 67%, of supply voltage. There was a similar charging circuit in Fig. 1(b) when we noted that the voltage across the test capacitor reached 63% of supply voltage after a period equal to the time constant of R and C had

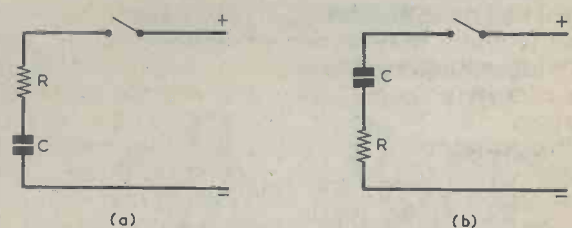


Fig. 1(a). When the switch is closed the voltage across the capacitor rises and reaches 63% of the supply voltage after a period equal to the time constant of the resistor and the capacitor (b). With this circuit the voltage across the capacitor increases in the same way after the switch closes, but the voltage on the lower plate is now negative-going

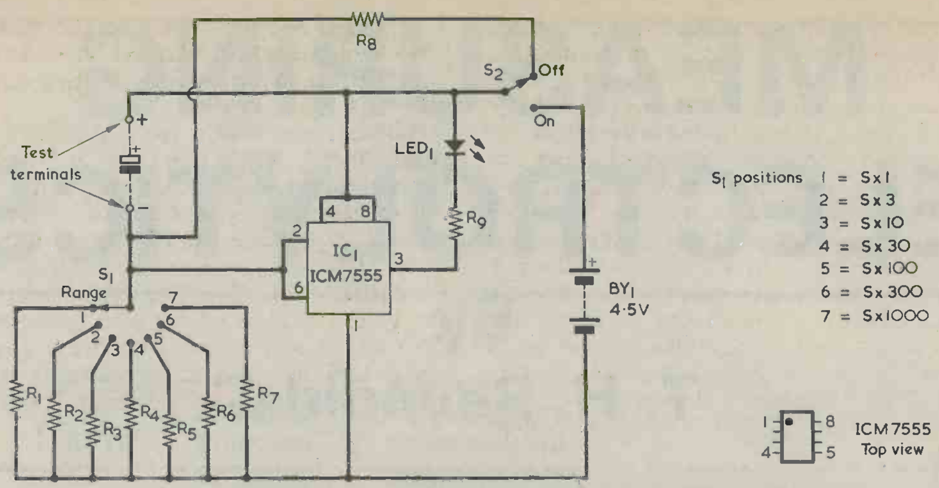


Fig. 2. The circuit of the capacitance measuring instrument. The test capacitance, in microfarads, is equal to the number of seconds the l.e.d. is alight multiplied by the appropriate figure for the setting of Range switch S1

elapsed. We shall not be introducing more than a slight error if we assume that the period during which the l.e.d. is alight in Fig. 2 is equal to the time constant of the capacitor and whatever resistor is brought into circuit by S1. Since we know the value of the resistor we can then find the value of the test capacitor by measuring the length of the period when the l.e.d. is alight. The process is quite easy to carry out and involves no complicated mathematics. The basic principle behind the circuit is not new, and was employed in G. A. French's "Suggested Circuit" in the May 1979 issue. This version used the old 555, employed a different switching arrangement and had the test capacitor charging from the negative rail. The present design has the capacitor charging from the positive rail because the ICM7555 output is then low during the initial charging period and is capable of illuminating an l.e.d. brightly. The ICM7555 output, in the high state, has a useful current capability of a few milliamps only, this being particularly the case with the present low supply voltage of 4.5 volts only.

COMPONENTS

Resistors
(All ¼ watt 5%)
R1 1MΩ
R2 330kΩ
R3 100kΩ
R4 33kΩ
R5 10kΩ
R6 3.3kΩ
R7 1kΩ
R8 10Ω
R9 220Ω

Semiconductor
IC1 ICM7555

Light-Emitting Diode
LED1 red l.e.d.

Switches
S1 1-pole 7-way rotary
S2 s.p.d.t. toggle

Battery
BY1 4.5 volt battery

Miscellaneous
2 insulated terminals
Control knob
Small plastic case
Wire, etc.

TIME MEASUREMENT

The period during which the l.e.d. is alight after operating S2 is measured by observing the seconds display on a digital watch or the sweep second hand of an analogue watch. If the watch is held fairly close to the l.e.d. it is a simple matter to observe the seconds readings whilst keeping the l.e.d., which offers a relatively bright light, within the field of vision. Useful indications are possible for timing periods of 2 seconds or longer.

IF S1 is in position 1 it selects the 1MΩ resistor R1. Should the test capacitor have a value of 5μF the l.e.d. will stay alight for 5 seconds. Thus, test capacitance values, in microfarads, on position 1 of S1 are directly equal to the number of seconds. R2 has a value which is one-third of R1, whereupon test capacitances are equal to the number of seconds multiplied by 3. If the time period is 4 seconds on this range the test capacitance is 12μF. R3 is one-tenth the value of R1 and the seconds multiplier becomes 10. The following resistors, R4 to R7 inclusive, follow the same pattern and the corresponding multipliers are listed in Fig 2.

To measure an unkown capacitor, this is connected to the test terminals and S1 is initially set to position 7. S2 is put to On. If the illumination of the l.e.d. is too brief to measure, the process is repeated with S1 at position 6. S1 is advanced one step at a time until the illumination period becomes sufficiently long to measure comfortably, and the test capacitance is then evaluated. Quite accurate measurements are possible if S1 is put to a lower setting to give illumination periods in the order of 15 to 40 seconds, although these will naturally take longer to carry out. In many instances a reasonable guess at the value of the capacitor will be possible by a consideration of its size, whereupon S1 can be initially put to a setting lower than 7. The minimum value which can be reasonably well measured is $2\mu F$ with S1 at position 1. There is really no limit to the maximum capacitance which can be evaluated. With S1 at position 7 a $10{,}000\mu F$ capacitor will cause the l.e.d. to be illuminated for 10 seconds.

The current drawn from the 4.5 volt battery is about 10mA when the l.e.d. is alight and falls to approximately $40\mu A$ when the l.e.d. is extinguished. An initial charging current of about 4.5mA flows when S1 is set to position 7. The battery can consist of three HP7 cells in series or a "flat" torch battery, Ever Ready No. 1289. The low battery voltage allows any electrolytic capacitor with a working voltage of 4.5 volts or more to be measured. The switch employed for S1 can be a single pole 12 way rotary switch with adjustable end stop set for 7 way operation. ■

A CENTURY OF GMT

BBC World Service Report

The method of time-keeping known as Greenwich Mean Time was one hundred years in 1980. The BBC World Service recently looked back over its past history origins.

In pre-industrial times most craftsmen in Britain were self-employed and decided themselves when to start work, but the growth of the factory system meant that labour had to be organised more systematically. Some of the early factories had clocks, but as the number of clocks increased it became impossible to decide which one was the most accurate.

Adding to the confusion, each locality kept its own time, usually based on the position of the sun at noon. So there could be variations of up to ten or sixteen minutes between different places in the country. Then came the advent of the railway and the need for a uniform time scale throughout the country.

In 1880, Parliament passed the 'Definition of Time' Act. This followed the installation of an electric clock by the Post Office at Greenwich from which an automatic signal was transmitted at exactly 10.00am every day to every telegraph office in the country. Because of the existence of this clock, Greenwich time was defined in 'The Definition of Time Act' as the time to which all the country's clocks should be set.

But although this act established Greenwich time as the legal standard in Britain, clocks in other parts of the world, of course, told a different time and there was no one standard time against which they could be set. This was particularly confusing to mariners travelling from one time zone to another.

In 1884 it was agreed at an international convention that all longitudes and time zones would be based on the Greenwich meridian and Greenwich time. The equipment for keeping the world on time is housed in gleaming aluminium and brick buildings.

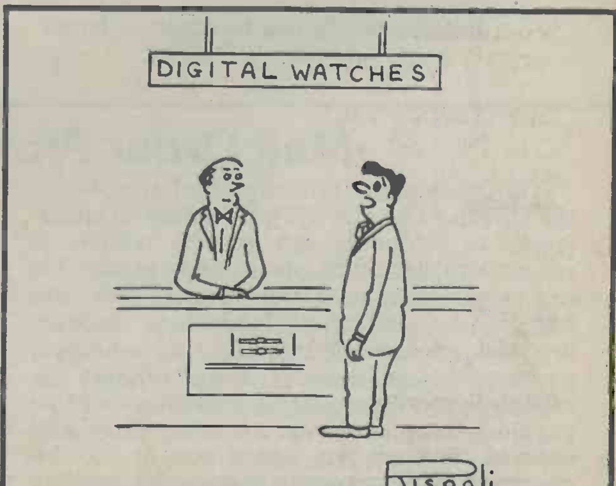
Inside one is the 28 inch Isaac Newton telescope, the largest in Western Europe. Another building houses chronometers and computers, and in a nearby alumunium shed stands the masterclock of the world – an instrument known as the photographic zenith tube.

It stares straight up at the sky, photographing and clocking the stars that traverse its field; and the scientists at Greenwich who look through it are able to mark the passage of the universe every thousandth of a millionth of a second.

It is they who provide the BBC with pips heard all over the world to mark the passing of each hour. The BBC keeps two landlines open to the Royal Observatory 24 hours a day, and the pips are transmitted from Greenwich to the BBC at 15 minute intervals.

Sadly however, Greenwich Mean Time has fallen out of favour, for the fact is that the earth is slowing down by about one second a year. Experiments in radio astronomy, geophysics and satellite communication systems demand even greater accuracy. So GMT has been superseded by the atomic clock which measures a second in terms of the number of vibrations of an atom.

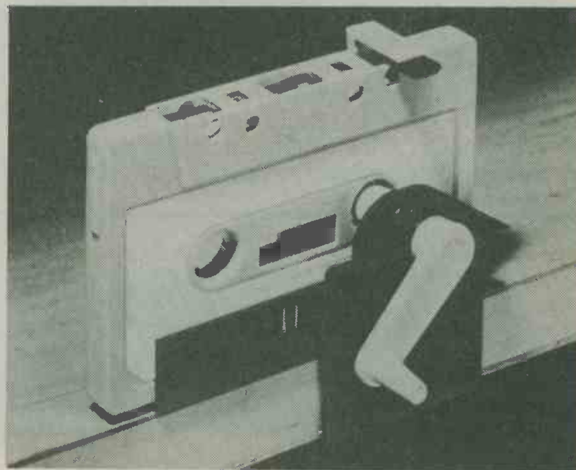
But whilst scientists split time to a billionth of a second, for most of us the pips of the Greenwich Time signal are sufficient.



"Have you got one that just tells the time?"

New Products

FIXOTAPE CASSETTE ACCESSORY



An answer to the perennial problem of tangled cassette tapes, faced by anyone interested in recording or recordings, is provided by Fixotape, a new device just launched by Jorephani Exports of Park Lane, Corsham, Wilts.

Simple in action, Fixotape snap-fixes to any table edge or shelf. The Cassette is pushed into it, the tape fed through a guide and at the turn of a handle any tangled, twisted, creased or knotted tape is freed within seconds.

Fixotape can also be used as the basis of a mini-workshop, because it is invaluable for editing, cleaning or repairing tapes. Simple, durable and always handy, Fixotape is now being patented worldwide, It is being sold through normal retail trade outlets, particularly hi-fi and record shops, but in the event of difficulty, can be obtained direct from Jorephani Exports, price £1.99 including post and packaging (with a money-back undertaking).

Built-in advantages in new clock radio

Eagle International have just launched a digital alarm clock radio which has been specially designed to be mounted neatly into a bedhead, kitchen unit or other site in the house where maximum advantage may be taken of its comprehensive facilities.

The RCA 20 has a removable back panel which, when unscrewed, leaves a fully enclosed unit that can be fitted into a prepared aperture. It is complete with all necessary mounting brackets and screws to enable a simple and neat installation. However, if the outer back panel is left in place, the slim-cased RCA 20 may be used free-standing in the conventional way.

The clock radio embodies an unusual variety of facilities for its price – retailing at around £44 (inc. VAT). The "touch-snooze" plate, as well as serving the late-night and early-morning listener, offers a timer facility for the busy cook, who can set the alarm for any period up to 59 minutes. It can be programmed, in fact, to give the listener up to half-a-dozen calls within the hour. The RCA 20 can be mounted in a kitchen unit facia, conveniently away from working surfaces.

The alarm function can be set for any desired time or radio station (both Medium wave and FM), and this automatically switches on the radio with or without a "warble" call as desired. The green LED time readout has a fully adjustable brightness control.

Further details can be obtained from:

Eagle International,
Precision Centre,
Heather Park Drive,
Wembley HAO ISU.

Mail Order Protection Scheme

The publishers of this magazine have given to the Director General of Fair Trading an undertaking to refund money sent by readers in response to mail order advertisements placed in this magazine by mail order traders who have become the subject of liquidation or bankruptcy proceedings and who fail to supply goods or refund money. These refunds are made voluntarily and are subject to proof that payment was made to the advertiser for goods ordered through an advertisement in this magazine. The arrangement does not apply to any falure to supply goods advertised in a catalogue or direct mail solicitation.

If a mail order trader fails, readers are advised to lodge a claim with the Advertisement Manager of this magazine within 3 months of the appearance of the advertisement.

For the purpose of this scheme mail order advertising is defined as:

"Direct response advertisements, display or postal bargains where cash has to be sent in advance of goods being delivered."

Classified and catalogue mail order advertising are excluded.

'NOTES FOR NEWCOMERS'

OHMS PER VOLT

By D. Snaith

Explaining a commonly encountered phrase

Digital multimeters, with readings given by an l.e.d. or liquid crystal display, are becoming more and more common. Unfortunately, they still tend to remain rather expensive and we can only hope that, like pocket calculators and digital watches, they will eventually start reducing in price. Whereupon, for the time being those of us with short pockets will continue to use the trusty old analogue multimeter with its pointer and scales.

METER RESISTANCE

What can be puzzling to the beginner in electronics is that the sensitivity of analogue multimeters on their voltage ranges is specified in terms of "ohms per volt". To understand how this expression arises we have first to examine what constitutes an analogue voltmeter.

In Fig 1(a) we have the basic meter movement for an analogue meter and, to choose a nice easy figure, this could have a full-scale deflection current (i.e. the current at which the needle indicates maximum on its scale) of 1mA. The meter movement will be a moving-coil type in which a coil having many turns of thin wire is pivoted to turn in a magnetic field. That coil is bound to have a significant resistance and a typical figure could be 170Ω. This is known as the "internal resistance of the meter movement.

Let's say that we want to use this meter in a voltmeter having a full-scale deflection of 1 volt. We do this by adding a resistor, R1, in series, as in Fig. 1(b). What is the value of this resistor? Well, we know from Ohm's Law that, if we apply a voltage of 1 volt across a resistance of 1kΩ the current which flows in the resistance is 1mA. Should we make the series resistor of Fig. 1(b) 1kΩ then? No, we can't do that because there is already 170Ω in the meter coil, and so we make the series resistor 1kΩ minus 170Ω, or 830Ω, as in Fig 1 (c). The total resistance between the voltmeter terminals is now 1kΩ and so if we apply 1 volt to those terminals 1mA of current will flow and the meter will indicate full-scale deflection, or "f.s.d." for short.

Let's next say that we want to add two more ranges to the voltmeter, to give f.s.d. readings at 5 volts and at 20 volts. This we start to do in Fig. 2(a). A current of 1mA will flow when 5 volts are applied to a resistance of 5kΩ. We already have 1kΩ in the meter movement coil plus R1, so we only need to add

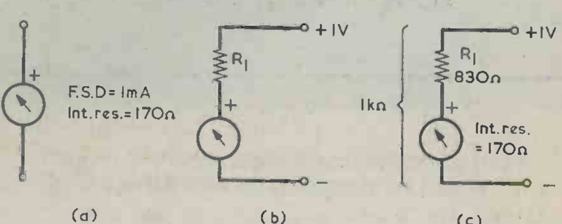


Fig. 1(a). A 0–1mA moving-coil meter movement. This can, typically, have an internal resistance of 170Ω
(b) Adding a resistor, R1, to produce a 0–1 voltmeter. What should be the value of R1?
(c) Since the total resistance must be 1kΩ, R1 requires a resistance of 830Ω

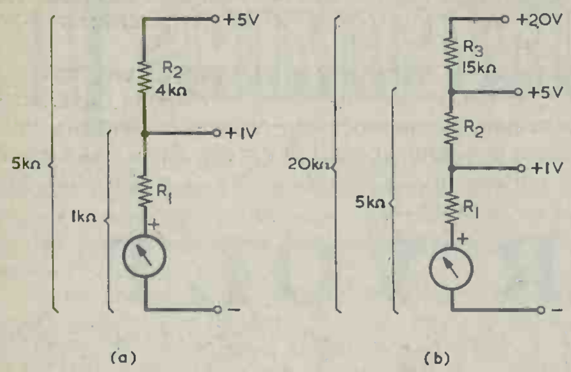


Fig. 2(a) R2 is added in series with R1 and the meter movement to produce an f.s.d. voltage indication at 5 volts (b) Yet another series resistor, R3, is added to produce a 0–20 volt voltmeter

another series resistor, R2, which has a resistance of 4kΩ. We advance to the 20 volt range in Fig. 2(b). Here we want 20kΩ for a current of 1mA to flow at f.s.d., and we add a further series resistor, R3, having a value of 15kΩ. So the grand total of resistance on the 20 volt range is 20kΩ.

SENSITIVITY

Summing up, we have 1kΩ voltmeter resistance on the 1 volt range, 5kΩ voltmeter resistance on the 5 volt range and 20kΩ voltmeter resistance on the 20 volt range. In other words we have a voltmeter with a sensitivity of 1kΩ per volt or, to make it sound grander, 1,000Ω per volt.

If our basic meter movement had an f.s.d. sensitivity of 100μA, which is one-tenth of 1mA, the total resistance values become multiplied by 10. On a 1 volt range we would have a total resistance (meter coil plus series resistor) of 10kΩ, on the 5 volt range a total resistance of 50kΩ and on the 20 volt range a total of 200kΩ. So, a basic meter movement with an f.s.d. sensitivity of 100μA permits us to make up a voltmeter with a resistance of 10,000Ω per volt. If the meter movement had an f.s.d. sensitivity of 50μA we could make up a voltmeter with a resistance of 20,000Ω per volt.

We have used voltage ranges of 1 volt, 5 volts and 20 volts in our example but the same results apply to other volt ranges. Thus, if a voltmeter with a sensitivity of 10,000Ω per volt has a 10 volt range, the total resistance presented on that range would be 100kΩ.

Expressing voltmeter sensitivity in terms of ohms per volt is not an engineer's idea for making things difficult for newcomers. It is a very useful method of showing how much loading a voltmeter will place on a circuit being checked. If our particular voltmeter is stated to be 10,000Ω per volt and we switch is to a 50 volt range to take a reading, we know that the voltmeter will load the circuit being checked with a resistance of 50 times 10,000Ω, or 500kΩ. ■

REGULATOR CIRCUITS

Fixed and variable voltage regulators

By
D. H. Trent

The 78L05 is a small 5 volt regulator with a maximum output current of 100mA. It is in a T092 encapsulation and the lead-out inset in Fig. 1 shows a bottom view with the lead-outs pointing towards the reader. Fig. 1 also shows the manner in which the regulator is normally connected into circuit. The unstablized input voltage should be at least 2 volts higher than the stablized output voltage. The two bypass capacitors ensure stability and should be wired close to the device. The 78L05 does not have output short-circuit protection, and output currents should not be allowed to exceed 100mA.

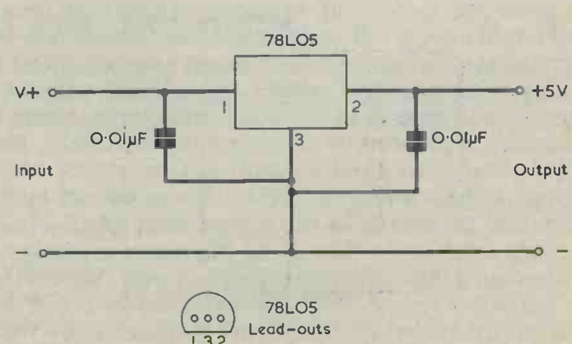


Fig. 1. The normal circuit in which the 78L05 voltage regulator is employed.

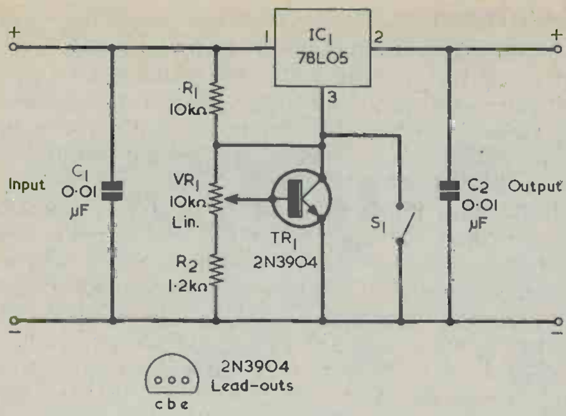


Fig. 2. With this circuit the stablized output voltage may be varied from about 5.6 to slightly more than 10 volts by adjusting VR1. Closing S1 produces a 5 volt stablized output.

VARIABLE VOLTAGE

If the common lead-out, pin 3, is taken positive of the negative rail the stablized output voltage is 5 volts positive of the pin 3 voltage. Fig. 2 shows a variable voltage stablized power supply which takes advantage of this effect. The collector voltage of TR1 is that which causes about 0.6 volt to be applied to its base so that, when VR1 slider is at the top of its track, approximately 0.6 volt appears across the transistor. When VR1 slider is at the bottom of its track, a voltage slightly in excess of 5 volts (assuming VR1 and R2 have their nominal values) is given across the transistor. Intermediate settings of VR1 give intermediate voltages.

The output voltage can, in consequence, be varied by VR1 over a range of around 5.6 volts to slightly more than 10 volts, all voltages having good stablization up to 100mA. In practice the maximum voltage may vary from the calculated figure. This is mainly because of variations of value in VR1, which will in most instances' be a 20% component. Switch S1 is closed to cause the regulator to give a 5 volt output. If this facility is not required, S1 may be omitted. The unstablized input voltage can be of the order of 14 to 18 volts.

Resistor R1 is not essential, but it gives a marginal improvement in performance by causing the transistor to pass a collector current greater than the small current available at pin 3 of the regulator. As a result, the voltage across the transistor is maintained at a more stable level.

REVERSE CURRENT

It is frequently of interest to try devices in circuit applications for which they are not primarily intended, and the author has checked out 78L05 preformance in the test set-up of Fig. 3. The regulated output is 5 volts as before, but current is drawn from it not towards the negative rail but in the opposite direction. The current is monitored by the milliammeter M1, and is varied by the potentiometer coupling to the positive terminal of the battery. M2 is a very high resistance voltmeter.

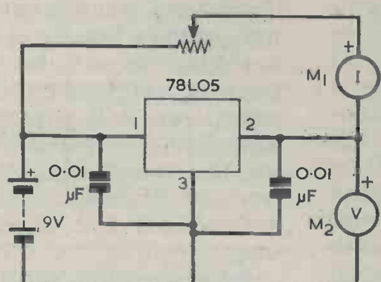


Fig. 3. An experimental circuit in which current is drawn from the regulator output in the opposite direction to normal.

Fig. 4 shows the graph obtained by plotting output voltage against the "reverse output current". The voltage remains steady at 5 volts until the current rises to some 0.5mA above which it starts to rise, reaching some 7.5 volts around 2mA. In consequence, and maintaining a safety factor, it would seem that the 78L05 is capable of maintaining its regulated output voltage for "reverse output currents" up to at least 0.3mA.

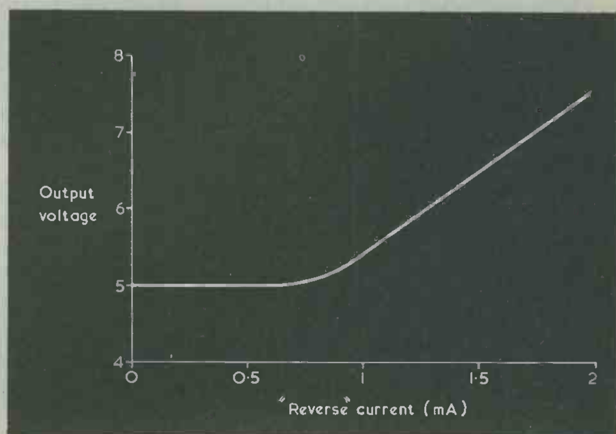


Fig. 4. Output voltage – current curve given with the test circuit of Fig.3.

A current of 0.3mA is very small in terms of power supplies but it nevertheless allows the regulator to provide a useful reference voltage in high impedance circuits, and it would be sufficient to drive, say, an emitter follower which itself passed some 50mA.

The variable voltage supply circuit of Fig. 2 is also capable of providing low "reverse output currents" without any change in output voltage. It can, therefore, provide a reference voltage adjustable within its range and having a source capability of 100mA and a sink capability of at least 0.3mA. ■

Radio Topics

* * * * *

By Recorder

There are always new people entering any pursuit, and it would seem that our particular hobby, that of constructing electronic projects, is becoming more and more favoured by those who wish to expand their experience and acquire assembly skills, as well as extract quite a lot of enjoyment from the process. Newcomers do not, obviously, know all the ropes, and there are almost always some hurdles which appear insurmountable at first until, magically, they have been successfully cleared.

The brand-new beginner in electronics will, of course, follow his own inclinations, and he may tackle quite ambitious projects right from the start. Others may prefer to gain confidence by constructing simpler designs. When it is found that these work after they have been completed, the new enthusiast can then carry on to more complex equipment.

MAIL ORDER SHOPPING

One continuing problem which besets the beginner is the purchasing of components. Not all of us have the good fortune to live near a well-stocked electronic component shop, and even then it is almost certain that such a shop will not have available some of the more out-of-the-way components that occasionally turn up in projects. The only recourse, then, is to obtain the parts required by mail order. If you look through the advertising pages of ***Radio & Electronics Constructor*** you will find listings of available parts by suppliers together with quite simple instructions for their purchase through the mail.

The newcomer will be even better served if he obtains component catalogues, as also advertised in this journal. Many suppliers have stocks which are so large and varied that they could not possibly be listed in magazine advertisements, and the only way to find out what items can be obtained is to send off for their catalogues. The catalogues are often full of extremely useful descriptions of the parts on offer, and the catalogues themselves may even contain basic constructional information for their use.

With a few catalogues in front of you, you can quickly find all the components you require for a particular constructional exercise and you can also, where there is a choice, pick the least expensive. Half an hour with the catalogues can enable you to order very many parts, and the only minor snag is that you have to wait a few days for the components to come through to you after you have posted off your order.

So, if you are embarking on electronic construction as the pleasurable pursuit that it is, do give serious consideration to obtaining mail order catalogues. They are interesting, instructive and can save you no end of time!

COLLECTING SPARES

The beginner will probably find, after he has spent some months at construction, that he is beginning to acquire quite a collection of odd components together with nuts, bolts and other hardware. Some components such as small resistors can be so cheap, even for these days, that it hardly seems worth buying just one of a particular value when that is all that is called for in a project. So you may order say, five, and keep the spare resistors on one side for possible future use. Again some items, especially hardware, are on sale in packets rather than singly. Sometimes you may strip down a project whereupon, provided they have been treated carefully, quite a few if not all of the components can be used all over again. However it happens, you will almost inevitably find that you are becoming the owner of quite a large number of items, all of them serviceable and all ready for use.

As soon as this stock of spare parts begins to become large it is a very good idea to keep the items sorted out. Small glass or clear plastic jars are surprisingly useful here because you can see the contents, and if they have screw-on caps they are even more useful. The last thing I would want to do is influence your family's eating habits but you may find it worth-while, the next time you are in your local supermarket, to look around for items of food which are sold in transparent containers that would be just right for your spare parts collection.

COMPONENT MARKINGS

A good way of keeping spare resistors sorted out is to put them in groups corresponding to the third colour in their colour coding. Thus, all resistors graded orange would be in the range 10kΩ to just short of 100kΩ, those graded yellow would run from 100kΩ to less than 1MΩ, and those in the green grade would be single figure megohm values. Keeping resistors sorted out in this way saves a lot of searching when you need a value in a hurry.

Capacitors can be sorted out in terms of type. Silvered-micas could constitute one group, polystyrenes another group, and so on. Take care with capacitors having printed values because the printing can become rubbed off very easily.

Because of the impermanence of the markings on some semiconductors, it is very advisable to have a container for each type. Otherwise, you might find yourself soldering into circuit a 78L05 voltage regulator in the happy belief that it is a BC184L, or a ZN4114 radio i.c. instead of a BC109C. Incidentally, you can't blame the manufacturers if the marking on some semiconductor devices soon becomes smudged or erased. In normal use the devices would simply be soldered to a printed board at some factory, and the markings would be perfectly able to withstand the small amount of handling then involved.

So you may well find yourself collecting more and more items without even seriously attempting to do so. These are then immediately available for experimental work, which can be even more fun then assembling published projects.

POCKET MAGNETOMETERS

The hand-held meter you can see in the photograph is not the sort of instrument you encounter every day. It isn't even an electrical instrument. It is a magnetometer and its function is to measure residual magnetism in steel parts, to measure magnetic polarity and to compare magnetic fields. The model shown is capable of measuring gauss up to plus or minus 5 gauss and has 0.5 gauss scale units.

The instrument is dual purpose and has an outer black scale and an inner red scale. The black scale gives direct gauss readings for a uniform magnetic field oriented parallel with the centre line on the scale. That centre line is immediately below the pointer pivot and has an arrow pointing directly downwards. The red scale is used to determine the magnitude and direction of a magnetic field which is parellel with the pointer.

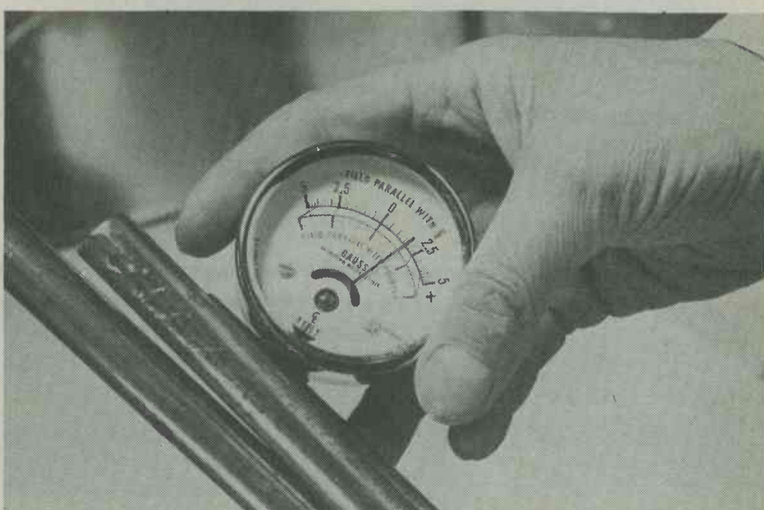
There is a range of 12 similar models, with type numbers from LR77/1 ro LR77/12 and these provide sensitivities from plus or minus 0.5 gauss up to plus or minus 100 gauss. Made in the USA by Annis, the meters are supplied by Leevers-Rich Equipment Limited, 319 Trinity Road, Wandsworth, London SW18 3SL.

MARCONI UMBRELLAS

Local a.m. radio stations have their problems, particularly with respect to finance. A considerable expense can be incurred with the provision of a suitable aerial system which, normally, requires to be about one quarter wavelength in height. So, if you set up a transmitter at around 400 meters you could need an aerial which is 100 metres, or nearly 110 yards high.

New medium wave "Umbrella Antennas" made by Marconi Communications Systems Limited overcome the problem, and these are being supplied to the Independent Broadcasting Authority. Following the successful comissioning of one such aerial for the IBA's local radio station in Cardiff, two further aerials have been ordered from the Marconi Antenna Systems Division for installation at the new Independent local radio stations at Aberdeen and Inverness. Marconi is also to provide the IBA with a transportable version for use as a standby.

The requirements of operators of local radio stations, and the problems they face, have resulted over the years in the development of a number of solutions. Of these, what must undoubtedly be one of the most innovative is the Marconi Umbrella Antenna



A pocket magnatometer available from Leevers-Rich Equipment Limited. This measures from –5 to +5 gauss in 0.5 gauss stages.

system. Basically, the operator requirements are to keep costs to a minimum while still providing a satisfactory coverage and, since aerials tend to be large and unsightly, to reduce environmental problems to a minimum.

With standard quarter-wave aerials, the cost of the basic structure at medium wave frequencies is disproportionately large in comparision with the cost of the transmitter itself. The Marconi Umbrella system, in which the aerial is "folded" so as to reduce its height, is less than half the size of conventional systems and makes a very considerable saving on the cost of installation. Furthermore the systems provided for Cardiff, Aberdeen and Inverness are such that the transmitter can be matched directly to the aerial without the need for an expensive aerial tuning unit.

Marconi Umbrellas are to be found all round the world and the company, which has almost one hundred years experience in aerial development, can well be considered a world leader in this field. Ranging from l.f. to s.h.f., Marconi aerials are used in satellite communications networks, tropospheric scatter, broadcasting, military and civil communications systems from Bahrein to the West Indies, and from Hong Kong to Norway.

Two of a new range of four combined data decoder and liquid crystal display modules available from Ambit International.

LCD DISPLAY MODULES

The second photograph shows two of a new range of miniature combined data decoder and liquid crystal display modules available from Ambit International, 200 North Service Road, Brentwood, Essex, CM14 4SG. These are types DM180 to DM183 and they provide ideal solutions to many m.p.u. data output decoding and display requirements.

Two versions, the DM180 and the DM181, which are based on the ICM7211 (DF411), provide simultaneous decoding and display from multiplexed BCD inputs. Additional options provide for either HEX or Code B displays. The DM180 and DM181 operate from 3.5 to 6 volts at typically only 20μA consumption.

The DM182 and DM183 provide decoding and display using serial data inputs compatible with most types of m.p.u. Consumption from 3 to 15 volts is typically 60μA only.

All the modules measure 60 by 30 by 7mm., and can be supplied with a panel mounting bezel if required.

From time to time we try to set aspects of our hobby in a wider context.

Recently there was an article in the *Financial Times* describing the new industries which are developing in Japan and will, in time, be more important to the Japanese than their traditional industries such as shipbuilding and car manufacturing.

According to the article new industries use a new "basic" raw material, namely Integrated Circuits. Japan is only second to the U.S.A. in producing I.C.s and it is anticipated that they will play a very big part in the Japanese economy during the 1980s.

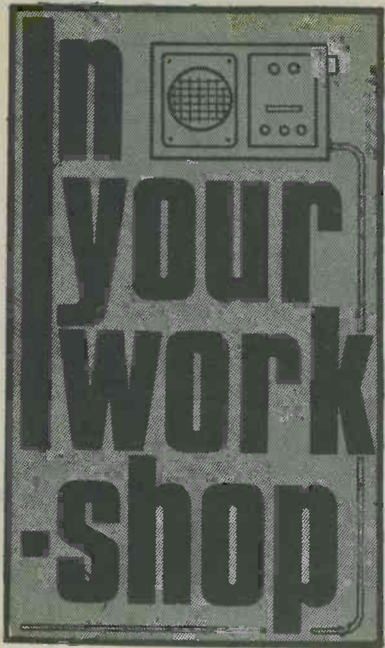
These new industries will almost certainly be successful and, apparently, video tape already earns them more foreign exchange than do colour TVs.

BACK NUMBERS

For the benefit of new readers we would draw attention to our back number service.

We retain past issues for a period of two years and we can, occasionally, supply copies more than two years old. The cost is 78p, inclusive of postage and packing.

Before undertaking any constructional project described in a back issue, it must be borne in mind that components readily available at the time of publication may no longer be so.



The transformer with a memory

Even ohmeter tests can lead you astray

The little monochrome TV in the smart white cabinet was the last set remaining on the "For Repair" rack. At its front, to the right of the screen, was the loudspeaker grille, and there was a rotary channel selector tuning control above this and a combined volume control and on-off switch below. Above the rear to the right projected an adjustable single wire loop aerial, and this had been pushed down flat over the top of the case.

Dick looked at the set cheerfully. He and Smithy had had a good day, and they had successfully cleared up a record quantity of faults, all obvious and all easy to repair. The life of a service engineer cannot always consist of frustration following frustration and the Fates had smiled fondly at the pair, presenting them with a succession of snags which were almost vying with each other in calling attention to their location. A noisy volume control, a wire adrift at a 2-way DIN plug, a 6-volt battery holder with one HP7 cell inserted wrong way round, a broken tuning drive cord, an unserviceable coaxial socket which had probably suffered from the repeated plugging and unplugging of a TV, game, a worn-out black and white cathode ray tube to which Smithy had given a further lease of life by application of his secret cathode emission rejuvinator. These were amongst the many elementary faults which had been triumphantly tackled and treated on this happy and halcyon day.

Dick picked up the little TV set, carried it over to his bench, pulled its loop aerial to a vertical position and plugged it into the mains. He rotated the volume control, and there was a click as the on-off switch operated.

MAINS INPUT RESISTANCE

The set remained silent. Dick waited patiently for the c.r.t. screen to light up but it stayed completely blank. He turned the volume control to its maximum setting and experimentally adjusted the tuning control. There was not even a hiss from the speaker, nor was there any glimmer of light from the tube.

If the form already established for the day was to continue, the fault would probably be nothing more complicated than an open-circuit fuse in the 13 amp mains plug. Dick pulled the plug of the TV set from the bench mains socket, switched his testmeter to a high resistance range, zeroed it and applied the test clips to the live and neutral pins of the plug. The needle moved over to indicate a resistance which was too low to be read from the meter scale. Dick switched to the lowest ohms range on his meter and re-zeroed it. He then applied the test clips once more to the live and neutral pins of the mains plug. (Fig. 1.)

With a surprising sluggishness, the meter needle moved to the right, to finally settle at a reading of about 40Ω. Dick disconnected one test clip from the mains plug and then reconnected it. The meter needle advanced, much more quickly, to the 40Ω reading.

Dick scratched his head. The TV set was still switched on and that 40Ω reading must almost certainly be the resis-

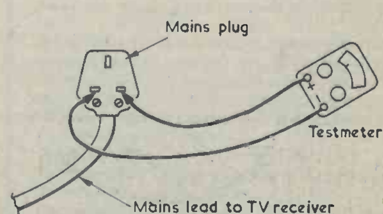


Fig. 1. Dick applied the leads of his testmeter, switched to a low ohms range, to the live and neutral pins of the mains plug connected to the television receiver he was examining.

tance of a mains transformer primary inside the set. So, at least, there were no blown fuses. But the behaviour of his testmeter was puzzling. Why should the needle have moved sluggishly the first time and then relatively rapidly the second time? Dick disconnected the test clip and reconnected it again. The meter needle moved over, with the same speed as on the last occasion, to the reading of 40Ω.

Frowning, Dick considered the situation. Could there be some peculiar type of capacitor connected across the mains input in the TV set which varied the rate at which the meter needle moved? Could the fact that the needle had moved so much more quickly on the second and third occasions indicate that the capacitor had acquired a charge from the testmeter ohms range battery during the first resistance reading? It was all very mysterious. Struck by a sudden inspiration, Dick removed the test clips from the mains plug pins and reconnected them the other way round. (Fig. 2.)

The meter needle rose sluggishly to indicate about 100Ω and then crept, quite slowly indeed, to the final reading of 40Ω. The total time needed to arrive at the final setting was much longer than the fairly extended period when Dick had first applied the testmeter, switched to its low ohms range, to the mains plug pins. Extremely puzzled now, Dick disconnected one test clip and re-applied it to its mains plug pin. The meter needle advanced to the 40Ω setting at the same relatively rapid speed as on the second and third occasions.

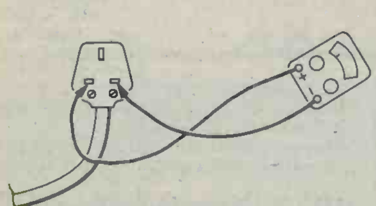


Fig. 2. Puzzled by the resistance readings he obtained, Dick changed over the testmeter leads – to obtain even more puzzling readings!

With trembling fingers, Dick disconnected the test clips, changed them over again and reconnected them. The meter needle rose sluggishly to the 100Ω calibration point and them crawled, quite slowly indeed, to its ultimate destination of 40Ω. Worried, Dick gazed at the meter scale. He removed the test clips and started to reconnect them, reversed yet again, to the live and neutral plug pins. After he had connected one clip a thought occurred to him and he switched off the TV set by rotating its volume control fully anti-clockwise. He then connected the remaining test clip to the plug.

The meter needle rose sluggishly to around 100Ω and then moved, quite slowly indeed, to its final setting of 40Ω.

MYSTERY OHMS

"Oh, no!"

Stricken, Dick slouched back on his stool and gazed apprehensively at the TV set and testmeter in front of him. A low moan escaped his lips.

"What on earth is the matter with you?"

Dick looked up at the sound of Smithy's voice.

"I've got a real enema over here, Smithy." he replied dolefully.

"A real ***what?***"

"A real enema."

"Well, I've given a few bad names to some of the snags I've encountered over the years, but I've never had any reason to call a fault **that**! What's the trouble?"

"It's too difficult to explain," said Dick. "Come on over and I'll show you."

Smithy rose from his stool and walked over to Dick's side.

"This TV came in dead," continued Dick, "and so I thought I'd just do a quick resistance check across its mains input. And I found that I got a slow movement in the testmeter needle when I first connected the test leads and a much quicker movement when I connected them again. Then, when I swopped the test leads over I got a ***really*** slow needle movement first time off and then the quick movement on connecting up once more. After this, the very slow movement came back at first when I changed the leads back to their original state. And the meter needle movement keeps on like that each time I connect it. What's more, the effect is still there even when the set is switched off!"

Dick demonstrated the behaviour of the meter needle with the test leads connected one way and then reversed. As he did so, a slow smile spread over Smithy's face.

"There you are," wailed Dick in conclusion, "A right enema!"

He turned round to face the Serviceman.

"Hey, he remarked suspiciously, "what are you grinning at?"

"Your mysterious effect. What do you call it?"

"An enema," repeated Dick. "Something which just cannot be explained."

Smithy burst into laughter.

"You great steaming nit," he roared. "The word is 'enigma'!"

"Oh, all right then, said Dick crossly. "There's no need to take the mickey out of me just because I'm not so – what's the word for being good at words?"

"Erudite?"

"Come off it, Smithy, that's for sticking things together. Well, perhaps I'm not so ***learned*** as you are with words. But there's still that queer ohmmeter business. If you're so clever, perhaps you can explain that."

Smithy beamed at his assistant.

"You're miffed," he pronounced cheerfully. "I can see that you're quite definitely miffed. Well, it's been such a good and successful day today that I can't let it finish with you in a state of advanced miffedness. So hang on a jiffy."

Smithy walked over to his spares cupboard and rummaged around inside. Eventually he returned and placed a large mains transformer on Dick's bench. He indicated two tags on a tagstrip mounted on top of the transformer.

"Those look to me," said Dick cautiously, "like the primary tags."

"They are," stated Smithy. "Now connect your testmeter clips to these two tags, first one way round and then the other way round."

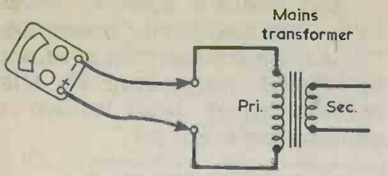


Fig. 3. Smithy used a mains transformer with no connection made to its secondary to demonstrate the types of resistance reading which can be obtained at the primary.

Dick did as he was told. He got precisely the same slow and fast needle movements that he had encountered at the mains input pins for the television receiver. The only difference was that the final resistance reading with this particular transformer was around 25Ω. (Fig. 3.)

MEMORY EFFECT

"I don't get it," he said helplessly as he laid his test leads down on his bench. "I just don't get it."

"What you've been seeing," said Smithy, "is a magnetic memory effect which can be quite readily observed with fairly large inductors having laminated iron cores. For the effect to be really noticeable you need to have an iron-cored inductor with a low resistance, and you can get this with the primary of a mains transformer designed to handle some 20 watts or more. Also, you need an ohmmeter which causes a current of at least 10mA to pass through the inductor when the resistance reading is being taken."

"How do you know what current the ohmmeter provides?"

"You can get a rough idea," said Smithy, "from the ohms figure which appears at the mid-scale point of the ohms scale of the meter. Rough check, if the mid-scale ohms figure is around 25Ω or less, the ohmmeter will pass the necessary current through the mains transformer primary. I'm speaking now of analogue meters, of course, and not digital meters. And when I talk of ohmmeters I'm referring to multimeters which are switched to an ohms range."

Dick looked down at his meter.

"On the low ohms range I switched my meter to," he said, "the mid-scale resistance figure is 20Ω."

"Fair enough," said Smithy, pleased at this confirmation of his comments. "Now, let's look at what happens when you apply the ohmmeter leads to the transformer primary. The basic property of inductance is that it opposes change in the current flowing through it. This is why the initial movement of the ohmmeter needle is fairly slow. When the needle settles at its final position a current in the order of tens of milliamps flows in the mains transformer primary, and it causes the laminations to become magnetised. When you remove the ohmmeter test leads the laminations retain some of the magnetisation which has been induced in them. The result is that if you apply the test leads again with the same polarity the meter needle rises more quickly to the final reading. This is because there's less magnetisation of the laminations to be carried out,"

"Humph," grunted Dick dubiously. "Well, I'll have to agree that what you've just said did take place. Go on, Smithy."

"Right," said Smithy briskly. "If, next, you reverse the ohmmeter leads and apply them to the transformer primary once more, the current in the primary is flowing in the opposite direction. The increase in current as the meter needle rises is slowed down not only due to the inductance of the primary but also because the laminations have to be demagnetised from their previous state and magnetised again with opposite polarity. The whole process takes longer than the first application of the ohmmeter leads, which merely took the laminations from an unmagnetised state, because this time you're taking the laminations from magnetisation with one polarity to magnetisation with the opposite polarity. Subsequent applications of the ohmmeter leads give quick rises in meter needle movement. But if you swop the ohmmeter leads over again you get the considerably slowed down rise in needle movement at the first application."

"It sounds," said Dick, "almost as though the laminations have a memory."

"That's precisely what they do have. They remember the polarity with which they were magnetised last."

"But," protested Dick, "a mains transformer is supposed to work with alternating current at 50 cycles in one second! It's not going to follow changes in current direction which take place at 50Hz if the laminations spend all their time remembering what was the last type of magnetisation they had!"

"It's because they *do* remember," replied Smithy, "that laminated core mains transformers have losses. If you take a mains transformer and, with nothing connected to its secondary or secondaries, connect the primary to the a.c. mains a small alternating current flows. This is loosely referred to as 'magnetising current' and is partly due to the fact that the primary does not have an infinite inductive reactance and so some normal inductive current must flow. But quite a sizeable proportion of that 'magnetising current' consists of the current which is needed to take the laminations from magnetisation with one polarity to magnetisation with the opposite polarity."

"Well, stap me," stated Dick. "I've never heard of that before. I've always looked upon mains transformers as being almost perfect components."

"A well-designed transformer is not all that far from being perfect," said Smithy. "With a good transformer, the magnetising current is much smaller than the ordinary primary current which flows when the secondary or secondaries are loaded."

Dick's thoughts turned to the TV set on his bench.

"There must obviously," he remarked, "be the primary of a mains transformer inside that TV at the end of the mains input lead."

"No doubt of it."

"But there's another mystery," stated Dick, frowning. "The transformer must have still been connected to the mains input lead when I switched the set off."

MAINS INPUT CIRCUIT

"Ah," said Smithy. "Now we're dealing with quite a different matter. Let's see if I can find the service manual for that TV."

This time Smithy walked over to the filing cabinet, from which he returned with a service sheet. He opened this out on Dick's bench and the pair of them looked at the circuit diagram. Dick's attention at once became centred on the power supply section. (Fig. 4.)

"Blow me," he gasped. "There's no on-off switch in the mains input circuit at all. The mains goes through a fuse straight into the mains transformer primary!"

"That's right," confirmed Smithy. "This set is one of those which can work either from the mains or from a 12 volt car battery. The on-off switch for the set appears after the mains rectifier circuit and after the 12 volt car battery input socket."

"But," objected Dick, "that means that as soon as you plug the set into the mains and switch on at the mains socket the mains transformer and rectifier circuit are live."

"It does," agreed Smithy. "The power consumed by the transformer and rectifier circuit when the set is switched off will be negligibly low and will almost certainly hardly be enough to make that little wheel in the electricity meter on the wall even think of turning round. Incidentally, this business of having part of a TV still running when it's supposed to be switched off is by no means new. In some TV sets the tube heater is run at a reduced voltage when the receiver on-off switch is turned off, so that there is a quick warm-up when the set is switched on again. Indeed, it is sometimes stated that keeping the tube heater warm during switch-off can even extend the life of the tube, because the thermal shock at the tube heater is less when it changes from a warm to a hot state than

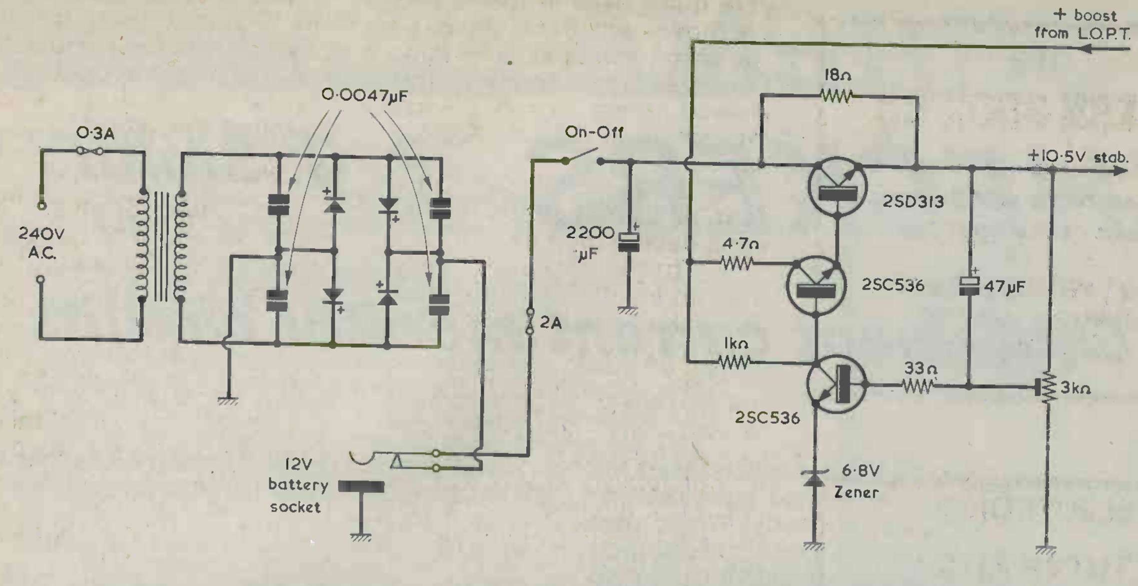


Fig. 4. The circuit of the power supply section of the television receiver. The rectified voltage from the bridge rectifier passes through a normally closed contact on the battery socket to the receiver on-off switch, and thence to the 3-transistor voltage regulator. This circuit is employed in the Sanyo Model 12-T280.

when it changes from a cold to a hot state."

"The fire chiefs are right, then."

"Fire chiefs? What fire chiefs?"

"The fire chiefs who give warnings every now and again about turning off TV sets. They say you should always switch off at the mains socket instead of just switching off at the set."

"Switching off at the mains socket," said Smithy, "would certainly ensure that there were no fire hazards from TV sets which aren't fully turned off by their own switches. Anyway, we'd better see what's wrong with this set now."

"As I said earlier on, it's completely dead," stated Dick. "No sound, no vision, nothing. That's why I started checking for continuity at the mains plug input pins to see if any fuses had blown. After which I got caught up with this mains transformer memory thing!"

"Well, apart from that," commented Smithy, "things have been very simple today. So let's see if our luck holds out with this set."

He turned the set round and took a cursory look at its back. Suddenly his eyes narrowed and he reached down and pulled a small plug out of a socket near the set bottom.

"Try it now, Dick," he said.

Dick took up the receiver mains plug and inserted it into the socket at the rear of his bench once more. He turned the volume control clockwise, whereupon a loud hiss became audible from the speaker. He next adjusted the tuning control and almost immediately picked up one of the three local transmissions. This gave perfectly acceptable vision and sound. The same results, after further adjustments of the tuning control, were available from the other two local stations.

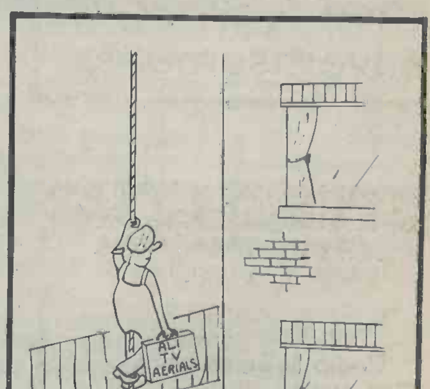
SUCCESS AGAIN

"It's at times like these," said Smithy, "that I feel I'm picking up money under false pretences. All that was wrong with this set was that someone had inserted the 12 volt battery plug into the battery socket. The contact at the battery socket had then automatically broken the circuit from the mains rectifiers to the on-off switch. Which means that we've cured this particular fault without even having to take the set back off. Things have certainly been good and easy today."

"Apart," commented Dick a little ruefully, "from that enigma of mine."

"Ah yes, your enigma," grinned Smithy. "What did you call it again?"

But Dick was not to be drawn by Smithy's taunts. And, knowing Smithy as we do, Dick was wise. Much as we appreciate the Serviceman's utterances, we have to admit that there are times when it is difficult to know whether his jibes are intended to be taken in jocular vein or in jugular vein. ■



CURRENT CHECKERS

By P. G. Smith

Equipment current monitor circuits.

It is sometimes desirable to be able to measure the current drawn by battery operated equipment to ensure that it is functioning correctly. Where such current checks are to be made as a matter of routine it can be helpful to provide the equipment concerned with a means of carrying out a quick connection without the fuss of opening the case and making what, with some battery clips, can be quite fiddling connections to get the meter in series with one of the battery leads.

CURRENT SOCKET

A very simple method of providing current measuring connections is to fit the equipment with a jack socket employing the circuit shown in Fig. 1(a). The socket is in series between the negative battery terminal and the equipment (shown as a "load") and, when no jack plug is inserted, its contacts complete the supply circuit.

A test lead assembly is made up consisting of two wires which connect at one end to a jack plug and, at the other end, to the terminals of a testmeter switched to a suitable current range. The positive meter terminal connects via the test lead assembly to the jack plug tip and the negative terminal to the jack plug sleeve. The equipment is switched on and the jack plug is then inserted to take the current reading. This method of working has the advantage that any electrolytic capacitors across the equipment supply rails will be charged before the connection is made and there will be no charging current surge in the meter.

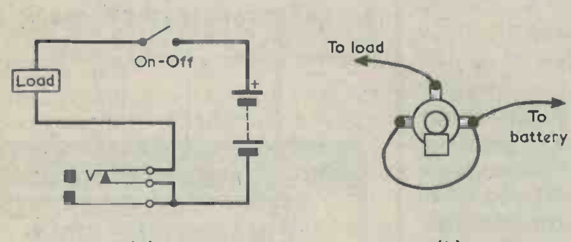


Fig. 1(a). Connecting a jack socket in series with the negative supply in an item of battery operated equipment. Current readings are obtained by inserting a jack plug connected to a testmeter which is switched to a suitable current range.

(b). A 3.5mm. jack socket is suitable and takes up little space. The wiring to it is as illustrated here.

The jack socket can be a standard 3.5mm. socket, and its tags are wired into circuit as shown in Fig. 1(b).

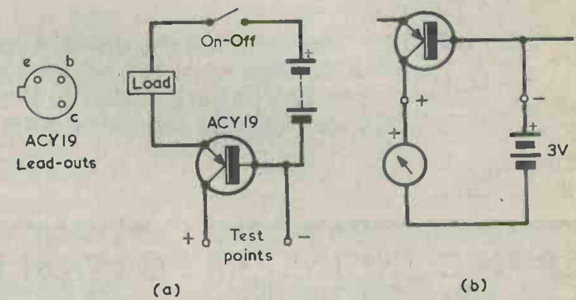


Fig. 2(a). A more unusual approach. The base-emitter junction of a p.n.p. transistor is permanently connected in the negative supply line.

(b). A current-reading meter and a 3 volt battery are connected to the test points with the polarities shown. The meter (a testmeter switched to a current range) indicates the current drawn by the equipment without altering its functioning in any way.

TRANSISTOR CIRCUIT

A more unusual circuit is shown in Fig. 2(a), in which the base-emitter junction of a transistor is permanently in series with the negative supply to the equipment. This time, two terminals are provided for current measurements.

The current reading meter, and a 3 volt battery, are connected to the test terminals as illustrated in Fig. 2(b), whereupon the meter indicates the current flowing in the base-emitter junction of the transistor! How is this achieved? The transistor is connected in the common base mode and has an emitter-to-collector current gain which is just slightly less than unity.

To keep voltage drop low, the transistor has to be an old-fashioned germanium type. This should be no problem to many constructors having a junk box of a few years' standing. In any case the transistor specified is still quite widely available, although it is getting a little pricey. Suitable alternatives, with the same lead-out layout, are ACY18, ACY20, and ACY21. All these, including the ACY19, have maximum base-emitter current ratings of 0.25 amp.

TRADE NEWS

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The 'CECILIA' is a unique bookshelf loud-speaker system which can be built in a weekend for around £35, the pair.

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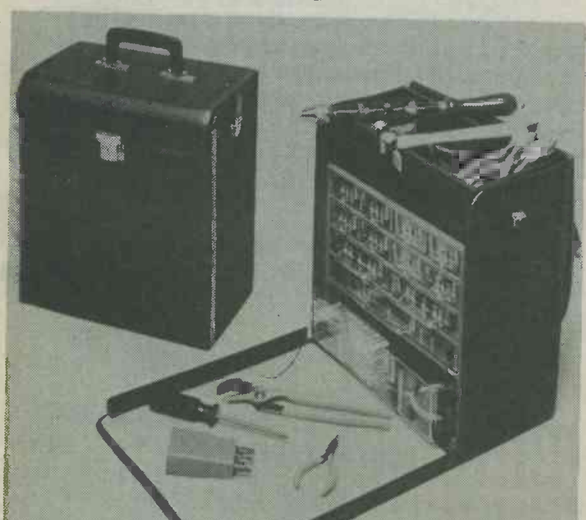

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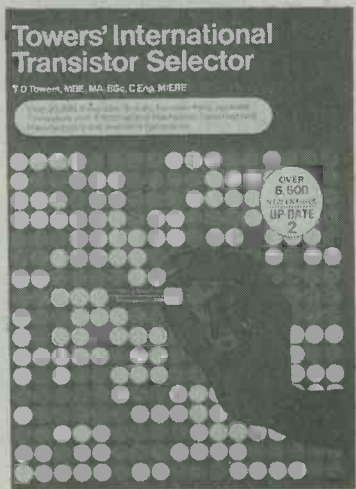

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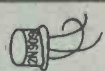

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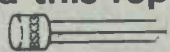

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TRUTH TABLES

Truth tables are employed to define the performance of logic circuits. With the commonly accepted positive logic, the figure "1" corresponds with a high (positive) voltage and the figure "O" to a low voltage.

In the symbol for the inverter, or NOT gate, of (a) the circle at the output indicates inversion. In the equation, the bar over A signifies NOT. The truth table below shows that the output is high when the input is low, and is low when the input is high.

The right hand side of the AND gate equation in (b) infers a multiplication between A and B. In Boolean algebra this indicates AND. The truth table shows that the ouput is high only when all inputs are high.

A NAND gate appears in (c). The performance is the same as the AND gate with the output inverted, so that the output is low only when all inputs are high.

An OR gate is shown at (d), and in the equation the plus sign signifies OR. The truth table shows that the output goes high when either one input goes high or both inputs go high. The output is low only when all inputs are low.

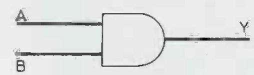
In (e) the device is a NOR gate. The output is the inverse of the OR gate output, and goes low when one or both inputs go high.

The gate in (f) is an exclusive-OR, or XOR gate. Its output goes high when one input goes high but goes low when both inputs are high. The equation states that the output equals (A and not-B) or (not-A and B).

$Y = \overline{A}$

A	Y
O	I
I	O

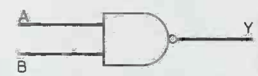
(a)



$Y = AB$

A	B	Y
O	O	O
I	O	O
O	I	O
I	I	I

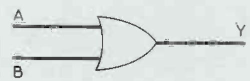
(b)



$Y = \overline{AB}$

A	B	Y
O	O	I
I	O	I
O	I	I
I	I	O

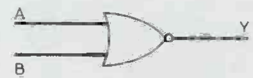
(c)



$Y = A + B$

A	B	Y
O	O	O
I	O	I
O	I	I
I	I	I

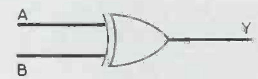
(d)



$Y = \overline{A+B}$

A	B	Y
O	O	I
I	O	O
O	I	O
I	I	O

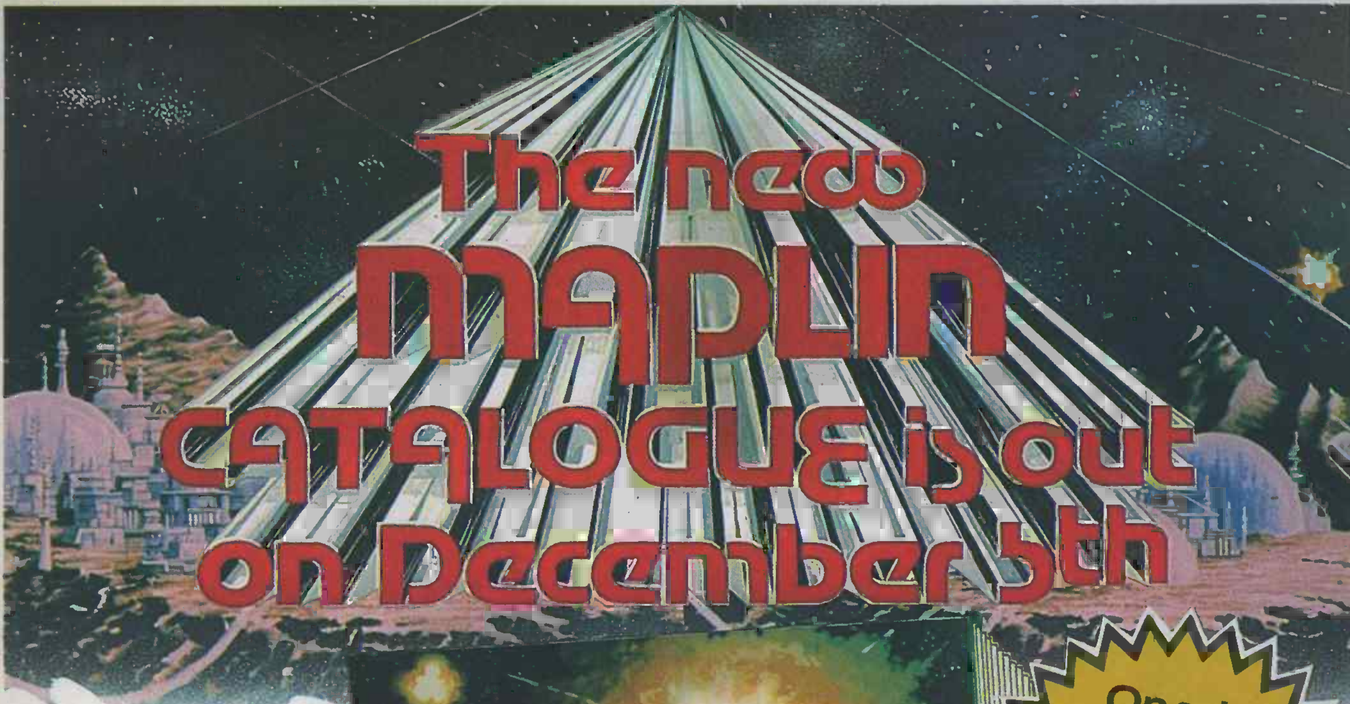
(e)



$Y = A\overline{B} + \overline{A}B$

A	B	Y
O	O	O
I	O	I
O	I	I
I	I	O

(f)



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